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Rapid Communication

First record of the Indian anchovy *Stolephorus indicus* (van Hasselt, 1823) (Clupeiformes: Engraulidae) in the Mediterranean Sea

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Abstract

The Indian anchovy *Stolephorus indicus* (van Hasselt, 1823) was recorded for the first time in the Mediterranean near Tel-Aviv, Israel on 15 May 2015. This Indo-West Pacific species evidently reached the Mediterranean via the Suez Canal from the Red Sea. Several specimens of *Stolephorus insularis* were also collected, which suggests that species has established a viable population in the Levant.

Key words: Engraulidae, Indo-West Pacific, first record, Mediterranean, Lessepsian migration, distribution

Introduction

The opening of the Suez Canal in 1869 connected the Red Sea with the Mediterranean, resulting in an almost unidirectional migration of Red Sea organisms into the Mediterranean ("Lessepsian migration") (Golani et al. 2002). A complete list of species to 2010 is provided by Golani (2010). Additional species were recorded after 2010, including: *Ostracion cubicus* Linnaeus, 1758, (Ostraciidae) (Bariche 2011); *Equulites elongates* (Günther, 1874) (Leiognathidae) (Golani et al. 2011); *Chaetodon austriacus* Rüppell, 1836 (Chaetodontidae) (Goren et al. 2011); *Chaetodon larvatus* Cuvier, 1831 (Chaetodontidae) (Salameh et al. 2011); *Stolephorus insularis* Hardenberg, 1933 (Engraulidae) (Fricke et al. 2012); *Chanos chanos* (Forsskål, 1775) (Chanidae) (Özvarol and Gökoğlu 2012); *Parupeneus forsskali* (Fourmanoir and Guézé, 1976) (Mullidae) (Bariche et al. 2013); *Gymnothorax reticularis* Bloch, 1795 (Muraenidae) (Stern and Goren 2013); *Synchiropus sechellensis* Regan, 1908 (Callionymidae) (Gökoğlu et al. 2014); *Sardinella gibbosa* Bleeker, 1849 (Clupeidae) (Stern et al. 2015); and *Epinephelus geoffroyi* (Klunzinger, 1870) (Serranidae) (Golani et al. 2015). To date, 96 Lessepsian fish species has been confirmed and recorded in the Mediterranean.

The Indian anchovy, *Stolephorus indicus* (van Hasselt, 1823), was originally described from India. It was considered as a valid species in a revision by Whitehead et al. (1988: 412–413). The species is native to the Red Sea and the Indo-West Pacific from South and East Africa east to Society Islands, north to Hong Kong (China), south to Gulf of Carpentaria (Australia). On 15 May 2015, a specimen of *S. indicus* was collected in the eastern Mediterranean Sea off Israel; this finding is reported and discussed in the present paper. It represents the arrival of a new Lessepsian migrant species of Red Sea origin in the Mediterranean Sea.

Figure 1. Lateral view of *Stolephorus indicus*, HUJ 20443 (74.3 mm SL), 15 May 2015, Tel-Aviv, Israel. Photograph by D. Darom.

Materials and methods

On 15 May 2015 the first two authors (RF and DG) collected 1 intact specimen of *S. indicus* (van Hasselt 1823) from a nocturnal trawl catch in the port of Jaffa, Israel; other specimens were partially damaged and were therefore used only for color description. In the Hebrew University Fish Collection (HUJ), one specimen of the Indian anchovy, *Stolephorus indicus* (Hasselt, 1823) (74.3 mm SL) (Figure 1), was deposited that had been collected on 15 May 2015 from a nocturnal catch of the commercial trawler *F/V Bilu*, using a 44 mm mesh size cod-end net, between Ga'ash (ca. 32°14'49" N 34°49'03" E) and Jaffa (ca. 32°02'49"N 34°44'22"E), in the vicinity of Tel-Aviv, Israel. Details of the collecting depth are not available, but the species was probably collected not far from the coast, in the upper 30 m above sand bottom. The specimens are registered under the catalogue number HUJ 20443. Counts and measurements follow Hubbs and Lagler (1947), fin-ray counts follow Fricke (1983) and Whitehead et al. (1988); the classification follows Eschmeyer (2015), the references follow Fricke (2015).

Results and discussion

Description of the Mediterranean specimen (Figures 1 and 2)

Body slender, elongate, round in cross-section, belly with 2 small needle-like pre-pelvic scutes, the first located under the middle of pectoral fin, the last well in front of pelvic fin. Maxilla tip pointed, reaching to or just beyond anterior border of preoperculum. Preoperculum distally convex, rounded. Isthmus evenly tapering anteriorly. Lower gill-rakers 24. Dorsal-fin rays iii,12. Anal fin short, with iii, 17 rays, its origin below the middle of dorsal fin base. Pectoral-fin rays i,15.

