E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2024; 12(1): 117-125

www.fisheriesjournal.com
Received: 14-12-2023
Accepted: 19-02-2024

Haiba Essam Gaber
Faculty of medicine, University of Derna, Derna, Libya

Ramadan AS Ali
Department of Zoology, Omar Al-Mukhtar University, Albaida, Libya

Sayed Mohamed Ali
Department of Zoology, Omar Al-Mukhtar University, Albaida, Libya

Corresponding Author:
Haiba Essam Gaber
Faculty of medicine, University of Derna, Derna, Libya

Habitat, morphology and age of cuttlefish and squids (Cephalopoda) in the southern Mediterranean Sea (Bumba Bay, eastern Libya)

Haiba Essam Gaber, Ramadan AS Ali and Sayed Mohamed Ali

DOI: https://doi.org/10.22271/fish.2024.v12.i1b.2899

Abstract
Habitat, morphology, and age composition of cuttlefish and squids of Bumba Bay, Southern Mediterranean Sea, were established. The random sample collected consisted of *Sepioteuthis lessoniana* (40 individuals), *Sepia officinalis* (31), *S. prashadi* (18), *S. elegans* (14), *S. orbignyana* (3), and three unidentified species designated Sb (6), Sc (4), and Sa (1). Twenty-seven key morphometric parameters measured for individual species were correlated with each other, and related to total length and body weight by regression equations. The cuttlefish and squids, by order of decreasing total weight were *Sa*, Sb, Sc, *S. officinalis*, *Sepioteuthis lessoniana*, *S. prashadi*, *S. elegans* and *S. orbignyana*; by order of decreasing body length, they were: *Sa*, *S. officinalis*, Sc, Sb, *Sepioteuthis lessoniana*, *S. prashadi*, *S. elegans* and *S. orbignyana*. Values of the Fulton condition factor of these species were comparable, ranging from 11.58±1.753 for mixed males/females Sc to 14.52±1.852 for male *S. orbignyana*. Females of *S. officinalis*, *Sepioteuthis lessoniana* and Sb had higher condition factor than males. *S. orbignyana* and *S. prashadi* were all males. Based on total length frequency distribution, *Sepioteuthis lessoniana* and *S. officinalis* populations consisted of single one-year-old cohorts. Cuttlefish and squids migrate to shallow, sandy, coastal water to breed during February to April.

Keywords: *Sepia, officinalis, Sepioteuthis, lessoniana, prashadi, elegans, orbignyana*, cuttlefish, squids, morphology, age cohort, Mediterranean Sea

Introduction

Cephalopoda, a major class of the phylum MolluSca, comprises 800 to 1000 known species distributed among cuttlefishes, squids, octopuses, and nautili (Hassan, 1974; "Welcome to CephBase", 2016) [1, 2]. Cephalopod fishery is important worldwide. Cephalopods are considered a delicacy food with high nutritional and medical value in many parts of the world. Many of the Mediterranean Sea countries practice cephalopods fishery; for example, in Egypt Mediterranean Sea, cephalopods constitute 9.8% of the total fish catch (Riad, 1993) [3]. In Libya, Abdulrraziq (2014) [4] recorded 4 Sepiidae species (*Sepia officinalis, S. orbignyana, S. elegans* and *S. prashadi*) that constitute, with other cephalopods, the basis of a small but significant seasonal artisanal fishery. However, the size of the potential has not been determined, and fisheries statistics and biological studies, are lacking. Among the countries that delineate the Mediterranean Sea, Libya has the longest coastline (1970 Km). However, the fisheries contribution to the national economy does not match the available resource (Abu Madinah, 2008) [5].

The objective of this study was to identify cuttlefish (Order Sepiida) and squids (Order Teuthida), (Superorder Decapodiformes) present in the southern Mediterranean Sea, exemplified by Bumba Bay, eastern Libya, and establish the nature of their coastal habitat, morphological traits, and cohort ages.

Procedures and Methods

Cuttlefish and squid samples used in the present study were collected from Bumba Bay (32°25' N-23°06' E), a very shallow lagoon (Fig. 1) that is an important wetland and bird habitat. Bumba Bay is typical of the lagoons that embay the southern Mediterranean coast.

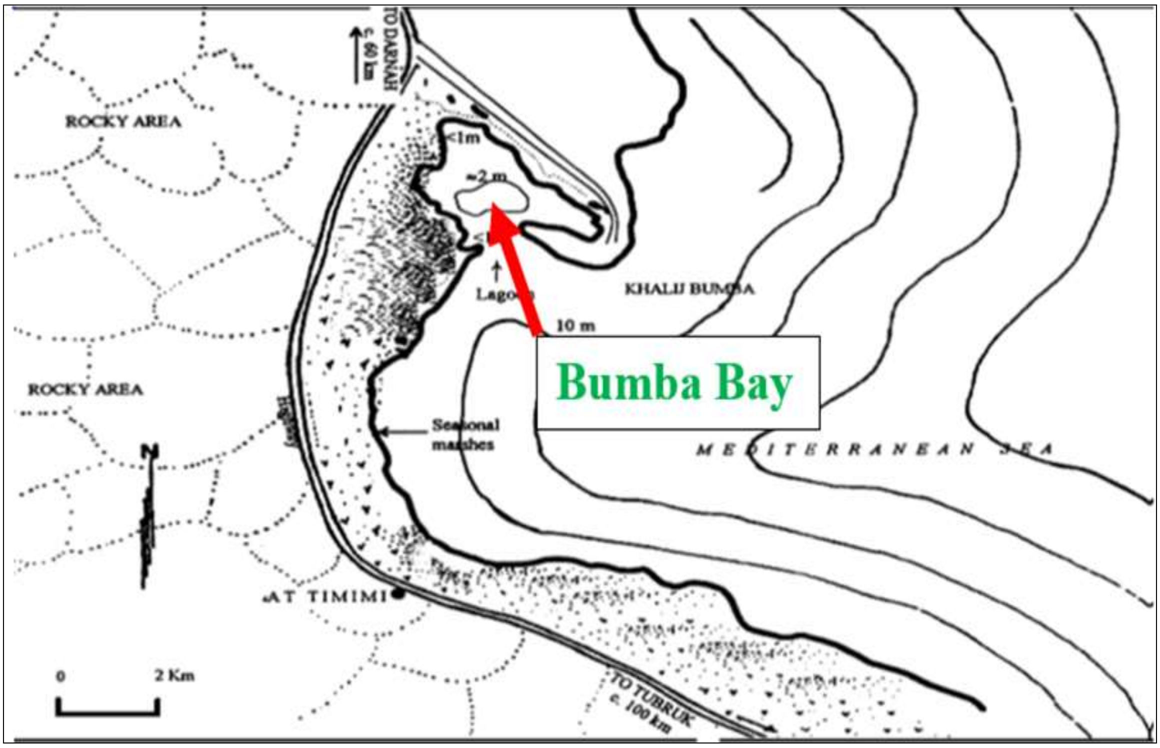

Fig 1: Bumba Bay, from which cuttlefish and squid samples used in the present study were collected (Reynolds *et al*., 1995) [6].

