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Juveniles and larvae of eleven fish species collected from three countries of the Arabian Gulf and the Arabian Sea

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ABSTRACT

The finding of larval and juvenile specimens from the Omani coast of the Arabian Sea and the Arabian Gulf waters of Saudi Arabia and Iraq is reported for the first time. Based on available information, one larva was a leptocephalus, *Conger* sp. (family Congridae) and one larva of an acronurus stage belonging to the genus *Acanthurus* (family Acanthuridae). Also juveniles of the following families are included in the present study: Clupeidae – *Tenualosa ilisha* (Hamilton, 1822) and *Nematalosa* sp.; Dactylopteridae – *Dactyloptena orientalis* (Cuvier, 1829); Gobiidae – *Acentrogobius* sp.; Bothidae – *Arnoglossus aspilos* (Bleeker, 1851); Scatophagidae – *Scatophagus argus* (Linnaeus, 1766); Sparidae – *Acanthopagrus arabicus* Iwatsuki, 2013 and *Sparidentex hasta* (Valenciennes, 1830); Tetraodontidae – *Lagocephalus* sp. The discovery of the barred rather than spotted juveniles of *S. argus* collected from pure freshwater environment of the Shatt al-Arab River, Basrah, Iraq was remarkable; it raises questions whether there is more than one species within the nominal *S. argus*. For both larvae and juveniles of bothid flounders, the olfactory organ is a useful character for the examination of the developmental stage of the metamorphosing specimens. The occurrence of the different early life history stages of fishes from the three Arabian countries shows the needs them to be studied further so that inferences about the areas and periods of spawning and development of these fishes can be made more accurately.

Key words: acronurus stage, Arabian Gulf, Arabian Sea, bothid flounders, fish larvae, juveniles, olfactory organ, *Scatophagus argus*

Молодь и личинки 11 видов рыб из трех стран Персидского залива и Аравийского моря

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РЕЗЮМЕ

Впервые сообщается о нахождении молоди и личинок рыб 11 видов в Аравийском море у побережья Омана и в Персидском заливе у берегов Саудовской Аравии и Ирака. В сборах обнаружены: личинка-лептоцефал морского конгерового угря *Conger* sp. (семейство Congridae); личинка на стадии acronurus одного из видов морских хирургов рода *Acanthurus* (семейство Acanthuridae). Определена также молодь, относящаяся к следующим семействам: сельдевые Clupeidae – *Tenualosa ilisha* (Hamilton, 1822) и *Nematalosa* sp.; долгоперовые Dactylopteridae – *Dactyloptena orientalis* (Cuvier, 1829); бычковые Gobiidae – *Acentrogobius* sp.; ботовые Bothidae – *Arnoglossus aspilos* (Bleeker, 1851); скатофагиды Scatophagidae – *Scatophagus argus* (Linnaeus, 1766); спаровые Sparidae – *Acanthopagrus arabicus* Iwatsuki, 2013 и *Sparidentex hasta* (Valenciennes, 1830); иглобрюхие Tetraodontidae – *Lagocephalus* sp. Примечательно обнаружение в пресных водах реки Шатт-эль-Араб (Басра, Ирак) не пятнистых, а полосатых особей *S. argus*; возможно, этот вид в современном понимании представляет собой видовой комплекс. Полезной структурой для определения стадий метаморфоза ювенильных особей и личинок ботовых камбал является ольфакторный орган. Обнаружение в водах трех арабских стран молоди рыб на различных стадиях ранних этапов их жизненного цикла показывает необходимость дальнейших исследований в этом направлении, для выяснения районов нереста, сроков размножения и особенностей развития рыб.

Key words: стадия acronurus, Персидский залив, Аравийское море, личинки рыб, ихтиопланктон, ольфакторный орган, *Scatophagus argus*

INTRODUCTION

The need for information about the early life history of fishes can be encountered in many areas of fisheries, ecological and ichthyological research. Among such studies, the species composition, abundance, spatial and temporal distribution of fish larvae offer important data about the locations and seasons of spawning of commercially important species (Chambers and Trippel 1997; Fuiman and Werner 2002). Fish eggs, larvae and juveniles can easily be affected by changes in the environmental factors (Houde 2008; Hare 2014). Early life history research can estimate the reproductive success of fish populations and future catches of commercially important species (Fuiman and Werner 2002; Hare 2014). In addition, the study of the early life history of fish can be used to monitor the anthropogenic impacts and climate change in marine ecosystem.

Fish fauna within the Arabian Gulf region is diverse. Ali et al. (2018) suggested that there are 322 marine species belonging to 193 genera and contained in 94 families. Recent study of the Arabian Gulf (Eagderi et al., 2019) showed that the total number of Chondrichthyes fish species is 74 belonging to 45 genera and located within 22 families, while the number of bony fish species is 670 belonging to 400 genera and contained within 109 families. The comparison showing clearly the fish biodiversity level in the Arabian Sea coast of Oman is much over that of the Arabian Gulf. According to Jawad and Al-Mamry (2018), there are 2 species of 2 genera and 1 family in the class Holocephali, 68 species of 44 genera and 23 families within class Chondrichthyes, while there are 933 species 455 genera and 127 families of bony fish.

