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Gillnet (Mashruah) selectivity for some fishes between Susah and Ras Al-Hilal Coasts, Libya

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ABSTRACT

About 1,167 fish specimens (24 bony fish species, three elasmobranches and one cephalopod species) were hauled by set gillnets (Mashruah) with 28, 40 and 50 mm mesh-sizes, between Susah and Ras Al-Hilal, seasonally from winter 2018 to fall 2019, This catch varied in a seasonal changes in winter and fall, lower than in spring and summer; with dominant species: *Pagrus pagrus*, *Diplodus annularis*, *Diplodus vulgaris*, *Mullus surmuletus*, *Seriola dumerili* and *Epinephelus marginatus*, counted as 225, 184, 132, 76, 66 and 47 specimens, respectively. Catch of 28 mm nets reached the half of total in all seasons, compare to the other mesh-sizes; where harvest of the dominant fishes by Mashruah of 40 and 50 mm mesh-size; this declines from 58.5 in *P. pagrus*, till 20.0% in *E. marginatus*, till the sizes of catch of 50 mm gillnet, that decreased into 32.2 in *P. pagrus*, and 6.3 in *D. vulgaris*. Comparing to the legal landing-sizes; length frequency distribution recorded modes lower sizes till 63.2% in *P. pagrus*, 46.9% *D. annularis*, 66.6% *D. vulgaris*, and 50.0% for *M. surmuletus*; meanwhile *S. dumerili* summited 50.0%. and till 66.7% for *E. marginatus*. The lengths of fishes caught by 28 mm mesh-sized gillnets were smaller than the legal landing size, more than the catch of 40 and 50 mm mesh-sized nets. Decreasing of using gillnets with 28 mm nominal bar length may serve as

protective measures, to prevent the catch of juveniles, and to catch fishes with a desirable size range.

1. INTRODUCTION

Gillnets are one of the most used fishing gear globally and over the Mediterranean Sea and the Black Sea as a multi-species fishing gear (Hamley, 1975; Reis and Pawson, 1992; Martin *et al*., 1999; Hovgård and Lassen, 2000; Papaconstantinou and Farrugio, 2000; Karakulak and Erk, 2008 and Kocabaş *et al*., 2018). Yokota *et al*., (2001), Holst *et al*., (2002) and Dinçer and Bahar, (2008) described gillnets as a popular "passive fishing gear" among small-scale crafts, because of its simple design, construction, operation, and low investment cost (Brandt, 1984). Also, it can be applied in lakes, rivers, coasts and open seas, manually or without much mechanical power, for catching fish with high commercial value (Hameed and Boopendranath, 2000).

The selectivity of fishing gears is a critical factor to administrate fisheries catch and population successfully, to protect fish populations and to sustain the fisheries. Most fishing gears in the Mediterranean are selective relatively, with a lower or no impact for the others (Holt, 1963 and Gulland, 1983). Hamley, (1975) stated that selectivity is affected by the visibility and elasticity of meshes. Compare to the other fishing crafts, gillnets are more selective to the stock, with some regulations only on mesh size (McCombie and Fry, 1960; Regier and Robson, 1966; Hamley and Regier, 1973; Hamley, 1975; Gulland,

1983; Barandt, 1984; Karunasinghe and Wijeyaratne, 1991; Reis and Pawson, 1992).

In Al-Jabal Al-Akhdar coasts, fishermen use about 4-10 pieces of gillnets "Beyatah and Mashruah" per fishing unit, with a crew of three or less to catch fishes of amberjacks, seabreams and mugils (Lamboeuf *et al*., 2000). However, very few studies on gill, trammel and trawling nets used in the Libyan shores.

Hence, there are no published worksabout their size selectivity and elasticity in most of the Mediterranean so far (Anonymous, 1998). Although McCombie and Fry, (1960); Regier and Robson, (1966); Hamley and Regier, (1973); Hamley, (1975); Reis and Pawson, (1992) Santos *et al*., (1998); Petrakis and Stergiou, (1995); Stergiou and Erzini, (2002) and Fonseca *et al*., (2005); Dincer and Bahar, (2008); Sbrana *et al*., (2007); Fabi and Grati, (2008); Ayaz *et al*., (2009); Doll *et al*., (2014); Bolat, and Tan, (2017); Faye *et al*., (2018); Ayaz *et al*., (2019); Lucchetti *et al*.., (2020) and Petetta *et al*., (2020) paid wide attention for gill-nets selectivity in various areas of the world.

