Catch Per Unit Area (CPUA) estimation and distribution pattern of pharaoh cuttlefish from North Coast of Gulf of Oman

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Abstract

This research was carried out to assess the amount of Catch Per Unit of Area (CPUA) and also to determine the distribution pattern of *Sepia pharaonis* as one of the common species of cuttlefish caught in the north coast of the Gulf of Oman. Sampling was conducted at 70 trawl stations along the north coast of the Gulf of Oman (Meidani (58° 55' E) to Gwatre Bay (61° 30' E)) using classified random method. The study area was stratified to five stratum (A to E) covering the depth layers of 10-20, 20-30, 30-50 and 50-100 m. The highest value of CPUA for *S. pharaonis* was recorded in the central part of the study area (stratum C or Gordim and Rashedi, 1418 kg/nm2) and in depth layer of 50-100 m (819.1 kg/nm2). While, the lowest value was observed for stratum D (Chabahar, Konarak and Ramin, 24.6 kg/nm2) and in depth layer of 10-20 m (61 kg/nm2). It was concluded that the density of *S. pharaonis* showed ascending trend with increasing the depth. As an overall result, the west part of the Gulf of Oman were the ideal fishing ground for Pharaoh cuttlefish and the central region had the lowest density due to high fishing pressure of Pharaoh cuttlefish by fishermen in Chabahar and Konark.

Keywords: Demersal fishes, Catch Per Unit Area, *Sepia pharaonis*

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Introduction

Sepia pharaonis, a coastal Indo-West Pacific species, is the largest cuttleflsh in the Gulf of Oman. It grows up to 80 cm or slightly more in dorsal mantle length (Sundaram, 2014). The *S. pharaonis* is native to at least the western Indian Ocean, including the Red Sea and Gulf of Oman (Al-Marzouqi *et al*., 2009). It holds a special position in fisheries in this region because of its economic importance in the export trade (Nair *et al*., 1993). This species supports industrial or artisanal fisheries throughout its range.The great bulk of the landings is obtained as by catch in trawlers in Gulf of Oman, while a small portion comes by traps in the Persian Gulf and is one of the most important cuttlefish species fished in both areas (Jereb and Roper, 2005).

Increase fishing pressure is threatening the sustainability of commercial aquatic resource in the Gulf of Oman. Currently, there are few effective management controls in this area. Due to the vulnerability of aquatic systems, it is necessary to monitor the changes in aquatic stocks and trends. Bottom research trawler as regional fishery survey in different populations is a method to achieve this goal. Various studies have provided valuable information on the abundance of demersal fish stocks in the Gulf of Oman over the last decades. The first research of bottom trawls as a coastal fishery in the Gulf of Oman was conducted between 1976 and 1979 by UNDP/FAO (Kesteven *et al*., 1981). A number of trawl surveys have recently been conducted to investigate Catch Per Unit of Swept Area (CPUA) and demersal fish biomass in the Gulf of Oman (Ghotbeddin *et al*., 2015; Mirzaei *et al*., 2017; Zeinali *et al*., 2017; Mirzaei *et al*., 2019; Mahmoodzadeh and Sahand, 2020). Although extensive research has been carried out on biological and morphological aspects (Valinasab *et al*., 2001), Population diversity (Valinassab, 1999) and phylogenetic analyses (Anderson *et al*., 2007) of *Sepia pharaonis*, no single study exists which adequately covers distribution, and CPUA of this species in the north coast of Gulf of Oman. The aim of this study, therefore, was to determine CPUA and distribution of *Sepia pharaonis* from different stratum and depth layers in the northern part of Gulf of Oman, Iranian territorial waters.

Material and methods

The survey was conducted between October 2019 and November 2019 in the northern region of the Gulf of Oman between longitudes 58º55’ E (Meidani) and 61º30’ E (the Gwatre Bay) by R/V Ferdwos 1 equipped with fish bottom-trawl net (headline 72 m) (Fig. 1). The study area was divided, from west to east, into 5 stratum (A, B, C, D and E), each stratum was classified into four depth layers of 10 – 20 m, 20-30 m, 30-50 m and 50–100m. A total of 70 trawl stations was selected following a stratified random procedure, and at each station a one-hour haul was taken at the speed of 3 knots.