Despite the great biodiversity of fish fauna, no studies of the early life history of fishes are available from waters of the Arabian Gulf of Saudi Arabia. A few investigations of eggs, larvae and juveniles in the waters of other Arabian Gulf countries, including Iraq and Oman, have been published. In general, the work of Richards and AL-Yamani (2008) is considered the leading reference for the early life history of fishes in the Arabian Gulf area. Other general references on the Arabian Gulf are that of Houde et al. (1986) and Bibik et al. (1970). There have been several investigations on the early life history studies in Iraq (Ahmed 1990; Ahmed and Hussain 2000a, 2000b, 2000c; Al-Okailee 2015). The work of Than-

garaja and Al-Aisry (2001) represents the pioneer study of early life history in Oman and recently major studies on the larvae and juveniles of the southern coasts of Oman were published (Chesalina et al. 2013; Al-Abri et al. 2017).

The aim of the present study is to report for the first time the presence of fish juveniles and larvae of eleven fish species collected from Arabian Gulf waters of Iraq and Saudi Arabia and the Arabian Sea coast of Oman. These findings have important implications in the future studies on the development and reproduction of fish by identifying their breeding grounds in both the Arabian Gulf area and the north-western part of the Arabian Sea.

MATERIALS AND METHODS

The area studied. The Arabian (or Persian) Gulf is a semi-enclosed marginal sea located between 24° to 30.300° N latitude and 48° to 56.250° E longitude and oriented northwest to southeast. This Gulf is connected to the Indian Ocean through the 56 km wide Hormuz Strait and the Sea of Oman. Its length is about 1000 km, has a maximum width of 350 km, average depth of 40 m, and maximum depth of 120 m at the Strait of Hormuz; the straits open on the Gulf of Oman with surface area of about 239,000 km^2 and its volume is 8780 km^3 (Evans 2020). From the east and from the west it receives the Shatt al-Arab River (formed by the Euphrates and Tigris in Iraq) and the Karoon River in Iran running in the Khuzestan province of Iran. Its total length from the Hormuz Strait to the last point in the west is around 805 km (Jawad 2018).

In the northern part of the Gulf, the climate is influenced by the effect of highlands or orography, the mountain series of Turkey, Iran, and the Arabian Peninsula. In addition, it is also affected by the climate of the Tigris–Euphrates Valley. The general climate look in the Gulf area is affected mainly by the extra-tropical weather systems from the northwest (Reynolds 1993). The usual weather that performs over the Gulf is the presence of high clouds and the skies are often clear, but fog can reduce visibilities in coastal regions. Maximum air temperature at daytime along the immediate coast averages between 19 and 23°C, and that of the inland areas rises to 21–29°C. The minimum temperature along the coast falls between 7 and 19°C.

Because of its location and bathymetry, the Gulf's marine environment is characterised by environmental extremes. Evaporation is far greater than the combined rainfall and river discharge within the Gulf, leading to an inverse estuarine circulation and a counter clockwise circulation. The bathymetry study of the Gulf shows that it is shallow in the northwest and west coasts. Evaporation in the Gulf exceeding the inflow of freshwater from rivers in its north-eastern and north-western parts and the net loss of water creates a reverse-flow, estuarine circulation. The average salinity of the Gulf is 37–40%, which is high relative to the ocean because of the high evaporative rate over this restricted basin; values of 40–50% or higher are reached in shallow waters along the United Arab Emirates (UAE) coast. The circulation study within the Gulf indicates northwest flow with speeds greater than 10 cm/s along the Iranian coast with weaker flow to the west or south.

The southern coast of the Arabian Peninsula is represented by the Arabian Sea coasts of Oman. This sea has a surface area of about 3,862,000 km^2, the maximum width is approximately 2400 km, and it has a maximum depth of 4652 m (Morgan et al. 2019). Along the Omani coast of the Arabian Sea, there is a striking type of ocean circulation caused by wind. Such water movement is induced by the summer monsoon starting in June and ending in September and as result a clockwise circulation develops in the area. Upwelling starts at the end of May and reaches its peak in July–August and slows down at the end of September. The upwelling has a great effect on primary productivity in this area and therefore is increased tenfold because of the increase in the level of nutrient concentration. The regular and seasonal monsoon cycle consists of the northeast monsoon from December until February where winds usually blow from the northeast and the southwest monsoon running from June to September with strong winds gusting from the southwest. During the intermonsoon periods the winds have remarkable effects on the hydrography of the region with a significant influence on the distribution of fish and other marine fauna.

Specimens of larval, postlarval and juveniles used in the present study were obtained from three localities: Iraq, Oman and Saudi Arabia. Eleven species were collected from Shatt al-Arab River, Basrah and the southern marshes, Iraq using seine net (140 m long with a 36 mm mesh size) in the period March 2017 – April 2019. One larva was collected from the waters in the vicinity of Jubail City, Saudi Arabia,

Table 1. Morphometric characters of juveniles and larvae of fishes examined.

