E-ISSN 1307-234X

J FisheriesSciences.com

Vol. 8 Issue 1
2014

Journal of FisheriesSciences.com

Journal of FisheriesSciences.com
E-ISSN 1307-234X

Journal of FisheriesSciences.com

E-ISSN 1307-234X

is published in one volume of four issues per year by www.FisheriesSciences.com.

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Journal of FisheriesSciences.com
E-ISSN 1307-234X

Journal abbreviation: **J FisheriesSciences.com**
Vol. 8 Issue 1 Page 1-87 (2014)

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8(1): 1-7 (2014) DOI: 10.3153/jfscom.2014001

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

SHORT COMMUNICATION KISA MAKALE

ZOOPLANKTON OF UZUNÇAYIR DAM LAKE (TUNCELI-TURKEY)

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Received: 26.01.2013 / Accepted: 05.05.2013 / Published online: 28.12.2013

Abstract: In this research zooplankton distribution of Uzunçayır Dam Lake were determined between March 2010 - February 2011. Zooplankton samples were taken regularly in each month from the dam lake. pH, dissolved oxygen and water temperature values were recorded in situ by using portative equipments. In the dam lake 23 zooplankton species were recorded. All of these species 15 species from Rotifera, 6 species from Cladocera and 2 species from Copepoda were identified. The most attractive species were from Rotifera because of its species richness and number of individuals. Especially in spring months zooplankton were recorded in highest individual numbers and species. Numbers of species diversities were determined high in May (12 species). The study has got an importance as to be the first research on zooplankton in Uzunçayır Dam Lake.

Keywords: Rotifera, Cladocera, Copepoda, Uzunçayır Dam Lake

Öz: **Uzunçayır Baraj Gölü (Tunceli-Tükiye) Zooplanktonu**

Bu araştırmada Uzunçayır Baraj Gölü zooplankton dağılımı Mart 2010-Şubat 2011 tarihleri arasında tespit edilmiştir. Zooplankton örnekleri gölden her ay düzenli olarak alınmıştır. pH, çözünmüş oksijen ve su sıcaklık değerleri portatif aletler kullanılarak arazide kaydedilmiştir. Baraj gölünde 23 zooplankton türü kaydedilmiştir. Bunlardan 15 türün Rotifera, 6 türün Cladocera ve 2 türün Copepoda ya ait oldukları tespit edilmiştir. Rotifera tür zenginliği ve bireylerin sayısı bakımından en dikkat çekici grup olmuştur. Özellikle ilkbahar aylarında zooplankton yüksek birey ve tür sayıları ile kaydedilmiştir. Tür çeşitliliğinin en yüksek Mayıs ayında (12 tür) olduğu belirlenmiştir. Bu çalışma Uzunçayır Baraj Gölü zooplanktonu üzerinde yapılan ilk araştırma olması bakımından önemlidir.

Anahtar Kelimeler: Rotifera, Cladocera, Copepoda, Uzunçayır Baraj Gölü

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Introduction

In Lake Ecosystem, zooplankton occupy the second trophic level of food chain and are important food source for invertebrates and fishes. In addition, they act as indicator of water quality, eutrophication and the level of water pollution (Sharma, 1983; Saksena, 1987; Berzins and Pejler, 1987). A lot of work has been carried out on the zooplankton fauna of Turkey Ozdemir and Sen (1994), Saler and Şen (2002) Bekleyen (2003), Saler (2004, 2009), Kaya and Altındağ (2007), Saler and Şen (2010); Saler *et al* (2011).

However, the zooplankton fauna of Uzunçayır Dam Lake has not been studied before. The present study was therefore conducted to determine the zooplankton composition in Uzunçayır Dam Lake.

Materials and Methods

Uzunçayır Dam Lake is located on Munzur River at the southeastern of Tunceli. Dam Lake was built to produce electric and also fishing was made in dam reservior.

In this research zooplankton distribution of Uzunçayır Dam Lake were determined between March 2010 - February 2011. The zooplankton samples were collected with a standart plankton net (Hydrobios Kiel, 25 cm diameter 55 µm mesh size) horizontal hauls from three stations (Station I 39°09.59''N, 39°30'2.53''; Station II, 38°59'59.56''N, 39°31'1.43''E and station III, 38°58'59.19''K, 39°31'41.06''E) and the specimens were preserved in 4% formaldehyde solution in 100ml plastic bottles.The map of research field was given in fig 1. The species were identified according to Kolisko (Edmondson, 1959; Grasse (1965); Kolisko, 1974; Koste, 1978 a, b; Dumont ve De Ridder 1987). Temperature and dissolved oxygen were measured by an Oxi 315i/SET oxygen-meter, pH by a Lamotte (pH 5-WC) model pHmeter.

Figure 1. The location of Uzunçayır Dam Lake.

Results and Discussion

In Uzunçayır Dam Lake 15 species of Rotifera, 6 species of Cladocera and 2 species of Copepoda were identified and given below.

The montly distribution of Rotifera, Cladocera and Copepoda are given in Uzunçayır Dam Lake (Table 1 and 2). Total Montly distribution of zooplankton fauna is shown in Uzunçayır Dam Lake (Table 3).

S.pectinata the most abundant species was observed for 9 months during the study period and showed its peak May with 6114 ind./m^3 while the lowest were recorded in March, September and January with 509 ind./ m^3. The second most dominant species was *P. dolichoptera,* which occured in 7 monts. The highest number of this species was recorded in May with 9171 ind./m^3, and the lowest in September, November and December with 509 ind.m^3.

Phylum: Rotifera	
Classis: Monogononta	
Ordo: Ploimia	*Notholca acuminata* (Ehrenberg, 1832)
Familia: Brachionidae	*Notholca squamula* (O.F.Müller, 1786)
	Kellicottia longispina (Ehrenberg, 1879)
	Keratella cochlearis (Gosse, 1851)
	Keratella quadrata (O.F.Müller, 1786)
Familia: Synchaetidae	*Synchaeta pectinata* Ehrenberg, 1832
	Polyarthra dolichoptera Carlin, 1943
Familia: Asplanchnidae	*Asplanchna priodonta* Gosse, 1850
	Asplanchna sieboldi (Leydig, 1854)
Familia: Gastropodidae	*Ascomorpha saltans* Bartsch,1870
Familia: Trichocercidae	*Trichocerca capucina* Wierzejski-Zacharias, 1893
Familia: Notommatidae	*Cephalodella gibba* (Ehrenberg, 1838)
Familia: Trichotriidae	*Trichotria tetractis* (Ehrenberg, 1830)
Familia: Colurellidae	*Lepadella ovalis* (O.F.Muller, 1786)
Familia: Lecanidae	*Lecane luna* (O.F.Muller, 1776)
Phylum: Arthropoda	
Subphylum: Crustacea	
Classis: Branchiopoda	
Ordo: Cladocera	
Familia: Daphnidae	*Daphnia longispina* O.F. Müller, 1875
	Simocephalus vetulus (O.F. Müller, 1776)
	Ceriodaphnia reticulata (Jurine, 1820)
Familia:Bosminidae	*Bosmina longirostris* (O.F. Müller, 1785)
	Chydorus sphaericus (O.F. Müller, 1776)
Familia: Leptodoridae	*Leptodora kindtii* (Focke, 1844)
Classis Maxillopoda	
Subclassis Copepoda	
Ordo: Calanoida	
Familia: Diaptomidae	*Acanthodiaptomus denticornis* (Wierzejski, 1887)
Ordo: Cyclopoidae	*Cyclops vicinus* Uljanin, 1875

Cyclops vicinus, the Copepoda group was observed for 8 months during the study period. In addition the total zooplankton individual was showed that maximum (5604 ind/m^3) in June. The recorded species than Cladocera group were not demonstrate permanent distribution. *Ceriodaphnia reticulata* was recorded during for 4 months. *Simocephalus vetulus* was recorded in only September.