According to Millar, (1992) and Ayaz *et al*., (2011); it is possible to adjust length-frequency distribution to estimate the size distribution of commercial fish population, with the selectivity scale. Mismanagement could be a result if the landings length-frequency for gear selectivity were not adjusted, estimation of the biological parameters (age, growth, and mortality in population), and artificial factors as well; where Anon., (2004) stated that catch pressure caused

by the nets at a certain length interval and the minimum catch length obligation. The size selectivity of gillnets depends on various factors such as: mesh size, net height, elasticity, the hanging ratio, twine thickness and color, fish behavior and fishing method and target species, fishing areas, depth and seasons (Clark, 1960; Hamley, 1975; Millar, 1992; Petrakis and Stergiou, 1995; Millar and Holst, 1997; Santos *et al*., 1998; Stergiou and Erzini, 2002; Fonseca *et al*., 2005; Illkyaz and Kinacigil, 2006; Kinacigil *et al*., 2006; Dincer and Bahar, 2008; Sbrana *et al*., 2007; Fabi and Grati, 2008; Karakulak and Erk, 2008 and Ayaz *et al*., 2009; Ayaz*et al*., 2011 and Olguner and Deval, 2013). All these might be biased, which may result in.

Length distribution, reproduction biology of commercial species and the selectivity parameters of the nets that are used to determine stock, by correlating the selectivity parameters with the biology of fishes, to contribute the information about fishing with less damage (Illkyaz and Kinacigil, 2006). Petrakis and Stergiou (1995); Illkyaz and Kinacigil, (2006) and Kinacigil *et al*., (2006) mentioned that gill net selectivity estimates for Red mullet *Mullus surmuletus* and Annular Seabream *Diplodus annularis* for some of the most commonly used mesh sizes (17, 19, 21 and 23 mm) in Greek coasts, and selectivity for some cyprinids in Greek lakes have been presented by Boy and Crivelli (1988). The rational management relies upon according to Petrakis and Stergiou, (1995) on technical measures concerning the mesh sizes

used, closed seasons and/or areas, and minimum legal landing sizes, with the viewpoint of ecosystem-based fisheries management.

This research aims to determine the catch amounts and the selectivity of gillnets, in mesh sizes 28, 40 and 50 mm; between Susah and Ras El-Hilal shores, and their effects on the fish stocks for six dominant species and relations of lengths with the legal catch sizes in this area.

2. MATERIALS AND METHODS

2.1. Study Area: Seasonally, between December 2018 and September 2019, the fish specimen were collected by local fishermen, moving between **(a) Susah Harbor (31°54' N 21°58' E) from the west:** A harbor with poor shelter by old jetty, protected by barrier. Moorage for small artisanal fishing-crafts, including medium gillnetters (Reynolds *et al*., 1995; MBRC, 2005; Abu-Madinah, 2008), and **(b) Ras al-Hilal Harbor (32°52′58″N 22°10′49″E) from the east:** About 55 km to the north-east of Albayda, nearly all its beaches are far from forests or significant vegetation, isolated from the lack of a direct coastal road connecting between Susah and Dernah (El-Khajkhaj, 2008). Abziew, (2015) mentioned this area as one of the most important fishing areas in coasts of Dernah, the most common fishing gears are trammel net, depending on the fishing season.

2.2. Sampling: Using typical Mediterranean set gillnets (Mashruah) with 28, 40 and 50 mm mesh-sized knotless polyamide (PA) material,

and height about 150/200 meshes, one float 75 mm and 2 lead 180g every 100 cm, applied in less than 10 fathoms depth. Set at sunset, hauled at sunrise, fishing after night captured on local boats (Flouka and Mator), then taken to the landing site of Susah harbor.

The mesh-size of gillnets in the area were measured; using MR Light digital Caliper (0-150 mm Range), to measure the distance between opposite corners of the mesh when it is fully stretched (stretched mesh size) according to Illkyaz and Kinacigil, (2006) and Scanu *et al*., (2020).

2.3. Species Identification: In lab of Marine Sciences, Faculty of Science, Omar Al-Mukhtar University, Albayda. Specimen had been identified according to Whitehead *et al*., (1984) ; Serena, (2005); Golani, *et al*., (2006); Iglésias, (2006); Jereb and Roper, (2010) and Ben-Abdalla *et al*., (2009 & 2012).

2.4. Statically analysis: To calculate selectivity parameters. Data of total length TL (0.0cm) was taken from all individuals. In determining the selectivity parameters; normal distribution function was used, and calculations were carried out in MS-Excel 2010 (Holt, 1963; Somerton, 1980 and Illkyaz *et al*.,1998).

A B C

D E F

G H I

Figure (1): (**A-D**): The study area (Susah and Ras Al-Hilal shores), maps from google earth, (**E**):Some fish specimens, (**F**): the gill nets (Mashruah) in different mesh sizes, (**G-H**): measuring the mesh-size of gillnet, using MR Light digital Caliper, 0-150 mm Range (Source: Study's field work), (**I**): measuring the mesh-size of gillnet (Rosman, 1980).