Species	*TL*, mm	*SL*, mm (%*TL*)	Indexes, % *SL*															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conger sp., leptocephalus larva	80	–	3.4	55.6	44.4	33.3	6.5	–	–	–	–	–	5.3	–		9.1	–	–
Tenualosa ilisha	43.3	36 (83.1)	25.8	5.6	6.4	11.1	44.4	–	27.8	13.9	–	9.2	–	–	–	29.7	13.1	11.1
Nematalosa sp.	17.1	13.8 (80.7)	19.6	8.0	6.5	13.0	43.5	–	26.1	19.6	–	13.1	–	–	–	35.5	9.4	3.0
Dactyloptena orientalis	12	8.8 (73.3)	31.8	0.7	21.6	18.2	35.2	–	30.7	23.9	–	34.1	–	–	–	39.7	17.0	13.6
Acentrogobius sp.	29.6	25.9 (81.5)	21.6	8.5	4.3	6.2	30.1	–	25.9	14.3	–	12.7	–	–	–	10.3	14.3	5.8
Arnoglossus aspilos	10	8 (80)	20	4	–	–	–	–	–	–	–	–	–	–	–	32.5	–	–
Scatophagus argus	20.2	15.4 (75.3)	45.7	16.8	8.2	16.4	58.1	79.2	37.8	26.6	42.1	17.3	66.8	–	3.8	61.9	9.3	9.2
Acanthurus sp., postlarval stage (acronurus)	56	54 (96.4)	30.9	18.2	10.6	8.1	34.7	82.3	31.9	23.3	30.2	6.7	41.1	99.8	48.2	72.8	5.6	0.1
Acanthopagrus arabicus	12.7	10.0 (78.7)	30.0	13.0	10	8.3	43.0	–	30.0	33.0	–	30.0	–		–	30.0	17.0	10
Sparidentex hasta	8.3	6.0 (72.3)	21.7	11.7	13.8	11.7	50.0	–	38.3	28.3	–	16.7	–	–	–	38.3	16.7	11.7
Lagocephalus sp.	12	10.2 (85)	30.4	15.7	5.9	–	–	–	28.4	–	–	–	60.8	–	–	50.9	6.9	2.9

Characters: 1 – Head length; 2 – Snout length; 3 – Eye diameter; 4 – Postorbital distance; 5 – Predorsal fin distance; 6 – Postdorsal distance; 7 – Prepectoral fin distance; 8 – Pectoral–fin distance; 9 – Prepelvic fin distance; 10 – Pelvic–fin distance; 11 – Preanal fin distance; 12 – Postanal fin distance; 13 – Anal–fin distance; 14 – Body depth; 15 – Caudal peduncle distance; 16 – Caudal peduncle depth.

Table 2. Meristic counts of juveniles and larvae of specimens examined.

Species	Dorsal fin	Anal fin	Pectoral fin	Pelvic fin	Caudal fin	Number of abdominal scutes
Conger sp., leptocephalus larva	13	12	17	–	–	–
Tenualosa ilisha	19	18	15	8	–	32
Nematalosa sp.	16	18	13	8	–	–
Dactyloptena orientalis	I+I+V+9	6	33	I,4	5+5	–
Acentrogobius sp.	VI,I+9	I,8	19	5	–	–
Arnoglossus aspilos	83	60	11	7	–	–
Scatophagus argus	XII,17	IV,14	17	I,5	16	–
Acanthurus sp., postlarval stage – acronurus	XIII,11	III,19	16	–	–	–
Acanthopagrus arabicus	XI,11	III,8	14	I,5	–	–
Sparidentex hasta	XI,12	III,9	16	–	–	–
Lagocephalus sp.	13	12	17	–	–	–

Arabian Gulf by shrimp trawler in April 2018 and four specimens were collected from the Arabian Sea coasts of Oman during the ichthyological survey by the bottom trawler "Al-Mustaquila" during the period 2006 – 2008. All morphological characters (morphometric and meristic) were measured at the time of collection of the specimens and presented in Tables 1 and 2. Terminology of the developmental stages of larvae follow Leis and Trnski (1989) and Richards and Al-Yamani (2008). The specimens were fixed in 10% formalin and preserved in 70% ethanol. Methods for making counts and measurements follow Leis and Trnski (1989). Measurements were made to the nearest 0.1 mm using a stereomicroscope camera (Leica DFC495, Germany). The specimens of juveniles and larvae were deposited in the ichthyological collection of the following institutions: Department of marine Fisheries, College of Agriculture, University of Basrah, Iraq; Fish Welfare Branch, Ministry of Agriculture, El- Jubail Province, Saudia Arabia; and Marine science and Fisheries Centre, Ministry of Agriculture and Fisheries, Muscat, Oman.

