

# *Sphyraena intermedia* sp. nov. (Pisces: Sphyraenidae): a potential new species of barracuda identified from the central Mediterranean Sea

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*A potential new species of Barracuda Sphyraena intermedia sp. nov. (Perciformes: Actinopterygii) is reported from the Gulf of Taranto in the central Mediterranean Sea. This classification was based upon a thorough anatomical comparison with well documented species from the region (Sphyraena sphyraena and Sphyraena viridensis). Principally, Sphyraena intermedia sp. nov. differed from the other species within the genus in terms of body shape, otoliths, dentition and pyloric caeca.*

**Keywords:** Sphyraenidae, *Sphyraena intermedia*, new species, Gulf of Taranto, Mediterranean Sea

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## INTRODUCTION

Currently, the genus *Sphyraena* (barracudas) is thought to contain 27 species world-wide, with a distribution spanning temperate and tropical regions (Eschmeyer, 2008). Individuals within this genus are typically found in shelf waters ranging to a depth of approximately 100 m (Robins & Ray, 1986; Fischer *et al.*, 1987; de Silva, 1990; Demestre *et al.*, 2000). There appears to be some ontogenetic separation, however, with young individuals found in shallow waters (often > 1 m) (Okiyama, 1988) forming numerous small schools, while adults tend to be solitary (de Silva, 1975; de Silva & Williams, 1986; Gasparini & Floeter, 2001; Barreiros *et al.*, 2002).

In the Mediterranean Sea the genus *Sphyraena* comprises four species: (1) the lessepsian *Sphyraena chrysotaenia* (Klunzinger, 1884) (Spicer, 1931; Ben-Tuvia, 1971, 1986; Golani & Ben-Tuvia, 1995; Pallaoro & Dulcic, 2001); (2) *S. flavicauda* (Rüppell, 1838) (Golani, 1992; Bilecenoglu *et al.*, 2002); and two Atlantic–Mediterranean species; (3) *S. sphyraena* (Linnaeus, 1758); and (4) *S. viridensis* (Cuvier & Valenciennes, 1829) (George *et al.*, 1971; Tortonese, 1975; Miniconi, 1980; de Silva, 1990; Bizsel & Cihangir, 1996; Ralini & Orsi Ralini, 1997; Vacchi *et al.*, 1999). Building on this long-established classification, this study puts forward morphological evidence for the existence of a previously undocumented fifth species within the region.

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## MATERIALS AND METHODS

### Study sites and sample collection

Between July and October 2003 and May to November 2004, 78 barracudas were captured through a range of fishing techniques (gill-nets, trawl nets, seining and 'lampara' engine) in the Gulf of Taranto in the Mediterranean Sea at five sites: (1) Metaponto (40°22'2643"N–16° 5'5553"E); (2) Taranto (40°23'54 82"N–17°10'56 63"E); (3) Torre Columena (40°17'33 05"N–17° 44'32 62"E); (4) Porto Cesareo (40°15'16 98"N–17° 5'45 95"E); and (5) Gallipoli (40°02'38 10"N–17°55'40 44"E) (Figure 1). Of these specimens collected, 28 individuals (15 males, 12 females and 1 juvenile without secondary sexual characteristics) were identified as *S. sphyraena*, 36 as *S. viridensis* (19 males and 17 females), with 19 individuals (6 males, 7 females and 6 juveniles) not-conforming to the taxonomic description of either species (later described as the new species *S. intermedia*). Figure 2 provides a visual comparison of *S. intermedia* with *S. viridensis* and the drawings of Figure 3 provide the different scaled pre-opercular and opercular areas.

