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Full Length Research Paper

The effects of jig color and lunar bright on coastal squid jigging

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Squid jigging experiments were carried out to determine whether differences occurred between different colors and lunar brightness in Middle Eastern coast of Aegean Sea. Five different colors of jigs (red, blue, green, orange and white) were used together in same angle. According to one-way analysis of variance results, red jigs were found to be the most efficient in squid capturing ($p < 0.01$). General linear model results proved that lunar brightness of full moon phase showed positive effects to squid catching ($p < 0.01$). The differences between jigs were statistically significant except between blue and green. In addition, the relationship between dorsal mantle length of captured specimens and color of jigs were not significant.

Key words: *Loligo vulgaris*, Aegean sea, squid, jigging, colors, lunar phase.

INTRODUCTION

European squid *Loligo vulgaris* (Lamarck, 1798), is one of the most important cephalopod species that has high economical potential in market. Not only as food for human consumption but also utilization in fisheries such as live bait for angling and feed of some aquaculture species. It has showed a large distribution in North-East Atlantic, from North Sea to African coasts and whole Mediterranean (Roper et al., 1984). This neritic and semipelagic species has very important commercial value (Sifner and Vrgoc, 2004). Cephalopod fisheries are among the few still with some local potential for expansion; in fact, as ground fish landings have declined globally, cephalopod landings have increased. This increase support the hypothesis that, although, increased cephalopod landings may partly reflect increased market demand, overfishing ground fish stocks has positively affected cephalopod populations (Caddy and Rodhouse, 1998). There is an increase which is observed on cephalopod production in recent years in the world. Total squid, cuttlefish, and octopus production was calculated as 3173272 tons in the world in 2002 (FAO, 2002). This is 6.42% of the whole fishery production of the world. In addition, ban of some fishing techniques and restricted or forbidden fishing areas such as sea meadows could increase this positive effect.

According to fishery statistics in Turkey, total cephalopod annual production is 2619 tons. A total of 844 tons were squid, and 667 tons of them were recorded from Aegean Sea (Tuik, 2007). In 2001, usage of beach seine nets was decided to ban of for all over the Turkish waters (Anonymous, 1999). The ban of seine nets causes increase in squid population. Therefore, the squid fishing became more important than other fishing techniques.

Large amounts of European squid were caught by trammel nets (Akyol and Kara, 2003). Old combined commercial prawn trammel nets has an important role in European squid fishery in Izmir Bay which is located at Middle Eastern coasts of Aegean Sea (Gokçe et al., 2005). On the other hand, jigging for squid is one of the most popular methods used in coastal squid fishery in Turkey. There are number of studies on techniques and efficiency of squid jigging (Mercer and Bucy, 1983; Metin et al., 2003; Ulas et al., 2004). However, very little information is available regarding the effect of color on squid fishing efficiency (Altinagac, 2006). Furthermore, there is no literature about lunar brightness effect on squid jigging. The aim of this study is to determine the effects of jigging color and lunar brightness on squid jigging

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Abbreviations: FM, Full moon; **HM,** half moon; **DM,** dark moon.