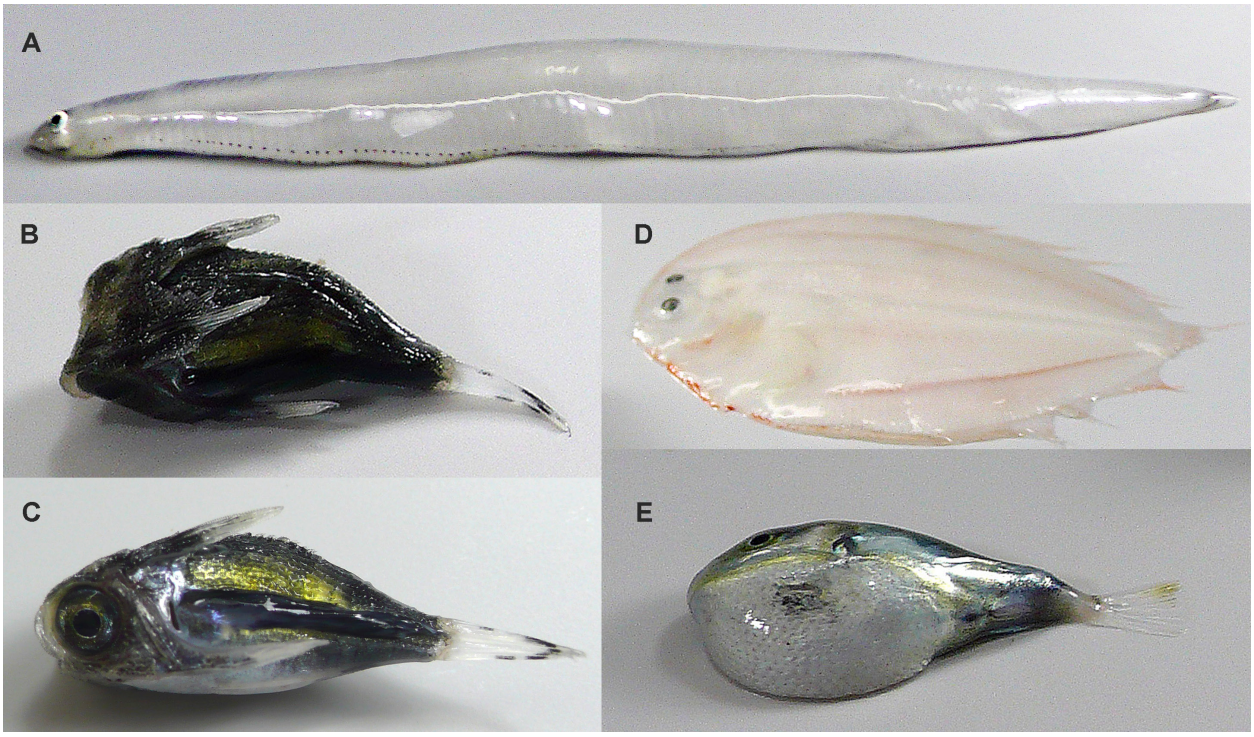

Fig. 1. Fish juveniles from the Arabian Sea coast of Oman: A – *Conger* sp., leptocephalus larva, 80 mm *TL*, B – *Dactyloptena orientalis* 20.3 mm *TL*, ventrolateral view; C – same specimen, dorsolateral view; D – *Arnoglossus aspilos* juvenile, 35 mm *TL*; E – *Lagocephalus* sp. 22 mm *TL*.

RESULTS

Order Anguilliformes

Family Congridae

***Conger* sp.**, eel leptocephalus larva (Fig. 1A)

Material. 1, 80 mm *TL*, Salalah, Arabian Sea coast of Oman, 2007.

Description. The general morphology of the leptocephalus larvae of the family Congridae usually devoid of lateral pigment; body moderate to elongate; tail and dorsal fin are variable; ventral pigment extends the length of the gut and sometimes beyond. A crescentic patch of pigment is present under the eye.

The present leptocephalus larva was recognized as belonging to the family Congridae based on the following set of characters: elongated and laterally compressed body; presence of ventral pigmentation; presence of obliques and close-set rows of melanophores along the hypaxial myosepta below the midline in the fresh specimen; presence of pigmentation below eye; presence of 17 rays in the pectoral fin; myosepta are distinct on the posterior part of body but not on the anterior part; eye rounded and with no pigmentation; tail pointed; nephros terminus present, but the number of myomeres anterior to the last vertical blood vessel arising from it, a diagnostic character for the identification of eel leptocephali, could not be counted.

Order Clupeiformes

Family Clupeidae

***Tenualosa ilisha* (Hamilton 1822)** (Figs 2A, B)

Material. 2, 41.2 and 43.3 mm *TL*, Shatt al-Arab River, Basrah, Iraq, 2017–2019.

Description. Juveniles of *T. ilisha* can be recognised by the number of the ventral scutes that ranges between 30 and 32. The following characters can be seen in the juvenile of *T. ilisha*: moderately deep and compressed body; no striated area on the top of head; a distinctive median notch on upper jaw; gill rakers very fine and numerous; caudal fin moderately large. Colour: back blue-green; shiny band along body extending from rear head nearly to the caudal-fin base;