### Morphometrics

The following morphometrics were recorded for each barracuda collected: total length (TL), standard length (SL), head length (HL), pre-pelvic length (PPL), pre-dorsal length (PDL), body depth (BD), pre-pectoral length (PpL), pre-orbital length (POL), longitudinal eye diameter (LED) and jaw length (JL) (Figure 4). The number of lateral scales, and the distance to the first dorsal fin ray (D1), the second dorsal fin ray (D2), the pectoral fin ray (P), the pelvic fin rays (Pe), the anal fin rays (A) and vertebrae number were

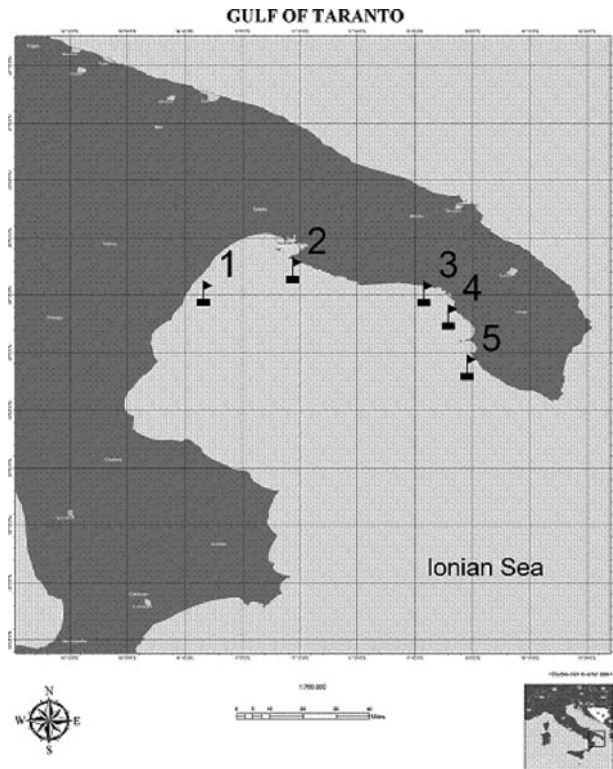


Fig. 1. The fishing sites of barracudas in the Gulf of Taranto: Metaponto (1); Taranto (2); Torre Colimena (3); Porto Cesareo (4); Gallipoli (5).

also considered. The number of vertebrae of each species was counted to be 22 between occiput and hypural plate. Otoliths were removed from five specimens of each *S. sphyraena*, *S. viridensis* and the new form ( $N = 15$  fish in total) for comparison (Figure 5). The different anatomical feature of the jaws and dentition is given in Figure 6.

Lastly, a brief morphometric comparison was made with records of previously documented lessepsian migrants (*S. chrysotaenia* and *S. flavicauda*) and with other potential lessepsian migrants such as *Sphyraena qenie*, *S. jello* and *S. putnamae* to prevent misidentification of the unidentified barracuda collected from the Gulf of Taranto.

#### SYSTEMATICS

##### Genus SPHYRAENA

##### *Sphyraena intermedia* sp. nov.

(Figures 2–7)

#### SPECIMENS COLLECTED

Holotype: adult female, 745 mm SL, preserved with formalin (catalogue No. 3274, Mar Grande, Gulf of Taranto, trawl,



Fig. 2. Two specimens of barracudas: *Sphyraena intermedia* (above) and *Sphyraena viridensis* (below), 60 cm SL.

