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Identification of three cephalopods from the Iranian waters of the Gulf of Oman (Continental shelf area)

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Abstract
This study aimed to find new species of cephalopods in the Iranian waters of the Gulf of Oman. Two species of Oegopsida (*Abralia steindachneri* Weindl, 1912 and *Joubiniteuthis portieri* (Joubin, 1916)) and also one species of Sepiida (*Sepia omani* Adam & Rees, 1966) were identified. Samples were collected in March and April 2019, using a Myctophidae trawler. To capture *A. steindachneri* a two-panel bottom trawl (codend mesh size (A) equal to 60 mm) was used, while for *J. portieri* and *S. omani* a four-panel midwater rope trawl (codend mesh size (A) equal to 90 mm) was applied. Taxonomic studied on these rare cephalopods, in this region, would be helpful for protecting their stocks as well as safely exploitation them.

Key words: *Abralia steindachneri, Cuttlefish, Joubiniteuthis portieri, Sepia omani, Squid.*

INTRODUCTION

Cephalopods are the smartest and the most complex invertebrates. Cephalopods have been living on the planet for about 500 million years and have fascinated humans for thousands of years (Hanlon *et al.*, 2018). The class Cephalopoda is subdivided into two subclasses named Coleoidea and Nautiloidea (Kröger *et al.*, 2011). Undoubtedly, subclass Coleoidea is more species-diverse and species-evolved in the class Cephalopoda (Kröger *et al.*, 2011; Voss *et al.*, 1998a; Voss *et al.*, 1998b); also, they have been become more interested in fishery purpose (Roper *et al.*, 1984). Coleoidea includes all living octopods, squids, and cuttlefishes, and also extinct forms such as belemnites (Hanlon *et al.*, 2018).

Cephalopods are an important component of both marine food webs and fisheries (Hunsicker *et al.*, 2010). As exploitation of commercial fish is increasing worldwide, low-harvest marine resources, such as Cephalopoda, are considered by many countries (Salahi-gezaz *et al.*, 2016). Moreover, Current demands have no historical precedent and ecosystems in which cephalopods are highly exploited as a targeted resource and as an ecological support service should be further evaluated to prevent the unsustainable development of marine fisheries within them. (Hunsicker *et al.*, 2010). In recent years, the three orders of Coleoidea Including Oegopsida, Myopsida, and Sepiida have participated in more than 50% of total cephalopods capture in the world (FAO website (online query), 2018). Therefore, the focus of researchers on these three orders indicates their importance (Adam & Rees, 1966; Rosa *et al.*, 2013a; Rosa *et al.*, 2013b). However, between 1997 and 2007, Cephalopods had been composed only one percent of RECOFI (Regional Commission for Fisheries including Islamic republic of Iran, Iraq, Bahrain, Qatar, Kuwait, Oman, UAE, and Saudi Arabia) captures in the Gulf of Oman and four percent in the Persian

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Gulf (FAO, 2010). So, this study aimed to find new species of cephalopods in the Iranian waters of the Gulf of Oman. The present study reports the first records of three cephalopods species from Iranian water bodies. These three species include *A. steindachneri* and *J. portieri* from the order Oegopsida and *S. omani* from the order Sepiida.

MATERIAL AND METHODS

The sampling was done in March and April 2019. The specimens were captured by a Myctophidae trawler (namely Aria-Jahan). Its specifications were 40 meters LOA, 8.60 meters beam, 3.50 meters bow draft, 4.40 meters stern draft, 396 tones GRT, 149 tones NRT, and 1200 Hp power. Used net to capture *A. steindachneri* was a two-panel bottom trawl and for capturing *J. portieri* and *S.omani* four-panel midwater rope trawl due to net rip was used. Codend and cover mesh size of two-panel bottom trawl were 60 and 120 millimeters (A), But Codend and cover mesh size of four-panel midwater rope trawl were 90 and 160 millimeters (A), individually. The geographic coordinates of the hauling for *A. steindachneri, J. portieri* and *S. omani* were 25°35.400' N-57°11.459' E (start) & 25°29.600' N-57°03.740' E (end), 25°34.000' N-57°12.500' E (start) & 25°26.585' N-57°02.802' E (end), and 25°35.567' N-57°12.272' E (start) & 25°29.200' N-57°04.166' E (end), respectively (Fig. 1). Google Earth Pro software was applied to draw the studied area maps. *A. steindachneri, S. omani, and J. portieri,* were found at 3-31 meters above the bottom (depth of the trawl activity) where the average bottom depth was 220.5, 230.5, and 264 m, respectively. Hauling period for *A. steindachneri* was 3 o'clock after 12 noon, while for *J. portieri* and *S. omani* was about 4 o'clock before 12 noon. The geographical direction domain of the hauls was between 220 and 245 degrees.

