Abstract—Larval descriptions for the majority of fish species in the Gulf of Mexico (GOM) are lacking due to incomplete size range collections or poor diagnostic characteristics. Without these descriptions, a gap in knowledge of the population structure and larval ecology exists for many fishes in the GOM, which can hinder both fisheries stock assessment and ecosystem-based fisheries management. Juveniles of all 6 triggerfish species occurring in the GOM are described, but only 4 have a published larval description. This paper describes 4 larvae of the circumtropical triggerfish *Melichthys niger*, commonly known as the black durgon, collected in the northern GOM. These larvae can be separated from the other triggerfish in the GOM by fin ray counts DIII, 34 and A31. The presence of a caudal bar of pigment separates larval *M. niger* from both species of *Canthidermis* that occur in the GOM. Additional pigmentation differences can assist with distinguishing this species from sargassum triggerfish (*Xanthichthys ringens*) and gray triggerfish (*Balistes capriscus*).

Larvae of the black durgon (*Melichthys niger*) (Teleostei: Balistidae) from the northern Gulf of Mexico

Denice Drass (contact author)
Glenn A. Zapfe

Email address for contact author: Denice.Drass@noaa.gov

Trawl and Plankton Branch
Population and Ecosystems Monitoring Division
Southeast Fisheries Science Center
National Marine Fisheries Service, NOAA
3209 Frederic Street
Pascagoula, Mississippi 39567

Introduction

Data from ichthyoplankton surveys are frequently used in both ecological studies and fishery management to define taxon-specific distributions, identify adult spawning habitats, calculate abundance indices for stock assessments, describe community structure, and inform our understanding of population connectivity (e.g., Cowen et al., 2000; Gledhill and Lyczkowski-Shultz, 2000; Auth and Brodeur, 2013; Hare and Richardson, 2014; McClatchie et al., 2014). These studies are not optimized without the ability to accurately identify the early life stages of fish species collected in the surveys. Larval identifications are based on formal descriptions with illustrations of a developmental size series of specimens from published literature. Although there is a large amount of material available to draw from, many taxa have not been described due to the similarity of species during the early life stages or the lack of a full size range of specimens (e.g., Moser, 1996; Leis and Carson-Ewart, 2000; Richards, 2005; Fahay, 2007). In the Gulf of Mexico (GOM), only 30% of 2000+ marine fish species have their early life stages described, and 70% are undescribed or inadequately described due to incomplete descriptions or poor diagnostic characteristics (Richards, 2006; Fahay, 2007).

The lack of published descriptions can be problematic as misidentifications can occur for species sharing similar or overlapping meristic counts and morphological characteristics. Further, misidentifications are more likely when larvae of closely related species are collected in the same survey area, resulting in a lack of certainty in calculating abundances. In those cases, the use of molecular techniques can aid in identifying the species and provide verified identification (Batta-Lona et al., 2019; Morales-Pulido et al., 2023).

Early life history data for federally managed species in the GOM are collected from fishery-independent surveys conducted by the Southeast Area and Monitoring Program (SEAMAP) to calculate relative larval abundance indices used in stock assessment (Gledhill and Lyczkowski-Shultz, 2000; Hanisko et al.[1]; Hanisko et al.[2]). Gray triggerfish (*Balistes*

[1] Hanisko, D. S., A. Pollack, and G. Zapfe. 2015. Vermilion snapper (*Rhomboplites aurorubens*) larval indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2012. Southeast Data, Assessment, and Review SEDAR45-WP-05, 34 p. [Available from https://sedarweb.org/assessments/sedar-45/.]

[2] Hanisko, D. S., A. G. Pollack, D. M. Drass, P. J. Bond, C. Stepongzi, T. Wallace, A. Millet, C. Cowan, C. M. Jones, G. Zapfe, et al. 2017. Red snapper (*Lutjanus campechanus*) larval indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2016. Southeast Data, Assessment, and

capriscus) is a managed species in the GOM whose larval abundance indices are used for stock assessments. Six species of triggerfish (family Balistidae) have been reported in the GOM: *B. capriscus,* queen triggerfish (*B. vetula*), rough triggerfish (*Canthidermis maculata*), ocean triggerfish (*C. sufflamen*), black durgon (*Melichthys niger*), and sargassum triggerfish (*Xanthichthys ringens*) (Moore, 1967). In order to create a relative abundance index, *B. capriscus* larvae must be accurately identified. Although the juvenile stages of all 6 triggerfish species occurring in the GOM have been described, there are only 4 species with published larval descriptions: *B. capriscus, C. maculata, C. sufflamen*, and *X. ringens* (Lyczkowski-Shultz and Ingram, 2006). Without detailed larval descriptions to distinguish among all species, misidentification of balistids including *B. capriscus* remains a possibility, which could impact the efficacy of the larval index used in assessments.

This paper describes, for the first time, a sequence of larval development of *M. niger* from wild collected specimens. *Melichthys niger* is a circumtropical species (Randall and Klausewitz, 1973) and the only representative of the genus in the GOM (Berry and Baldwin, 1966; Moore, 1967). Adult *M. niger* are found on coral reefs but are uncommon in the GOM (Matsuura, 2002; McEachran and Fechhelm, 2005) with sightings in the Flower Garden Banks National Marine Sanctuary (Sonnier et al., 1976; Pattengill-Semmens et al.[3]; Campbell[4]) and rare occurrences in the Florida Keys (Johnson[5]; Reef Environmental Education Foundation Volunteer Fish Survey Project Database, available from https://www.reef.org/db/reports/dist?end_date=2022-05-12&group_ids=0207&group_type=species&language=common&region_code=TWA&start_date=1993-01-01, accessed May 2022).