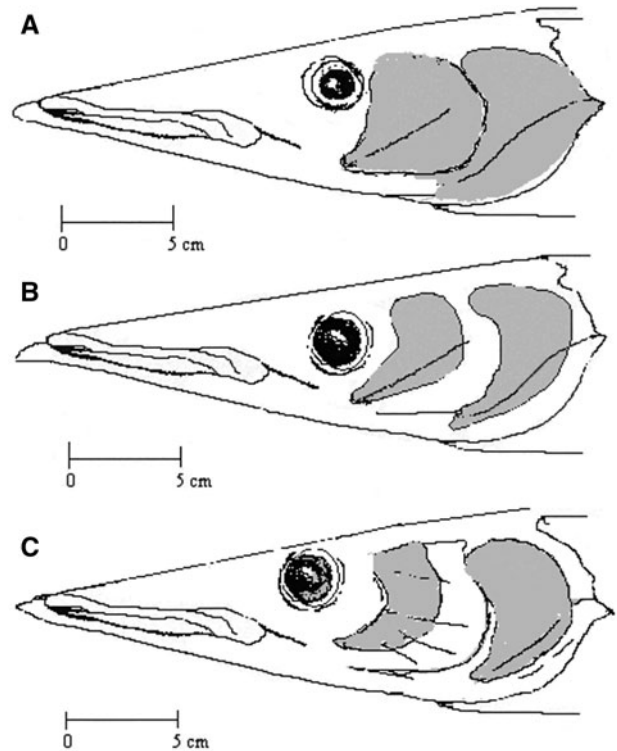


Fig. 3. Heads of adult specimens: scaled areas on pre-operculum and operculum respectively in *Sphyraena sphyraena* (A), *Sphyraena viridensis* (B) and *Sphyraena intermedia* sp. nov. (C) (original drawings).

$40^{\circ}23'54''N-17^{\circ}10'56''E$ , August 2004, Pastore, IAMC–CNR, Fish Collection).

Paratype: a male specimen 375 mm SL (catalogue No. 3255, Torre Columena, Gulf of Taranto,  $40^{\circ}17'33''N-17^{\circ}44'32''E$ , seining, from a fish-shop, August 2004, IAMC–CNR, Fish Collection).

Other specimens: 1 mature ♂ (79 cm SL), 5 immature ♂♂ (respectively: 42–59.5–63.5–64.5–75 cm SL), 4 mature ♀♀ (respectively: 34.5–35.5–36.5–39.5 cm SL), 3 immature ♀♀ (30.5–32.7–34 cm SL), 4 young (20.5–20.8–21–21 cm SL).

#### DESCRIPTION

Body slender, tapering, weakly compressed, with conical, hydrodynamic snout; body depth 12.8% SL. Mouth long,

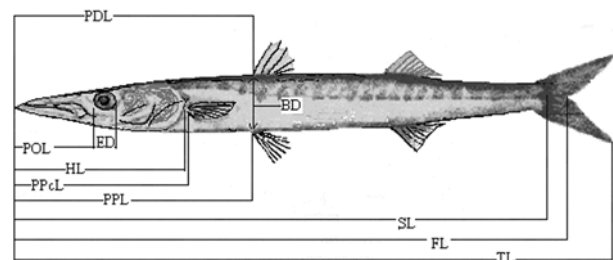


Fig. 4. Sphyraenidae body measures: TL, total length; LF, length to the furca; SL, standard length; LL, lateral line; POL, pre-orbital length; ED, eye diameter; HL, head length; PPL, pre-pelvic length; PDL, pre-dorsal length; PPcL, prepectoral length; BD, body depth (partially modified draw referred to *Sphyraena sphyraena* from FAO Fishes (Fisher et al., 1981)).

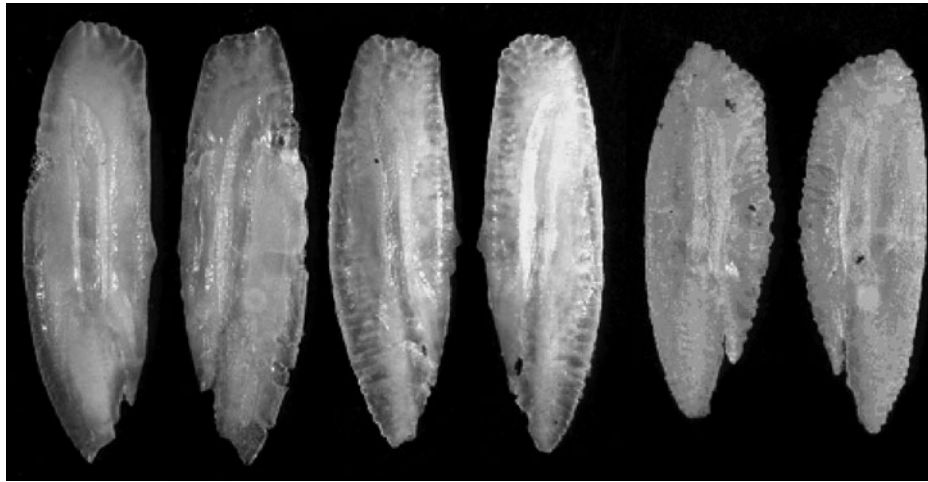


Fig. 5. Otoliths, image 10 $\times$ : left, *Sphyraena sphyraena*, 320 mm standard length (SL); middle, *Sphyraena intermedia*, 320 mm SL; right, *Sphyraena viridensis*, 330 mm SL.