Habitat and fishery of the studied cephalopods

These were established through visits to fishing and landing sites in Bumba Bay, as well as interviewing the local fishers there.

Collection of the study samples

A total of 117 samples were collected randomly from the artisanal catch of Bumba Bay during winter and spring (January to April), 2019. The samples were identified according to Abdulrraziq (2014) [4] as *Sepioteuthis lessoniana* (40 individuals), *S. officinalis* (31), *S. prashadi* (18), *S. elegans* (14), and *S. orbignyana* (3) species; another three species, designated Sb (6), Sc (4) and *Sa* (1), were sent abroad for identification.

The morphometric study

Twenty-seven morphometric parameters (Table 1 and Fig. 2) were measured for the individual samples. Then the samples were dissected to establish their sex and remove their beaks, radulae, and shells.

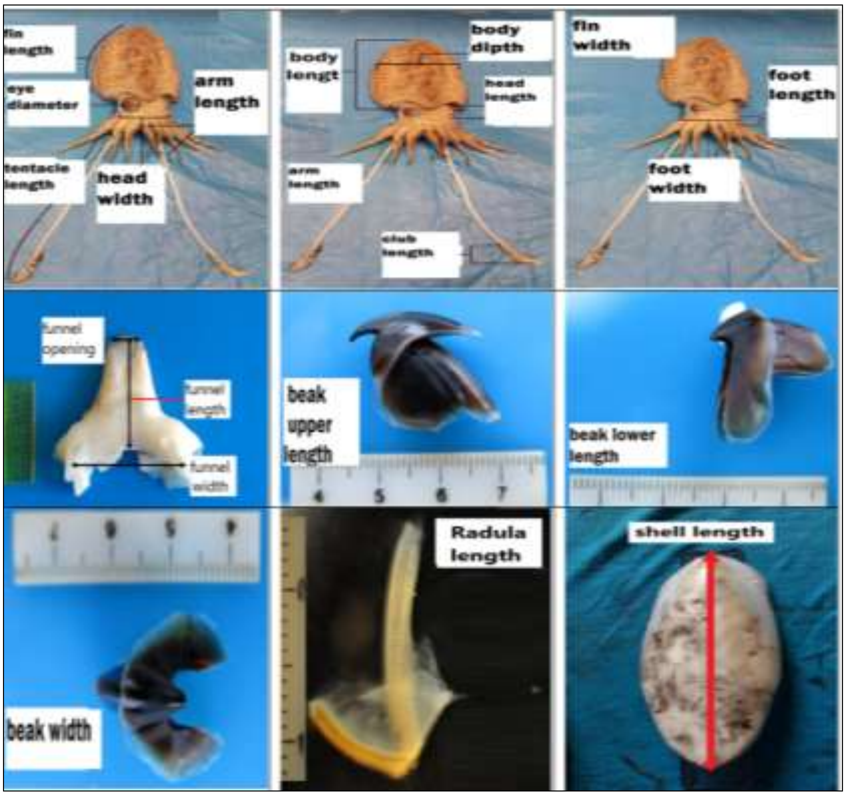

Fig 2: Some of the different morphometric measurements taken for *Sepia officinalis.*

Table 1: The morphometric parameters measured for the individual samples.

Measured parameters	Code	Measured parameters	Code	Measured parameters	Code
Total weight	Tw	5th arm length	A5l	Shell weight	Swe
Total length	Tl	Fin length	Fl	Beak Upper Length	Bul
Body length	Bl	Fin width	Fw	Beak Lower Length	Bll
Body depth	Bd	Foot length	Fol	Beak Width	Bw
Head length	Hl	Foot width	Fow	Funnel Length	Ful
Head width	Hw	Eye diameter length	EDl	Funnel width	Fuw
Tentacle length	Tel	Eye diameter width	EDw	Funnel opening length	Fuol
Club length	Cl	Shell length	Sl	Radula free length	Rl
1st arm length	A1l	Shell width	Sw	Radula attached length	R2

The length-weight relationship

Power, linear and logarithmic regressions of the total length-total weight (Tl-Tw) and body length-total weight (Bl-Tw) were calculated for the individual species according to Le Cren, (1951) [7] and Ricker (1975) [8]:

$Tw = {}_aTl^b$ in power; $Tw = a + bTl$ in linear; $Tw = a + b \log Tl$ in logarithmic regressions.

Where: Tl: Total length in centimeters and Tw: Total fish weight in grams. "a" is the intersection of the regression line on the y axis, "b" is the slope of the line.

Condition factor

Fulton's (1902) [9] condition C_F was calculated as:

$$C_F = 100\ Tw/Tl^3$$

Aging of the collected species

Examination of shells and beaks of the collected samples did not reveal the presence of clear annual growth rings that could be used for aging. Therefore, the frequency distribution of total length and body length was used for aging *Sepioteuthis lessoniana* and *S. officinalis*. The other species were not aged because their numbers were too small to generate frequency distributions.

Results

Habitat and fisheries

Mature cephalopods migrate to the shallow, sandy, protected coastal waters of Bumba Bay (and the other coastal lagoons found Scattered along the Libyan coast) from February to April to breed. During this period, they are caught, together with other fishes, by lured and baited lines, and trammel drag nets. Fishing takes place during dark nights (moonless nights). Light and bait are used to attract cephalopods and fish to the gear area. In Libya, cephalopods are consumed only by a few people.

The average total weight and body depth of the species under consideration

Sepioteuthis lessoniana was the most common species; of the 117 collected samples, 90 were males and 27 were females (Table 2). The species by order of decreasing total weight (Table 2) were: Sb, Sc, *S. officinalis*, *Sepioteuthis lessoniana*, *S. prashadi*, *S. elegans* and *S. orbignyana*; by order of decreasing body length (Table 3), they were: *Sa*, *S. officinalis*, Sc, Sb, *Sepioteuthis lessoniana*, *S. prashadi*, *S. elegans* and *S. orbignyana*. The other measured morphometric parameters are given in Table 4; differences between the means of the parameters of the studied species became minimal when the parameters were related to total length by as percent ratio. This procedure decreases the effect of size (Table5). Females tend to be larger than males (Tables 2 and 3).

Table 2: Mean total weight (Tw ± StE in grams) of the studied species by sex. No: nonmember of individuals per species. Means with different superScripts are significantly different.