3. RESULTS AND DISCUSSION

In this work, between Susah and Ras Al-Hilal, about 1,167 individuals belong to these species were used in fishing experiments of this study, which were sampled with Gillnet (Mashruah) hauls. In winter of 2018/2019 about 168 specimens from 17 species were recorded as the lowest diversity season. Meanwhile it was 330 individuals in spring (25 species), although it was not more than that in summer (424 specimens in 21 species), followed by 245 individuals from 18 species in autumn. According to seasons and according to species were given in table (1). A total of 28 species were caught, including 24 bony fishes, three elasmobranches and

one cephalopod species. (Table 1, Figure 2), with six dominant species with 793 individuals were determined that the dominant species were: [Red Porgy *Pagrus pagrus*, Annular Seabream *Diplodus annularis*, Common two-banded sea bream *Diplodus vulgaris* (Fam. Sparidae), Red Mullet *Mullus surmuletus* (Fam. Mullidae), Amberjack *Seriola dumerili* (Fam. Carangidae) and Dusky Grouper *Epinephelus marginatus* (Fam. Serranidae)], counted as 225, 184, 132, 76, 66 and 47 specimens, respectively.This seasonal variation and abundant species record was close to results of Illkyaz and Kinacigil, (2006) and Kinacigil *et al*., (2006) in the Turkish coast of Ege sea, and to the catch of Buzaid (2008) in Benghazi. Sparids in some Libyan shore have the most presence in their catch, such as Motaref, (2014) who indicated to the highest percentage for abundant species in Ain Al-Ghazala lagoon in Tubruk coast, it was *Pagrus pagrus* (50.5%) *Lithognathus mormyrius* (20.8%), *Diplodus annularis* (8.1%) and *Oblada melanura* (5.4%). Meanwhile *Pagellus erythrinus* was the lowest percentage (0.1 % of the Sparid catch). Also, Shakman and Kinzelbach, (2007) suggested that the highest percentage for native species was *D. annularis* in the eastern region of the Libyan coast, whereas the smallest percentage was *Crenidens cernidens*.

In table (1); specimens of *P. pagrus* had the zenith ratios, from winter 2018 till fall of 2019 by records of 23.81, 18.18, 17.69 and 20.41 respectively. Followed by the annular sea bream *D. anularis*

as the second presence in most seasons (17.26% in winter, 16.36% in spring and 15.33% in summer), except in autumn (14.69%); when the goatfish *M. surmuletus* reached 15.10%,whereas it was observed in winter (table 1-A), spring and summer by 14.88, 9.09 and 9.43% respectively.Another abundant species; Amberjack *S. dumerili*, Common two-banded sea bream *D. vulgaris* and dusky grouper *E. marginatus* individuals were observed between 8.33, 7.74 and 5.95% respectively in winter, till their lower values in spring (4.85% for *S. dumerili*), summer (5.90% for *D. vulgaris*) and 1.22% for *E. marginatus* in fall . About the lowest values in all seasons; *Rhinobatus rhinobatus* ranged between 0.47% in summer, and 1.63% in fall (Table 1-D), and the tope shark *Galeurhinus galeus*as well by 0.24 and 0.82 % respectively. These elasmobranches were observed by Buzaid, (2017) and (2019) in Susah and Dernah shores. Also, another species were recorded in winter such as *Apogon imberbis*, *Diplodus sargus* and *Serranu scabrilla* (0.60 % for each), *Scorpaena porcus*, *Uranoscopus scaber* (1.19 % for each), and *Sepia officinalis* (2.98 %) (Table 1-A). In spring (Table 1-B), the lowest values were: *Diplodus sargus* and *Trachurus mediterraneus* (0.91 %); *Scorpaena porcus* (0.61 %) and (0.30 %) for *A. imberbis* and *Taeniura grabata* .In summer, *Belone belone* was about 0.71%, meanwhile *U. scaber* and *E. marginatus* were the nadir values (1.22 % for each) in autumn. Most of these species were recorded as well

in by-catch in purses of trawling nets by Buzaid *et al*., (2017) in Benghazi coast.

Figure (2) shows the seasonal variation in selectivity percentage (%) in different mesh-sizes, where the catch of 28 mm mesh-sized nets reaches the half of total catch in all seasons, between 57.27% in spring, till 62.81% in fall. Meanwhile the catch get lower than the third; from 30.36 in winter 2018 to 22.73% in fall 2019, On the contrary, winter recorded the the least harevest values in 50 mm mesh size of Mahrouh (11.31%) and peaked slightly till 14.46% in autumn.

In the dominant species in figure (3); the capture of 40 mm mesh-size; this declines from 58.5 in *P. pagrus*, till 20.0% in *E. marginatus* respectively, and in harvest of that species in gillnet of 50 mm was decreased as well into 32.2 in *P. pagrus*, to 6.3 in *D. vulgaris* ; all of these values compare to the catch of 28 mm mesh size.

Table (1–A): Seasonal distribution of species captured into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019 (Source: Study's field work).