with low protractile capacity and with prognathic lower jaw and a moderate fleshy excrescence on top (less than in *S. viridensis*). Eye diameter 4 times the POL. Pre-operculum and operculum not completely scaled (however not like in *S. viridensis*) (Figure 3c). Maxilla reaching to below anterior margin of eye. Minute teeth on the entire premaxillary bone, and 2–3 strong canine-like teeth on the superior symphysis, the second nearly double than the first. The upper jaw (Figure 6C, C1, C2) with 3 acute teeth, the second stronger than the other two, after them there is a row of minute and crooked behind denticles, 1 very strong canine-like tooth on the symphysis; lower jaw with a first acute tooth and an arrow of teeth, increasing in length; palatine with 2 teeth, the second stronger than the first and after these a row of minute denticles.

Lateral scale series 118–135 (127–154 in *S. sphyraena* and 137–163 in *S. viridensis*). First dorsal fin (D<sub>1</sub>) with 5 rays and origin lightly before the pelvic fin; second dorsal (D<sub>2</sub>) with 10 rays; pectoral fin (P) with 11–13 rays not reaching the origin

of the first dorsal fin; anal fin (A) with 10 rays gives rise lightly after second dorsal fin; pelvic fin (Pe) with 6 rays; lobes of caudal fin with internal margins weakly concave (right in *S. sphyraena* and falcate in *S. viridensis*).

A lengthening index of the sagittae ( $I_1 = W \times 100/SL$ ) is calculated how  $I_1 = 28.95$  ( $I_1 = 26.83$  in *S. sphyraena*, and  $I_1 = 31.43$  in *S. viridensis*) (Figure 5 middle). Vertebral bodies, 22; intestinal villi, 30–32 (Figure 7c).

Colours: blue-darkish on back, from the snout until the caudal fin; 22 bars on body, with the bars 1 to 7 crossing the lateral line; 4th–7th longer than others; first and second dorsal fins brownish; pelvic fin white in young specimens and brownish with white tip in adults; anal fin ever white; caudal fin almost black. Mouth with inferior jaw borders orange and tongue with a longitudinal red-brownish medial line.

Remarks: stomach contents of 11 specimens consist of rest of cephalopods, *Sardina pilchardus* or *Sardinella aurita*, from