Sex Species	Mixed	No. (%)	Male	No.	Female	No.	Male / female
S. officinalis	a 373.8±17.8	31(26.5%)	A 371.4±17.9	30	a445.00	1	1:0.03
S. elegans	a 194.9±28.7	14(12%)	A 145.1±23.1	8	a261.3±49.4	6	1:0.75
S. orbignyana	-	3(2.6%)	161.7±26.0	3	-	0	1:0
S. prashadi	-	18(15.4%)	250.8±20.0	18	-	0	1:0
Sepioteuthis lessoniana	a276.1±16.4	40(34.9%)	b247.1±18.1	27	c336.1±27.5	13	1:0.48
Sa	-	-	-	0	576.00	1	0:1
Sb	a451.0±66.6	6(0.0%)	a477.5	2	a342.7±61.0	4	1:2
Sc	a406.0±78.9	4(3.4%)	a275.0	2	a 537	2	1:1

Table 3: Mean body length (Bl ± StE in cm) of the studied species by sex. Means with different superScripts are significantly different.

Sex Species	Mixed	Male	Female
S. Officinalis	14.71± 0.32 ^{a}	14.70±0.33 ^{a}	15.00 ^{a}
S. elegans	10.75±0.61 ^{a}	9.63±0.59 ^{b}	12.25±0.072 ^{c}
S. orbignyana	-	10.33±0.66	-
S. prashadi	-	12.43±0.44	-
Sepioteuthis lessoniana	12.88±0.28 ^{a}	12.44±0.34 ^{a}	13.81±0.39 ^{a}
Sa	-	-	16.00
Sb	13.33±1.10 ^{a}	15.50±1.36 ^{a}	13.50±1.36 ^{a}
Sc	14.12±1.08 ^{a}	12.50 ^{a}	15.75 ^{a}

Table 4: Means ± StE of the studied species' morphometric parameters. The minimum and maximum values were placed within parenthesis below the means. Weights are in grams, and lengths in centimeters.

Parameters	*S. officinalis*	*S. elegans*	*S. orbignyana*	*S. prashadi*	*S. lessoniana*	*Sa*	Sb	Sc
Tw	abc 373.8±17.8 (203-589)	h 195±287 (66-403)	efgh 161.7±26.0(115-205)	bdefgh 250.8±20.0 (87.0-394.0)	cdgh 276.1±16.4 (117 -521)	abcd 576.00	a 451.0±66.6 (226-723)	abcdefg 406.0±78.9 (260-590)
Tl	ab 45.60±1.22 (29.0-56.0)	b 35.57±2.1 (21.050.0)	ab 36.7±0.9 (35.0-38.0)	ab 41.7±1.4 (28.0-50.0)	a 42.6±0.8 (31.0-52.0)	ab 51.00	a 46.17±1.89 (39.0-52.0)	a 46.4±2.4 (41.0-52.5)
Bl	a 14.7±0.32 (10.5-18.0)	ce 10.8±0.6 (7.5-15.0)	bcdef 10.3±0.7 (9.0-11.0)	def 12.4±0.44 (8.5-15.0)	f 12.9±0.3 (9.0-17.0)	abcdef 16.00	abcdef 13.3±1.1 (8.5-15.5)	abdf 14.1±1.09 (12 -17)
Bd	ab 11.1±0.3 (9.0-14.0)	f 8.3±0.5 (6.0-11.5)	cdef 8.0±0.5 (7.0-8.5)	bdef 9.4±0.39 (6.5-12.5)	abe 9.9±0.2 (6.5-14.0)	ab 14.0	a 11.7±0.7 (9.0-14.0)	abcde 11.5±0.9 (9.5-14.0)
Hl	a 3.5±0.1 (2.0-5.5)	a 2.8±0.1 (2.0-3.5)	a 2.3±0.2 (2.0-2.5)	a 2.9±0.16 (1.5-4.0)	a 3.4±0.1 (2.0-6.1)	a 4.00	a 3.75±0.33 (2.50-4.50)	a 3.9±0.2 (3.5-4.4)
Hw	a 6.9±0.1 (5. 9-9.0)	c 4.9±0.3 (3.0-6.5)	abc 5.1±0.0 (5.1-5.2)	ab 5.5±0.2 (3.8-7.0)	c 5.3±0.2 (3.5-7.7)	abc 6.50	ab 6.71±0.38 (6.0-8.5)	abc 6.2±0.3 (5.5-7.0)
TeL	a 31.8±1.0 (3.8-40.0)	bc 21.1±2.1 (9.0-33.0)	abc 25.3±1.2 (23.0-27.0)	ac 26.7±.12 (13.0-34.0)	a 28.2±0.6 (19.0-35.0)	abc 34.0	a 32.5±1.3 (30.0-39.0)	abc 29.2±1.6 (25.0-33.0)
Cl	ace 4.0±0.1 (2.0-7.0)	efgh 3.6±0.2 (2.0-5.0)	abcdefgh 3.1±0.1 (3.0-3.5)	Cdgh 3.2±0.2 (1.6-5.3)	bdfh 3.0±0.1 (0.31-5.4)	abdefgh 6.0	a 5.2±0.1 (5.0-5.50)	a 5.1±0.4 (4.0-6.0)