Species	Winter 2018-2019							
	28 mm		40 mm		50 mm		TOTAL	
	count	%	count	%	count	%	count	%
Apogon imberbis	1	*0.60*					1	0.6
Belone belone								
Boops boops								
Dicentrarchus labrax	6	*3.57*					6	*3.57*
Diplodus anularis	18	*10.71*	7	*4.17*	4	*2.38*	29	*17.26*
Diplodus sargus			1	*0.60*			1	*0.6*

Diplodus vulgaris	9	*5.36*	3	*1.79*	1	*0.60*	13	*7.74*
Epinephelus marginatus	6	*3.57*	2	*1.19*	2	*1.19*	10	*5.95*
Galeurhinus galeus			1	*0.60*	1	*0.60*	2	*1.19*
Lithognathus mormyrus								
Mullus barbatus								
Mullus surmuletus	16	*9.52*	6	*3.57*	3	*1.79*	25	*14.88*
Oblada melanura			9	*5.36*			9	*5.36*
Pagrus pagrus	21	*12.50*	13	*7.74*	6	*3.57*	40	*23.81*
Rhinobatus rhinobatus	1	*0.60*					1	*0.6*
Sarpa salpa								
Sciaena umbra								
Scorpaena porcus	2	*1.19*					2	*1.19*
Sepia officinalis	**3**	*1.79*	2	*1.19*			5	*2.98*
Seriola dumerili	9	*5.36*	3	*1.79*	2	*1.19*	14	*8.33*
Serranus cabrilla			1	*0.60*			1	*0.6*
Serranus scriba								
Sparus aurata	6	*3.57*	1	*0.60*			7	*4.17*
Spicara smaris								
Symphodus tinca								
Taeniura grabata								
Trachurus mediterraneus								
Uranoscopus scaber			2	*1.19*			2	*1.19*
Total / haul [count&%]	**98**	***58.33***	**51**	***30.36***	**19**	***11.31***	**168**	***100.02***

Table (1–B): Seasonal distribution of species captured into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019 (Source: Study's field work).

Species	Spring 2019							
	28 mm		40 mm		50 mm		TOTAL	
	count	%	count	%	count	%	count	%
Apogon imberbis	1	*0.30*					1	*0.3*
Belone belone			10	*3.03*			10	*3.03*
Boops boops								
Dicentrarchus labrax	11	*3.33*	2	*0.61*	1	*0.30*	14	*4.24*
Diplodus anularis	32	*9.70*	18	*5.45*	4	*1.21*	54	*16.36*
Diplodus sargus	1	*0.30*	1	*0.30*	1	*0.30*	3	*0.91*
Diplodus vulgaris	16	*4.85*	3	*0.91*	1	*0.30*	20	*6.06*
Epinephelus marginatus	9	*2.73*			1	*0.30*	10	*3.03*
Galeurhinus galeus			1	*0.30*			1	*0.3*
Lithognathus mormyrus	9	*2.73*	8	*2.42*			17	*5.15*
Mullus barbatus	6	*1.82*	3	*0.91*	1	*0.30*	10	*3.03*
Mullus surmuletus	17	*5.15*	8	*2.42*	5	*1.52*	30	*9.09*
Oblada melanura	11	*3.33*	3	*0.91*	2	*0.61*	16	*4.85*
Pagrus pagrus	30	*9.09*	19	*5.76*	11	*3.33*	60	*18.18*
Rhinobatus rhinobatus	2	*0.61*					2	*0.61*
Sarpa salpa	1	*0.30*	2	*0.61*	3	*0.91*	6	*1.82*
Sciaena umbra	4	*1.21*	1	*0.30*	1	*0.30*	6	*1.82*
Scorpaena porcus			2	*0.61*			2	*0.61*
Sepia officinalis	10	*3.03*	7	*2.12*	3	*0.91*	20	*6.06*
Seriola dumerili	10	*3.03*	3	*0.91*	3	*0.91*	16	*4.85*
Serranus cabrilla								
Serranus scriba	9	*2.73*	3	*0.91*	1	*0.30*	13	*3.94*
Sparus aurata	5	*1.52*					5	*1.52*
Spicara smaris			6	*1.82*			6	*1.82*
Symphodus tinca	3	*0.91*			1	*0.30*	4	*1.21*
Taeniura grabata			1	*0.30*			1	*0.3*
Trachurus mediterraneus	2	*0.61*	1	*0.30*			3	*0.91*
Uranoscopus scaber								
Total / haul [count&%]	**189**	***57.27***	**102**	***30.91***	**39**	***11.82***	**330**	***100***

Table (1–C): Seasonal distribution of species captured into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019 (Source: Study's field work).