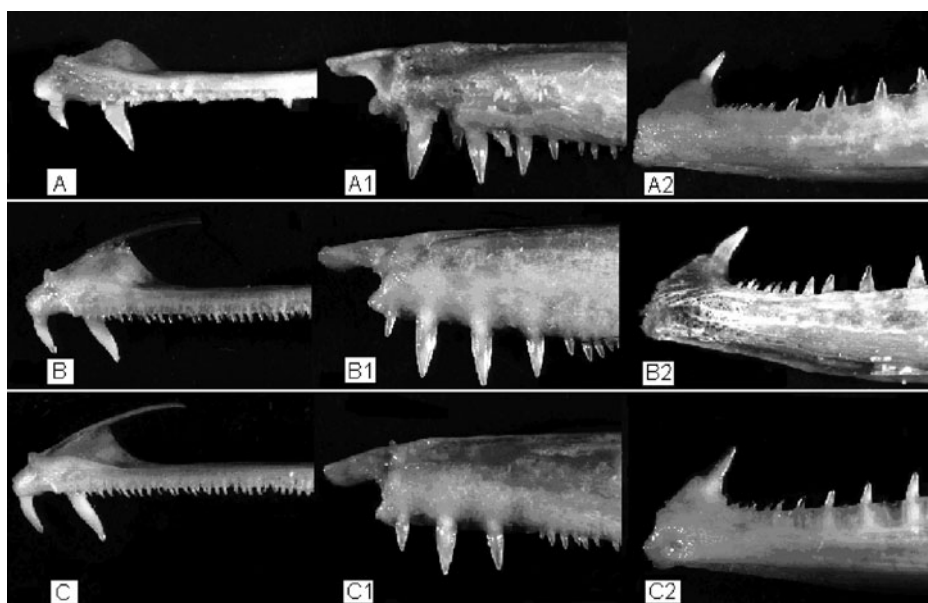


Fig. 6. Bone jaws and dentition in the 3 forms: A, A1, A2 *Sphyraena sphyraena*; B, B1 and B2, *Sphyraena viridensis*; C, C1 and C2 *Sphyraena intermedia*.



Fig. 7. Intestinal villi of *Sphyraena sphyraena* (5a), *Sphyraena viridensis* (5b) and *Sphyraena intermedia* (5c).

5 specimens; a young *S. sphyraena* in the stomach of a male; 2 empty guts and 4 guts with fluidified materials.

Some specimens affected on the outer face of stomach and on the gonads by the anisakid nematode *Anisakis* sp. Two specimens had regressive male gonads in favour of female gonads in development.

## DISCUSSION

Table 1 shows the main differences of *S. intermedia* in comparison with *S. sphyraena* and *S. viridensis*, such as: the inter-medial body depth between the other two species; the eye longitudinal diameter/POL; the scale numbers on the lateral line relatively reduced; the intestinal villi, the number of which is less than in the other two species; the size, inter-medial in comparison with the sizes of the two other species.

The livery differs also among the three species: no vertical bars in *S. sphyraena* and with 22 bars in *S. viridensis* and in the new species; caudal fin decidedly black, while it is blackish in *S. viridensis*.

The main differences between the two lessepsian species *S. chrysotaenia* and *S. flavicauda* are relative to the size (*S. chrysotaenia* is a small species and *S. flavicauda* is a medium-sized species); lateral scale series 118–135 (82–87 in *S. Chrysotaenia* and 84–91 in *S. flavicauda*); body with longitudinal bars (no bars or stripes and blotches in *S. chrysotaenia*, and with 2 brown or brownish yellow longitudinal stripes in *S. flavicauda*); caudal fin dark (yellowish in *S. chrysotaenia* and in *S. flavicauda*).

According to the literature (de Sylva & Williams, 1986), the main differences with the three Indo-Pacific species *S. putnamae*, *S. qenie* and *S. jello* are: *S. qenie* is a large species (maximum total length 115 cm); lateral-line scales 127 to 130; origin of pelvic fins before first dorsal-fin origin. Caudal fin forked, in adults with a pair of small lobes at posterior margin. Colour: many dark bars crossing lateral line on body, each bar oblique in upper half, but nearly vertical in lower half; caudal fin largely blackish; *S. jello* is a large species

(maximum total length 125 cm); lateral-line scales 130 to 140; origin of pelvic fins before first dorsal-fin origin. Caudal fin typically forked in all stages. Colour: many dark bars crossing lateral line on body, each bar oblique in upper half, but nearly vertical in lower half; caudal fin largely yellowish without white tips; *S. putnamae* is a large species (maximum total length 87 cm); lateral-line scales 123 to 136; origin of pelvic fins before first dorsal-fin origin. Caudal fin forked, in large adults with a pair of indistinct lobes at posterior margin. Colour: many characteristic dark chevron markings crossing lateral line on body; caudal fin largely blackish without white tips.

## CONCLUSION

*Sphyraena intermedia* differs, in comparison with the other two native species *S. sphyraena* and *S. viridensis* for a certain number of relevant emphasized differences as shown in Table 1 and Figures 3, 5, 6 & 7. The species differs too from the lessepsian migrants and the Indo-Pacific species. For the three species (*Sphyraena sphyraena*, *S. viridensis* and *S. intermedia* sp. nov.) a DNA collateral study has been made that confirms the separation of them. The reason to believe that *S. intermedia* is a distinct species in comparison with *S. sphyraena* and *S. viridensis* is that the morphological characters are steadily distinct among the three forms in all stages, so we must believe *S. intermedia* is not a hybrid *S. sphyraena* × *S. viridensis*.