S. omani and *J. portieri* were identified using valid identification keys, the first volume of Cephalopods of the world (Jereb & Roper, 2005) and the second volume of Cephalopods of the world (Jereb & Roper, 2010), respectively. Whereas *A. steindachneri* either for its small size or difficult to identify was initially preserved in 5% formalin, thoroughly washed with fresh water after returning to the laboratory, and transferred to 70% ethanol (Urbano & Hendrickx, 2018). Then, the aquatic genus was determined in the Tree of Life web project (Young & Tsuchiya, 2018). Next, species were identified by examining tentacle clubs, eye photophores, and integumental photophores (Tsuchiya, 2009). Finally, weight, mantle length, fin length, tentacle length, head length, arm length, and the round of body of all species were measured (plus sexuality). The latest taxonomy of each species was written, according to WoRMS's website (2019).

SST (°C) and CHL-a (mg/m^3) data, were provided through the INCOD policy for Ocean and marine data management of the Iranian National Institute for Oceanography and Atmospheric Science same INIOAS (http://incod.inio.ac.ir). These parameters had been obtained from MODIS-Aqua atlas (since 2010). Wind velocity (m/sec), wind direction (Deg), wave height (m), and wave direction (Deg) were observed from Iranian waves estimation database of Port and Maritime Organization same PMO (http://77.77.77.42 in Persian). These parameters had been estimated by a suitable offshore wave buoy about 25°07' N-57°45' E. Concerning SST and CHL-a of the study area, the average of their monthly data was considered in the last decade (March also April). Besides, wind velocity, wind direction, wave height, and wave direction were taken into account when capturing operations of each species (daily average).