Species	Summer 2019							
	28 mm		40 mm		50 mm		TOTAL	
	count	%	count	%	Count	%	count	%
Apogon imberbis								
Belone belone					3	*0.71*	3	*0.71*
Boops boops	10	*2.36*					10	*2.36*
Dicentrarchus labrax	9	*2.12*	1	*0.24*			10	*2.36*
Diplodus anularis	36	*8.49*	22	*5.19*	7	*1.65*	65	*15.33*
Diplodus sargus								
Diplodus vulgaris	12	*2.83*	13	*3.07*			25	*5.9*
Epinephelus marginatus	17	*4.01*	5	*1.18*	2	*0.47*	24	*5.66*
Galeurhinus galeus	1	*0.24*					1	*0.24*
Lithognathus mormyrus	17	*4.01*	11	*2.59*	5	*1.18*	33	*7.78*
Mullus barbatus	11	*2.59*	5	*1.18*	3	*0.71*	19	*4.48*
Mullus surmuletus	25	*5.90*	10	*2.36*	5	*1.18*	40	*9.43*
Oblada melanura	14	*3.30*			3	*0.71*	17	*4.01*
Pagrus pagrus	42	*9.91*	22	*5.19*	11	*2.59*	75	*17.69*
Rhinobatus rhinobatus		*0.00*	1	*0.24*	1	*0.24*	2	*0.47*
Sarpa salpa	5	*1.18*			1	*0.24*	6	*1.42*
Sciaena umbra			3	*0.71*	1	*0.24*	4	*0.94*
Scorpaena porcus								
Sepia officinalis	11	*2.59*	5	*1.18*	2	*0.47*	18	*4.25*
Seriola dumerili	14	*3.30*	6	*1.42*	3	*0.71*	23	*5.42*
Serranus cabrilla			12	*2.83*		*0.00*	12	*2.83*
Serranus scriba	15	*3.54*	6	*1.42*	4	*0.94*	25	*5.9*
Sparus aurata	5	*1.18*			4	*0.94*	9	*2.12*
Spicara smaris								
Symphodus tinca								
Taeniura grabata								
Trachurus mediterraneus	1	*0.24*	1	*0.24*	1	*0.24*	3	*0.71*
Uranoscopus scaber								
Total / haul [count&%]	**245**	***57.78***	**123**	***29.01***	**56**	***13.21***	**424**	***100.01***

Table (1–D): Seasonal distribution of species captured into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019 (Source: Study's field work).

Species	Fall 2019							
	28 mm		40 mm		50 mm		TOTAL	
	count	%	count	%	Count	%	count	%
Apogon imberbis								
Belone belone	6	*2.48*			2	*0.83*	8	*3.27*
Boops boops	7	*2.89*			2	*0.83*	9	*3.67*
Dicentrarchus labrax	8	*3.31*	3	*1.24*	1	*0.41*	12	*4.9*
Diplodus anularis	27	*11.16*	6	*2.48*	3	*1.24*	36	*14.69*
Diplodus sargus								
Diplodus vulgaris	11	*4.55*	3	*1.24*	1	*0.41*	15	*6.12*
Epinephelus marginatus	3	*1.24*					3	*1.22*
Galeurhinus galeus					2	*0.83*	2	*0.82*
Lithognathus mormyrus								
Mullus barbatus								
Mullus surmuletus	20	*8.26*	11	*4.55*	6	*2.48*	37	*15.1*
Oblada melanura	10	*4.13*	4	*1.65*	1	*0.41*	15	*6.12*
Pagrus pagrus	25	*10.33*	15	*6.20*	10	*4.13*	50	*20.41*
Rhinobatus rhinobatus					1	*0.41*	1	*1.63*
Sarpa salpa								
Sciaena umbra	6	*2.48*	2	*0.83*	1	*0.41*	9	*3.67*
Scorpaena porcus								
Sepia officinalis	3	*1.24*	1	*0.41*	1	*0.41*	5	*2.04*
Seriola dumerili	10	*4.13*	2	*0.83*	1	*0.41*	13	*5.31*
Serranus cabrilla								
Serranus scriba								
Sparus aurata	10	*4.13*	3	*1.24*	1	*0.41*	14	*5.71*
Spicara smaris	3	*1.24*	2	*0.83*			5	*2.04*
Symphodus tinca	3	*1.24*	1	*0.41*	1	*0.41*	5	*2.04*
Taeniura grabata								
Trachurus mediterraneus								
Uranoscopus scaber			2	*0.83*	1	*0.41*	3	*1.22*
Total / haul [count&%]	**152**	***62.81***	**55**	***22.73***	**35**	***14.46***	**242**	***99.98***

Table (2 A&B) and figure (4) elaboratethe seasonal observed and legal catch lengths of the nets and legal catch of the most abundant species in at 28, 40 and 50 mm mesh sizes and the annual length distribution frequency in figure (4) as well. Starting by to modes of *Pagrus pagrus* as: 49.1% (106-115 mm), 47.8% (126-135 mm) and 63.2% (176-185 mm) in table (2-A) and figure (4). These results are close to İlkyaz, (2005) and Illkyaz and Kincegil (2006). Both the fact that all of the optimum catch length values are smaller than the first maturity length and the similar results in three different studies indicate that the stocks of *P. acarne* are affected in a dangerous manner by the red mullet gillnet fisheries. İşmen *et al*.(2010) recorded the first maturity length for males and females of *P. acarne* in Saros Bay as 153and 181mm, respectively.