In the Gulf of Taranto the new species appears sympatric with the other two. The exact distribution and abundance of *S. viridensis* are unknown because most published records do not separate it from *S. sphyraena* and perhaps have confused this form with the new species.

The 'yellow mouth barracuda' name given to *Sphyraena viridensis* is not correct because also *S. sphyraena* and *S. intermedia* have almost the internal part of the mouth, yellowish the first and orange the second, so that it is not a good distinguishing character.

To distinguish the three native Mediterranean species a key is given.

Table 1. Main distinctive features of 3 forms.

	<i>Sphyraena sphyraena</i>	<i>Sphyraena viridensis</i>	<i>Sphyraena intermedia</i>
Body depth	11.5% SL	14.1% SL	12.77% SL
Eye longitudinal diameter/POL	2.9–3.5 times	4.1–5 times	4 times
Scales on the lateral line	127–154	137–163	118–137
Intestinal villi	35–38	37–40	30–32
Maximum size in the Mediterranean	60	165	90

POL, pre-orbital length; SL, standard length.

## KEY TO THE THREE NATIVE MEDITERRANEAN SEA BARRACUDAS:

Body depth less than 12% of SL; pre-operculum and operculum entirely scaled; eye diameter 3.5 times the pre-orbital length; no prominent fleshy excrescence on top of the lower jaw; top of the pre-pectoral fin far from the origin of the first dorsal fin; caudal fin with internal margins right in each lobe . . . . . *S. sphyraena*

Body depth more than 12% of SL; pre-operculum and operculum not completely scaled; eye diameter 4 or more times the pre-orbital length . . . . . 2

Body depth 14.1% of SL; a prominent fleshy excrescence on top of the lower jaw; eye diameter 4–5 times the pre-orbital length; pectoral fin top reaches the origin of the ID fin; lateral scales 137–163; internal margin of caudal fin falcate in each lobe; intestinal villi 37–40 . . . . . *S. viridensis*

Body depth 12.8% of the SL; a moderate fleshy excrescence on top of the lower jaw; eye diameter 4 times the pre-orbital length; pectoral fin top does not reach the origin of the ID fin; lateral scales 118–135; internal margin of caudal fin weakly concave in each lobe; intestinal villi 30–32. . . . . *S. intermedia*

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## REFERENCES

Barreiros J.P., Santos R.S. and de Borda A.E. (2002) Food habits, schooling and predatory behaviour of the yellowmouth barracuda, *Sphyraena viridensis* (Perciformes: Sphyraenidae) in the Azores. *Cybium* 26, 83–88.

Ben-Tuvia A. (1971) Revised list of Mediterranean fishes of Israel. *Israel Journal of Zoology* 20, 1–39.

Ben-Tuvia A. (1986) Sphyraenidae. In Whitehead P.J.P., Bauchot M.L., Hureau J.C. and Tortonese E. (eds) *Fishes of the north-eastern Atlantic and the Mediterranean*. Paris: UNESCO, 3, pp. 1094–1096.

Bilecenoglu M., Taskavak E. and Kurt K.B. (2002) Range extension of three lessepsian migrant fish (*Fistularia commersoni*, *Sphyraena flavicauda* and *Lagocephalus suezensis*) in the Mediterranean. *Journal of the Marine Biological Association of the United Kingdom* 82, 525–526.

Bizsel K.C. and Cihangir B. (1996) A new fish record for the Turkish seas; yellow mouth barracuda (Sphyraenidae; *Sphyraena viridensis* Cuvier, 1829). *Turkish Journal of Zoology* 20, 357–359.

Cadenat J. (1964) Notes d'ichtyologie ouest-africaine, XLI. Les Sphyraenidae de la côte occidentale d'Afrique. *Bulletin IFAN de Science Naturelle* (A) 26, 659–685.