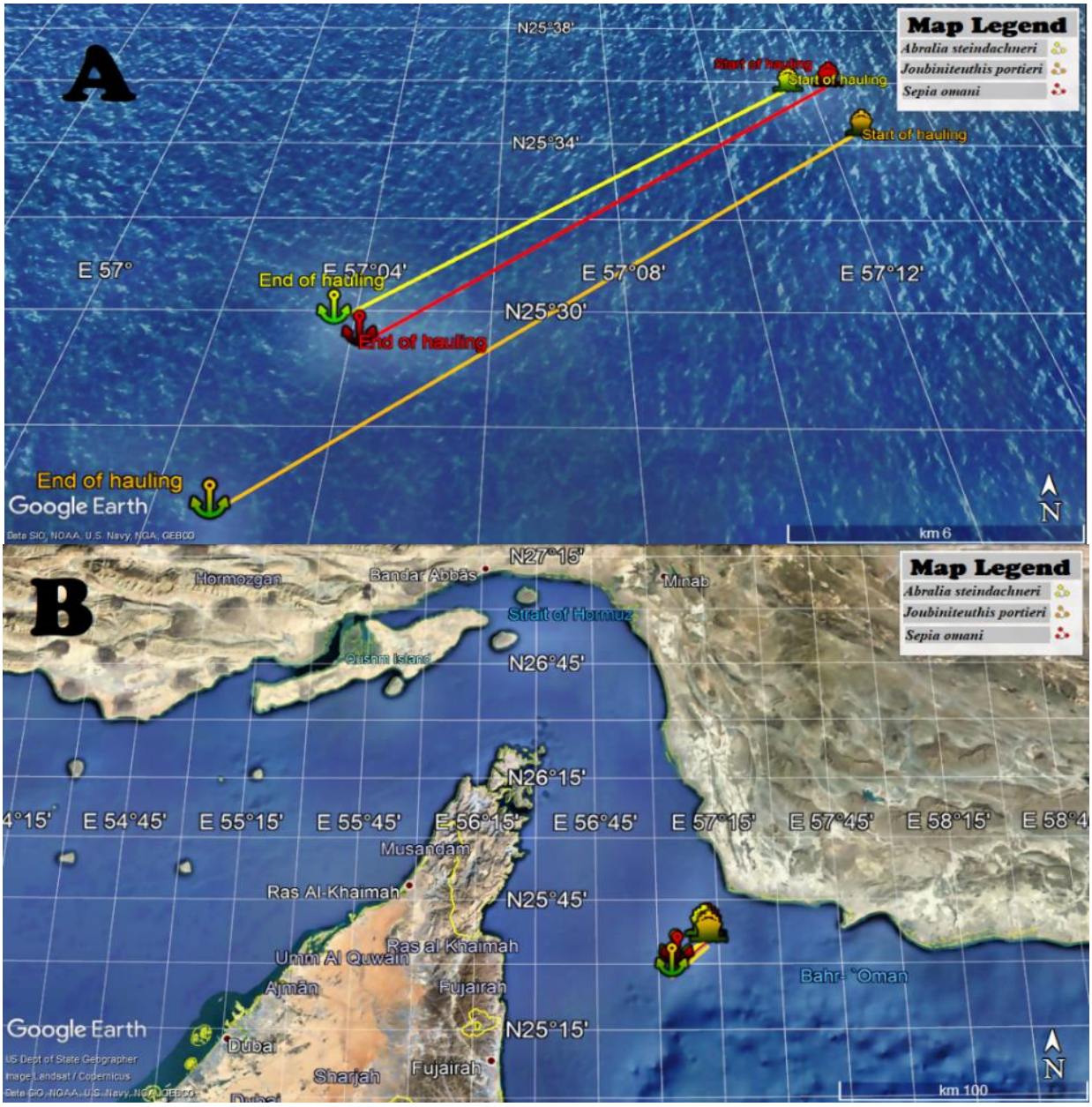

FIGURE 1. Geographical coordinates of studied area. A) hauling path for each species; B) study area in Iranian waters from north of the Gulf of Oman.

RESULTS

Abralia steindachneri Systematics: Phylum Mollusca Linnaeus, 1758; Class Cephalopoda Cuvier, 1795; Subclass Coleoidea Bather, 1888; Superorder Decapodiformes Young, Vecchione & Donovan, 1998; Order Oegopsida d'Orbigny, 1845; Family Enoploteuthidae Pfeffer, 1900; Genus Abralia Gray, 1849; Subgenus Abralia (Abralia) Gray, 1849; Species *Abralia (Abralia) steindachneri* Weindl, 1912.

Joubiniteuthis portieri or Joubin's squid Systematics: Phylum Mollusca Linnaeus, 1758; Class Cephalopoda Cuvier, 1795; Subclass Coleoidea Bather, 1888; Superorder Decapodiformes Young, Vecchione & Donovan, 1998; Order Oegopsida d'Orbigny, 1845; Family Joubiniteuthidae Naef, 1922; Genus Joubiniteuthis Berry, 1920; Species *Joubiniteuthis portieri* (Joubin, 1916).

Sepia omani or Oman cuttlefish Systematics: Phylum Mollusca Linnaeus, 1758; Class Cephalopoda Cuvier, 1795; Subclass Coleoidea Bather, 1888; Superorder Decapodiformes Young,