In Uzunçayır Dam Lake the highest number of zooplankton was recorded in May (21907 individual/m^3) and the least organism in February (2036 individual/m^3)

In Uzunçayır Dam Lake, the highest water temperature was found as 20.1°C in August. In January, the lowest water temperature was recorded as 7.1 °C. In March, the highest value of dissolved oxygen was recorded as 10.1 mg/L. In November, the lowest dissolved oxygen value were recorded 4.6 mg/L. pH value was changed between 6.8 and 8.1. Temperature, dissolved oxygen and pH values of the Uzunçayır Dam Lake were recorded in the field and shown in the Table 4.

Table 1. The montly distribution of Rotifera in Uzunçayır Dam Lake (ind./m³)

	Mar	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
ROTIFERA												
A. priodonta	-	509	2547	-	1528	-	-	509	1019	509	1019	-
A. saltans	509	-	-	1019	-	-	-	-	-	-	-	-
A.sieboldi	2038	-	-	-	-	-	1019	-	509	-	-	-
C. gibba	-	-	-	-	-	2547	1019	509	-	-	-	509
K. cochlearis	-	-	-	1528	2038	-	509	-	1019	-	1019	-
K.quadrata	-	-	509	-	-	-	-	-	-	-	1019	-
K. longispina	-	-	-	-	-	1528	-	-	-	-	-	-
L. luna	-	509	-	1019	509	-	-	-	509	-	-	-
L.ovalis	-	-	1019	-	509	-	-	-	-	-	-	-
N. acuminata	1019	509	-	-	-	-	-	-	-	1019	-	-
N. squamula	509	-	509	-	-	-	-	509	-	-	-	509
P. dolichoptera	-	1019	9171	5605	-	1019	509	-	509	509	-	-
S. pectinata	509	1019	6114	3057	2547	1019	509	1019	-	-	509	-
T. capucina	-	1019	-	-	-	-	-	-	-	-	-	-
T. tetractis	-	509	-	-	-	509	-	-	509	509	-	509
TOTAL	**4584**	**5093**	**19869**	**12228**	**7131**	**6622**	**3565**	**2546**	**4074**	**2546**	**3566**	**1527**

Table 2. The montly distribution of Cladocera and Copepoda in Uzunçayır Dam Lake (ind./m³)

	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
COPEPODA												
A. denticornis	-	-	-	3057	509	-	-	-	509	-	-	-
C. vicinus	1528	4585	2038	2547	-	-	1019	1019	509	1019	-	-
TOTAL	**1528**	**4585**	**2038**	**5604**	**509**	**-**	**1019**	**1019**	**1018**	**1019**	**-**	**-**
CLADOCERA												
B. longirostris	-	1019	-	-	-	-	-	1019	-	-	-	-
C. reticulata	2038	-	-	509	1019	-	-	-	-	-	509	-
C. sphaeriscus	-	1528	-	-	-	-	509	-	-	-	-	509
D. longispina	-	-	-	-	-	-	-	509	1019	1019	-	-
L.kindtii	-	509	-	1019	-	-	-	-	-	-	-	-
S. vetulus	-	-	-	-	-	-	1019	-	-	-	-	-
TOTAL	**2038**	**3056**	**-**	**1528**	**1019**	**-**	**1528**	**1528**	**1019**	**1019**	**509**	**509**

Table 3. Montly distribution of zooplankton in Uzunçayır Dam Lake

	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
ROTIFERA	4584	5093	19869	12228	7131	6622	3565	2546	4074	2546	3566	1527
COPEPODA	1528	4585	2038	5604	509	-	1019	1019	1018	1019	-	-
CLADOCERA	2038	3056	-	1528	1019	-	1528	1528	1019	1019	509	509
TOTAL	**8150**	**12734**	**21907**	**18360**	**8659**	**6622**	**5602**	**5093**	**6111**	**4584**	**4075**	**2036**

Table 4. Monthly recorded values of dissolved oxygen, temperature, and pH in Uzunçayır Dam Lake

	Monhts											
Parameters	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Dis.Oxygen mg/L	10.1	5.2	4.9	4.8	5.2	4.7	4.8	4.9	4.6	7.4	6.2	6.3
Temperature C°	11.6	12.4	18.6	17.5	16.3	20.1	15.9	15.8	11.3	8.6	7.1	7.7
pH	8.1	7.4	7.3	7.3	7.3	7.2	7.1	7.1	7.2	7.3	7.5	6.8

Rotifers are regarded as bioindicators of water quality (Sladecek, 1983; Saksena, 1987) and high rotifer density has been reported to be a characteristic of eutrophic lakes (Sendacz, 1984).

In eutrophic lakes, permanent dominant rotifer species have been reported, such as Brachionus and Keratella (Tanyolac, 1993). In Uzunçayır Dam Lake, the Rotifera group was more dominant than the other two groups.

According Segers (2007), all the recorded rotifer species in the present study are widely distributed around the world. Also many of the recorded species are common in Turkey (Kaya and Altındağ, 2007; Kaya *et a*l., 2007). Only six species of Cladocera were observed in Uzunçayır Dam Lake. Among them *B.longirostris* and *C.sphaeriscus* are cosmopolitan species (Buyurgan *et al*., 2010). The ecological features of the recorded species show that most of them are cosmopolitan and littoral inhabiting (Kolisko, 1974).

Additionally, among the recorded species, *B. longirostris* and *C. vicinus*, *P. dolichoptera*, *K.cochlearis* are well known indicators of eutrophy (Ryding and Rast, 1989; Haberman, 1998). *D. longispina*, and *C. sphaericus*, of the Cladocera group, were dominant in the lake; however, these species are generally found in eutrophic lakes (Berzins and Bertilson, 1989). All of these species were recorded in the dam lake.

Saler and Haykır (2011) reported there was a marked decrease in total zooplankton species richness and individual number in winter and a sharp increase in spring and summer months in Pulumur Stream. Similar results have been reported in this study.

Saler (2011), reported 11 zooplankton species from Munzur River. Uzunçayır Dam Lake was built on Munzur River and in the dam lake 23 zooplankton species were identified.

Saksena (1987), mentioned Rotifers as the dominant zooplankton in in freshwater ecosystems. In Uzunçayır Dam Lake Rotifers were found in every season.

Saler *et al.* (2000), in Euphrates River, Saler and Sen (2001), in Zıkkım Stream emphasized that, rotifers were observed maximum numbers in spring. Zooplanktonik organisms have been recorded in high individual numbers over the period of the spring in the present study.