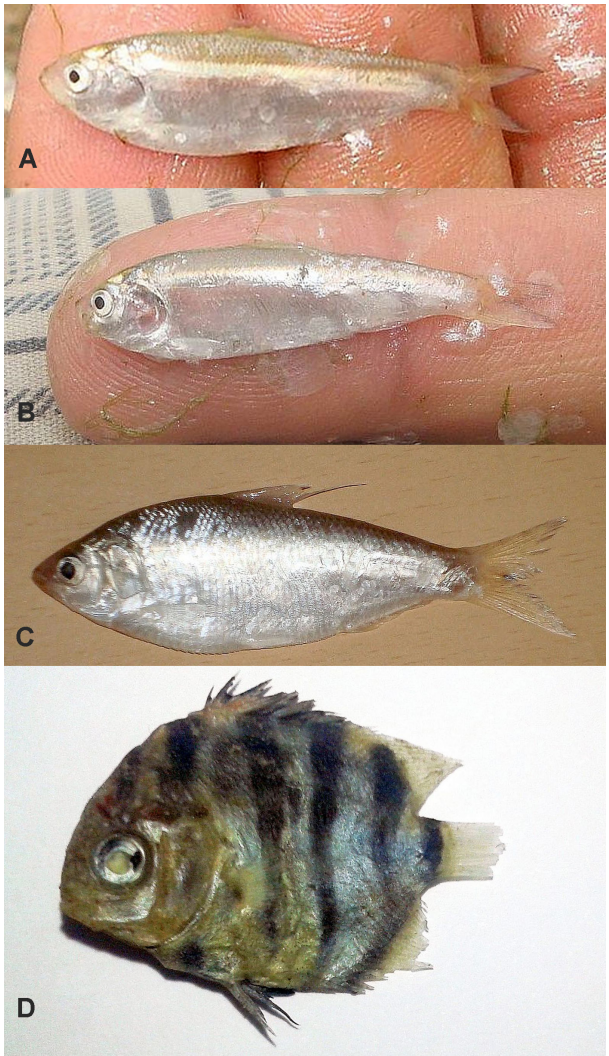

Fig. 2. Fish juveniles from the Shatt al Arab River, Basrah, Iraq: A – *Tenualosa ilisha*, 43.3 mm *TL*; B – same species, 41.2 mm *TL*; C – *Nematalosa* sp., 78 mm *TL*; D – *Scatophagus argus* juvenile, 20.2 mm *TL*.

the dark blotch behind the gill opening seen in adults is not yet developed in the specimens examined.

***Nematalosa* sp.**

Material. 1, 17.1 mm *TL*, Shatt al-Arab River, Basrah, Iraq, 2017–2019.

Description. The presence of a filamentous last dorsal-fin ray makes the identification of the juvenile of *Nematalosa* sp. possible. This specimen has deep and compressed body; sharp scutes in a shape of keel present on belly; front-parietal striae on the top of head 9; mouth inferior; snout bulging; lower jaw widening outward along its edge; posterior margin of scales finely serrate; a double series of overlapping predorsal scales. Colour: back blue/green or grey; body silvery; the dusky mark behind gill opening that usually found in the adult is not present in this juvenile specimen.

The length of the depictured juvenile is 78 mm *TL* (Fig. 2C).

Order Scorpaeniformes

Family Dactylopteridae

***Dactyloptena orientalis* (Cuvier, 1829)** (Figs. 1B, C)

Material.1, 20.3 mm *TL*, Salalah, Arabian Sea coast of Oman, 2007.

Description. In general, the juveniles of the family Dactylopteridae can be easily identified for their distinctive armoured head and their body shape. The following characters identified the studied juvenile as *D. orientalis*: head bony and enormous; snout blunt; pterotic and preopercular spines large; large eye; pectoral and pelvic fins elongated; a noticeable short immovable spine preceding the soft portion of dorsal fin; isolated dorsal-fin spine just behind the head; widely separated from the spinous dorsal fin; scales have begun to develop on the body; pigmentation on head and body is denser than on the fins; distal part of the occipital spine is heavily pigmented; membranes between the first three spines of the main part of the first dorsal fin slightly pigmented; the bases of the preopercular and the post-temporal spines also only slightly pigmented.

Order Gobiiformes

Family Gobiidae

***Acentrogobius* sp.**

Material. 6, 24.3 – 120.3 mm *TL*, southern marshes of Iraq, 2019. The length of the depictured juveniles is 23.2 mm and 58.2 mm *TL* (Fig. 3A).

Description. Body elongate, more or less laterally compressed; head depressed and moderate in size; eye moderately large; caudal fin rounded; body with mostly ctenoid scales; upper three rays of pectoral fin free of membrane; scales extended anteriorly to above middle of preopercle; check naked. Colour: body with pale yellowish brown; presence of large; irregular brown patches on body; presence of a longitudinal rows of small bluish spots on scale; dorsal and caudal fins with small blue spots.

Order Pleuronectiformes

Family Bothidae

***Arnoglossus aspilos* (Bleeker, 1851)**

Material. 1, 10 mm *TL*, Salalah, Arabian Sea coast of Oman, 2007.

Description. Elliptical body shape, with greatest depth near 33% of the standard length, its depth slightly more or less than 1/3 its length; dorsal contour evenly arched; ventral contour pointed at posterior tip of lower jaw, and then gently rising to caudal-fin base; caudal peduncle narrow; head blunt; snout short; eyes ovoid separated by a high bony ridge, with lower eye marginally in advance of upper eye or on the same vertical line; mouth oblique, arched and large; scales and lateral line present on ocular side; anal fin similar in shape to dorsal fin, caudal fin rounded. Colour: body in general is pale orange to yellow; little pigmentation along the myosepta; small chromatophores irregularly scattered on posterior half of the opercle; abdominal portion, and both jaws; median fins paler than body.

The length of the depictured juvenile is 35 mm *TL* (Fig. 1D).