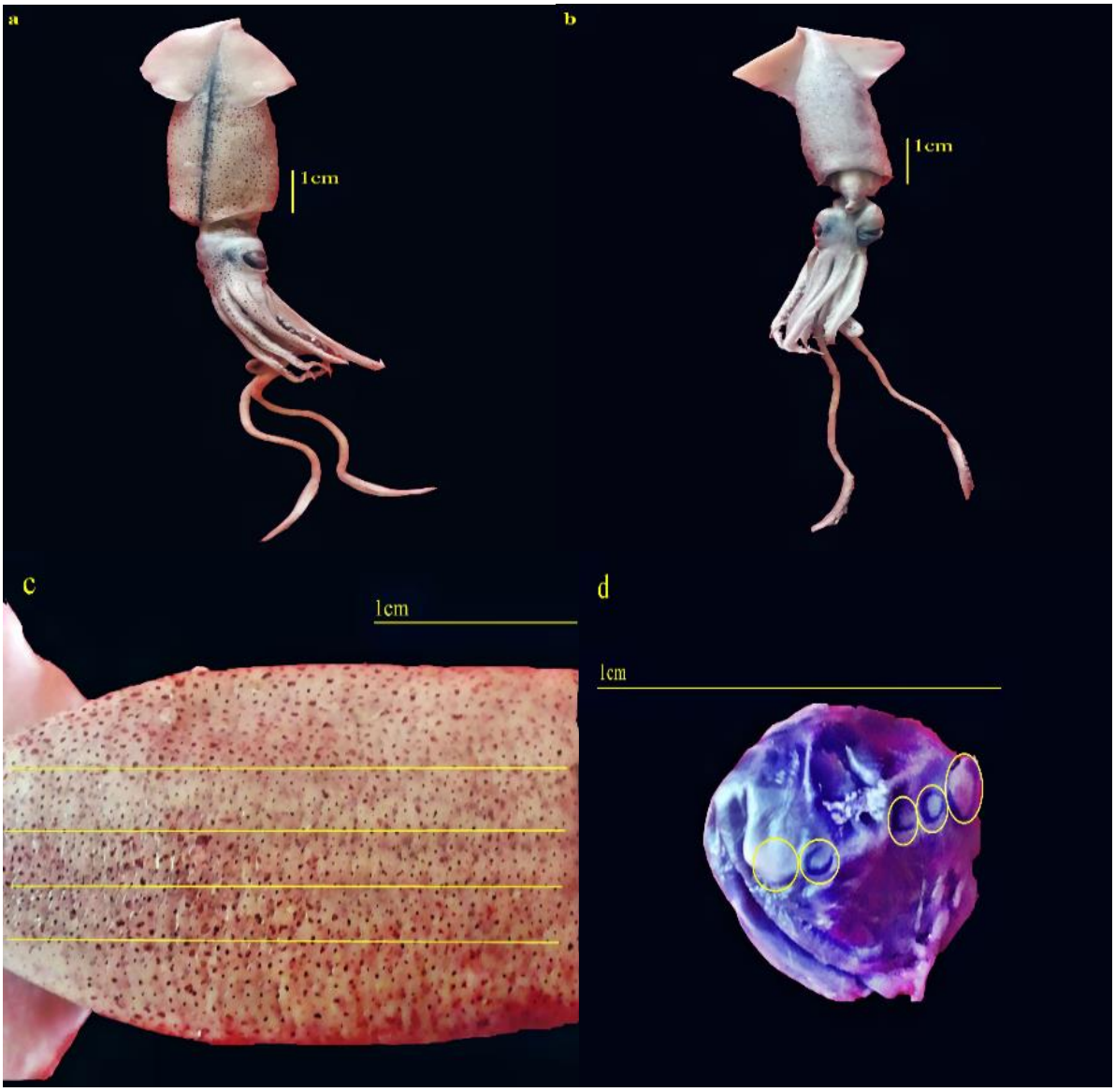

FIGURE 2. *Abralia steindachneri*: a) dorsal view; b) ventral view; c) integumental photophores from ventral view; d) eye photophores**.**

Vecchione & Donovan, 1998; Order Sepiida Zittel, 1895; Family Sepiidae Keferstein, 1866; Genus Sepia Linnaeus, 1758; Species *Sepia omani* Adam & Rees, 1966.

A. steindachneri (Fig. 2) diagnustic characters are: 1) six hooks on the ventral side of tentacle clubs, 2) four longitudinal stripes of integumental organs separated by photophore-less on the ventral mantle, and 3) five major complex organs on eyes including two large (terminal and opaque) organs also three intermediate (silvery) organs.