Güher and Erdoğan (2005), have reported spring and summer rotifer maksimums from Gala Lake. In Kesikköprü Dam Lake Yigit (2006), observed rotifers in greater number in spring and autumn than in other seasons. Seasonal distribution of rotifer fauna of Uzunçayır Dam Lake is shown an agreement with the findings of Güher and Erdogan (2005).

Rotifer species belonging to the family Brachionidae species that were observed in Gumuldur Stream by Ustaoglu *et al*. (1996) have showed similarities to that recorded in Uzunçayır Dam Lake.

Ipek and Saler (2008), found rotifers as the most abundant species in spring period in Seli Stream. They emphasized Brachionidae species of rotifers as the most observed family as in Uzunçayır Dam Lake.

pH is significantly effective on distribution of zooplankton in terms of zooplankton density Limit pH value for zooplankton is reported as 8.5

(Berzins and Pejler, 1987). Dam lake pH value ranged within normal limits.

Temperature is one of the most important factors affecting the distribution of rotifers (Kolisko, 1974). In parallel with the increase of temperature the embryonal development time of rotifer species is getting shorter and consequently to this they reproduce in a short time period. This finding explains the reason of existence of rotifer species in the highest density in spring and summer in Uzunçayır Dam Lake

Conclusion

The zooplankton of Uzunçayır Dam Lake consist mainly of Cladocera, Copepoda and Rotifera groups. Uzunçayır Dam Lake 23 zooplankton species were recorded. Dam Lake were represented with 15 Rotifers species. Rotifera showed higher diversity compared to other groups, reaching also high densities throughout the study period.

Acknowledgment

This study is supported by Firat University Scientific Research Project (FÜBAP) under Project No. 2006.

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8(1): 8-16 (2014) DOI: 10.3153/jfscom.2014002

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

BAYES TEORİSİNİN SU ÜRÜNLERİNDE KULLANIM OLANAKLARI

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Received: 24.01.2013 / Accepted: 20.08.2013 / Published online: 28.12.2013

Öz: Bu çalışma ile Bayesyen istatistik yöntemin, su ürünleri alanındaki uygulama olanakları araştırılmıştır. Balıkçılık çalışmalarında kullanılan boy-ağırlık verilerine doğrusal regresyon yapılarak hem Bayesyen istatistik yöntem hem de klasik istatistik yöntemle ilgili parametreler ve güven aralıklar tahmin edilmiştir. Sonuçta, Bayesyen yaklaşımın klasik yaklaşımdan daha isabetli ve güvenilir olduğu saptanmıştır.

Anahtar Kelimeler: Bayesyen istatistik yöntem, Boy-Ağırlık, Doğrusal regresyon, Klasik istatistik yöntem, Balıkçılık

Abstract: **The Usage of Bayes Theory in Fisheries Sciences**

In this study, we have examined the focus of using the Bayes statistical method to the field of fisheries. It has been estimated the parameters and confidence intervals for length-weight simple linear regressionin fisheries by applying the Bayesian and classical statistical methods. Therefore, it could be concluded that the Bayesian approach was better than classical statistical method in the sense of efficiency and giving narrow confident intervals.

Keywords: Bayesian statistical method, Length-Weight, Simple linear regression, Classical statistical methods, Fisheries

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Giriş

İstatistiki metotların, doğanın ve içerisinde barındırdığı canlıların biyo-ekolojik özelliklerinin anlaşılmasında kullanımı oldukça yaygındır. Canlıların yayılım mekanizmaları, büyüme dinamikleri, birbirleriyle olan ilişkileri, üremeleri ve daha birçok özelliği, istatistiki metotlar kullanılmadan anlaşılamamaktadır. Bu nedenle, istatistik bilimi, zaman içerisinde tüm diğer bilim dallarının temeline yerleşmiş ve temel bir bilim dalı halini almıştır. Bu da birçok alanda yeni istatistik metotların doğmasına neden olmuştur.

İstatistik biliminin gelişim sürecinde temel olarak iki farklı yaklaşımın etkili olduğunu iddia etmek pek yanlış olmaz. Bunlar; klasik yaklaşım ve Bayesyen yaklaşımdır (Ekici, 2009; Wade, 2000; Kinas ve Andrade, 2007; Mc Charty, 2007). Bayesyen yaklaşımının temelleri, 1763 yılında İngiliz rahip ve matematikçi olan Thomas Bayes tarafından yazılan, ancak ölümünden belli bir süre sonra arkadaşı Richard Price tarafından yayınlanan "*An Essay Towards Solving a Problem in the Doctrine of Changes*" isimli makaleyle atılmıştır. Bu makale, günümüzde kullanılan Bayesyen yaklaşımının da temelini oluşturmaktadır (McCarthy, 2007; Ekici, 2009; Link ve Barker, 2010; Savchuk ve Tsokos, 2011). Her ne kadar ortaya çıkışı üzerinden 250 yıl geçmiş olsa da, teori, popülerliğine 1950'den sonra kavuşma şansı bulmuştur. Bu tarihlerden sonra özellikle ekonomide, genetikte, mühendislikte ve sağlık bilimlerinde yaygın olarak kullanılmıştır. Su ürünlerindeki kullanımı ise son 20 yıla denk gelmektedir. Ülkemizde ise henüz su ürünleri alanında yapılmış bir çalışmaya rastlanılmamıştır. Bu çalışmayla bu alan için bir başlangıç yapılmaya çalışılmıştır.

Özellikle balıkçılık araştırmaları gibi doğal populasyonların korunmasını, sürdürülebilirliğini ve anlaşılmasını amaçlayan araştırmalardan elde edilen sonuçlar, söz konusu populasyonların geleceğini doğrudan etkilemektedir. Yine balık üretimi gibi besin arzını direkt ilgilendiren alanlarda, özellikle birim hacme düşen ürünün maksimize edilmesi açısından, denemelerin planlanması, yürütülmesi ve elde edilen sonuçların uygun istatistiki metotlar yardımıyla analiz edilmesi ve yorumu, oldukça önem arz etmektedir. Bu bağlamda gelişen bilimsel bilginin daha isabetli tahmin yapmada kullanılması elzem olmakla birlikte kaçınılmaz hale gelmektedir.

Materyal ve Metot

Bayes Teoremi

Bayes teoremi matematiksel istatistiğin önemli bir teoremidir. Bu teorem; herhangi bir durumun modelini oluşturmada evrensel doğruları ve gözlemleri kullanarak sonuçlar üretmeyi amaçlar. Kesinlik içermeyen bir bilginin tahmininde, gözlemleri ve sübjektif görüşleri kullanması ise bu yaklaşımı, klasik istatistiksel yöntemlerden ayıran en önemli özelliğidir (Ekici, 2009; Çevik, 2009; Box ve Tiao, 1992; Congdon, 2003; Link ve Barker, 2010).