Legally, Red sea breams are not able for handling if its individuals size is lower than 150 mm (Law no. 14, 1989). Meanwhile Cacaud, (2006) indicated to the legal size of *Pagellus* Spp. not lower than 120 mm in Tunisia and Albania, and 150 mm in Morocco as well. Biologically, asa total size, to attain a marketable landing size and to give the maximum relative fecundity, Ali, (2008) stated that Red sea bream *P. pagrus* in Susah, get mature from 166 mm TL for males and 176 mm for females. Meanwhile in Ain El-Ghazala shores, a higher than 154 mm are mature females, males with a higher than 134 mm are mature (Motaref, 2014) .

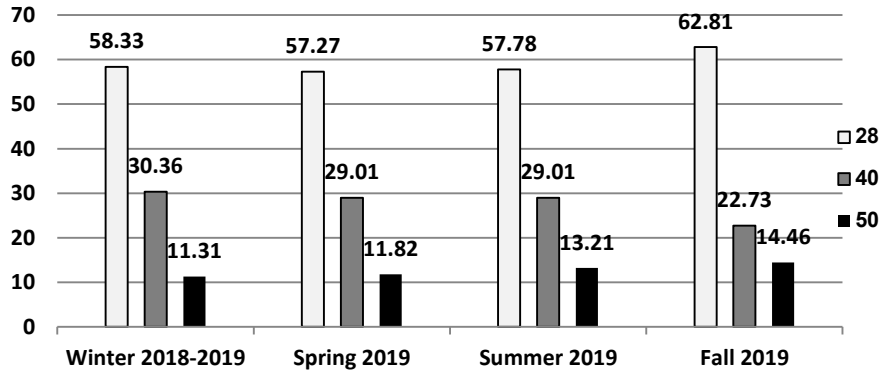

Fig (2): Seasonal variation in selectivity percentage (%) in captured fishes into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019.

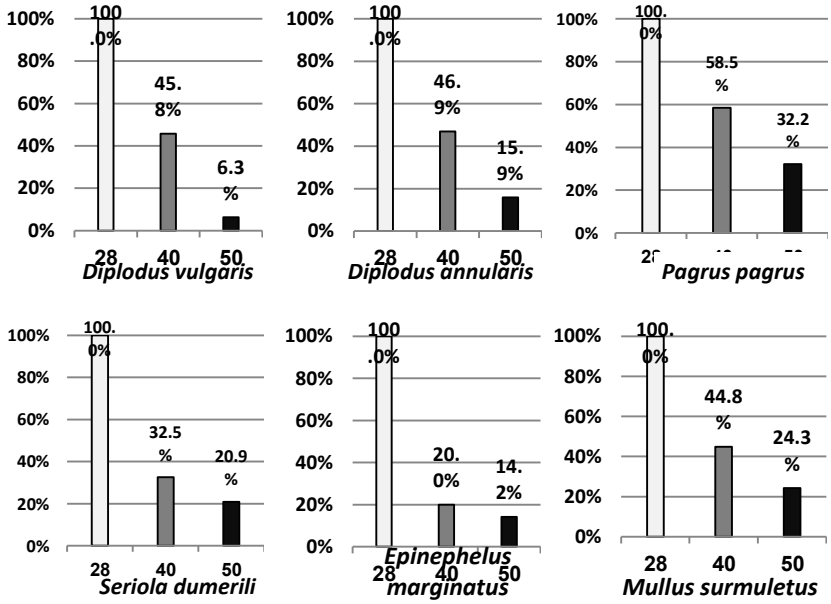

Fig (3): Comparison in selectivity percentage (%) in the most abundant fish species captured into captured into gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019.

Like the other Sparids, such as *Diplodus annularis* and *Diplodus vulgaris* in table (2-A) and figure (4) their peaks were 46.9% (106-115 mm), 43.3% (116-125 mm) and 44.4% (146 - 155 mm), for *D. annularis*. Meanwhile *D. vulgaris* reached values of 39.6% (86-90 mm) , 60.0 % (126-130 mm) and 66.6 % (131-135 mm) at 28, 40 and 50 mm, respectively (Table 2 and figure 4). Considering to the maturity size; Abdallah, (1996) stated that the stages of its first sexual maturity starts at 156 mm and 158 mm for male and female respectively. Either; Mouine et al., (2012) recoded length at first maturity was 174 ± 2 mm TL for *D. vulgaris* and 97 mm TL for *D. annularis* in the Gulf of Tunis.

In table (2-B) and figure (4); Goatfishes *Mullus surmuletus* have been records in modes of 50.0 % (126 -130 mm), 45.5 % (136-140 mm) and 42.2% in size group of 166 - 170 mm. Law no. 14, (1989) forbids to catch the juveniles of this species that lower than 150 mm in Libya, 120 mm in Tunisia, 110 mm in Morroco and 90 mm in Italy (Cacaud, 2006). Abziew, (2009) recorded the beginning of sexual maturity for malesat148mmandat163 mm in females of *M. surmuletus* in Dernah.