Materials and methods

Larval collections

Larvae were obtained from ichthyoplankton samples collected in the northern GOM by SEAMAP. The design for the SEAMAP ichthyoplankton surveys is a standardized grid across the northern GOM with stations set 30-n mi or 0.5° (~56 km) apart (Fig. 1). The standard gear is a 60-cm bongo frame outfitted with a 0.333-mm mesh and a 1×2-m neuston frame outfitted with 0.950-mm mesh. The bongo is towed in a double oblique pattern from the surface to near bottom, or in deeper stations, to a depth of 200 m. The neuston net is towed at the surface with half of the frame submerged for a total of 10 min. Other gear used to collect larvae from these surveys include the Methot Trawl and the Multiple Opening and Closing Net and Environmental Sampling System (MOCNESS). The MOCNESS samples discrete depth bins in an oblique tow from the bottom, or 200 m, up to the surface using a series of nine 0.505-mm mesh nets. The Methot trawl is a 2.32×2.24-m frame outfitted with a 3.175-mm mesh netting with an overall length of 13 m. The frame is outfitted with weights to submerge the frame below the surface and maintain the net opening in a vertical position at all towing speeds. All samples were initially preserved in 95% ethanol and transferred to fresh 95% ethanol after 24 h. Processing of samples and initial identification of larvae to the family Balistidae were conducted at the Sea Fisheries Institute, Plankton Sorting and Identification Center, in Szczecin, Poland, under a Joint Studies Agreement with the National Marine Fisheries Service. Larvae are archived at the SEAMAP Archive Center in St. Petersburg, Florida.

Larval identification

A Nikon dissecting scope equipped with a digital camera system (model DS-FI2, Nikon Corp., Tokyo, Japan) was used to take images of larvae for analysis. All myomere, fin-ray counts, and measurements were performed on the left side of the larvae. The Nikon Elements BR software package (Nikon Corp.) was used to make all measurements to the nearest 0.01 mm using the Length Measurement tool calibrated with a stage micrometer. Abbreviations and measurements follow Leis and Carson-Ewart (2000).

Specimens collected on SEAMAP surveys from 2009–2019 and identified as balistids (Lyczkowski-Shultz and Ingram, 2006) were examined regardless of gear type. A total of 1362 balistid specimens were examined as part of the Southeast Data Assessment and Review process in the management of *B. capriscus* in the GOM. All identifications were done using published larval identification guides (Matsuura and Katsuragawa, 1981; Watson, 1996; Lyczkowski-Shultz and Ingram, 2006). During the examination process, a 6.74-mm specimen originally identified as *X. ringens* was recognized as *M. niger* (Fig. 2) based on meristics. The soft dorsal and anal fin ray counts (D34 and A29, respectively) did not overlap with any other balistid species known to occur in the GOM (Moore, 1967;

Review SEDAR52-WP-11, 36 p. [Available from https://sedarweb.org/assessments/sedar-52/.]

[3] Pattengill-Semmens, C., S. R. Gittings, and T. Shyka. 2000. Flower Garden Banks National Marine Sanctuary: a rapid assessment of coral, fish, and algae using the AGRRA Protocol. Mar. Sanctuaries Conserv. Ser. MSD-00-3, 15 p. [Available from SSMC4, N/ORM62, Mar. Sanctuaries Div., NOAA, 1305 East-West Highway, Silver Spring, MD 20910.]

[4] Campbell, M. 2022. Personal commun. Southeast Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 3209 Frederic St., Pascagoula, MS 39567.

[5] Johnson, M. 2022. Personal commun. Southeast Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 4700 Avenue U, Galveston, TX 77551.