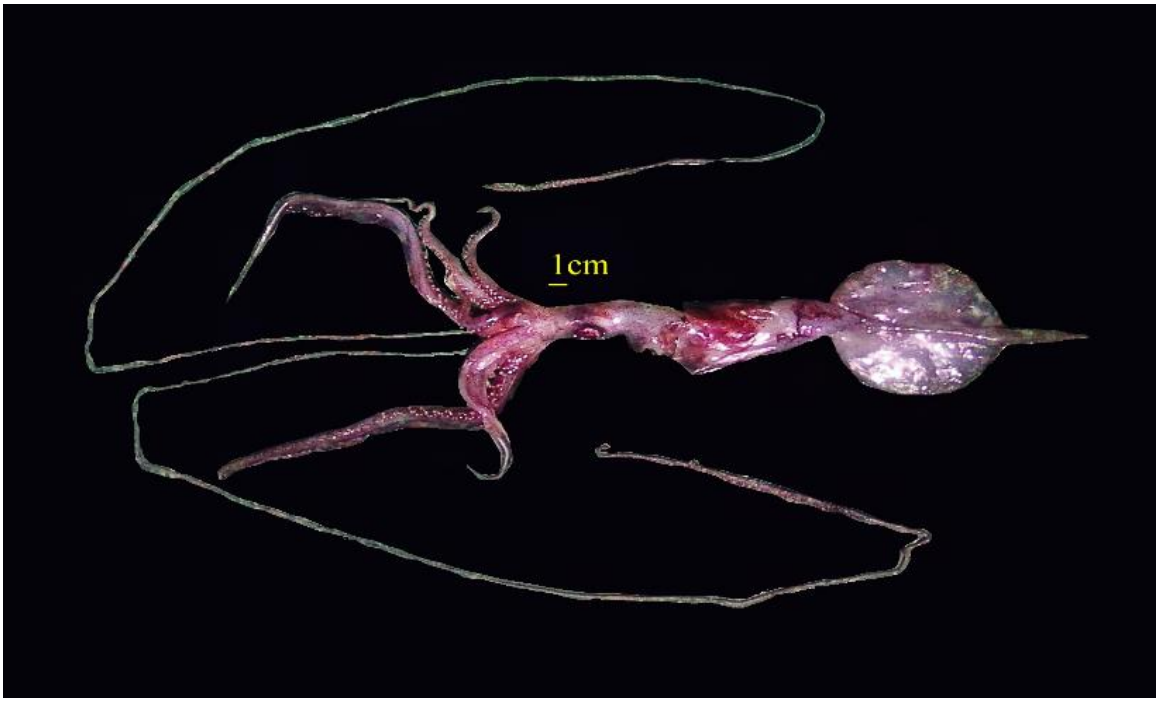

FIGURE 3. *Joubiniteuthis portieri*: dorsal view.

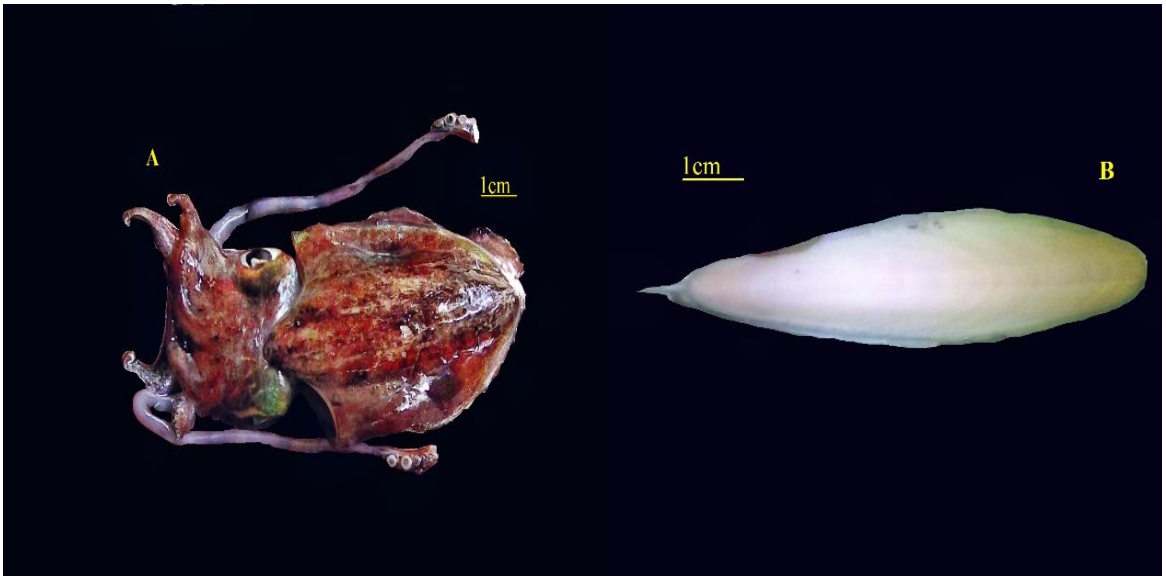

FIGURE 4. *Sepia omani*: A) dorsal view; B) dorsal view of cuttlebone.