A1l	a 10.2±0.3 (5.5-15.0)	b 7.1±0.6 (3.5-1.0)	ab 6.00±1.00 (4.0-7.0)	ab 9.3±0.4 (5.0-13.0)	ab 9.3±0.4 (5.0-16.2)	ab 8.0	ab 8.3±0.5 (7.0-11.0)	ab 8.3±0.6 (7.0-10.0)
A5l	a 8.3±0.2 (4.0-11.0)	c 5.0±0.4 (3.0-8.0)	ab 4.5±0.5 (3.5-5.0)	ab 7.03±0.4 (2.5-11.0)	b 6.9±0.2 (4.0-11.0)	abc 8.0	abc 7.0±0.6 (5.0-9.0)	abc 6.1±0.6 (5.0-7.3)
Fl	a 17.7±0.5 (13.0-29.0)	bdf 11.7±0.7 (7.5-17.0)	cdef 12.1±0.6 (11.0-13.0)	ef 14.5±0.6 (9.0-18.0)	abce 16.0±0.4 (10.0-22.0)	abcdef 20.0	ace 16.8±1.1 (12.0-19.0)	abcdef 16.7±0.8 (15.0-19.0)
Fw	a 1.31±0.1 (0.2-2.8)	ab 0.8±0.1 (0.4-1.5)	ab 0.83±0.17 (0.50-1.00)	b 1.2±0.2 (0.3-3.6)	a 1.3±0.1 (0.2-2.8)	ab 2.00	ab 1.2±0.2 (0.5-2.0)	ab 1.4±0.2 (1.0-2.1)
FoL	a 2.5±0.1 (2.0-3.5)	ab 2.2±0.1 (1.5-3.0)	ab 1.83±0.17 (1.50-2.00)	b 1.8±0.1 (1.1-3.3)	a 2.5±0.1 (1.5-3.3)	ab 7.00	ab 2.4±0.2 (2.0-3.5)	ab 2.5±0.2 (2.0-3.0)
Fow	b 1.3±0.1 (0.2-2.8)	ab 0.8±0.1 (0.4-1.5)	ab 0.83±0.17 (0.50-1.00)	ab 1.2±0.2 (0.3-3.6)	a 1.3±0.1 (0.1-3.9)	ab 7.00	a 6.7±0.45 (5.5-8.1)	ab 6.6±0.5 (5.5-8.0)
EDl	b 1.2±0.1 (0.4-2.4)	ab 1.4±0.1 (1.0-1.6)	ab 1.1±0.1 (1.0-1.2)	b 1.0±0.1 (0.6-1.5)	a 1.7±0.1 (1.0-2.9)	ab 1.50	ab 1.5±0.1 (1.3-1.8)	ab 1.3±0.1 (1.0-1.6)
EDw	ab 0.61±0.1 (0.1-2.1)	b 0.5±0.1 (0.2-1.0)	ab 0.7±0.1 (0.5-1.0)	b 0.4±0.1 (0.1-0.8)	ab 0.7±0.1 (0.1-3.5)	ab 1.00	a 1.1±0.1 (1.0-1.3)	ab 0.8±0.1 (0.5-1.0)
Sl	a 14.4±0.2 (12.0-17.0)	bce 10.5±0.6 (7.0-15.0)	cdef 10.6±0.1 (10.0-11.0)	ef 11.9±0.4 (8.5-14.5)	a 12.6±0.2 (9.0-16.0)	abcdef 15.3	a 14.8±0.9 (11.5-18.0)	g 14.1±0.9(12.5-16.5)
Sw	b 5.2±0.1 (4.3-6.0)	b 3.9±0.2 (2.5-5.6)	b 3.67±0.44 (3.00-4.50)	b 4.5±0.1 (3.3-5.4)	b 4.7±0.1 (3.5-6.5)	b 6.50	b 5.50±0.2 (4.5-6.5)	a 5.5±0.3 (4.5-6.0)
Swe	a 20.9±0.9 (11.0-32.0)	cde 10.5±1.5 (2.0-20.0)	bcde 9.0±0.5 (8.0-10.0)	de 13.5±1.0 (5.0-21.0)	e 14.5±0.8 (6.0-29.0)	abcd 25.00	a 23.6±3.9 (11.0-40.0)	abcde 20.0±3.7 (11.0-28.0)
Bul	a 2.5±0.1 (2.0-3.0)	ceg 1.7±0.1 (1.2-2.4)	bcdefg 1.67±0.17 (1.50-2.00)	defg 1.9±1. 0 (1.4-2.5)	fg 2.01±0.1 (1.0-3.0)	efg 2.70	a 2.5±0.1 (2.0-3.0)	abd 2.42±0.1 (2.4-2.4)
Bll	ab 1.61±0.1 (1.3-2.0)	bde 1.3±0.1 (0.8-1.7)	cde 1.1±0.13 (1.0-1.4)	abcde 1.5±0.1 (1.0-1.6)	bd 1.4±0.1 (1.0-1.7)	abce 1.70	a 1.7±0.1 (1.4-2.0)	ab 1.6±0.1 (1.5-1.8)
Bw	ab 1.2±0.1 (1.0-2.0)	b 1.0±0.1(0.5-1.56)	ab 0.9±0.1 (0.9-1.0)	ab 1.1±0.1 (0.6-1.5)	a 1.3±0.1 (0.6-2.0)	ab 1.30	ab 1.3±0.1 (1.1-1.5)	ab 1.4±0.1 (1.4-1.5)
Ful	a 4.4±0.1 (3.5-6.0)	b 3.2±0.2 (2.0-5.0)	b 2.8±0.2 (2.3-3.1)	b 3.7±0.1 (1.6-4.6)	b 3.4±0.1 (2.3-4.0)	a 6.00	a 5.2±0.3 (4.0-6.0)	a 4.8±0.5 (4.0-6.0)
Fuw	i 4.2±0.1 (3.0-6.0)	bcdefh 3.2±0.2 (2.0-5.0)	efghi 3.6±0.6 (3.0-5.0)	dh 3.4±0.1 (2.4-5.0)	cdgh 3.4±0.1 (2.5-4.3)	abcdefghi 5.50	a 5.4±0.3 (4.5-7.0)	aei 4.7±0.4 (4.0-6.0)