Bayes teoremi koşullu olasılık tanımından elde edilen bir teoremdir. Buna göre Bayes teoremini tanımlayacak olursak; herhangi A ve B gibi iki olay için B bilindiğinde A'nın olma olasılığı;

$$P(A|B) = P(A \cap B)/P(B)\,, \quad P(B) > 0 \qquad (1)$$

olur ve A olayı bilindiğinde B'nin olma olasılığı da;

$$P(B|A) = P(A \cap B)/P(A), \quad P(A) > 0 \qquad (2)$$

olur. Koşullu olasılığın bu tanımını genelleştirecek olursak; bir örnek uzayı içerisinde tümü B olayıyla kesişen ve birbirini karşılıklı olarak engelleyen k tane A olayı olduğunu varsayalım. B olayı bilindiğinde A_i olayının olma olasılığı;

$$P(A_i|B) = P(A_i).P(B|A_i)/P(B) \qquad i = 1,2,\dots,k \qquad (3)$$

olacaktır. Eşitlik (3)'teki P(B)'nin açılımı aşağıda verilmiştir.

$$P(B) = P(A_1).P(B|A_1) + \cdots + P(A_k).P(B|A_k) = \sum_{j=1}^{k} P(A_j).P(B|A_j) \qquad (4)$$

Eşitlik (4), eşitlik (3)'te yerine konulduğunda;

$$P(A_i|B) = P(A_i).P(B|A_i)/\sum_{j=1}^{k} P(A_j).P(B|A_j)\,, \; i = 1,2 \dots k \qquad (5)$$

elde edilir ki bu da Bayes Teoremidir (Lindley, 1972; DeGroot, 1989; Box ve Tiao, 1992; Congdon, 2003; Lee, 2004; McCarthy, 2007; Link ve Barker, 2010; Savchuk ve Tsokos, 2011).

Bayes Teoreminin uygulanabilmesi için $P(A_i)$ olarak verilen ön bilgi olasılıklarının bilinmesi gerekmektedir. Bu teoremden hareketle parametre tahmini yapılabilir. Uygulamada kullanılan Bayes teorisinin elde edilmesi ise şu şekilde yapılmaktadır. Eğer p(.) bir olasılık fonksiyonu, θ parametre vektörünü, y gözlemlere ait vektörü ve $p(y, \theta)$ da ortak olasılık fonksiyonunu gösterirse;

$$p(y, \theta) = p(\theta|y).p(y) = p(y|\theta).p(\theta) \qquad (6)$$

buradan da;

$$p(\theta|y) = p(\theta).p(y|\theta)/p(y) \qquad (7)$$

bulunur. $p(y)$ gözlemlere ait olasılığı vermektedir. $p(y)$'nin açılımı; eğer ki gözlemler sürekli özellik gösteriyorsa,

$$p(y) = \int p(y|\theta).p(\theta)d\theta$$

olur. Kesikli ise;

$$p(y) = \sum p(y|\theta).p(\theta)$$

şeklinde yazılır ve eşitlik ön bilgi olasılığı ve son bilgi olasılığı ile birlikte yazıldığında;

$$p(\theta|y) \propto p(\theta).l(y|\theta) \qquad (8)$$

veya

Son bilgi olasılığı $\propto$ ön bilgi olasılığı $\times$ maksimum olabilirlik fonksiyonu

halini alır. Buradaki $\propto$ işareti oransallığı ifade etmektedir (Box ve Tiao, 1992; Congdon, 2003; Ekici, 2005; Kinas ve Andrade, 2007; Çevik, 2009). Verilen (8) eşitliği, parametre tahmininde kullanılacak olasılık yoğunluk fonksiyonunu vermektedir.

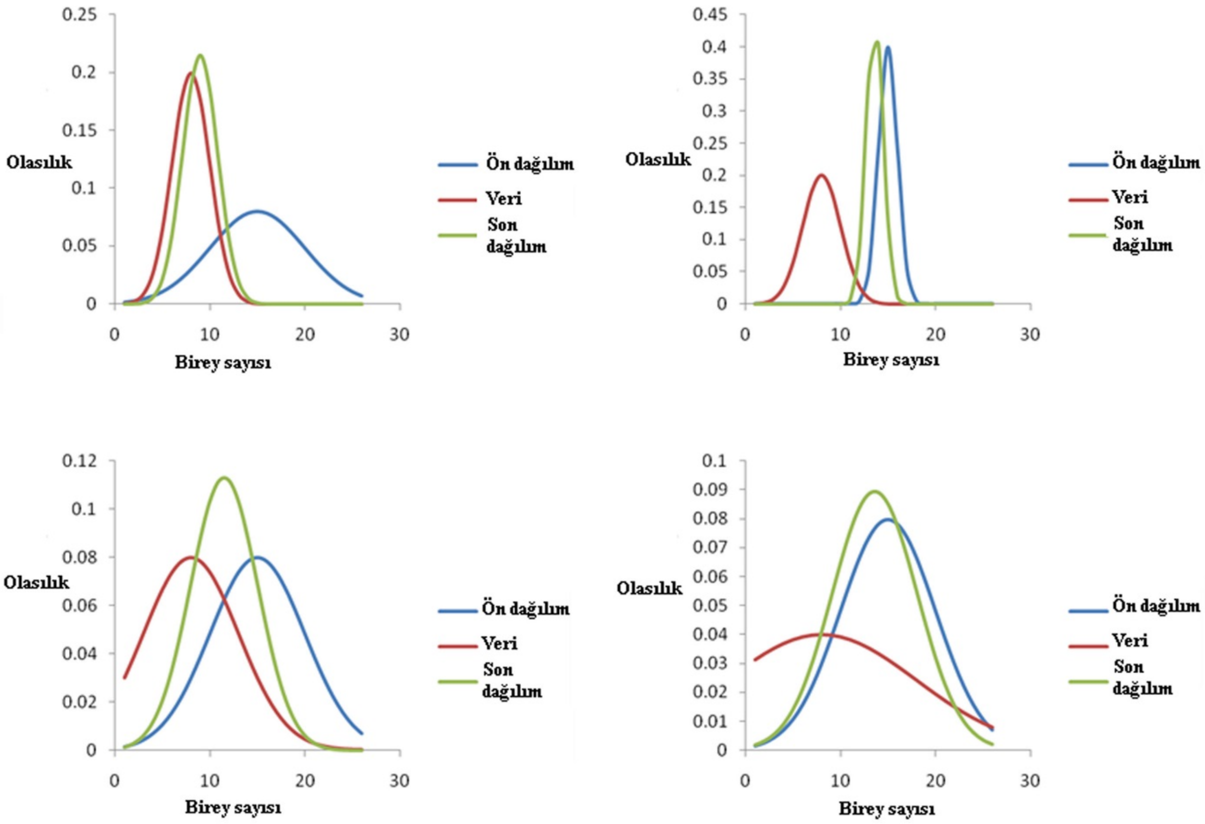
Ön Bilgi Dağılışları ve Son Bilgi Dağılışları