Colour (based on fresh specimens): body light transparent fleshy brown, with a silver stripe on the side; no dark pigment lines between head and dorsal fin. Eyes silver-grey with black pupil.

Discussion

This species was first described as *Engraulis indicus* by van Hasselt (1823: 329) from Vizagapatam, India (based on an illustration by Russel, 1803: 71, pl. 187; see footnote in Alfred 1961: 83). The name is available with van Hasselt as the author according to Kottelat (1987: 370). It was treated as a valid species in a revision by Whitehead et al. (1988: 412–413), distributed in the Red Sea and the Indo-West Pacific. The species was subsequently reported by Paxton et al. (1989: 161) as occurring south to Mackenzie Island, Queensland, Australia at 23°31'S, by Young et al. (1994: 222) from Taiwan, by Myers (1999: 62) from the Caroline and Mariana Islands in Micronesia, Nakabo (2000: 250) and Sakai et al. (2001:86) from the Ryukyu Islands, Hutchins (2001: 18) from Western Australia, Randall et al. (2004: 7) from Tonga, Fricke et al. (2011: 354) from New Caledonia.

The species is placed in the genus *Stolephorus* Lacepède, 1803 due to the normally shaped (not tapering or rat-tailed) body, the anal fin not joined to the caudal fin, the upper pectoral-fin rays not detached from each other, the presence of needle-like prepelvic scutes (Figure 2), no postpelvic scutes, the isthmus evenly tapering anteriorly, and the anal fin with less than 25 fin-rays (see Whitehead et al. 1988: 309–310, 401). Counts and proportions of the Mediterranean specimen of *S. indicus* are consistent with those of Red Sea and Indo-West Pacific specimens (Table 1).

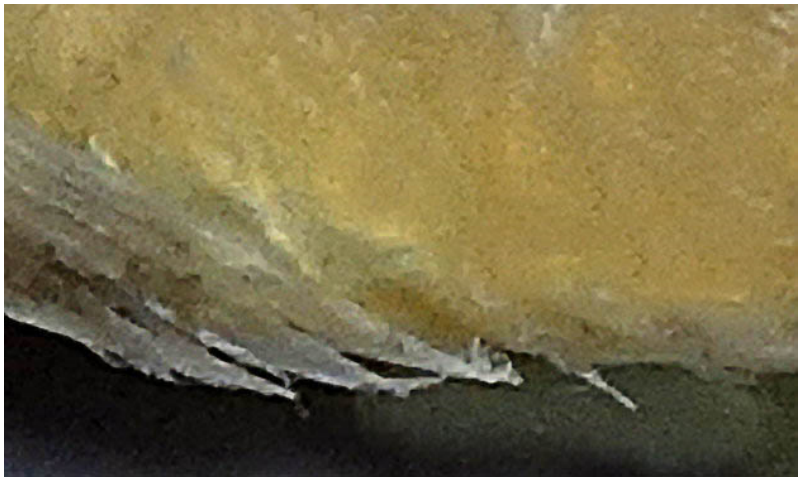

Figure 2. Close up view of needle-like prepelvic scutes, *Stolephorus indicus*, HUJ 20443 (74.3 mm SL), 15 May 2015, Tel-Aviv, Israel. Only the posterior scute clearly visible; the anterior scute partly hidden behind the pectoral fin. Photograph by D. Darom.

Table 1. Comparison of selected counts and proportions of *Stolephorus indicus* from the eastern Mediterranean and the Indo-West Pacific.

	HUJ 20443, Israel, Mediterranean Sea	Red Sea, Indo-West Pacific (Whitehead and Wongratana 1986; Whitehead et al. 1988; Randall 1995)
Dorsal-fin rays	iii, 12	iii, 12-14
Anal-fin rays	iii, 17	iii, 16-18
Pectoral-fin rays	i, 15	i, 12-15
Pelvic-fin rays	i, 6	i, 6
Lateral scale rows	ca. 41	38-42
Lower gill rakers	24	20-28
Needle-like scutes on belly	2	2-6
Head length in standard length	4.4	4.3-5.0
Eye diameter in head length	3.3	3.3-3.5
Body width in body depth	1.6	1.5-2.0

Stolephorus indicus schools over soft bottoms mainly around 20–50 m depth, but young fish occur shallower, and larvae are found in estuaries. The biology of the species is poorly known (Whitehead et al. 1988: 413). However, Hajisamae et al. (2003) examined the food and feeding habits of the species in Singapore.