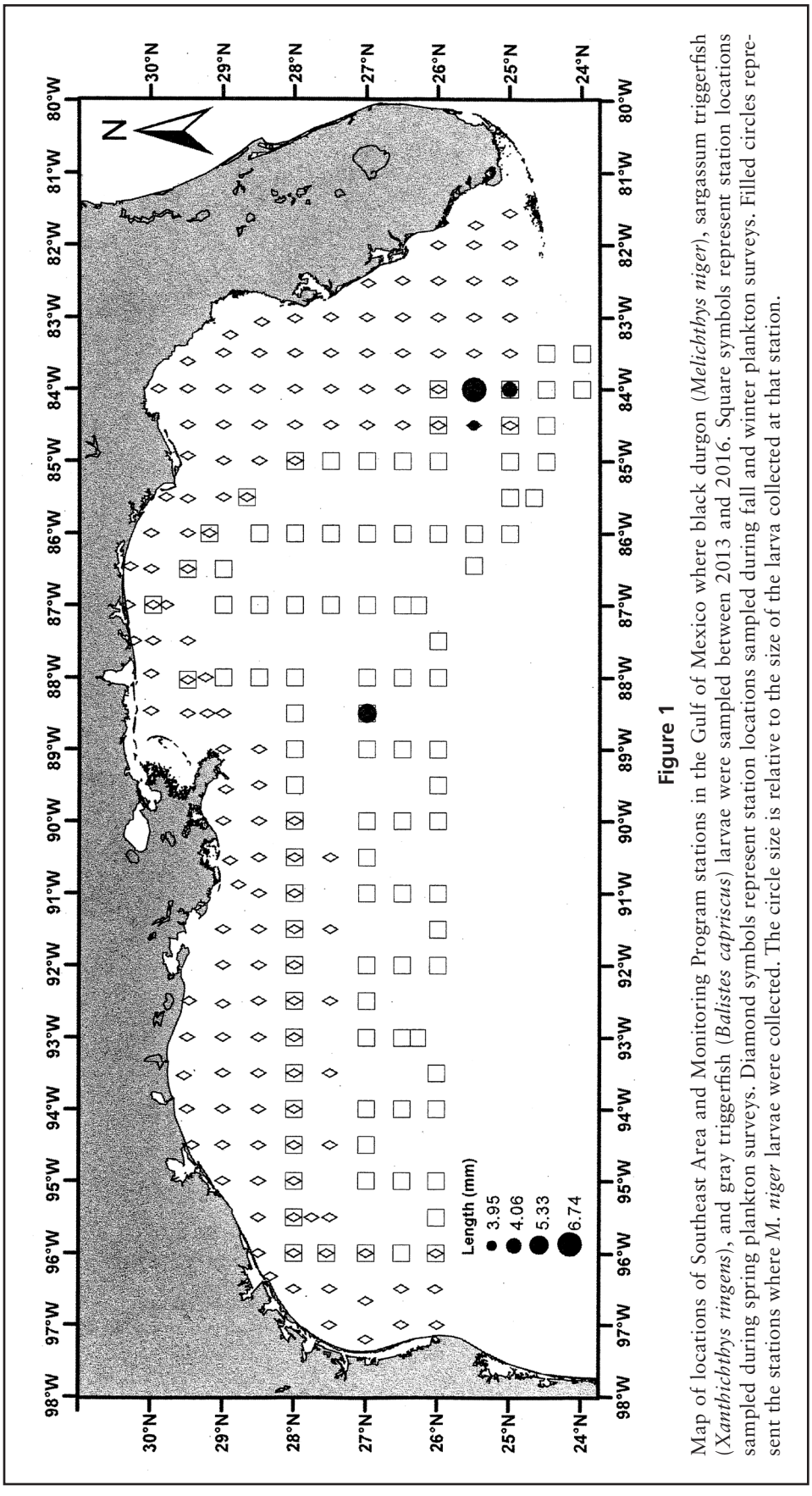

Figure 1

Map of locations of Southeast Area and Monitoring Program stations in the Gulf of Mexico where black durgon (*Melichthys niger*), sargassum triggerfish (*Xanthichthys ringens*), and gray triggerfish (*Balistes capriscus*) larvae were sampled between 2013 and 2016. Square symbols represent station locations sampled during spring plankton surveys. Diamond symbols represent station locations sampled during fall and winter plankton surveys. Filled circles represent the stations where *M. niger* larvae were collected. The circle size is relative to the size of the larva collected at that station.