Bayesyen yaklaşımda, klasik istatistiki yöntemlerden farklı olarak örnekten elde edilen bilginin yanı sıra ön bilgi dağılışlarının da kullanılması, bazı problemler ortaya çıkarmaktadır. Bu problemlerden en önemlisi ise parametrenin yapısının ön bilgi dağılışının seçimini etkilediği gerçeğidir. Zaman içerisinde bu problemden kaynaklı olarak ön bilgi dağılımlarının belirlenmesinde üç farklı metot ortaya çıkmıştır. Bunlar; bilgi içermeyen ön bilgi dağılımı(noninformative), eşlenik ön bilgi dağılımı(cojugated) ve sübjektif ön bilgi dağılımıdır. Bilgi içermeyen ön bilgi dağılımı kullanıldığında analiz sonucunda klasik yaklaşımlarla benzer sonuçlar elde edilirken, eşlenik ön bilgi dağılımı ve sübjektif ön bilgi dağılımı ile belirlenen ön bilgi dağılımları kullanıldığında elde edilen sonuçlar klasik yaklaşımdan farklı olmaktadır. Çünkü bu her iki dağılım da, ek bilgileri ön bilgi olarak analize dahil etmektedir. Tablo 1'de eşlenik ön bilgi dağılımı kullanıldığında elde edilmesi gereken son bilgi dağılımları verilmiştir. Tablo 1'den de anlaşılacağı üzere verinin sahip olduğu dağılış ve ön bilginin sahip olduğu dağılış ile son bilgi dağılışı bir birleriyle uyumlu olmak zorundadır. Şekil 1'de de örnek olarak farklı birey sayısına sahip dört farklı popülasyonun birey sayısı tahmininde ön bilgi dağılışının meydana getirdiği değişim görülmektedir.

Tablo 1. Verinin maksimum olabilirlik fonksiyonları, Eşlenik Ön Bilgi Dağılımları ve Son Bilgi Dağılımları

Table 1. Likelihood Functions of Data and Their Prior Conjugate and Posterior Distributions

Maksimum Olabilirlik Fonksiyonu	Eşlenik Ön Bilgi Dağılımı	Son Bilgi Dağılımı
Binom	Beta	Beta
Negatif Binom	Beta	Beta
Normal	Normal	Normal
Poisson	Gama	Gama
Üstel	Gama	Gama
Gama	Gama	Gama
Bernoulli	Beta	Beta



Şekil 1. Farkli populasyonlara ait ön bilgi, veri yapısı ve son bilgi dağılışlarının birbirlerine göre durumu

Figure 1. Statement of different prior, likelihood and posterior distribution of different population

Bayesyen yaklaşımda, ön bilgi dağılışı ve mevcut çalışmadan elde edilen veriyi koşullu olarak kullanarak son bilgi dağılışı kolayca belirlenebilmektedir. Teorik olarak böyle olmasına karşın pratikte çoğu zaman parametreye ait son bilgi dağılımı kolayca elde edilemez. Bu gibi durumların çözümü için birçok yöntem ortaya konulmuştur. Monte Carlo integrasyonu bu yöntemlerden biridir. Monte Carlo yöntemi fizik biliminde şans sayısı türetilerek integral hesaplanması için geliştirilmiş bir metottur. Ancak Bayesyen yaklaşımda ve ilgili birçok alanda da yaygın olarak kullanılmaktadır. Yine bunun yanında Bayesyen yaklaşımda Monte Carlo integrasyonunun birlikte kullanıldığı Markov Zinciri yöntemi de işin içine girmektedir. Buna göre bu yöntem; herhangi bir t anında, şans değişkeni olan X_t'nin, alacağı mümkün x değerlerinden oluşan durum uzayındaki farklı değerlerinin meydana geliş olasılıklarının sadece şans değişkenlerinin mevcut değerlerine bağlı olarak bulunabileceğini gösteren bir süreçtir (Ekici 2005). Süreç olarak nitelendirilmesinin nedeni de örnek seçiminin bir seri işlemle yapılması ve bu işlemlerin birbiri ardı gerçekleşen örnekleme yöntemi olmasından kaynaklanmaktadır. Markov Zinciri Monte Carlo (MZMC) yöntemleri stokastik süreçlerdir. Modele ait parametrelerin marjinal son bilgi dağılımlarını yorumlamada oldukça işlevsel olan bu yöntemlerden en önemlisi ve su ürünleri araştırmalarında da yaygın olarak kullanılanı Gibbs Örneklemesi yöntemidir. Bu yöntemle, şartlı yoğunluk fonksiyonlarının hepsinden örnekleme yapmak suretiyle, modeldeki tüm parametrelerin ortak yoğunluk fonksiyonuna bir yaklaşımda bulunulur (Fırat 2002). Tüm bu analizlerin de kolayca yapılabildiği bir de program mevcuttur.

BUGS Paket Programı

Bayesian inference **U**sing **G**ibbs **S**ampling (BUGS) programı Cambridge Üniversitesinde 1996 yılında geliştirilmiştir (http://www.mrc-bsu.cam.ac.uk/bugs/winbugs/contents.shtml). Bu program yardımıyla Bayesyen istatistiksel yöntemin her türlü uygulaması pratik bir şekilde gerçekleştirilebilmektedir (Meyer ve Millar 1999). Program, MCMC kullanarak karmaşık modellerin Bayesyen yaklaşımla analizini gerçekleştirmek üzere oluşturulmuştur. Temel olarak bir modelin parametrelerini tahmin etmek amacıyla çeşitli şekillerde elde edilmiş güncel verinin ön bilgiler ile birleştirilerek tahmin yapılması ilkesine dayanmaktadır. Ön bilgi olasılıkları ile mevcut bilginin birleştirilip son bilgi dağılışını oluşturulmasında Gibbs Örneklemesi yöntemini kullanmaktadır. Programın ismi de buradan gelmektedir.

Su Ürünlerinde Bayes Teoremi

İstatistiki yaklaşımda Bayesyen uygulaması, özellikle çevre bilimlerinde ve balıkçılıkta son 20 yıldır oldukça iyi bir gelişme sağlamıştır. Özellikle Hilborn ve diğ., (1993) ile Ludwig ve diğ., (1993)'nın yaptıkları çalışmalar balıkçılık araştırmaları için başlangıç çalışmaları olarak görülmektedir (Kinas ve Andrade, 2007). Bu çalışmaların ardından Bayesyen yaklaşımı doğal bir alternatif haline gelmiştir. Bu süre zarfında, model kurgusundaki esneklik ve birçok veri kaynağından faydalanılabilmesi nedeniyle bu teorem, birçok alanda, oldukça cazip hale gelmiştir (Punt ve Hilborn, 1997; Mc Allister ve Ianelli, 1997; Millar, 2002; Michielsen ve diğ., 2008; Punt ve diğ., 2011; Juntunen ve diğ., 2012). Bayesyen yaklaşımı, stok tahmini, popülasyon modellemesi, ve büyüme parametrelerinin tahmini gibi alanlarda çeşitli uygulamalara sahiptir (Chen ve Holtby, 2002; Helser ve Lai, 2004; Siengfried ve Sansó, 2006; Helser ve diğ. 2007). Bu uygulamalarda temel olarak iki yaklaşım ön plana çıkmaktadır. Bunlar durum uzayı modellemesi (state-space modelling) ve hiyerarşik meta analizi (hierarchical meta analysis). Her iki yaklaşım da yaygın olarak kullanılan ve her geçen gün gelişen yaklaşımlardır.