Looking to Amberjacks *Seriola dumerili* in length ranges of 116-125 mm summited to 41.8 %, 50.0 % (156-165 mm) and 33.3% for smaller than 185 mm (table 2-B and figure 4). According to law no. 14, (1989), it is not allowed to harvest pre-adults smaller than 200 mm in Libya shores, including shores of Al-Hamama, where females

higher than 1534 mm TL and males higher than 1054 mm TL of *S. dumerili* are mature (Mohammed, 2015).

Among the Serranids, the Duscky groupers *Epinephelus marginatus* have peaked in 28 mm mesh of gillnets by 62.5% (116-125 mm), 33.3% (121-125 mm) in 40 mm and 66.7% (156-165 mm) in 50 mm gillnets (table 2-B and figure 4). These groupers are not allowed to be handled in sizes lower than 350 mm (Law no. 14, 1989); Saleh, (2012) indicated to the first appearance of a mature male specimens of dusky grouper *E.guaza*, that was at the length of 435-504 mm and from size group of 225- 294 mm for mature female in Susah coast.

The non-target sizes, as a discarded catch rate in most fishing gears; it was calculated as15% by Kelleher (2005) around Mediterranean and Black Sea, about 10% in Benghazi coast (Buzaid, 2008 and Buzaid *et al*., 2017), 56 - 58% according to Aydın *et al*., (1997) and Aydın *et al*., (2008) and Ayaz *et al*.,(2010),and less than 81.4% in red mullet gillnets in the Aegean-Turkish coast according to Aydın *et al*. (2013).

Table (2-A): Seasonal variation in selectivity, catch comparison (*) and legal catch (**) of the most abundant fish species in gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019.

	Pagrus pagrus **(Total = 225)**			***Diplodus annularis*** **(Total = 184)**			***Diplodus vulgaris*** **(Total = 76)**		
Mesh size (mm)	**28**	**40**	**50**	**28**	**40**	**50**	**28**	**40**	**50**
Winter 2018-2019	21	13	6	18	7	4	9	3	1
Spring 2019	30	19	11	32	18	4	16	3	1
Summer 2019	42	22	11	36	22	7	12	13	
Fall 2019	25	15	10	27	6	3	11	3	1

Count	**118**	**69**	**38**	**113**	**53**	**18**	**48**	**22**	**3**
Catch comparison % (*)	*100.0%*	*58.5%*	*32.2%*	*100.0%*	*46.9%*	*15.9%*	*100.0%*	*45.8%*	*6.3%*
Min. Length (mm)	96	128	155	91	128	147	83	108	125
Max. Length (mm)	121	142	177	117	132	166	102	123	135
Mean Length ±SD (mm)	112±62	133±42	163±11	103±54	129±11	151±19	93±35	111±23	131±94
Legal Length (mm) (**)	150			150			150		

Table (2-B): Seasonal variation in selectivity, catch comparison (*) and legal catch (**) of the most abundant fish species in gill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019.

	Mullus surmuletus **(Total = 132)**			***Seriola dumerili*** **(Total = 66)**			***Epinephelus marginatus*** **(Total = 47)**		
Mesh size (mm)	**28**	**40**	**50**	**28**	**40**	**50**	**28**	**40**	**50**
Winter 2018-2019	16	6	3	9	3	2	6	2	2
Spring 2019	17	8	5	10	3	3	9		1
Summer 2019	25	10	5	14	6	3	17	5	2
Fall 2019	20	11	6	10	2	1	3		
Count	**78**	**35**	**19**	**43**	**14**	**9**	**35**	**7**	**5**
Catch comparison % (*)	*100.0%*	*44.8%*	*24.3%*	*100.0%*	*32.5%*	*20.9%*	*100.0%*	*20.0%*	*14.2%*
Min. Length (mm)	121	132	154	122	151	164	101	115	158
Max. Length (mm)	133	150	170	143	166	196	122	149	175
Mean Length ±SD (mm)	126 ± 94	140 ± 88	164 ± 65	132 ± 22	156 ± 43	183 ± 18	112 ± 44	133 ± 33	151 ± 92
Legal Length (mm) (**)	150			200			350		