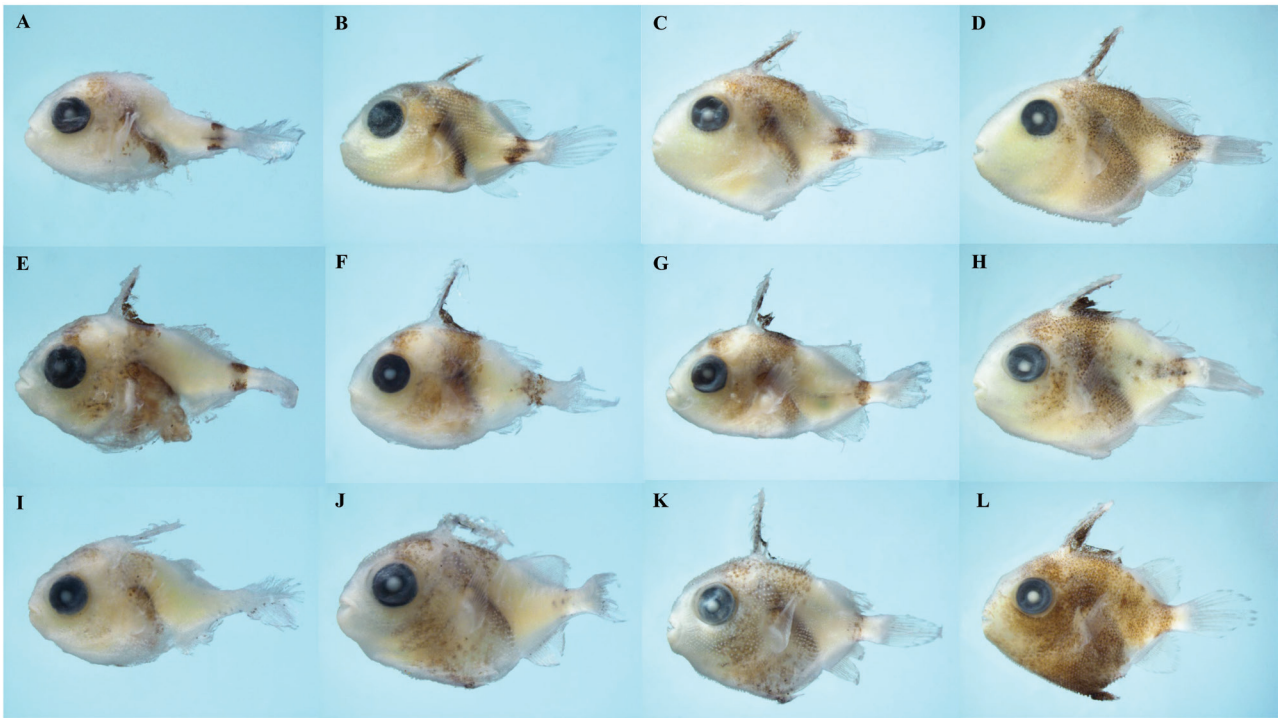

Figure 2

Photographs of black durgon (*Melichthys niger*), sargassum triggerfish (*Xanthichthys ringens*), and gray triggerfish (*Balistes capriscus*) larvae sampled in the northern Gulf of Mexico by the Southeast Area and Monitoring Program (SEAMAP) between 2013 and 2016: (**A**) *Melichthys niger*, SEAMAP 49040, SML531787-000, 3.95 mm standard length (SL); (**B**) *Melichthys niger*, SEAMAP 46892, SML499556-000, 4.06 mm SL; (**C**) *Melichthys niger,* SEAMAP 49405, SML527165-000, 5.33 mm SL; (**D**) *Melichthys niger,* SEAMAP 51738, SML568379-000, 6.74 mm SL; (**E**) *Xanthichthys ringens*, SEAMAP 51901, SML575554-000, 4.04 mm SL; (**F**) *Xanthichthys ringens*, SEAMAP 43715, SML447142-000, 4.13 mm SL; (**G**) *Xanthichthys ringens*, SEAMAP 45373, SML471960-000, 5.17 mm SL; (**H**) *Xanthichthys ringens*, SEAMAP 52055, SML578443-000, 6.37 mm SL; (**I**) *Balistes capriscus*, SEAMAP 49492, SML535040-001, 3.93 mm SL; (**J**) *Balistes capriscus*, SEAMAP 41920, SML429694-000, 4.19 mm SL; (**K**) *Balistes capriscus*, SEAMAP 44168, SML452611-000, 5.20 mm SL; and (**L**) *Balistes capriscus*, SEAMAP 39935, SML410184-000, 6.92 mm SL.

Lyczkowski-Shultz and Ingram, 2006). Closer examination of this specimen led to the recognition of several pigmentation patterns that allowed for corrected identifications of an additional 3 smaller specimens (Fig. 2). The 2 smallest specimens were originally identified as *X. ringens* based on the caudal pigment band, but after examination and comparison to the largest specimen of *M. niger*, these specimens were recognized as *M. niger*. The last specimen was originally identified as *B. capriscus;* however, there was no pigment on the pelvic tubercle or in the dorsal fin membrane, both characteristic of *M. niger* but not *B. capriscus*. A caudal bar develops in *M. niger, X. ringens,* and *B. capriscus* but not in *C. maculata* or *C. sufflamen*. Prior to the following larval description of *M. niger*, initial identifications could be erroneously made to either *X. ringens* or *B. capriscus* based on the presence of a caudal pigment band.

Material examined

NOAA Ship *Gordon Gunter* 1501, Pascagoula station number 00015; SEAMAP 49040, SML531787-000; SEAMAP station number B148; right bongo, 3.95 mm, 7 March 2015.

NOAA Ship *Pisces* 1305, Pascagoula station number 00167; SEAMAP 46892, SML499556-000; SEAMAP station number B129; MOCNESS net 3, 4.06 mm, 24 September 2013.

NOAA Ship *Oregon II* 1502, Pascagoula station number 00045; SEAMAP 49405, SML527165-000; SEAMAP station number B288; right bongo, 5.33 mm, 13 May 2015.

NOAA Ship *Gordon Gunter* 1606, Pascagoula station number 00106; SEAMAP 51738, SML568379-000; SEAMAP station number B130; MOCNESS net 4, 6.74 mm, 27 September 2016.

Results

Morphology

The body is deep and not compressed, with the greatest depth at the pectoral fin base. The gut is compact and coiled by 3.95 mm with only a small gap between the anus and the anal fin. There are 18 vertebrae. A tuft of spinules should be found on the preopercle (cheek) at smaller sizes than the smallest specimen described here, as found in other balistids (Leis and Carson-Ewart, 2000), and no other head spination observed. There are dermal spinules on the body, typical of trigger- and filefish larvae. The largest specimen (6.74 mm) has 6+6 principal caudal rays and fin ray counts of DIII, 34; A29. The first dorsal spine is the longest in all balistids, with barb-like projections that become more numerous through development. Both the second and third spines are much shorter and thinner than the first dorsal spine.

Pigment

The caudal bar in *M. niger* (Fig. 2A) develops as very dark dorsal and ventral patches with melanophores also developing along the lateral midline internally. The dorsal surface of the gut is heavily pigmented in the smallest specimen. The dorsal head pigment reaches to the posterior portion of the eye and extends down the body diagonally toward the gut (Fig. 2A). Viewed from above, the head pigment forms a *U* shape around the hindbrain (Fig. 3A).

During the flexion stage, by 4.06 mm, additional melanophores extend from the dorsal and ventral patches toward the lateral midline pigment (Fig. 2B). This pigment is not as dense or as dark as the initial patches. A diagonal internal line of pigment forms anteriorly below the third dorsal spine and extends to the middle of the soft dorsal fin. The dorsal gut pigment remains a dark band. The dorsal head pigment remains posterior to the eye, extending toward the gut. Viewed from above, the head pigment forms a *U* shape around the hindbrain with additional melanophores closer to the posterior portion of the eye (Fig. 3B). Pigment develops on the body below the first dorsal fin. The pigment in the dorsal fin is restricted to the first dorsal spine.