Durum uzay modelleri, 1960'lardan bugüne mühendislik, ekonomi ve ekoloji gibi birçok alanda uygulama alanı bulmuş matematiksel bir modelleme yöntemidir. Bunun yanında birçok fiziki, biyolojik ve ekonometrik sürecin modellenmesinde de kullanılmaktadır. Durum uzayı, gözlenebilen (observed) ve gözlenemeyen (unobserved) dinamik bir sistemin matematiksel yaklaşımla ifade ediliş şeklidir. Özellikle, modellemenin daha düzgün ve işlevsel olabilmesi için gözlenemeyen değişkenleri de sisteme katmaktadır. Bu şekilde oluşturulan bir modele daha sonra kolaylıkla Kalman filtresi yöntemi ya da olabilirlik yöntemi uygulanabilmektedir (Rivot ve diğ., 2004; Yaşar, 2008).

Durum uzayı modeli içerisinde iki tip eşitlik bulunan bir modelleme yöntemidir. Bu eşitliklerden biri sistemin gerçek dinamiğini tanımlayan durum ya da geçiş eşitliği, diğeri de toplanan veriye gizlenmiş olan sistem dinamiğini ifade eden gözlem eşitliğidir (Meyer ve Millar, 1999; Rivot ve diğ., 2004; Yaşar, 2008).

Hiyerarşik model ise özellikle karmaşık modellerin analizinde bize oldukça büyük bir kolaylık sağlayan Bayesyen yaklaşımdır (McCarthy 2007). Özellikle tahmin edilecek parametre sayısı fazla ve bu parametreler de birbirleriyle bağlantılı ise, parametreler arası bağımlılık söz konusu olacak ve bu da elde edilen sonucu olumsuz yönde etkileyecektir. Bu bağımlılığın modele yansıtılması bu problemin ortadan kaldırılmasına yardımcı olacaktır. Bu durumda uygulanan en iyi yöntemlerden biri de hiyerarşik analizdir (McCarthy, 2007; Congdon, 2010; Karadağ, 2011; Lunn ve diğ., 2013). Hiyerarşik analiz MZMC ile birlikte uygulandığında daha güvenilir ve yansız sonuçlar vermektedir (Karadağ 2011).

Bulgular ve Tartışma

Uygulama için Mart, Nisan ve Ekim 2012 tarihlerinde İskenderun körfezinden araştırma avcılığıyla elde edilen 141 *Mullus barbatus barbatus*'a ait boy ve ağırlık verileri kullanılmıştır. Veriler hem klasik doğrusal regresyon yöntemiyle, hem de Bayesyen doğrusal regresyon yöntemiyle analiz edilmiştir. Böylelikle her iki yöntem kıyaslanıp farkları ortaya konulmuştur.

Bayesyen yöntem için regresyon parametreleri olan a ve b için ön bilgi dağılışı olarak Fishbase.org sitesinde yer alan ilgili türe ait 54 farklı çalışmadan elde edilen a ve b değerlerinin ortalaması ve varyansı eşlenik normal ön bilgi dağılımı olacak şekilde kullanılmıştır. Bayesyen yaklaşımın uygulaması için OpenBUGS v3.2.2 (Spiegelhalter ve diğ., 2003) paket programı kullanılmış ve aşağıdaki kod yardımıyla analiz yapılmıştır.

```
model{
    loga~dnorm(-4.7217,0.0465)
    a<-exp(loga)
    b~dnorm(3.11,0.0264)
    residual_sd~dunif(0.00001,100)
    inv_var<-1/pow(residual_sd,2)
```

```
        for(i in 1:N){
        logw[i]~dnorm(mean[i],inv_v
    ar)
        mean[i]<-
    loga+b*logL[i]+0.5/inv_var
        }
    }

list(N=141)
logL[]    logw[]
```

Klasik regresyon analizinin uygulaması ise Excel yardımıyla yapılmıştır.

Yapılan analiz sonucunda klasik yöntemle elde edilen sonuçlar tablo 2’deki gibi bulunmuştur.

Bayesyen yöntemle elde edilen sonuçlar tablo 3’deki gibi bulunmuştur. Parametre tahminlerine ait son bilgi olasılıkları da şekil 2’de verilmiştir.

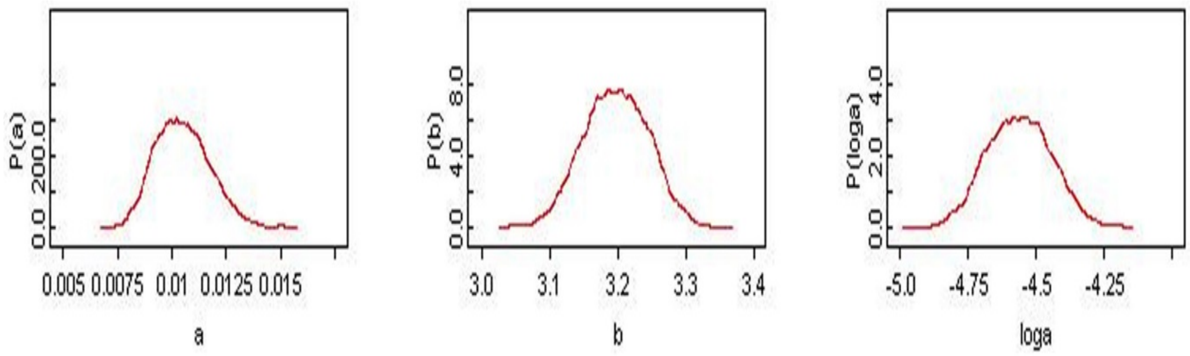
Tablo 2. Klasik Doğrusal Regresyon Yöntemiyle Parametre Tahmini

Table 2. Parameter Estimation of Classical Linear Regression Method

Parametre	Tahmin	Std. Hata	p	95%’lik Güven Sınırları	
				Alt	Üst
Ln(a)	-4.563	.115	.000	-4.824	-4.302
b	3.198	.047	.000	3.093	3.304

Tablo 3. Bayesyen Doğrusal Regresyon Yöntemiyle Parametre Tahmini
Table 3. Parameter Estimation of Bayesian Linear Regression Analysis

Parametre	Ort.	Std. Sap.	MC Hata	95%’lik GüvenSinirlari			Zincir Başlangici	Zincir Uzunluğu
				Alt	Ortanca	Üst		
a	0.011	0.0013	0.00006	0.008	0.010	0.013	10000	90001
b	3.197	0.0489	0.00244	3.102	3.197	3.290	10000	90001
Ln(a)	-4.563	.121	0.00605	-4.794	-4.563	-4.327	10000	90001



Şekil 2. Bayesyen doğrusal regresyon yöntemiyle yapılan parametre tahminlerinin olasılık yoğunluk fonksiyonu

Figure 2. Probabilty and density function of posterior distribution of parameters

Herhangi bir parametre için yapılan tahminin isabetli bir tahmin olup olmadığı, elde edilen tahmine ait standart hata ve güven aralıkları gibi ölçülere bakılarak karar verilir. Tahminin küçük standart hatası ve dar güven aralığa haiz olması demek tahminin isabet derecesinin de güçlü olduğunu ortaya koyar (Mosteller ve Tukey, 1977; Draper ve Smith, 1998; Rawlings ve diğ., 1998; Rao ve Toutenburg, 1999; Freund ve diğ., 2006).