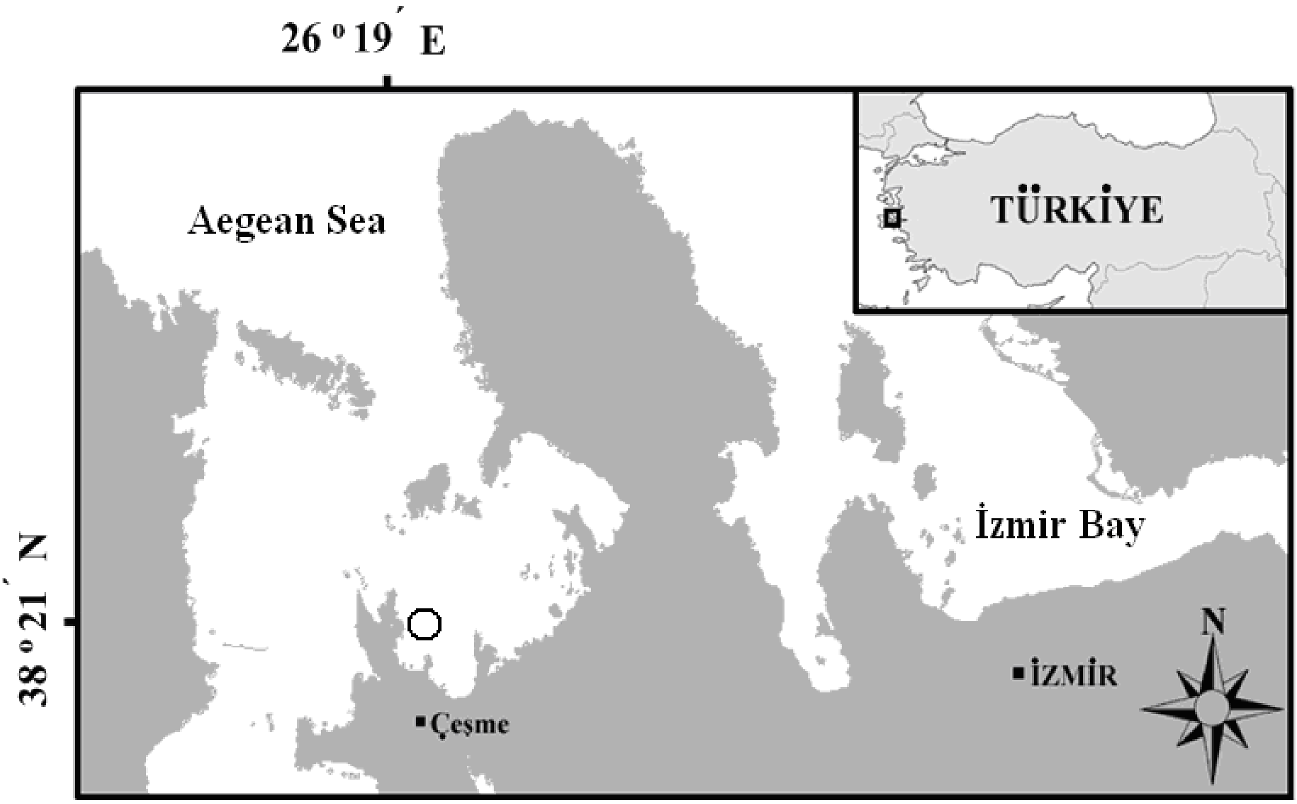

Figure 1. Map of the study area.

efficiency.

MATERIALS AND METHODS

Experiments were conducted between August-December, 2008 in Cesme coasts located in the east central region of Aegean Sea (Figure 1). The fishing depths were ranged between 25 and 40 m. A commercial fishing vessel "FIRAT" which has 9 m overall length (LAO) and 38 HP was used in samplings. During the operation, the vessel was not fixed by mooring, but it was flown away by wind. Each fishing trip was fixed for 3 h, started just before dusk, until the dark night. Three commercial fishermen had squid jigs in five different colors (red, blue, green, orange and white) in their lines. Yozuri jigs which have SS size (12 cm) were used in fishing operations. 0.70 mm angles monofilament lines were used as a main body. A swivel was used to avoid the twisting. After a swivel, jigs were tied to 0.60 mm monofilament lines and 350 g sinkers were used at the end of rig. In order to determine differences between lunar brightness effects, experiment were carried out in three different periods of the moon; namely, full moon (FM) as bright, half moon (HM) as semi bright and dark moon (DM) as dark. Three operations for every phase were accomplished every month as replicates. Dorsal mantle length (DML) of individuals were measured to the nearest 0.1 cm using a 30 cm ruler. The wet weight, W, was taken using a digital balance with a precision of 0.1 g. General linear model (GLM) was used for two factor analysis of variance (ANOVA) namely, color of jig and lunar brightness in order to investigate their main effects and interactions. Also, one-way ANOVA was used to understand whether differences occurred between DML and jigs.

RESULTS AND DISCUSSION

During the study, a total of 1089 *L. vulgaris* were caught with jigs. Descriptive statistics values of measured individuals are presented separately in Table 1 according to jig colors.

According to the results, red colored jigs were the most efficient among all experiments ($p < 0.01$). On the other hand, the differences between green, blue, orange, and white jigs that are ordered based on their efficiencies were not significant (Figure 2 and Table 2). After several colors of jigs were tested by Mercer and Bucy (1983) in a squid fishing boat which had electrical lamps, they did not find any relationship between efficiency and colors.

Altinagac (2006) determined that the green jigs were more efficient than red ones in his day time samplings. The sampling months and poor data might have created this difference. Not only time of the day, but also low visibility of water in Izmir Bay could be the reasons too. Mercer and Bucy (1983) deduced that, small squids were willing to attack jigs that were almost as large as themselves. In this study, the differences between DML of caught species and color of jigs were not statistically significant (Figure 3 and Table 3).