Melanophores develop in the postflexion stage by 5.33 mm, connecting the dorsal blotch to the midline (Fig. 2C). The internal midline pigment starts to become obscured by the external melanophores as does the diagonal internal pigment. The dorsal gut pigment remains a dark band. The dorsal head pigment remains posterior to the eye, extending toward the gut. Viewed from above, the head pigment blends with the dorsal body pigment, obscuring the *U* shape around the hindbrain (Fig. 3C). Additional melanophores form anteriorly between the eyes but posterior to the middle of the eye. The dorsal body pigment extends posteriorly to the origin of the soft dorsal fin and ventrally to the gut. The pigment in the dorsal fin is restricted to the first dorsal spine with 2 melanophores extending in the fin membrane.

Later in the postflexion stage (by 6.74 mm), melanophores develop, forming the complete caudal bar and obscuring the internal midline pigment (Fig. 2D). The dorsal gut pigment remains a dark band but is now covered by external melanophores. The dorsal head pigment remains essentially unchanged except that small melanophores are added anterior to the middle of the eye (Fig. 3D). The dorsal body pigment extends posteriorly to the caudal bar and ventrally to the gut. This external body pigment now obscures the internal diagonal pigment. The pigment in the dorsal fin is restricted to the first dorsal spine with 2 melanophores in the fin membrane between the first and second dorsal spines. Additional pigment in this largest specimen includes melanophores lining the edge of the orbit from the middle of the eye posteriorly to the middle of the eye ventrally. Pigment is found on the body between this line of melanophores posteriorly to the gut. There are 3 melanophores in a line at the base of the pectoral fin.

Discussion

The caudal bar in *M. niger* (Fig. 2A) and *X. ringens* (Fig. 2E) develops darker dorsal and ventral patches of pigment at smaller sizes (3.95 mm *M. niger*, 2.70 mm *X. ringens*) than the caudal pigment development of *B. capriscus*. *Balistes capriscus* initially develops a few melanophores on the dorsal and ventral edges (Fig. 2I), but the timing is variable, with a 3.1-mm specimen developing 1 to 2 dorsal melanophores with a postanal ventral series of approximately 7 melanophores, while other similar sized specimens have no dorsal pigment. Dorsal and ventral pigmentation in *B. capriscus* becomes denser on specimens greater than 4 mm in length. Melanophores develop along the lateral midline internally and eventually become an internal horizontal line in *M. niger* (Fig 2A–D) and *X. ringens* (Fig 2E–H), but the melanophores remain scattered in *B. capriscus* (Fig 2I–L). In addition, *M. niger* develops a diagonal internal line of pigment forming anteriorly below the third dorsal spine that extends to the middle of the soft dorsal fin (Fig. 2, B and C). *Balistes capriscus* also develops an internal diagonal line of melanophores (Fig. 2, J and K). External melanophores appear laterally on the midline in *M. niger* (>4.0 mm), *X. ringens* (4.1 mm), and *B. capriscus* (between 3.5 and 4.0 mm) with eventual connection of the dorsal and ventral pigment to form the caudal bar (Fig. 2). The internal pigment of all three species becomes obscured by external pigment with development at sizes greater than 5.2 mm (Fig. 2, D, H, and L).