Fuol	a 1.2±0.1 (0.6-2.0)	a 0.9±0.1 (0.5-1.5)	a 0.8±0.1 (0.5-1.0)	a 1.2±0.2 (0.3-3.6)	a 0.9±0. 1 (0.5-1.3)	a 1.30	a 1.3±.07 (1.0-1.5)	a 1.2±0.1 (1.0-1.5)
R1	cdef 0.4±0.1 (0.2-1.0)	def 0.4±0.1 (0.2-1.5)	bcdef 0.3±0.1 (0.3-0.3)	f 0.3±0. (0.2-0.4)	ef 0.4±0.1 (0.2-0.6)	abcd 1.00	a 1.1±0.1 (0.5-1.5)	ab 0.8±0.1 (0.5-1.0)
R2	b 0.7±0.1 (0.3-2.0)	bc 0.6±0.1 (0.3-2.0)	bc 0.5±0.1 (0.4-.6)	c 0.4±0.1 (0.2-0.5)	bc 0.6±0.1 (0.3-0.9)	ab 1.50	a 1.5±0.1 (1.0-2.1)	a 1.5±0.2 (1.0-2.0)

Table 5: Percent ratios (± StE) of values of morphometric parameters from the total length. Minima and maxima were set within parenthesis.

Parameters	*S. officinalis*	*S. elegans*	*S. orbignyana*	*S. Prashadi*	*Sepioteuthis lessoniana*	*Sa*	Sb	Sc
% Bl	a 32.9±1.1 (26-51.4)	a 30.9±1.9 (25.8-51)	a 28.3±2.4 (23.7-31.5	a 29.7±0.4 (26-31.7)	a 30.2±0.3 (25.6-34	a 31.4	a 28.8±2.0 (21.8-32)	a 30.4±1.3` (26.7-32)
% Bd	a 24.8±0.9 (19.2-40.0)	a 23.9±1.4 (20.2-37)	a 21.9±1.8 (18.4-24.3	a 22.5±0.7 (13.8-27)	a 23.1±0.2 (20-28.0)	a 27.4	a 25.7±2.5 (17.3-36)	a 24.8±1.3 (21-26.8
% Hl	a 7.8±0.4 (4.7-15.3)	a 7.9±0.5 (5.4-11.9)	a 6.4±0.5 (5.4-7.1)	a 7±0.2 (43-8.0)	a 7.9±0.2 (5.6-12.1	a 7.8	a 8.1±0.7 (5.4-10.3)	a 8.3±0.2 (7.8-8.5)
% Hw	a 15.4±0.5 (15.3-23.5)	ab 14.2±0.80 (10.8-22)	ab 14. ±2.1 (13.7-14.7	a 13.2±0.3 (10-14.7	b 12.3±0.2 (8.9-16)	ab 12.7	ab 14.8±1.4 (12.7-22)	ab 13.5±0.5 (12-14.6
% Tel	a 71.9±3.2 (7.2-10.7)	a 61.2±6.4 (23.5-100	a 69.0±0.6 (65.7-72.9	a 63.7±1.9 (37-71.4)	a 66.3±1.0 (5.8-94.2	a 66.6	a 71.4±5.9 (57.6-100	a 63.0±0.7 (60.9-64)
% Cl	a 9.0±0.5 (4.5-20.0)	a 10.2±0.5 (8.0-16.9)	ab 0 .6±2.9 (7.8-10.0)	ab 7.7±0.6 (4.9-13.7)	b 7.1±0.36 (0.7-14.3)	ab 11.7	a 11.3±0.5 (9.7-13.6)	ab 11.0±0.74(8.8-12.2)
% A1l	a 22.9±1.0 (12.0-37.1)	a 19.8±1.4((11-27.5)	a 16.4±1.5 (10.5-20)	a 22.3±0.6 (17.8-27)	a 21.7±0.7 14.6-32	a 15.6	a 18.4±2.0 (14.4-28	a 18.0±0.9 (15.9-20)
% A5l	a 18.7±0.8 (8.1-31.4)	b 14.2±1.2 (9.6-25.4)	ab 12.3±2.1 (9.2-14.2)	ab 16.7±0.8 (8.9-22.9	ab 16.1±0.3 (12-22.4)	ab 15.6	ab 15.6±1.9 (10.8-23)	ab 13.2±1.0 (11-15.8)
% Fl	a 39.4±1.4 (29.6-56.8)	b 33.5±2.0 27.5-54.2	ab 33.2±0.4 (28.9-35.7	ab 34.6±0.7 30 -40.9	ab 37.3±0.5 30.5-45	ab 39.21	ab 37.0±3.4 (23-48.7)	ab 36.1±1.1 (33.3-39)
% Fw	a 2.9±0.23 (0.6-5.8)	a 2.4±0.2 (1.3-5.0)	a 2.2±0.5 (1.3-2.86)	a 3.1±0.50. (8-10.3)	a 3.1±0.29(0.1-10.3	a 3.92	a 2.6±0.4 (1.0-4.0)	a 3.0±0.3 (2.4-4.0)
% Fol	a 5.7±0.18 (4.0-8.3)	a 6.5±0.3 (5.0-10.1)	ab 5.0±0.7 (3.9-5.7)	b 4.4±0.3 (2.3-7.7)	a 5.9±0.11 (4.6-7.1)	ab 5.88	ab 5.4±0.74 (4.2-8.9)	ab 5.5±0.6 (3.8-6.6)
% Fow	b 11.0±0.9 (6.5-26.4)	a 14.7±1.0 (10-25.1)	ab 12.7±0.21(11.8-14)	ab 13.4±0.4 (9.8-17)	a 14.2±0.3 (11.1-22)	ab 13.7	ab 14.7±1.3 (11-20.5)	ab 14.2±0.9 (13-17.0)
% EDl	b 2.7±0.2 (1.0-5.2)	a 4.0±0.6 (3.0-5.7)	ab 3.0±0.3 (2.7-3.4)	b 2.4±0.1 (1.5-3.5)	a 3.9±0.1 (2.3-6.0)	ab 2.94	ab 3.3±0.2 (2.5-4.6)	ab 2.7±0.1 (2.4-3.1)
% EDw	a 1.4±0.1 (0.1-4.3)	a 1.5±0.1 (0.6-3.3)	a 2.0±1.5 (1.3-2.6)	a 1.0±0.1(0.1-1.9)	a 1.6±0.2 (0.3-9.2)	a 1.96	a 2.5±0.12.5 (2.4-2.5)	a 1.8±0.2 (1.1-2.2)
% Sl	a 32.5±1.1 (25.9-48.5)	a 30.47±2.0 21.6-50.8	a 29.1±1.4 (26.3-31.4	a 28.7±0.4 23-30.4	a 29.6±0.2 26-32.9	a 30.0	a 32.7±3.1 (22.-46.1	a 30.4±0.7 28.2-31.4
% Sw	a 11.7±0.3 (9.2-17.0)	a 11.5±0.7 (8.7-18.9)	a 10.0±1.8 (7.8-12.8)	a 10.9±0.2 (9.5-13.9)	a 11.1±0.1 (9.2-2.8)	a \12.7	a 12.1±1.0 (8.6-16.6)	a 11.8±0.4 10.9-12.7
% SWe	ab 46.5±2.5 (28.0-91.4)	cde 28.6±4.0 (8.0-67.8)	bcde 24.5±0.5 (21.0-27.0	de 31.8±1.8(17.8-44)	e 33.4±1.4 (19-55.7)	abcde 49.0	a 53.0±11.0 (21-102.5	abcde 42.5±6.5 (24.4-53)
% Bul	a 5.5±0.1 (4.5-7.3)	ab 5.0±0.3 (4.0-8.1)	ab 4.5±0.5 (3.9-5.7)	b 4.5±0.1 (3.3-5.2)	b 4.7±0.1 (2.4-5.8)	ab 5.29	ab 5.5±0.5 (3.8-7.6)	ab 5.2±0.2 (4.6-5.8)
% Bll	ab 3.6±0.1 (3.1-5.4)	a 3.8±0.1 (3.0-5.7)	ab 3.1±0.4 (2.6-4.0)	ab 3.6±0.1 (3-4.20)	b 3.2±0.1 (2.8-3.6)	ab 3.33	ab 3.7±0.3 (2.6-5.1)	ab 3.5±0.1 (3.2-3.8)
% Bw	a 2.9±0.1 (2.0-5.5)	a 3.0±0.1 (2.0-5.0)	a 2.6±0.1 (2.3-2.8)	a 2.8±0.2 (1.5-5)	a 3.2±0 (1.9-4)	a 2.55	a 2.9±0.2 (2.4-3.8)	a 3.2±0.1 (2.8-3.5)
% Ful	abd 9.9±0.4 (7.8-17.1)	abcde 9.3±0.5 (7.7-16.9)	bcde 7.6±0.8 (6.2-9.0)	de 8.9±0.2 (4.1-10.4)	ce 8.0±0.1 (6.6-9.6)	acde 11.76	a 11.5±1.0 (7.7-15.4)	abcde 10.4±0.6 (8.8-11.7)

% Fuw	ab 9.7±0.52 (6.5-17.6)	abc 9.4±0.8 (6.7-16.9)	abc 10.0±2.0 (7.8-14.2)	bc 8.1±0.2 (6.2-10.9)	c 7.9±0.1 (6.9-9.6)	abc 10.78	a 11.9±1.2 (9.6-17.9)	abc 10.1±0.5 (8.89-11.4
% FuOl	a 2.8±0.16((1.4-5.29)	a 2.7±0.2 (1.6-4.7)	a 2.2±0.4 (1.3-2.8)	a 2.9±0.4 (1.0-7.6)	a 2.2±0.1 (1.3-3.0)	a 2.55	a 2.8±0.2 (2.1-3.8)	a 2.5±0.1 (2.4-2.8)
% R1	d 0.9±0.1 (0.5-2.8)	bcd 1.3±0.2 (0.8-5.0)	bcd 1.1±0.2 (0.9-1.6)	cd 0.8±0.0 (0.7-0.9)	bcd 1.1±0.0 (0.8-1.5)	abcd 1.96	a 2.4±0 (1.0-3.8)	ab 1.8±0.2 (1.2-2.2)
% R2	bc 1.8±0.2 (0.7-5.7)	bcd 1.9±0.3 (1.1-6.7)	bcd 1.5±0.1 (1.2-1.8)	d 0.9±0.1 (0.4-1.4)	cd 1.4±0.1 (0.9-2.0)	abcd2.94	a 3.3±0.4 (2.1-5.1)	ab 3.2±0.2 (2.4-3.8)

Binary correlations

Most morphometric parameters of each species correlated significantly with each other.