Cuvier G. and Valenciennes A. (1829) *Histoire naturelle des Poissons*. III. Paris: F.G. Levrault.

Demestre M., Sánchez P. and Abelló P. (2000) Demersal fish assemblages and habitat characteristics on the continental shelf and upper

slope of the north-western Mediterranean. *Journal of the Marine Biological Association of the United Kingdom* 80, 981–988.

de Sylva D.P. (1975) Barracudas (Pisces: Sphyraenidae) of the Indian Ocean and adjacent seas—a preliminary review of their systematics and ecology. *Journal of the Marine Biological Association of India* 15, 74–94.

de Sylva D.P. (1990) Sphyraenidae. In Quero J.C., Hureau J.C., Karrer C., Post A. and Saldanha L. (eds) *Check-list of the fishes of the eastern tropical Atlantic (CLOFETA)*. Lisbon: JNIC; Paris: SEI and Paris: UNESCO, II, pp. 860–864.

de Sylva D.P. and Williams F. (1986) Sphyraenidae. In Smith M.M. and Heemstra P.C. (eds) *Smiths' sea fishes*. Berlin: Springer-Verlag, pp. 721–726.

Eschmeyer B. (2008) *Catalog of fishes on-line*. (<http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>)

Fischer W., Bauchot M.L. and Schneider M. (1987) Sphyraenidae. In *Fiches FAO d'identification des espèces pour les besoins de la pêche. Méditerranée et Mer Noire. Zone de pêche 37. v. II. Vertébrés*, pp. 1377–1380.

Gasparini J.L. and Floeter S.R. (2001) The shore fishes of Trindade Island, western South Atlantic. *Journal of Natural History* 35, 1639–1656.

George C.J., Athanassiou V. and Tortonese E. (1971) The presence of a third species of the Genus *Sphyraena* (Pisces) in the marine waters of Lebanon. *Annali del Civico Museo di Storia Naturale, Genova* 78, 256–263.

Golani D. (1992) *Rhabdosargus haffara* (Forskål, 1775) and *Sphyraena flavicauda* Rüppell, 1833—new Red Sea immigrants in the Mediterranean. *Journal of Fisheries Biology* 40, 139–140.

Golani D. and Ben-Tuvia A. (1995) Lessepsian migration and the Mediterranean fisheries of Israel. In Armantrout N.B. (ed.) *Conditions of the world's aquatic habitats. Proceedings of the World Fisheries Congress, Theme 1*. New Delhi: Oxford & IBH Publications Company, pp. 279–289.

Miniconi R. (1980) Poissons de Corse et de Méditerranée. Parc naturel régional de la Corse. *Arpège*, 21.

Okiyama M. (1988) *Family Sphyraenidae. An atlas of the early stages of fishes of Japan*. Tokyo: Tokai University Press.

Pallaoro A. and Dulcic J. (2001) First record of *Sphyraena chrystaenia* (Klunzinger, 1884) (Pisces, Sphyraenidae) from the Adriatic Sea. *Journal of Fish Biology* 59, 179–182.

Relini M. and Orsi Relini L. (1997) The two species of barracuda (Sphyraenidae) in the Western Mediterranean. *Cybium* 21, 216–222.

Robins C.R. and Ray G.C. (1986) *A field guide to Atlantic coast fishes of North America*. Boston, USA: Houghton Mifflin Company.

Spicer I.J. (1931) Fisheries. In *Report of the Department of Agriculture and Forests for the years 1927–30*. Jerusalem: Printing Office, Russian Building, pp. 159–160.

Tortonese E. (1975) Sphyraenidae. In *Fauna d'Italia, XI. Osteichthyes (Pesci ossei), II*. Bologna: Edizione Calderini, pp. 26–29.

and

Vacchi M., Boyer M., Bussotti S., Guidetti P. and La Mesa G. (1999) Some interesting species in the coastal fish fauna of Ustica Island (Mediterranean Sea). *Cybium* 23, 323–331.

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