As it was seen in Figure 4, the FM phase was the most efficient period of all sampled months ($p < 0.01$) while a little difference appeared in data input between HM and

Table 1. Descriptive statistics of various measurements (n, number of individuals; DML, dorsal mantle length; W, weight; min, minimum; max, maximum; st. dev., standart deviation).

Parameter	n	ML (mm)	W (gr)
Blue	204		
min		13	65.1
max		33.7	600.3
mean		20.3	211.3
st. dev		4.01	101.38
Green	222		
min		13.3	75.2
max		37	695.1
mean		19.5	196
st. dev		3.76	97.12
Orange	174		
min		13.8	75.3
max		34.6	645.4
mean		20.09	207.1
st. dev		3.83	98.17
Red	369		
min		12.2	55.2
max		28.7	490.2
mean		20.3	213
st. dev		3.5	60.81
White	120		
min		15.4	100.3
max		26.7	325.6
mean		20.3	206.2
st. dev		2.48	60.81
Total	1089		

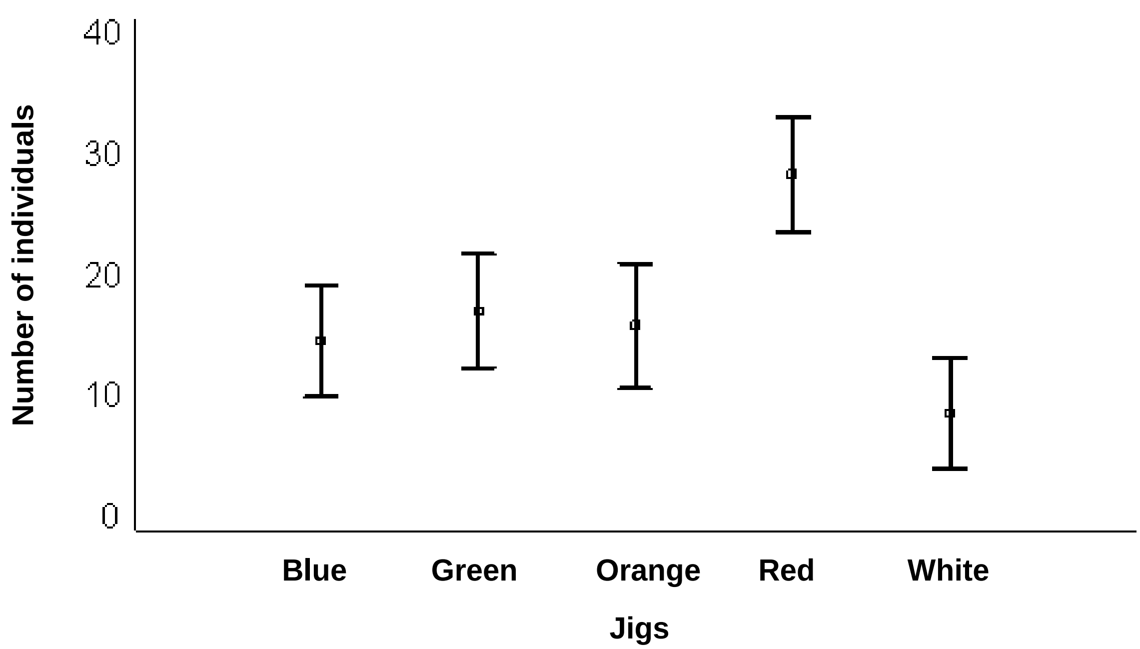

Figure 2. Means and 95% LSD intervals of ANOVA differences between jigs.

Table 2. ANOVA table for number of individuals by jigs.