The dorsal fin pigment of *M. niger* also differs from

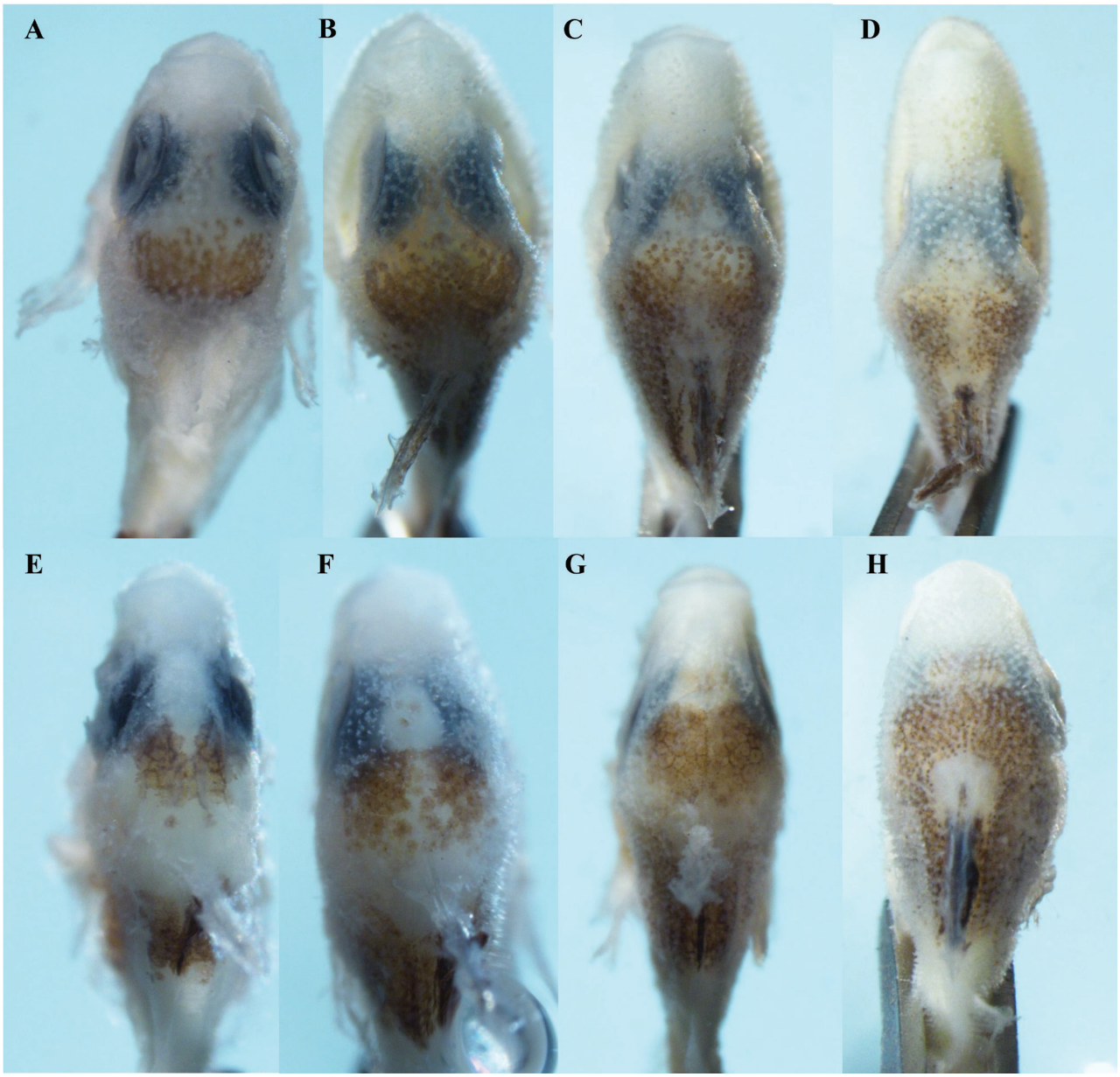

Figure 3

Photographs showing the dorsal head pigment of black durgon (*Melichthys niger*), sargassum triggerfish (*Xanthichthys ringens*), and gray triggerfish (*Balistes capriscus*) larvae sampled in the northern Gulf of Mexico by the Southeast Area and Monitoring Program (SEAMAP) between 2013 and 2016: (**A**) *Melichthys niger*, dorsal view, SEAMAP 49040, SML531787-000, 3.95 mm standard length (SL); (**B**) *Melichthys niger*, dorsal view, SEAMAP 46892, SML499556-000, 4.06 mm SL; (**C**) *Melichthys niger*, dorsal view, SEAMAP 49405, SML527165-000, 5.33 mm SL; (**D**) *Melichthys niger*, dorsal view, SEAMAP 51738, SML568379-000, 6.74 mm SL; (**E**) *Xanthichthys ringens*, dorsal view, SEAMAP 51901, SML575554-000, 4.04 mm SL; (**F**) *Xanthichthys ringens*, dorsal view, SEAMAP 43715, SML447142-000, 4.13 mm SL; (**G**) *Xanthichthys ringens*, dorsal view, SEAMAP 45373, SML471960-000, 5.17 mm SL; and (**H**) *Xanthichthys ringens*, dorsal view, SEAMAP 52055, SML578443-000, 6.37 mm SL.

Table 1

Morphometrics (in millimeters) of similarly sized larvae of black durgon (*Melichthys niger*), sargassum triggerfish (*Xanthichthys ringens*), and gray triggerfish (*Balistes capriscus*) collected in the northern Gulf of Mexico by the Southeast Area and Monitoring Program (SEAMAP) between 2013 and 2016. The morphometrics measured include the following: body length (BL), head length (HL), orbit diameter (OD), snout length (to orbit; SnL), orbit to dorsal margin of head (ODM), orbit to ventral margin of body (OVM), first dorsal spine length (DSL1), body depth at P1 base (BD[P]), body depth at anus (BD[A]), and caudal peduncle length (PedL).

Taxon	SEAMAP	BL	HL	OD	SnL	ODM	OVM	DSL1	BD(P)	BD(A)	PedL
M. niger	49040	3.95	1.27	0.68	0.28	0.17	0.58	–	1.65	0.67	0.96
X. ringens	51901	4.04	1.34	0.65	0.30	0.26	0.55	0.79	1.82	1.21	1.05
B. capriscus	49492	3.93	1.41	0.68	0.24	0.27	0.51	1.18	1.79	1.27	1.01
M. niger	46892	4.06	1.54	0.81	0.36	0.11	0.87	1.04	1.88	1.42	0.64
X. ringens	43715	4.13	1.66	0.80	0.35	0.26	0.88	1.27	2.23	1.65	0.70
B. capriscus	41920	4.19	1.84	0.86	0.42	0.25	0.93	1.39	2.30	1.52	0.50
M. niger	49405	5.33	2.46	1.07	0.82	0.32	1.43	1.66	3.32	2.17	0.46
X. ringens	45373	5.17	1.74	0.82	0.38	0.36	0.69	1.20	2.13	1.63	1.07
B. capriscus	44168	5.20	2.14	1.04	0.52	0.34	1.20	1.57	2.99	1.99	0.83
M. niger	51738	6.74	2.99	1.20	1.16	0.36	1.91	1.85	3.68	2.46	0.67
X. ringens	52055	6.37	2.70	1.28	0.78	0.64	1.54	2.11	3.57	2.77	0.75
B. capriscus	39935	6.92	2.71	1.22	0.82	0.49	1.53	1.88	3.75	2.81	0.79

that of *X. ringens* and *B. capriscus*. The melanophores in the dorsal fin of *M. niger* are primarily restricted to the first dorsal fin spine (Fig. 2B–D). *Melichthys niger* has at most 1 to 2 melanophores between the first and second dorsal fin spines, leaving the dorsal fin membrane essentially unpigmented (Fig. 2, C and D). *Xanthichthys ringens* develops very dark pigmentation from the posterior edge of the first dorsal fin spine throughout the spinous dorsal fin membrane starting at 3.1 mm (Fig. 2E). *Balistes capriscus* develops pigment along the posterior edge of the first dorsal fin spine through the fin membrane to the second dorsal fin spine around 3.9 mm (Fig. 2I). With development, this pigment extends through the dorsal fin membrane to the third dorsal fin spine and into the membrane between the third spine and the body (Fig. 2L).