The length-weight relationship

The power, linear, and logarithmic regressions of Tl-Tw and Bl-Tw for the individual species had comparable R^2 values (Table 6; Fig. 3) indicating that they had equal power in expressing the relationship. *S. prashadi*, *Sepioteuthis lessoniana* and Sc had higher R^2 values compared to the other species. The Bl-Tw relationship was generally stronger than the Tl-Tw relationship (had higher R^2 values).

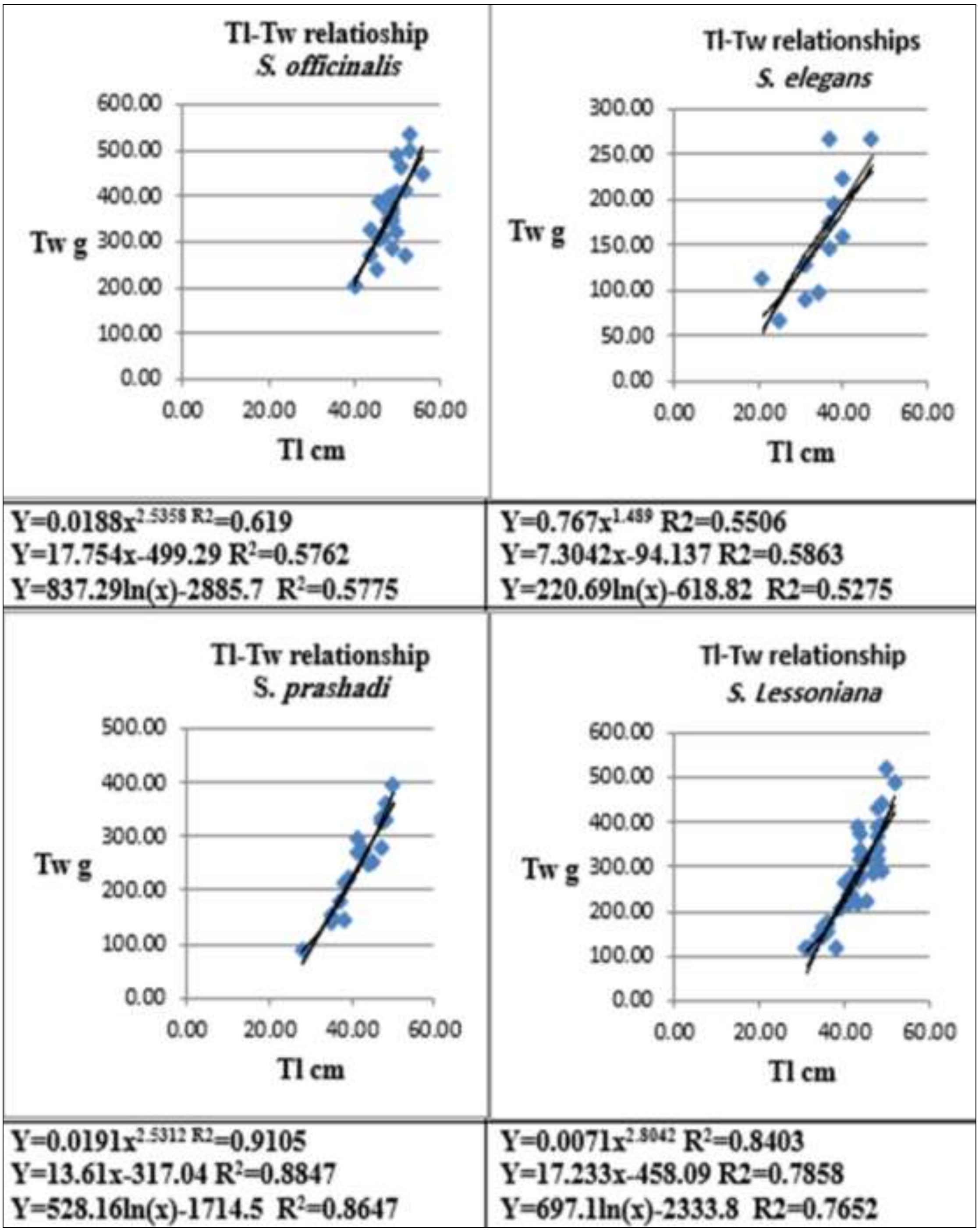

Fig 3: Power, linear, and logarithmic regressions of the length-weight relationship.

Table 6: The length-weight relationship: Power (P), linear (Li), and logarithmic (Log) regressions of Tl-Tw and Bl-Tw relationship. ns: indicates insignificance; asterisks: indicate significance at 0.05, 0.01and 0.00.

Species	Regress.	Tl-Tw				Bl-Tw			
		a	b	R^2	P	a	b	R^2	P
S. Officinalis	P	*0.02*	2.54	0.62	***	7.12	1.46	0.44	***
	Li	17.75	-499.29	0.58	***	-190.24	38.34	0.49	***
	Log	837.29	-2885	0.58	***	-1023.05	520.99	0.44	***
S. elegans	P	*0.77*	*1.49*	*0.55*	**	0.478	2.49	0.93	***
	Li	*220.69*	*618.82*	*0.5*	**	-291.75	45.73	0.92	***
	Log	*7.30*	-94.32	0.59	**	-926.29	476.26	0.88	***
S. orbignyana		**Only one sample was available**							
S. prashadi	P	0.02	2.53	0.91	***	0.57	2.40	0.947	***
	Li	13.61	-317.0	0.88	***	-285.36	43.18	0.914	***
	Log	528.16	-1714.	0.8647	***	-1011.11	503.31	0.905	***
Sepioteuthis lessoniana	P	0.007	2.80	0.84	***	0.246	2.73	0.922	***
	Li	17.23	-458.1	0.78	***	-444.60	55.92	0.916	***
	Log	697.1	-2333.8	0.77	***	1505.55	699.52	0.893	***
Sa	**Only one sample was available**								
Sb	P	1E	-2.716	0.53	ns	0.054	3.36	0.997	**
	Li	-26.83	+1689.5	0.58	ns	-729.61	79.43	0.988	**
	Log	-1215	+5103.3	0.58	ns	-2365.75	1041.95	0.985	**
Sc	P	0.00	3.25	0.71	ns	0.484	2.53	0.930	*
	Li	29.12	-944.32	0.78	ns	-588.59	70.41	0.942	*
	Log	1347.2	-4757	0.77	ns	-2286.82	1020.27	0.950	*

Fulton`s condition factor (F_c)

Values of F_c of the different species were comparable (Table 7). They ranged from 11.58±1.753 for mixed Sc to 14.52±1.852 for male *S. orbignyana*. Females of *S. officinalis* and *Sepioteuthis lessoniana* Scored higher F_c than males; *S. orbignyana* and *S. prashadi* were all males, while all *Sa* were females.