Tablo 1 ve tablo 2'de verilen sonuçlardan da anlaşılacağı üzere Bayesyen yöntemle elde edilen tahminlerin hataları daha düşük güven aralıkları daha dardır. Bunun yanında Bayesyen yöntemde parametre tahmini bir değer olmaktan ziyade bir olasılık belirtmektedir ki bu da sonucun hangi olasılıkla nerede olduğunu ifade eder. Bu, Bayesyen olasılıksal metodun doğasıyla ilgili bir durumdur (Lunn ve diğ., 2013). Yine eşlenik ön bilgi dağılımının kullanılması, geçmiş bilginin parametre tahminini ne denli etkilediğinin bir kanıtıdır. Çünkü klasik regresyonda ön bilgi dağılımı olarak geçmiş çalışmalar modele eklenmemekte bu da sadece örnekten elde edilen tahminle yetinildiğini göstermektedir. Oysaki geçmiş çalışmalardan elde edilen değerler ön bilgi olasılığı olarak modele eklenmesi sonucunda hem tahminin örnekten kaynaklı hatasını azaltmış hem de tahminin isabet derecesini arttırmış olunmaktadır. Nitekim elde edilen sonuçlar bu durumun önemli bir kanıtı niteliğini taşımaktadır.

Sonuç

Yaptığımız çalışmadan ve elde ettiğimiz sonuçlardan da anlaşılacağı üzere Bayesyen metodu ile yapılan tahminler dar güven aralığına ve düşük standart hataya sahiptir. Bu da tahmin problemlerinde özellikle de su ürünleri alanındaki tahmin problemlerinde geniş bir uygulama alanına sahip olacağı anlamına gelmektedir. Bu çalışmayla birlikte su ürünleri alanında, ülkemizde söz konusu yöntemin bu çalışmayla birlikte gittikçe önem kazanacağı ve araştırmaların da artacağı düşünülmektedir.

Teşekkür

Bu makalenin uygulama kısmında kullanılan veriler, SÜF2011BAP7 nolu Çukurova Üniversitesi Bilimsel Araştırmalar Proje Başkanlığı projesinden yararlanılarak elde edilmiştir.

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8(1): 17-26 (2014) DOI: 10.3153/jfscom.2014003

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

CHEMICAL COMPOSITION, CHOLESTEROL, TRACE METALS AND AMINO ACID COMPOSITION OF DIFFERENT CANNED FISH PRODUCTS PRODUCED AND SOLD IN TURKEY

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Received: 20.03.2013 / Accepted: 01.10.2013 / Published online: 28.12.2013

Abstract: Commercial Turkish canned fish products were analysed for chemical composition and food quality attributes inclusive potentially toxic heavy metals of the fish content (anchovy, sardine, mackerel, bonito, and trout). The average fat content ranged from 6.7% (trout) to 24.3% (mackerel). Cholesterol was low (41-69 mg/100g). No phosphate based additives have been added during production. The samples contained high amounts of taurine (20-67 mg/100 g) and histidine (146-424 mg/100g, except trout). The cadmium and lead concentrations were below the Turkish Food Codex and EU limits (4.0-19.8 µg/kg and 16.7-60.6 µg/kg, respectively). Zinc ranged from low contents in mackerel, bonito and trout (5.8-6.9 mg/kg) to higher contents in anchovy and sardine (27.3 and 17.6 mg/kg). Copper concentrations were found to be low around 0.5 mg/kg.

Keywords: Canned fish, Chemical composition, Trace metals, Free amino acids, Cholesterol, Taurine

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Öz:

Türkiye'de Üretilen ve Satılan Farklı Konserve Balık Ürünlerinin Kimyasal Kompozisyon, Kolestrol, İz Metal ve Amino Asit Kompozisyon Değerleri

Ticari Türk konserve balık ürünleri (hamsi, sardalya, uskumru, palamut, alabalık) potansiyel toksik ağır metalleri içeren gıda kalite özellikleri ve kimyasal kompozisyonu için analiz edilmiştir. Ortalama yağ içeriği alabalıkta % 6.7'den uskumruda %24.3'e kadar değişim göstermiştir. 41-69 mg/100 g olarak bulunan kolestrol değerleri düşük bulunmuştur. Üretim boyunca fosfat bazlı katkılar eklenmemiştir. Numuneler yüksek miktarda taurin (20-67 mg/100 g) ve histidin (146-424 mg/100 g, alabalık hariç) içermektedirler. Kadmiyum ve kurşun konsantrasyonları Türk Gıda Kodeksi ve Avrupa limit değerlerinin (sırayla 4.0-19.8 µg/kg vve 16.7-60.6 µg/kg) altında bulunmuştur. Çinko, uskumru, palamut ve alabalıkta 5.8-6.9 mg/kg olarak düşük, hamsi ve sardalyada 27.3 and 17.6 mg/kg olarak daha yüksek değerlerde tespit edilmiştir. 0.5 mg/kg civarında tespit edilen bakır konsantrasyonları düşük olarak bulunmuştur.

Anahtar Kelimeler: Konserve balık, Kimyasal kompozisyon, İz metaller, Serbest amino asitler, Kolesterol, Taurine

Introduction

In a recent paper (Aydin 2011) about fish and fishery products consumption in Turkey it was demonstrated that 32% of Turkish households consumed such products when taking the average of the last 12 years while the remaining 68% did not consume fish at all.

Another study (Erdoğan et al. 2011) demonstrated that canned seafood was most preferred (37.6%) followed by frozen seafood products (26.8%).

This underlines the importance to have a good and comprehensive knowledge about the nutritional properties and present risks in canned products processed in Turkey from Turkish raw materials. In canned products a number of nutritionally important components as amino acids, taurine, selenium, and lipids are present but also the occurrence of heavy metals as cadmium and lead are reported. The concentrations of all toxic elements and essential elements in selected products like canned anchovy or tuna fillets were found to be high and often exceeded legal limits set by health authorities (Celik et al. 2007). Therefore the authors concluded that these products must be monitored more often. Data about other components such as cholesterol content, phosphorous, alkali elements and heavy metals as zinc and copper are almost lacking.

Also in the raw fish material from Turkish waters which can be used for canning elevated concentrations of heavy metals have been reported (Celik et al. 2004; Dalman et al. 2006; Ersoy et al. 2010; Mendil et al. 2010; Mol et al. 2012; Tuzen 2009; Uluozlu et al. 2007; Yildirim et al. 2009; Yilmaz et al. 2010).

In the case of canned fish production a storage process (chilling or freezing) is needed for storing the raw material prior to canning. A heating step (cooking, smoking, and frying) is normally applied for reducing water content and inactivating endogenous enzyme activity. A rigorous thermal treatment (sterilization) is undertaken to inactivate micro-organisms and to guarantee a prolonged shelf life. Labile and essential nutrients (proteins, vitamins, lipids, minerals) present in the raw fish are exposed to different processing conditions that can reduce the nutritional and sensory values of the final product (Aubourg 2001).