Dorsal body pigment forms early in *X. ringens* between dorsal spines 2 and 3, and with development extends in a band down toward the gut (Fig. 2E–H). The 4.06-mm specimen of *M. niger* has dorsal body pigment in the area between the second and third dorsal fin spines and gut as well, but the pigment also extends anteriorly to under the first dorsal fin spine (Fig. 2B) and ventrally to the gut (Fig. 2A–D). The dorsal pigment in the 4.06-mm specimen also extends posteriorly to the caudal band and anteriorly connecting to the head pigment. The dorsal pigment in *X. ringens* does not connect to the head pigment over the eye until specimens are 5.5 mm or larger. This leaves an unpigmented area at the base of the first dorsal fin spine (Fig. 2, E and F) until specimens begin to develop the diagnostic specialized scales at around 8 mm. Dorsal body pigment also forms in *B. capriscus* between the second and third dorsal spines, and with development extends anteriorly to connect with the head pigment. The pigment extends posteriorly to the caudal band at sizes greater than 5.5 mm.

The pelvic tubercle is unpigmented in *M. niger* (Fig. 2A–D) and *X. ringens* (Fig. 2E–H) but is pigmented in *B. capriscus* (Fig. 2I–L) as small as 3.5 mm.

The dorsal head pigment of *M. niger* reaches to the posterior portion of the eye (Fig. 3A–D). *Xanthichthys ringens* has early-forming (2.70 mm) dorsal head pigment that reaches to the orbit at approximately the midpoint of the eye (Fig. 3E–H). With development, the dorsal surface of the head is pigmented in both species, but pigment does not appear anterior to the eye until much larger sizes (Fig. 3A–H). The largest specimen (6.74 mm) of *M. niger* has lightly scattered melanophores dorsally on the head close to the midline anterior to the midpoint of the eye (Fig. 3D).

Cheek pigmentation is found in *X. ringens* (Fig. 2E–H) and *B. capriscus* (Fig. 2I–L) but not *M. niger* (Fig. 2A–D). Pigment on the cheek area is found in *X. ringens* as small as 3.0 mm, while the size range at first appearance is more variable in *B. capriscus*.

Melichthys niger is most likely to be confused with *X. ringens* due to the presence of the similar dark, early-forming caudal band pigment in both species. In addition to the dark caudal pigment, *X. ringens* has dark pigment on the body below the first dorsal fin that is present in early development (2.76 mm and larger, Fig. 2E) in contrast to *M. niger,* where it does not form until larger sizes (4.06 mm and larger, Fig. 2B–D).

Based on the 4 specimens of *M. niger* and comparatively sized specimens of *X. ringens* and *B. capriscus,* morphometrics could assist with distinguishing between *M. niger, X. ringens,* and *B. capriscus* (Table 1). The eye

in *M. niger* is more dorsally and more posteriorly located than the eye in *X. ringens* and *B. capriscus*. The measurements between the snout and the orbit (SnL) and the orbit to the ventral margin of the body (OVM) are greater in postflexion *M. niger* (SnL, 15% and 17% standard length [SL]; OVM, 27% and 28% SL) than those in *X. ringens* (SnL, 7% and 12% SL; OVM, 13% and 24% SL) and *B. capriscus* (SnL, 10% and 12% SL; OVM, 23% and 22% SL). At smaller preflexion and flexion sizes, most of the measurements are similar among all 3 species except the orbit to the dorsal margin of the head, which is smaller in *M. niger* (4% and 3% SL) than in *X. ringens* (6% and 6% SL) and *B. capriscus* (7% and 6% SL).

Conclusions

Adult *M. niger* are known to occur sparsely in the GOM; therefore, it is not surprising that early life stages are not common or abundant in larval collections. As larvae, *M. niger* is most likely to be confused with *X. ringens* due to the presence of the very dark, early-forming caudal band pigment in both species. *Xanthichthys ringens* has dark head pigment that extends down to the eye at all figured sizes (Figs. 2 and 3) as well as dark pigment on the body below the first dorsal fin that is present in early development (2.76 mm and larger, Fig. 2) but absent until larger sizes in *M. niger* (>4.06 mm, Fig. 2). Due to the distinct differences between *M. niger* and the other larval balistid species in the northern GOM, morphological characteristics can be used for identification without the need for additional molecular verification.

Acknowledgments

We thank the Ichthyoplankton Group, Sea Fisheries Institute, Plankton Sorting and Identification Center, Szczecin and Gdynia, Poland; J. Fletcher and K. Hoolihan, SEAMAP Archiving Center, St. Petersburg, Florida; P. Bond and M. Campbell, Population and Ecosystem Monitoring Division (PEM), Pascagoula, Mississippi; and M. Johnson, PEM, Galveston, Texas, for information on the distribution of adult *M. niger* in the GOM. We also thank the crews of the NOAA Ships *Oregon II*, *Gordon Gunter,* and *Pisces*.

Literature cited

Auth, T. D., and R. D. Brodeur.
2013. An overview of ichthyoplankton research in the northern California Current region: contributions to ecosystem assessments and management. CalCOFI Rep. 54:107–126.