Source	MS	df	P
Between groups	693.392	4	**
Within groups	146.342	60	
C=0.528			***

***p<0.05, **** p<0.01, ***** p<0.001;MS, mean square; df, degrees of freedom; C, Cochran's test.

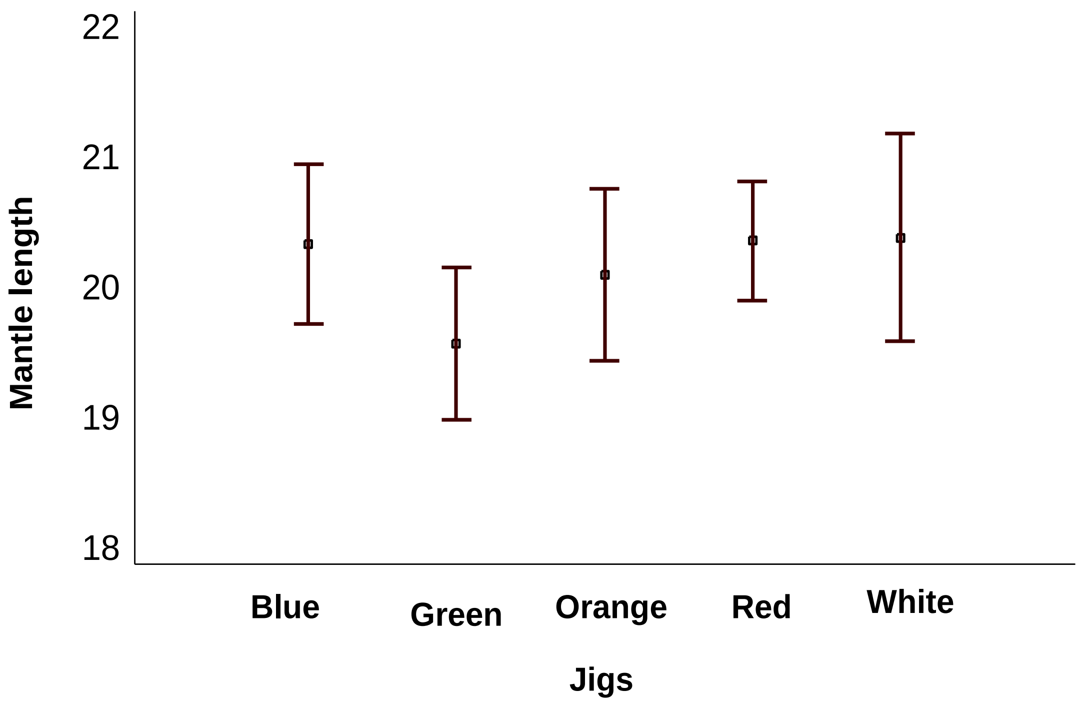

Figure 3. Means and 95% LSD intervals of ANOVA differences between DML and jigs.

NM, which was not statistically significant ($p > 0.05$). The previous research had shown that squid, octopus and cuttlefish are able to detect polarized light as well as create signals using polarized light on their skin (Shashar and Cronin, 1996; Shashar et al., 1996; Shashar and Hanlon, 1997). It was also concluded that cephalopods which can detect differences in polarized light may use their abilities to detect polarization to help catch prey.

All the variables in GLM analysis, color of the jigs and lunar brightness have contributed significantly to the model $p < 0.001$, for color of the jigs and $p < 0.01$ for lunar brightness (Table 4). Moreover, the interactions between jigs and lunar phase were also statistically significant ($p < 0.001$).

Experiences of regional commercial fishermen guide us to investigate dusk period fishery in east central Aegean coasts. Dawn time jigging has not yet been carried out at Turkish coasts of Aegean Sea. However, Lipiński (1987) determined that most squid fed late during the night and/or during the early morning. Stationary fishing gears such as gill and trammel nets also cause some problems in squid jigging. Jigs could hang out easily to those of which when fishermen used "kateti" method.

Conclusions

Since 2001, the beach seine nets were banned, squid fishing have been an important financial asset for Turkey due to the high commercial value. Small scale fishermen have fished squids by jigging. Jigging is one of the catching methods to target species in fisheries. There is no discard rate in catch composition of jigging. Octopuses and cuttle fish are rarely caught alive by by-catch species in squid jigging. Those under the legal size can be released back to nature. This method is environmentally friendly. This investigation revealed that, color choice of jigs and fishing time of the day is important for catch efficiency in squid jigging. In further studies, investigating the dawn time effects would be useful in the