Estimation of age

The growth rings on beaks and shells were not clear and aging based on them was not possible. The plot of the frequency distribution of total length and body length of *Sepioteuthis lessoniana* and *S. officinalis* suggested an age of +1 year `for the sampled populations at peaks of 45.5 and 46 cm in order (Figs. 4 and 5). Frequency distribution was not generated for the other species because their numbers were small.

Table 7: Fulton's condition factor (F_c) of the individual species (mean ± SD). M: males, F: females, Mi: mixed males and females.

Species	Sex	Tw	Bl	F_c
S. officinalis	Mi	373.8±98.8	14.71±1.8	12±5.6
	M	371.4±99.6	14.7±1.8	12±5.6
	F	445	15.0	13.2
S. elegans	Mi	194.9±107.2	10.8±2.3	14.3±3.1
	M	145.1±65.4	9.7±1.7	14.5±3.7
	F	261.3±121.1	12.3±2.2	11.8±1.6
S. orbignyana	Mi	-	-	-
	M	161.7±45.1	10.3±1.15	14.52±1.9
	F	-	-	-
S. prashadi	Mi	-	-	-
	M	250.8±84.98	12.48±1.9	12.3±1.69
	F	-	-	-
Sepioteuthis lessoniana	Mi	276.1±103.4	12.9±1.8	12.15±1.5
	M	247.1±94.0	12.4±1.8	11.9±1.5
	F	336.1±99.1	13.8±1.4	12.5±1.3
Sa	Mi	-	-	-
	M	-	-	-
	F	576.0	16.0	14.1
Sb	Mi	451.0±105.4	13.3±3.4	13.3±0.6
	M	477.5±17.7	15.5±0	12.8±0.5
	F	342.7±105.7	13.57±1.37	13.68±0.6
Sc	Mi	406.0±157.8	14.1±2.2	11.6±1.8
	M	275.0±21.2	12.5±0.7	14.1±1.3
	F	537.0	15.8	14

Tl cm	Frequency
31-32	2
32-33	1
33-34	1
34-35	2
35-36	3
36-37	0
37-38	1
38-39	1
39-40	1
40-41	5
41-42	2
42-43	3
43-44	5
44-45	2
45-46	0
46-47	1
47-48	6
48-49	3
49-50	1
50-51	1
51-52	1

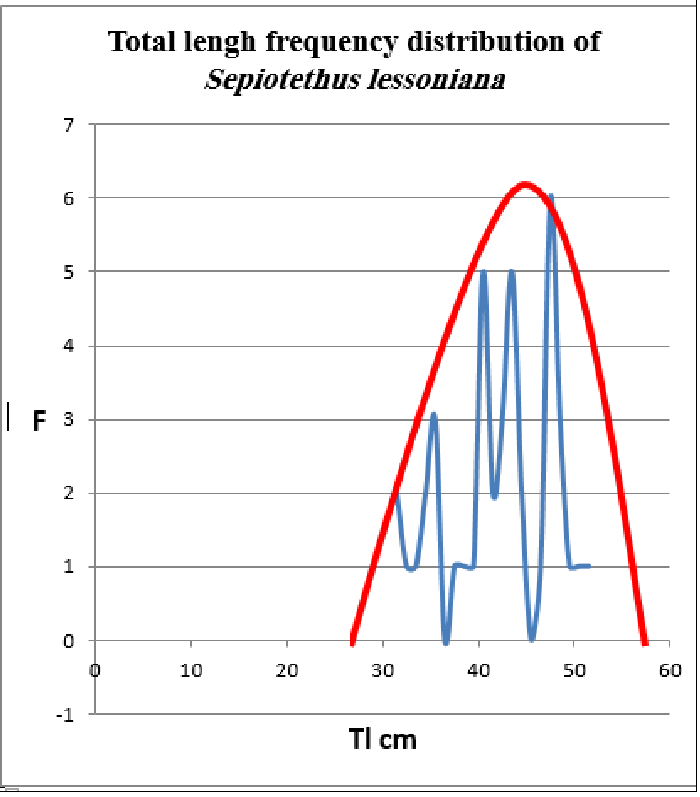

Fig 4: Aging of *Sepioteuthis lessoniana* using total length-frequency distribution.

Tl	Frequency
29.5	1
30.5	1
31.5	0
32.5	0
33.5	1
34.5	1
35.5	1
36.5	0
37.5	0
38.5	0
39.5	3
40.5	0
41.5	0
42.5	0
43.5	2
44.5	1
45.5	2
46.5	1
47.5	3
48.5	5
49.5	3
50.5	1
51.5	2
52.5	2
53.5	0
54.5	0
55.5	1

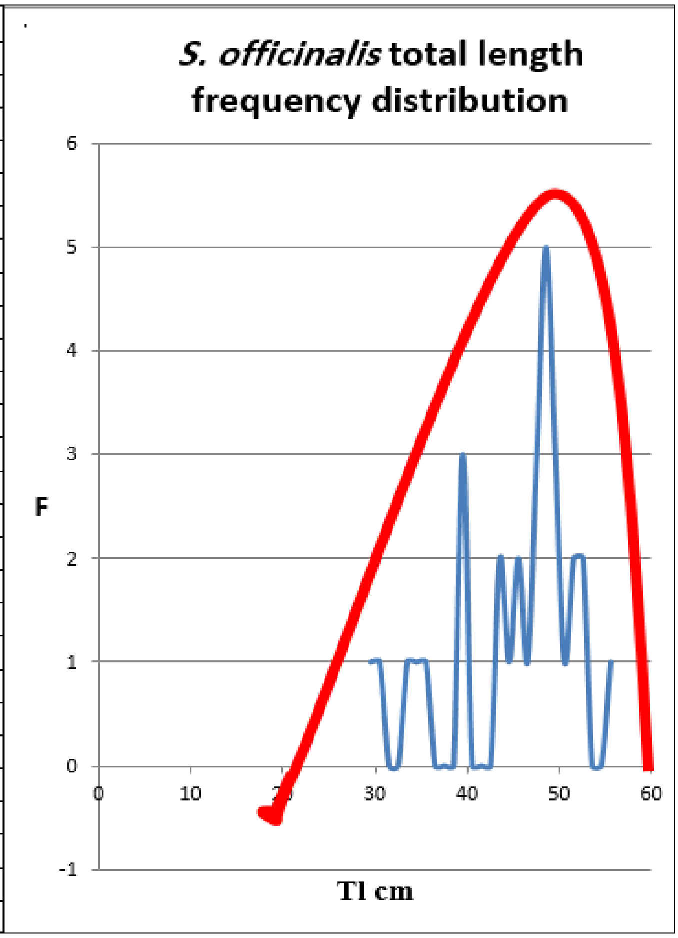

Fig 5: Aging of *S. officinalis* using total length-frequency distribution.