Batta-Lona, P. G., C. E. Galindo-Sánchez, M. C. Arteaga, J. Robles-Flores, and S. P. A. Jiménez-Rosenberg.
2019. DNA barcoding and morphological taxonomy: identification of lanternfish (Myctophidae) larvae in the Gulf of Mexico. Mitochondrial DNA Part A 30:375–383. https://doi.org/10.1080/24701394.2018.1538364

Berry, F. H., and W. J. Baldwin.
1966. Triggerfishes (Balistidae) of the eastern Pacific. Proc. Calif. Acad. Sci. 34:429–474.

Cowen, R. K., K. M. M. Lwiza, S. Sponaugle, C. B. Paris, and D. B. Olson.
2000. Connectivity of marine populations: open or closed? Science 287:857–859. https://doi.org/10.1126/science.287.5454.857

Fahay, M. P. (ed.).
2007. Early stages of fishes in the western North Atlantic Ocean (Davis Strait, Southern Greenland and Flemish Cap to Cape Hatteras), vols. 1 and 2, 1696 p. Northwest Atl. Fish. Organ., Nova Scotia, Canada.

Gledhill, C. T., and J. Lyczkowski-Shultz.
2000. Indices of larval king mackerel (*Scomberomorus cavalla*) abundance in the Gulf of Mexico for use in population assessments. Fish. Bull. 98:684–691.

Hare, J. A., and D. E. Richardson.
2014. The use of early life stages in stock identification studies. *In* Stock identification methods: applications in fishery science, 2nd ed. (S. X. Cadrin, L. A. Kerr, and S. Mariani, eds.), p. 329–364. Acad. Press, London.

Leis, J. M., and B. M. Carson-Ewart (eds.).
2000. The larvae of Indo-Pacific coastal fishes: an identification guide to marine fish larvae, 850 p. Brill, Leiden, Netherlands.

Lyczkowski-Shultz, J., and G. W. Ingram.
2006. Balistidae: triggerfishes. *In* Early stages of Atlantic fishes: an identification guide for western central North Atlantic, vol. 2 (W. J. Richards, ed.), p. 2387–2397. CRC Press, Boca Raton, FL.

Matsuura, K.
2002. Balistidae. *In* FAO species identification guide for fishery purposes. The living marine resources of the Western Central Atlantic. Vol. 3. Bony fishes part 2 (Opistognathidae to Molidae), sea turtles and marine mammals (K. E. Carpenter, ed.), p. 1963–1969. FAO, Rome.

Matsuura, Y., and M. Katsuragawa.
1981. Larvae and juveniles of grey triggerfish, *Balistes capriscus*, from southern Brazil. Jpn. J. Ichthyol. 28:267–275. https://doi.org/10.11369/jji1950.28.267

McClatchie, S., J. Duffy-Anderson, J. C. Field, R. Goericke, D. Griffith, D. S. Hanisko, J. A. Hare, J. Lyczkowski-Shultz, W. T. Peterson, W. Watson, et al.
2014. Long time series in US fisheries oceanography. Oceanography 27(4):48–67. https://doi.org/10.5670/oceanog.2014.86

McEachran, J. D., and J. D. Fechhelm.
2005. Balistidae: triggerfishes. *In* Fishes of the Gulf of Mexico. Volume 2: Scorpaeniformes to Tetraodontiformes, p. 893–900. Univ. Texas Press, Austin, TX.

Moore, D.
1967. Triggerfishes (Balistidae) of the western Atlantic. Bull. Mar. Sci. 17:689–722.

Morales-Pulido, J. M., C. E. Galindo-Sánchez, S. P. A. Jiménez-Rosenberg, M. C. Arteaga, P. G. Batta-Lona, and S. Z. Herzka.

2023. Identification of *Bothus ocellatus* and *Bothus robinsi* larvae using morphological and molecular approaches leads to a distribution record for the Gulf of Mexico. Environ. Biol. Fish. 106:43–59. https://doi.org/10.1007/s10641-022-01370-1

Moser, H G. (ed.).
1996. The early stages of fishes in the California Current region. CalCOFI Atlas 33, 1505 p. Allen Press, Lawrence, KS.

Randall, J. E., and W. Klausewitz.
1973. A review of the triggerfish genus *Melichthys*, with description of a new species from the Indian Ocean. Senckenberg. Biol. 54:57–69.

Richards, W. J. (ed.).
2006. Early stages of Atlantic fishes: an identification guide for western central North Atlantic, vols. 1 and 2, 2640 p. CRC Press, Boca Raton, FL.

Sonnier, F., J. Teerling, and H. D. Hoese.
1976. Observations on the offshore reef and platform fish fauna of Louisiana. Copeia 1976:105–111. https://doi.org/10.2307/1443779

Watson, W.
1996. Balistidae: triggerfishes. *In* The early stages of fishes in the California Current region (H G. Moser, ed.), p. 1417–1421. CalCOFI Atlas 33.

Published online 9 July 2024.

Cite as: Drass, D., and G. A. Zapfe. 2024. Larvae of the black durgon (*Melichthys niger*) (Teleostei: Balistidae) from the northern Gulf of Mexico. *In* Early Life History and Biology of Marine Fishes: Research inspired by the work of H Geoffrey Moser (J. M. Leis, W. Watson, B. C. Mundy, and P. Konstantinidis, guest eds.), p. 97–105. NOAA Professional Paper NMFS 24. https://doi.org/10.7755/PP.24.7