Since the opening of the Suez Canal in 1869, many fish species have emigrated from the Gulf of Suez (Red Sea) into the eastern Mediterranean, the so-called Lessepsian migrants (Golani 2010). In the early years, Lessepsian migrants were relatively few, as the Suez Canal was narrow and crossed some salt lakes (Bitter Lakes). After several enlargements and washing out of salt deposits, the passage for fishes is now easier, which results in higher numbers of Lessepsian migrant species reported from the eastern Mediterranean in recent years. The first anchovy migrant was reported by Fricke et al. (2012, *Stolephorus insularis*). As *S. insularis* and *S. indicus* are found in mixed schools, and *S. indicus* was reported from the Red Sea previously (Golani and Bogorodsky 2010), a Lessepsian migration of *S. indicus* was to be expected, which is confirmed by the present finding of *S. indicus*. The species may be more common in the eastern Mediterranean, but anchovy specimens in catches are often damaged so that the scutes on the belly cannot be distinguished. In the engraulids collected on 15 May 2015 near Jaffa, Israel, a total of approximately 1,000 specimens were examined. Most of these represented the common Mediterranean species *Engraulis encrasicolus* (Linnaeus, 1758), but about 10 specimens could be identified as *S. insularis*, and just a single specimen as *S. indicus*.

Stolephorus indicus is the second anchovy to invade the Mediterranean. It may have been included in earlier collections, but was probably missed due to its external similarities with *Engraulis encrasicolus*. *Stolephorus indicus* co-occurs with the Mediterranean indigenous species

Table 2. Comparison of selected characteristics of species of *Stolephorus* in the Red Sea, northwestern Indian Ocean, and eastern Mediterranean.

	S. indicus	*S. insularis*	*S. commersonnii*
Dorsal-fin rays	iii, 12–14	iii, 12–14	iii,12–14
Anal-fin rays	iii, 16–18	iii, 14–17	iii, 18–19
Pectoral-fin rays	i, 12–15	i, 14–16	i, 13–14
Pelvic-fin rays	i, 6	i, 6	i, 6
Lower gill rakers	20–28	21–28	23–28
Needle-like scutes on belly	2–6	4–8	0–5
Head length in standard length	4.3–5.0	3.7–4.1	4.2–4.4
Eye diameter in head length	3.3–3.5	3.2–3.5	3.6–4.0
Body width in body depth	1.5–2.0	1.6–1.9	1.8–2.0
Anal fin origin	Below middle of dorsal-fin base	Below middle of dorsal-fin base	Below second half of dorsal-fin base
Body colouration	Silvery stripe, no dark blotches behind occiput or pigment line on back behind dorsal fin	Golden, brown stripe, double pigment line on back behind dorsal fin	Silvery stripe, dark blotches on back behind occiput
Distribution	Red Sea, Indo-West Pacific, eastern Mediterranean	Red Sea, Indo-West Pacific, eastern Mediterranean	Indo-West Pacific

E. encrasicolus, which is apparently much more common than the Lessepsian invader in Israel, and *Stolephorus insularis* Hardenberg 1933 (Hardenberg 1933: 249), which was recorded from Israel by Fricke et al. (2012) and from Turkey by Dalyan et al. (2014). Several specimens of *S. insularis* were collected on 15 May 2015 together with the single confirmed specimen of *S. indicus*, which indicates that a population of *S. insularis* may well be established in the eastern Mediterranean. *Engraulis encrasicolus* differs mainly in the absence of needle-like prepelvic scutes; the anal fin which begins well behind the second dorsal-fin base; and a higher number of lower gill-rakers (27–43 in *E. encrasicolus*, 20–28 in *S. insularis*). The other Red Sea congener, *S. insularis*, is distinguished from *S. indicus* by having 4–8 (usually 6–7) needle-like pre-pelvic scutes [compared to 2–6 (usually 3–5) scutes in *S. indicus*]; iii,14–17 anal-fin rays (iii,16–18 in *S. indicus*); the maxilla reaching to or beyond posterior border of preoperculum (reaching to or only just beyond the anterior border of preoperculum in *S. indicus*); and a characteristic golden hue (silvery, grey or bluish colouration in *S. indicus*) (Whitehead et al. 1988: 412–414). In the northwestern Indian Ocean, another species of the genus is found, which was not yet reported from the Red Sea (*S. commersonnii* Lacepède 1803). *Stolephorus commersonnii* is quite similar to *S. insularis* and *S. indicus* (Table 2).

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