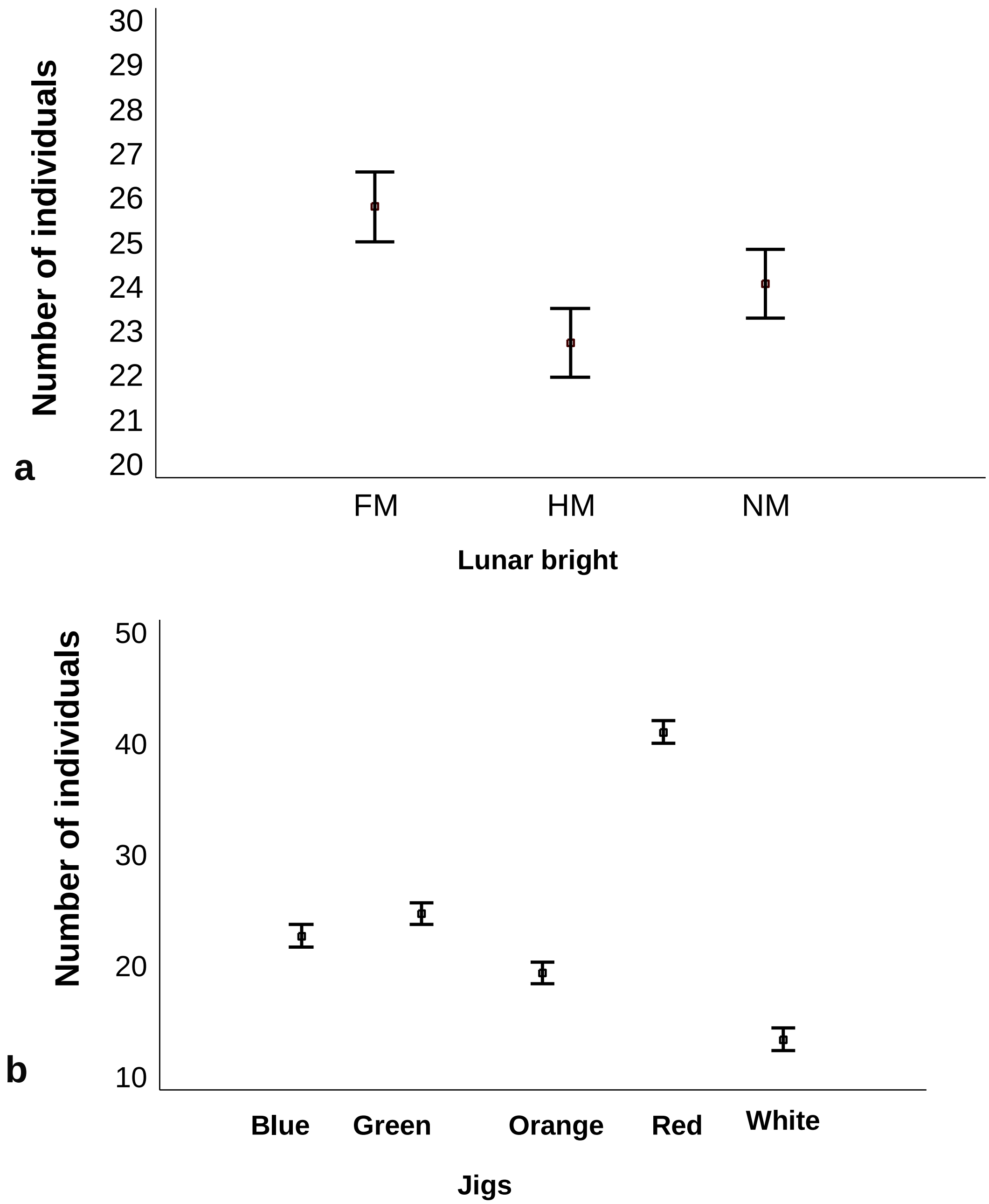

Figure 4. Means and 95% LSD intervals of ANOVA differences (a) phase of lunar bright, and (b) color of jigs.

Table 3. ANOVA table for ML by jigs.

Source	MS	df	P
Between groups	8.723	4	ns
Within groups	13.225	358	
C=0.253			ns

*****p<0.05, ****** p<0.01, ******* p<0.001; ns, not significant, MS, mean square; df, degrees of freedom; C, Cochran's test.

Table 4. ANOVA table of the GLM analysis.

Parameter	Type III SS	df	MS	F	P
Model	9286.53	14	663.32	152.2	***
Jigs	3839.2	4	959.8	220.36	***
Lunar bright	70.93	2	35.47	8.14	**
Jigs*Lunar bright	5376.4	8	672.05	154.3	***
Residual	130.67	30	4.36		
Total	9417.2	44			

SS, Sum of squares; df, degrees of freedom; MS, mean square; F, F-ratio; *****$p < 0.05$, ****** $p < 0.01$, ******* $p < 0.001$.

determination of effective squid fishery.

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