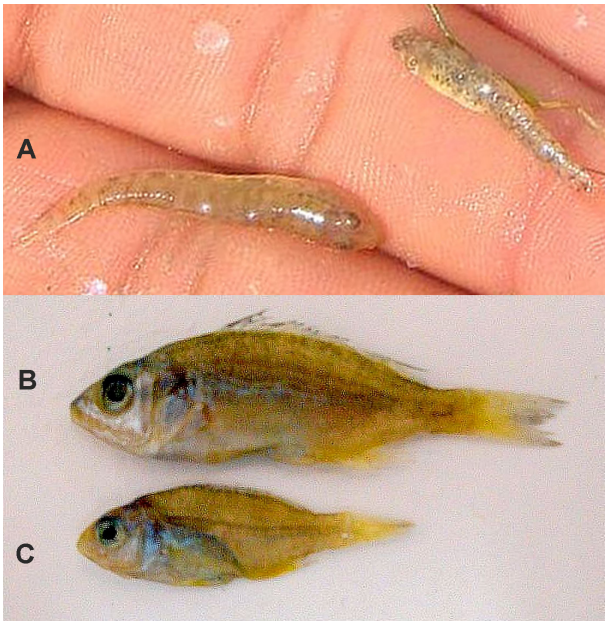

Fig. 3. Juvenile fishes from the southern marshes of Iraq: A – *Acentrogobius* sp., *TL* 23.2 mm (upper) and 58.2 mm (lower); B – *Acanthopagrus arabicus*, 37 mm *TL*; C – *Sparidentex hasta* 25 mm *TL*.

Order Perciformes

Family Scatophagidae

***Scatophagus argus* (Linnaeus, 1766)** (Fig. 2D)

Material. 1, 20.2 mm *TL*, Shatt al-Arab River, Basrah, Iraq, 2015.

Description. The specimen of *S. argus* has shown the following set of characters: body quadrangular and greatly compressed; dorsal head profile mainly concave rather than steeply straight; eye large; snout rounded; mouth small and terminal, with villiform teeth in several rows; first dorsal spine very short; spinous and soft portions of the dorsal fin separate by a deep notch; caudal fin rounded; head, body, caudal fin and soft part of anal fin are covered with small ctenoid scales; lateral line curved. Colour: body with ground greenish to yellow colour; six vertical black bands, anterior – posteriorly, one short band present across eye, but not extending the ventral edge of eye, one above the operculum, three across the body from just behind the spinous part of the dorsal fin to nearly the end of the soft part, and one across the caudal peduncle; one large black spot at the ventral edge of the operculum and another small spot at its posterior edge.

Family Acanthuridae

***Acanthurus* sp., postlarval stage – acronurus** (Fig. 4)

Material. 1, 56 mm *TL*, Jubail City, Saudi Arabia, Arabian Gulf, 2018.

Description. Body disc-shaped and greatly compressed; head large, with well-defined snout; eye large and located well above an imaginary line passing through the mouth; premaxilla reaching to below 1/3 of the anterior edge of the eye; posterior and ventral edges of operculum are straight; small pectoral fin; posterior tips of dorsal and anal fins above each other. Colour: body transparent including fins, with glassy appearance; posterior part of the operculum with iridescent blue colour when fresh; anterior body light blue; dorsal edge of the soft and spinous parts of dorsal fin, the base of caudal fin, and ventral edge of anal fin are lined with dark brown; five, large, pale brown spots arranged in a curved line starting from under the last 4 spines of dorsal fin and extending down to the base of caudal fin; posterior edge of caudal fin dusky; the vertebral column is very clear, with dark intervertebral areas.

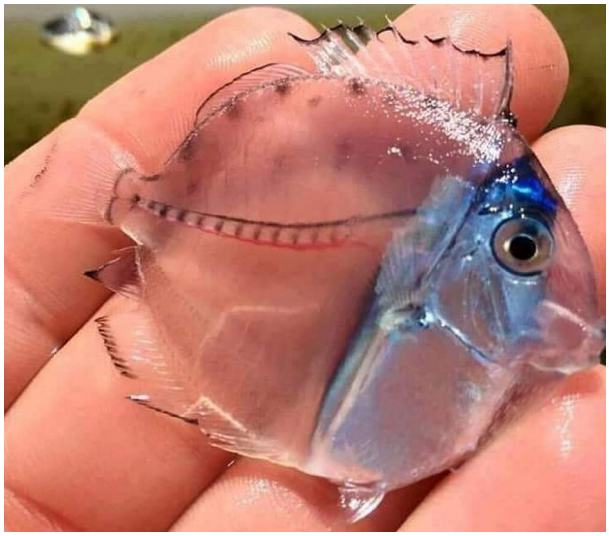

Fig. 4. *Acanthurus*, acronurus stage, 56 mm *TL*, Jubail City, Saudi Arabia, Arabian Gulf.

Family Sparidae

Acanthopagrus arabicus Iwatsuki, 2013

Material. 1, 12.7 mm *TL*, southern marshes of Iraq, 2019.