DiScussions

Cuttlefish and squid enter the sandy, shallow, protected, inshore lagoons of Libya from February to April to spawn. During this period, they are caught together with other fish at night under conditions of light attraction by lured and baited lines, and trammel and drag nets. Worldwide, cephalopod fisheries are either inshore or offshore, artisanal or commercial. The common techniques employed are jigging, rods, driftnets, traps, and bycatch in bottom trawling of demersal fishes, usually with light attraction at night during worm seasons (Bjarnason, 1992; Arkhipkin *et al*., 2015) [10, 11]. Compton and Wiley (2018) [12] reported that *Sepia officinalis* spawns in summer and spring in inshore water and then moves to deeper water during autumn and winter.

In the present study, eight species were encountered. Five were identified at the genus and species level: *Sepioteuthis lessoniana*, *S. officinalis*, *S. prashadi*, *S. elegans* and *S. orbignyana* according to their abundance in the catch. The identification of the other three species, designated Sb, Sc, and *Sa*, was not conclusive; they were represented by a few individuals in the collected study sample and were sent a broad for identification. Most of the collected species were males. Females tend to be larger in size than males.

Sepioteuthis lessoniana and the unidentified species are first records in Libya. Shakman and Kinzelbach (2007) [13] recorded 2 species of cephalopods (*Octopus* spp. and *Sepia officinalis*) in the coastal waters of the eastern part of Libya. Abdulrraziq (2014) [4], based on molecular techniques, identified five cephalopods from Ain El-Ghazala lagoon, eastern Linya: *Octopus vulgaris, Sepia officinalis, S. elegans, S. orbignyana*, and *S. prashadi. S. officinalis* was the most abundant.

The twenty-seven morphometric paramours established in the present study for the eight species were comparable in magnitude. Regressions of these parameters on total length were established. The length-weight relationships showed negative allometric growth. This agrees with Abdulrraziq (2014) [4]. The length-weight relationship based on body length was stronger than that based on total length.

The present study concluded that the identification of cuttlefish and squids on the basis of morphogenic (deScriptive characters), morphometric, and meristic characters alone is not easy. On the other hand, molecular techniques are time-consuming, expensive, and cannot be performed daily on a routine basis, for example, at the field by fisheries officers.

The different species' Fulton's condition factor values were comparable. Females of *S. officinalis*, *Sepioteuthis lessoniana* and Sb Scored higher condition factors than males; Abdulrraziq (2014) [4] mentioned that condition factors of the eastern Libyan Mediterranean Sea Sepias tended to decrease with increases in dorsal mantle length.

Sepioteuthis lessoniana and *S. officinalis* population existed in one cohort of +1-year age at peaks of 45.5 and 46 cm. According to previous research, sepias live for one to two years before spawning and dying (Dan *et al*., 2012) [14]. Starešinić (2004) [15] mentioned that *Sepioteuthis lessoniana* is a short-lived species, with a maximum recorded lifespan of 315 days. Lee (1994) [16] stated that cephalopods have fast growth rates, between 3 and 15% body weight per day. Mean females *Sa*, Sc, and *S. lessoniana* total weights were 576.00, 537, and 336.1 gm. According to Starešinić (2004) [15], *S. lessoniana* can reach 600 gm in only four months.

Conclusion

Hopefully the present study helps fisheries officials in managing cephalopods fishery in the southern Mediterranean. The short turn-over rate these cephalopods (short life span) acts as a buffer against long term deplition since the stocks can recover within few years of fishing ban.

References

1. Hassan AK. Studies on bottom MolluScs (*gastropods* and *bivalves*) in Abou Kir Bay. M. Sc. Thesis, Faculty of Science, Alexandria University; c1974. p. 319.
2. CephBase. Welcome to CephBase; c2016. Retrieved 29 January 2016.
3. Riad R. Studies on *cephalopod* molluScs of the Mediterranean waters of Alexandria. M. Sc. Thesis, Oceanography Department, Faculty of Science, Alexandria University; c1993. p. 246.
4. Abdulrraziq, Miftah Abdulrraziq. Fisheries and biological studies on *sepia* species in Ain AlGhazala Gulf, eastern Libya. M. Sc. thesis, Omar Al-Mukhtar University; c2014. p. 37.
5. Abu-Madinah HM. The Libyan harbors – A study in the Economic geography. The international house of books, Benghazi, Libya, 2nd ed; c2008. p. 368.
6. Reynolds JE, Haddoud DA, Vallet F. Planning for aquaculture development in Libya: A review. Tripoli/Rome: Food and Agriculture Organization of the United Nations; c1995. p. 94. Fl: DP/LIB/88/009 - Fl: GCP/LIB/021/lsDB, Field Document 9 (En).
7. Le Cren ED. The length – weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951;20(2):2–19.
8. Ricker WE. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of the Fisheries Research Board of Canada; c1975. p. 191.
9. Fulton TW. The rate of growth of fishes. 20th Annual Report of the Fishery Board of Scotland. 1902;3:326-446.
10. Bjarnason BA. Hand lining and squid jigging (FAO Training Series, no. 23). Rome; c1992.
11. Arkhipkin AI, *et al*. World Squid Fisheries. Reviews in Fisheries Science & Aquaculture. World Squid Fisheries, 2015, 23(2).
12. Compton A, Wiley L. Sepia officinalis. Animal Diversity Web. Retrieved 20 March 2018; c2018.
13. Shakman E, Kinzelbach R. Commercial fishery and fish species composition in coastal waters of Libya. Rostocker MeeresbiologiSche Beiträge. 2007;18:63-78.
14. Dan S, Hamasaki K, Yamashita T, Oka M, Kitada S. Age-based life cycle traits of the broadclub cuttlefish *Sepia latimanus* confirmed through release‒recapture experiments. 2012;17:181–195. Doi:10.3354/ab00474
15. Starešinić N, Vidal EAG, Walsh LS. New species for mariculture in the Eastern Pacific. Naše More. 2004;5(1–2):24–36. ISSN 0469-6255.
16. Lee PG. Nutrition of cephalopods: fueling the system. Marine and Freshwater Behaviour and Physiology. 1994;25:35-51.