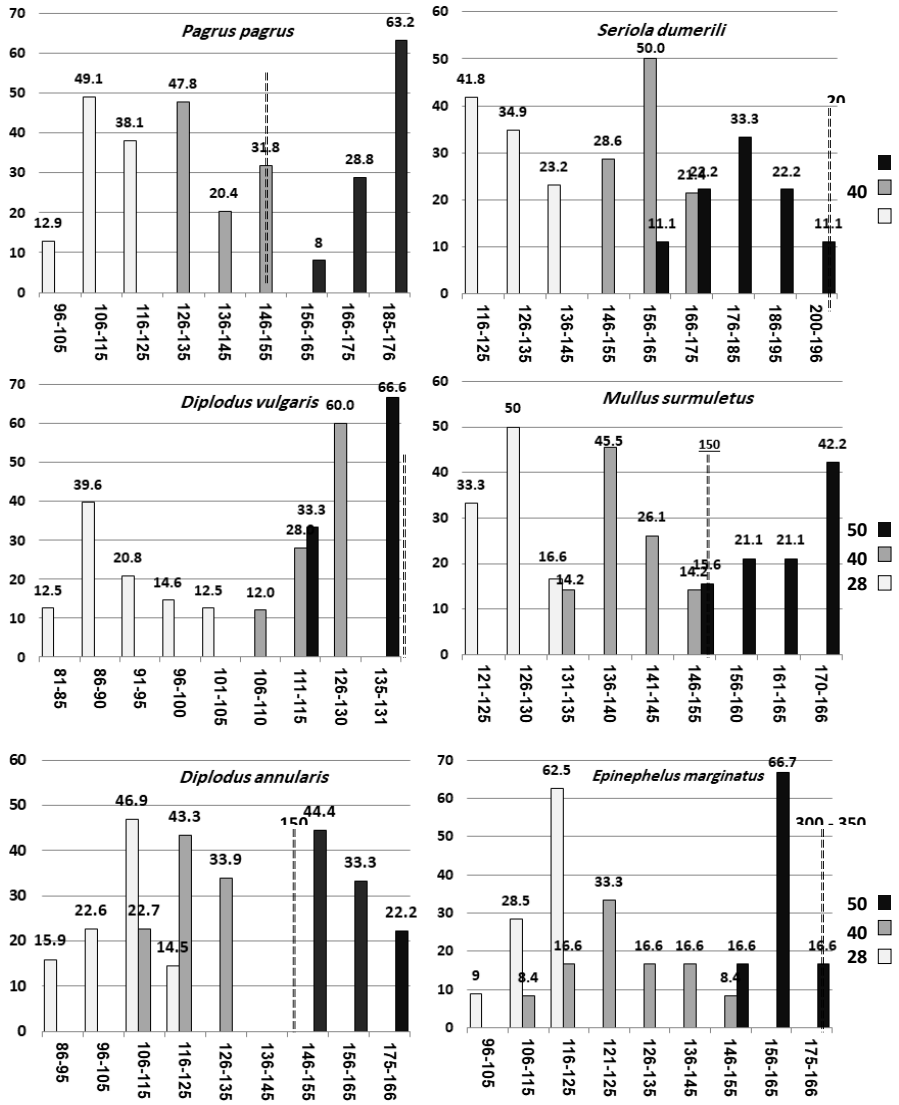

Fig (4): Length frequency distribution of the most abundant fish species captured intogill nets (Mashruah) in different mesh sizes between Susah and Ras Al-Hilal shores from winter 2018/2019 to fall 2019. [--- = the legal landing length according to Law no. 14 (1989)].

It is important for ecosystem sustainability and fisheries management; to protect the fish during their maximum growth in weight and maximum reproductive potential of every species (Gabr and Mal, 2016). According to Stergiou and Erzini, (2002); differences between first maturity length and higher optimum catch length can be explained by the geographical differences and varied environmental parameters. It is clear that any nominal bar length or gillnet will have an adverse effect on the stocks of these species (Bilgin and Çelik, 2009). So, mesh size is lower than 28 mm could endanger regenerating of the stocks.

According to Hovgård, (1996); Millar and Fryer, (1999);Erzini et al. (2006) and Ayaz et al., (2011); the indirect method is used widely, because its results varied between studies from variation of species, methods and models for analyzing selectivity pattern, even selectivity values could vary according to the fish morphometrics (length, body shape etc.), geographical differences and properties of gillnet (nominal bar length, net material, hanginig ratio… etc.), and then, it fits a variety of selectivity models (normal location, normal scale, log-normal, gamma and binormal).

Erzini*et al*., (2006) mentioned that using the optimum gillnets is extremely important to develop suitable management strategy in fisheries, management authority should understand the selectivity properties of whole fishing gears in its region (Millar, 1992;Millar and Holst, 1997). Selectivity studies are especially stick to target

species of gillnets, as an effective fishing gears in the multi species fishing fields. Besides, there is no studies on the single species management approach with the gillnets so far.

4. CONCLUSION

Study results showed that seasonal changes are important in selectivity, but further studies are needed because these changes should be considered in management arrangements related to gill net selectivity.

Most of the modal fish lengths caught by gillnets (Mashruah), with 28 mm mesh size are relatively smaller than the size at maturity and therefore the current commercial gillnet fishery which uses 40 and 50 mm mesh-size may not be a threat to the most dominant fishes, with a high commercial value in coasts of Susah and Ras Al-Hilal. According to this work; decreasing of using gillnets with 28 mm nominal bar length may serve as protective measures. To prevent the catch of juveniles, and to catch fishes with a desirable size range.

This study is one of the first studies about techniques and selectivity of fishing gears, as a new cell for data base for these studies in the future. conduct fishery-dependent selectivity studies in the Libyan coast should be aimed, to estimate changes of selectivity with location and type of gear. As well, a comprehensive age-based stock assessment is required to determine the mesh size that optimizes yield without adversely depleting the regeneration of fish stocks.

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