Description. Body deep and compressed; 4½ scale rows between fifth dorsal-fin spine base and lateral line; body covered with ctenoid scales; mouth sub-horizontal; lips thick; snout pointed, two nostrils just in front of eye; maxilla reaching to below posterior edge of pupil; rows of scales on cheek; antero-dorsal profile ascending gently from just above eye, curved; preopercular posterior margin not serrated; dorsal-fin spines strong, fourth longest; third anal-fin spine shorter than second spine; pectoral-fin tip reaching anterior edge of first anal fin spine. Colour: head and body silver, with white belly; weakly dusky bars along longitudinal rows of scales; weak diffuse dark blotch at origin of lateral line; dorsal fin greyish to hyaline; pectoral fins yellowish, with faint marks at base and axil of pectoral fin; pelvic and anal fins vivid or strong yellow, lower caudal-fin lobe yellow; black streaks absent proximally on inter-radial membranes between yellow anal-fin rays.

The length of the depictured juvenile is 37 mm *TL* (Fig. 3B).

Sparidentex hasta (Valenciennes, 1830)

Material. 1, 8.3 mm *TL*, southern marshes of Iraq, 2019.

Description. Moderate elongated body; head with straight profile from snout to above eye and then convex; mouth large and oblique; maxilla reaching beyond middle of eye; three pairs of solid canine teeth at front of each jaw; conical teeth along sides of jaws; fourth dorsal spine longest; second anal spine longer than third; caudal fin moderately forked; pectoral fin reaching posterior edge of anus. Colour: body generally silvery; a dark blotch at anterior end of lateral line; dorsal and caudal fins greyish at edges.

The length of the depictured juvenile is 25 mm *TL* (Fig. 3C).

Order Tetraodontiformes

Family Tetraodontidae

Lagocephalus sp.

Material. 1, 12 mm *TL*, Salalah, Arabian Sea coast of Oman, 2007.

Description. Body short, robust, broadly tapering posteriorly; spinules on the rounded ventral body surface; eye moderately large; fins small; snout short. Colour: body with iridescent green-blue colouration on the dorsal side; yellowish tint below and posterior to eye and the caudal fin; all fins are translucent.

The length of the depictured juvenile is *TL* 22 mm *TL* (Fig. 1E).

DISCUSSION

Despite the small sample size, the present study confirmed the presence of larva and juveniles of 11 species for the first time in the countries from where they were obtained. More studies should be done in the area, including monthly sampling to collect larvae and juveniles of as many fish species as possible, to have a complete picture of the development of the ichthyofauna in the studied areas.

Although the leptocephalus larva examined in the present study is small (80 mm *TL*), it was possible from certain characters such as presence of ventral pigmentation; presence of obliques rows of small, closely set melanophores on the hypaxial myosepta below the lateral line in the fresh specimen to ascertain that it was in the family Congridae. The specimen of leptocephalus larva obtained from the Arabian Sea coast of Oman looks similar to the description given for this larva by Raju (1985) and Richards and Al-Yamani (2008).

The identification of the juvenile of *D. orientalis* was expedited due the distinctive characters that the juvenile had, such as the large head spines, body shape, blunt snout, and dark pigment. The characters observed in the juvenile specimen from Omani waters are like those described by Jones and Kumaran (1964) and Richards and Al-Yamani (2008). The description of the present juvenile of *D. orientalis* fits also the earlier description of Koumans (1953). The juvenile of *D. orientalis* differs from that of *Dactylopterus volitans* described by Padoa (1956). There are three somewhat recurved spines at the ventral edge of the distal third of the preopercular spin in the later species. On the other hand, *Dactyloptena gilberti* Snyder, 1909 differs from *D. orientalis* by a broader and deeper interorbital space, 18–23% of *SL* and 12–17% of head length in *D. gilberti* vs. 13–15% of *SL* and 8–11% of head length in *D. orientalis*, respectively (Poss and Eschmeyer 1999; Bogorodsky et al. 2014).

The shape of the juvenile *Scatophagus argus* looks much like the adult individuals (Barry and Fast 1992). The presence of bars versus spots in the juveniles of this species raises questions about whether there is more than one species within the nominal species *S. argus*. Such difference may lead to the species being partitioned in the future. Jeyaseelan (1998) suggested that juveniles of *S. argus* from the Asian mangrove have spots on their body rather than bars, but Barry and Fast (1992) noted that the juveniles of this species obtained from the Philippines had bars instead of spots. The present specimens collected from Shatt al-Arab River need to have a genetic analysis to determine if they are a developmental variant of *S. argus* or separate species.

This will lead us to a question how these forms have arrived to the freshwater environment of Shatt al-Arab River, south of Iraq? There is only one possibility for such an arrival and that is by the intentional introduction from the aquarium trade that has been flourished recently in Iraq especially (Mutlak et al. 2017). The shape and size of small specimens of *S. argus* are attractive enough to have them in the aquarium as pets, but they become less attractive when they grow to a large size which may prompt their release into natural waters (Zammit and Schembri 2011).

It was suggested that the adults *S. argus* need full strength seawater to breed (Zammit and Schembri 2011; Gupta 2016). This is incorrect because adults of this species usually breed in the Shatt al-Arab River, a pure freshwater environment (Mohamed and Hameed 2019; Mohamed and Jawad 2021). Moreover, the location where the juveniles were collected is about 170 km north of the nearest marine environment.