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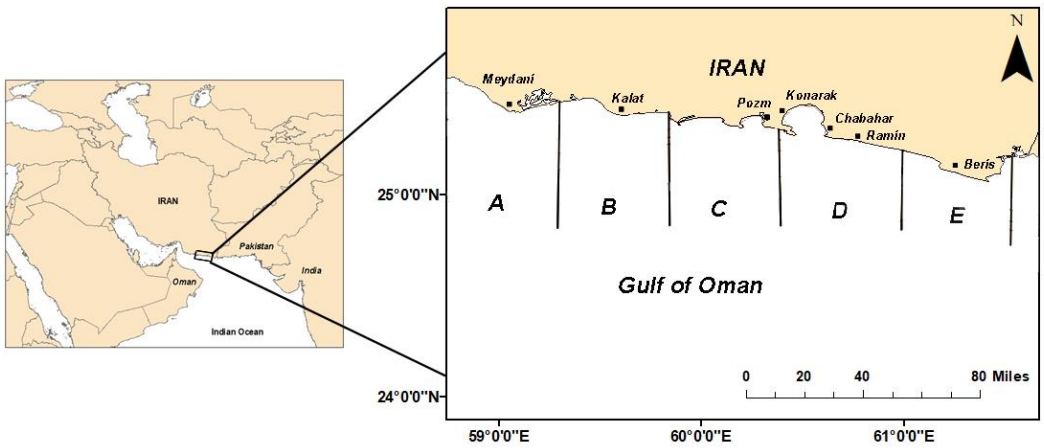

Figure 1: Map of sampling area along the Gulf of Oman, 2019.

The total area of each stratum or depth layer was calculated by using a plannimeter, which is given in Tables 1 and 2, respectively. For each trawl, date, time, duration, bottom depth, GPS position, towing distance, and towing speed were recorded in special log sheets.

Table 1: Characteristics of the study area in the north coast of Gulf of Oman

	A	*B*	*C*	*D*	*E*
Area (nm^2)	115.99	180.93	235.00	268.50	363.80
Longitude	55°58E-59°25E	59°25E-59°55E	59°55E-60°25E	60°25E-60°55E	60°55E-61°25E

Table 2: Area of depth layers in the north coast of Gulf of Oman.

	10-20	*20-30*	*30-50*	*50-100*
Area (nm^2)	358.30	178.26	174.08	453.58

All the catch was transferred on board, and all the sizeable samples were sorted, counted and weighed. Subsamples of small discards were collected for assessment the total weight and number of pharaoh cuttlefish catch.

The following equation was used to calculate CPUA in trawl survey (Valinassab *et al.*, 2006): CPUA=Cw/a. Where the Cw is catch weight (kg), and "a" is swept area (nm^2) for each hauling that is calculated by a= D.h.X1,
Where D is the distance covered (nm), h= the headline height (m), and X1=the wing spread coefficient (is equal to 0.6). Also, the Arc-GIS software (Version 10.2) was used to create distribution pattern map of pharaoh cuttlefish using the Inverse Distance Weighting (IDW) method.

Results

The mean CPUA was estimated as 340.2 nm^2 during the study period. The highest mean CPUA value observed in stratum C (1418 nm^2) as the main fishing grounds comparing to the other covering stratum and the lowest value

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was estimated in stratum D (24.6 nm^2) (Fig. 2).

The results obtained from the catch per unit area in different depth layers are shown in Figure 3. CPUA had an ascending trend by increasing the depth. The highest and lowest value belonged to the depths 10-20 and 50–100 m, respectively.