J. portieri (Fig. 3) can be distinguished by: 1) a pair of extremely long and thin arms, 2) the thick and long tentacle (clubs), 3) narrow head, 4) long neck, 5) long tail, and 6) fins width and length are approximately equal

S. omani (Fig. 4) is recognizable with: 1) an oval mantle, 2) three suckers with different size in tentacle club, 3) light brown color, with dark brown transverse stripes in the dorsal mantle, and 4) Dorsal median rib, parallel sides, distinct lateral ribs, plus one long and pointed spine in the cuttlebone. The morphometric characteristics of the mentioned species are presented in Table 1. The extracted data from sea level, wind in the sea, moreover sea wave is given in Table 2.

TABLE 1. Morphometric characteristics of present specimens (Weights are in grams and lengths also rounds are in millimeters).

Species	Characters							
	Sex	Weight	Round*	Lengths				
				Mantle	Fin	Tentacle	Head	Arm
Abralia steindachneri	Female	10	34	43	17	78	15	36
Joubiniteuthis portieri	Female	50	70	165	64	788	44	135
Sepia omani	Male	80	112	83	72	175	28	31

*Round the body.

TABLE 2. Some sea level, wind in the sea, and sea wave characteristics (SST in degree centigrade, CHL-a in milligram per cubic meter, wind velocity in meter per second, wind direction in degree, wave direction in degree, and wave height in meter).

Species	Sea level		Wind		Sea wave	
	SST (M^a/A^b)	CHL-a (M/A)	velocity (D^c ± $S.D^d$)	direction (D ± S.D)	height (D ± S.D)	direction (D ± S.D)
All species	16-32.50/16-32.50	0.8-9/0.09-3.4	-	-	-	-
Abralia steindachneri	-	-	3.44±1.79	248.7±115.59	0.43±0.17	151.71±77.05
Joubiniteuthis portiere	-	-	1.8±0.77	194±76.79	0.14±0.01	142.98±5.49
Sepia omani	-	-	5.01±1.07	125.66±11.20	0.38±0.11	318.40±6.10

[a] March since 2010 (limit); [b] April since 2010 (limit); [c] Daily average; [d] Standard Deviation

DISSCUSSION

The first record of *Abralia steindachneri* was in Shadwan Island in the Red Sea (Weindl, 1912). This species is quite large in comparison to the other congeners and has a mantle length of 50 mm. *A. steindachneri* is widely distributed in the Indo-West Pacific Ocean where it can be associated with shelf waters (Tsuchiya, 2018). Moreover, *A. steindachneri* is a mesopelagic species (Jereb & Roper, 2010). *Joubiniteuthis portieri* was reported for the first time from the Eeastern Central Atlantic Ocean (Joubin, 1916). The species is distributed in tropical, subtropical, and even temperate waters, especially in the Atlantic Ocean. *J. portieri* is a meso- to bathypelagic species (Jereb & Roper, 2010). The first observation of *Sepia omani* was in the South of the Gulf of Oman (Adam & Rees, 1966) and it is a neritic demersal species (Jereb & Roper, 2005). Other records of *S. omani* and *J. portieri* were from west of India (Sundaram, 2011) and east of Japan (Okutani & Kubota, 1972); respectively. While cuttlefish in Sundaram (2011) work is a *Sepia prashadi* sample (actually it is not *Sepia omani*).

Perhaps Melvill and Standen (1901) were one of the pioneers in terms of cephalopods studies in the Gulf of Oman that their study focused on the Mollusca of the Persian Gulf, Gulf of Oman and the Arabian Sea. Investigation of Rajabipour *et al.* (2001), after a century gap, was one of the recent and the most remarkable research in this case. They identified four species and one genus of squids in the Iranian waters of the Gulf of Oman (*Ancistrocheirus lesueurii, Liocranchia reinhardtii, Sthenoteuthis oualaniensis, Loligo duvaucelii, and Loligo sp*). According to the evidence provided by FAO (Jereb & Roper, 2005; Jereb & Roper, 2010; Jereb *et al.*, 2016), the species diversity of cephalopods in Iranian waters should be higher in the Gulf of Oman compared to the Persian Gulf. In this study, we have recorded three species *A. steindachneri, J. portieri,* and *S. omani* for the first time in Iran waters in the northwest Gulf of Oman. Hence, we believe that these findings would enhance our knowledge and understanding of the global distribution of these three species. Further studies are required to ventilate data on the likelihood of encountering more records in Iran. Probably, the paucity of cephalopods' records in Iran might be due to the lack of comprehensive samplings.

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