Günther (1873) probably was the first to know about the larval nature of acronurus. The late larval *Acanthurus* sp. is quite different from the juvenile. It is quite easy to identify for its disc-like, transparent body (Randall 1955). The postlarval stage acronurus obtained from the Arabian Gulf coast of Saudi Arabia match very well the description given by Randall (1955, 1956) and Strasburg (1961).

The characters of the bothid juvenile collected from the Arabian Sea coast of Oman agree with those of the juveniles of species in the family Bothidae given by Amaoka (1973). Moreover, Richards and Al-Yamani (2008) gave the ranges of meristic characters of some of the bothids from Kuwaiti waters. Those of the present specimen fall within the ranges of the species *Arnoglossus aspilos*.

Judging from the presence of both eyes on one side and absence of the long first ray of the dorsal fin the present juvenile of *A. aspilos* was in the metamorphosis stage from its pelagic to its demersal life (Amaoka 1973).

The nostrils and the olfactory lamellae can be used as an indicator of the developmental stage of larvae and juveniles in bothid flounders. Particularly, in larvae at the time of early metamorphosis, they are useful for the identification of smaller developmental increments because they show remarkable changes prior to the migration of the eye. The olfactory organ of the present juvenile is well-developed due to the adoption of the benthic life by the juvenile. The olfactory organ may be necessary as benthic feeding behavior becomes active. The development of the olfactory organ is accompanied by the growth of the mouth, teeth, and eyes, which are closely related to the feeding behavior (Amaoka 1973).

The morphological characters and especially the colouration of the juvenile of tetraodontid fish species obtained from the Arabian Sea coast of Omani are similar to those of *Lagocephalus* sp. given by Anguchamy Veeruraj et al. (2011). The characters are also similar to those species of the family Tetraodontidae described by Fujita (1966). The recent studies on the early life history of fishes in the Omani waters have not revealed any specimens of larvae or juvenile of the members of the family Tetraodontidae (Chesalina et al. 2013; Al-Abri et al. 2017). The reason could the

method of collection. The present specimen of the juvenile of *Lagocephalus* sp. was collected by a trawler, while those of Chesalina et al. (2013) and Al- Abri et al. (2017) were collected with plankton nets. This indicates that this juvenile had started its demersal type of life, which is typical for this species (Anguchamy Veeruraj et al. 2011).

The presence of juveniles of *T. ilisha* in Shatt al-Arab River provides evidence that hilsa fish do not breed in the marsh area, but in the Shatt al-Arab River and then the larvae move north to spend their juvenile life in the southern marshes of Iraq before leaving the freshwater environment to the Arabian Gulf (Mohamed et al. 2008 a; 2008 b; 2011; 2012).

This may also be true of the other marine species whose juveniles were found in the marsh areas (*Nematalosa* sp., *Acentrogobius* sp., *Acanthopagrus arabicus* and *Sparidentex hasta*). To support this hypothesis, larvae of those species would need to be found in the Shatt al-Arab River. Therefore, further research is needed in this field.

Oman, Saudi Arabia and Iraq are among the countries of the Arabian region that have high-diversity marine fish faunas. Those countries need information about larval fish taxonomy if they want to support their marine living resources. Therefore, they need to start research on the identification and descriptions of the early life history stages of the fish species living in their waters. They need to make such work available online to be used by scientists, because printed atlases and monographs may be too expensive to obtain. They should also allocate sections in the museums of their countries for collections of specimens of the early life history stages of fishes both kept freshly frozen for genetic analysis and preserved for morphological description. The collections of larvae and juveniles of fishes can be obtained from fishery agencies and universities in these countries. Such collections will not only enable taxonomic research, but also assist fishery and ecological research by delivering the ability to obtain data in the future on fish larvae and fish populations (Leis 2015).

It is quite interesting to compare the fish biodiversity in the Iraqi marine waters, which is located at the north of the Arabian Gulf with that of the Saudi Arabia situated at the middle of the Arabian Gulf. As far as the authors aware there is no single publication that list comprehensively the fish species inhabiting the Saudi Arabian coasts of the Arabian Gulf. What is available are incomplete list of fishes prepared for certain purposes such as McCain et al. (1984), Coles and Tarr (1990), Krupp and Anegay (1993), Krupp and Müller (1995), Krupp and Al–Marri (1996). Therefore, it is not feasible at this stage to make a comparison between the fish biodiversity of Iraq and Saudi Arabia.

CONCLUSION

The description of larvae and juveniles of 11 fish species from the Arabian Gulf waters of Saudi Arabia and Iraq, and the Omani coast of the Arabian Sea was done for the first time. The results showed that there is some variation in colouration of the juveniles of *S. argus* from the description available for this stage of the species. This suggests that there may be more than one species within the nominal *S. argus*. The results are also showed that it is possible to identify juveniles of bothid flounders based on the olfactory organ of the developmental stage of the metamorphosing specimens. As a conclusion, the occurrence of the different early life history stages from the three countries of the Arabian region needs to be studied further so that inferences about the areas and periods of spawning and development of these fishes can be made more accurately.

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Ethical Statement. The work is based on commercial fish species and the specimens were collected from a commercial catch. Therefore, ethical aspects are not applicable.

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