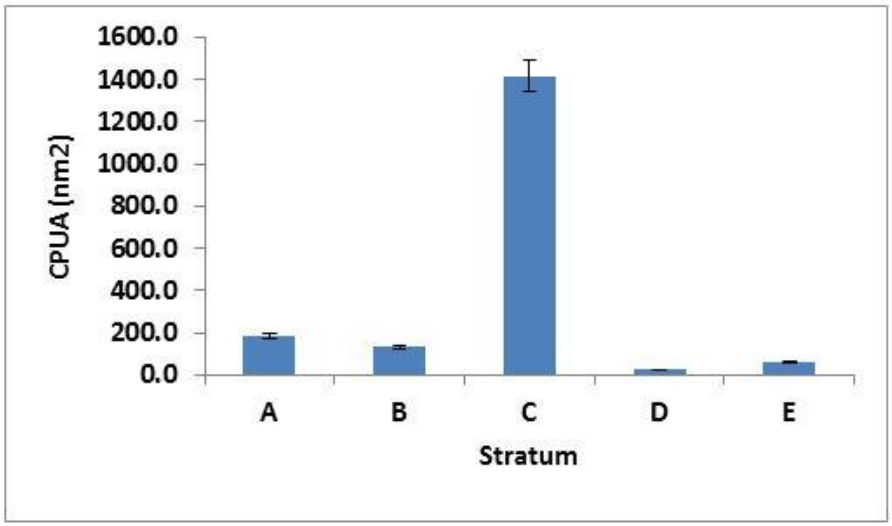

Figure 2: CPUA of *S. pharaonis* for different stratum from the north coast of Gulf of Oman.

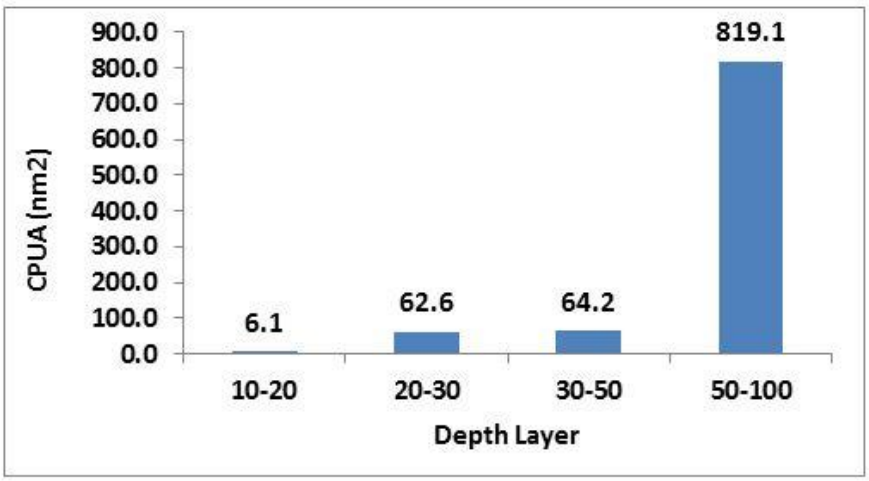

Figure 3: Catch per unit area (kg/ nm^2) of *S. pharaonis* for different depth layer from the north coast of Gulf of Oman.

Figure 4 showed the pharaoh cuttlefish widely distributed throughout the waters of the Gulf of Oman in different stratum and depth layers. The highest abundance and distribution of *S. pharaonis* was observed in the central part of the study area (Stratum C) and most of the *S. pharaonis* abundance was found in the deeper areas with an ascending trend with increasing the depth.

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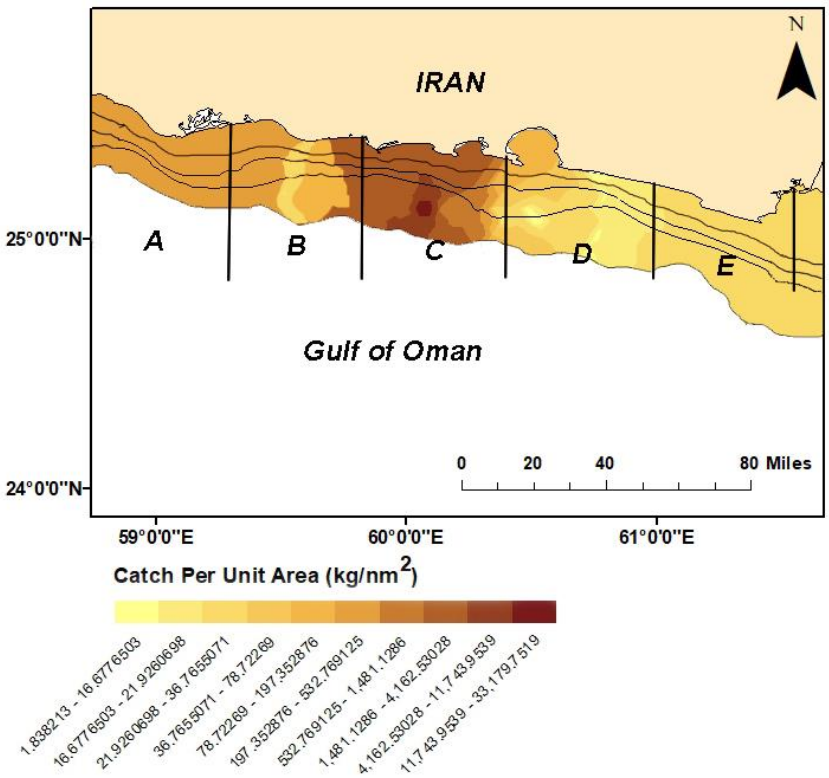

Figure 4: The distribution pattern of *S. pharaonis* from the north coast of Gulf of Oman.

Discussion

In the fishing industry and stock assessment, the catch per unit Area (CPUA) is a technique for evaluating the abundance of a target species. In stock assessment studies, the employment of data obtained from trawling surveys is more reliable than the information obtained from commercial fisheries. The present study was designed to determine the amount of CPUA of the pharaoh cuttlefish, *S. pharaonis* for different stratum and depth layers. The results of this study reveal that density and frequency of *S. pharaonis* in stratum C and depth layer 50-100 m are significantly more than other stratum and depth layers.

The results of this study show the highest value of mean catch per unit area is in stratum C (1418 nm^2) in centeral part of Gulf of Oman. In a comprehensive study which set out to monitoring of demersal resources in the Gulf of Oman, Valinassab (2013) reported that the highest amount of mean CPUA (375.3 kg/mn^2) of *S. pharaonis* was for stratum A in the western region of Gulf of Oman. In another study by Abbaspour Naderi *et al*. (2018), the highest mean CPUA of *S. pharaonis* in Gulf of Oman was calculated in stratum A (894 kg $/mn^2$). A possible explanation for these differences may be due to high trawling activity and subsequently higher fishing effort in western part of Gulf of Oman.

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Another possible reasons for the occurrence of such differences in CPUA may be due to tow duration, number of hauls and survey season. This finding is consistent with that of King (2007) who believes that the overexploitation cause lack of having a safe and suitable ecosystem and consequently cause the obligatory migration of fishes to other areas and shifting to a new fishing ground.

The stratum D and E showed the lowest amount of CPUA. This result is in agreement with the findings of research cruises in 2012 and 2016 in which as a permanent finding the lowest value of CPUA belonged to stratum D and E (Valinassab, 2013; Abbaspour Naderi *et al*., 2018). Therefore, as an overall result it can be concluded that the lowest density and frequency of *S. pharaonis* is found on the east coast of Gulf of Oman in border with Pakistan waters. One of the main reasons of the low density of *S. pharaonis* in the stratum D and E can be due to the high activity of illegal fisheries, higher fishing effort (CPUE) and using non-standard fishing gears in which have damaged to *S. pharaonis* resources or by overexploitation of other fishes in food web leading to decrease the amount of food and preys.

From point of depth, the maximum CPUA of *S. pharaonis* found in depth layer of 50-100 m, with value of 819.1 kg/nm^2 and the lowest value was estimated for depth layer of 10-20 m consist of 6.1 kg/nm^2. The results of previous studies indicated that the maximum CPUA of pharaoh cuttlefish was estimated for depth of 50-100 m and it is in agreement with findings of this study showing the highest amount of CPUA for 50-100 m depth layer as the best recommended depths for commercial fishing. As an overall review on previous studies and including the obtained findings of this investigation, it can be concluded that commercial fishing operation of *S. pharaonis* should be done at depths of 50-100 m. In addition, it can be drawn from the present study that stratum C located in the central part of Gulf of Oman considered as the main fishing grounds for this species as a commercial aquatic resource from the point of higher density and distribution. This can provide the basic information to access a sustainable management of pharaoh cuttlefish resource.

Despite existing restrictions on fishing effort, it is necessary to regularly monitor the stock of this species. As well as reproductive characteristics and population dynamics should be investigated to achieve adequate information to control these stocks effectively to create a sustainable exploitation of this species.

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