Amino acids are not only components of all peptides and proteins but also precursor compounds relevant to food flavour, taste and colouring (Belitz et al. 2009). The content of free amino acids in food and their losses due to industrial processing are also interesting because of nutritional aspects. Very remarkable is the content of taurine in fish. Taurine is a conditional essential free amino acid with several health-beneficial effects (Undeland 2009).

In this investigation both, nutritional positive components as well as potentially harmful elements as heavy metals have been analysed to give a good overview about the nutritional value of the canned fish products from Turkey.

Materials and Methods

Samples and Sample Preparation

Commercial brands of canned fish products were purchased in retail stores in Izmir, Turkey. Products chosen are typically consumed in Turkey. The samples analysed consisted of whole anchovy in oil (Dardanel Hamsi sosyete), headed sardine in oil (Dardanel sardalya), mackerel fillet in own juice (Migros Uskumru), bonito fillet in own juice (Migros Palamut), and trout fillet in tomato sauce (Migros Alabalik), 5 cans each.

The chemical analyses were performed in Hamburg, Germany. Convenient aliquots or pooled samples (depending on the amount of material) of the dripped fish part were homogenized in a knife mill and taken for analyses.

Proximate Analyses

Moisture was determined gravimetrically in an aliquot of the homogenate after drying for 12h in an oven at 105 °C until weight was constant. Percent raw protein was calculated by multiplying nitrogen (%) by 6.25 (nitrogen was measured by Dumas using a LECO TruSpecN (LECO instruments GmbH, Mönchengladbach, Germany)) (AOAC 2005). The lipid content was analyzed by a modified method of Smedes (1999) (Karl et al. 2012).

Ash content was determined according to Antonacopoulus (1973). The amount of salt was obtained by titration with 0.1 N $AgNO_3$ solution after protein precipitation with Carrez I and Carrez II (Karl et al. 2002).

Cholesterol Content

Cholesterol was analyzed according to the method and quantification based on the experimental procedure of Naemmi et al (1995) as modified by Oehlenschläger (2006).

Total Phosphorus Content

The total phosphorus content was determined photometrically in the nitric acid extract of the ash according to a modified official German method of the foodstuffs and animal feed code to measure phosphorus in meat (§ 64 LFGB 2008).

Free Amino Acid Composition

For sample deproteinization 10 g fish sample were homogenized with 90 mL 6 % perchloric acid (w/w) and subsequently filtrated. HPLC determination of the free amino acids (17, including taurine) was performed in the diluted extracts (1:10 up to 1:200). After precolumn derivatization with o-phthaldialdehyde (OPA) according to a modified method of Antoine and co-workers (1999), the amino acids were separated on a reversed-phase column by a gradient and then quantified by fluorescence detection using the internal standard method with 2-aminobutyric acid.

Mineral Element Analysis

The homogenised fish samples (1.6 – 2.0 mg wet weight) were digested in a mixture of 4 mL 65% nitric acid suprapur and 1 mL 30% hydrogen peroxide in closed tetrafluormethaxil quarz vessels of a temperature-time programmed Milestone ultraCLAVE III (Milestone SRL, Sorisole, Italy) digestion system.

Na, K, Ca and Mg were measured by flame AAS (contrAA® 700 high-resolution continuum source atomic absorption spectrometer with air-acetylene flame equipped with an autosampler, Analytik Jena, Jena, Germany).

Selenium Measurements

The samples were prepared as described above. Selenium was analyzed by the continuous flow hydride system of the contrAA® 700. For the reduction of Se (VI) to Se (IV) prior to the hydride generation 6 M HCl was added to an aliquot of the sample solution (1:1 v/v) and heated in a water bath for 30 min at 90 °C.

Quality Assurance of AAS Determination

The commercial reference material IAEA-407 of the International Atomic Energy Agency was used to validate the analytical methods and as quality control. The mean values obtained for analytical recovery were 101% (Na), 100% (K), 89% (Ca), 82% (Mg) and 83% (Se) (Table 1).

Heavy Metals

All samples were lyophilised in a Finn-Aqua Lyovac GT 2 freeze dryer (GEA Process Engineering Inc., Columbia, U.S.), milled in a ball mill made from agate and finally decomposed in an oxygen plasma ashing chamber. Differential pulse anodic stripping voltammetry (746 VA Trace Analyser, Metrohm, Switzerland) was used for the determination under the same experimental conditions, as described elsewhere in detail (Celik et al 2007). For analytical quality control the recommendations given in the guidelines of NMKL (2011) are followed whenever possible. The accuracy of the concentrations determined in this study was verified by measurements of certified reference materials. Results given in Table 1 show that all elements were determined with good accuracy.

Statistical Evaluation

One-way ANOVA (Tukey-Test) was applied for statistical analysis (SigmaStat version 3.5, Systat software Inc., San Jose, U.S.).

Results and Discussion

Proximate Composition and Cholesterol Content

The basic nutritional ingredients show that the canned fish products contained considerable amounts of raw protein. The highest average raw protein content was measured in bonito (23.6%) and the lowest in trout fillets (17.0%) (Table 2). The average fat content ranged between 6.7% (trout) and 24.3% (mackerel). Fish lipids are a very good source of essential unsaturated fatty acids. The consumption of such products can help to cover the daily amounts of valuable long chain unsaturated omega-3 fatty acids recommended for the prevention of heart diseases.

Table 1. Quality Assurance (QA) for elemental analyses based on certified reference materials. Concentrations based on a dry weight basis

	No. of analyses	**Units**	**Results**	**Certified reference material**	
				IAEA 407	CRM No. 422
Sodium	6	g/kg	13.29 ± 0.55 (101.5%)	13.10 ± 0.70	
Potassium	6	g/kg	13.29 ± 0,56 (101.5%)	13.10 ± 0.90	
Calcium	6	g/kg	24.22 ± 2.61 (89.4%)	27.00 ± 1.30	
Magnesium	6	g/kg	2.34 ± 0.08 (82.1%)	2.72 ± 0.14	
Selenium	10	mg/kg	2.39 ± 0.14 (84.5%)	2.83 ± 0.38	
Cadmium	5 5	µg/kg µg/kg	138.4 ± 29.4 (73.2%) 17.5 ± 0.75 (102.8%)	189.0 ± 4.0	 17.0 ± 2.0
Lead	5 5	µg/kg µg/kg	149.9 ± 25.2 (124.1%) 81.4 ± 9.41 (95.8%)	120.0 ± 20.0	 85.0 ± 15.0
Copper	5 5	µg/kg µg/kg	2.32 ± 0.56 (70.7%) 1.08 ± 0.09 (103.0%)	3.28 ± 0.08	 1.05 ± 0.07
Zinc	5 5	µg/kg µg/kg	66.3 ±14.2 (98.8%) 17.3 ± 1.0 (88.4%)	67.1 ± 0.8	 19.6 ± 0.5

Table 2. Proximate composition and cholesterol content of canned fish products from Turkey (arithmetic mean ± standard deviation, range: min – max, on a wet weight basis)

Fish Component	N	Anchovy, whole, in oil	Sardine, headed, in oil	Mackerel, fillet in own juice	Bonito, fillet in own juice	Trout, fillet in tomato sauce
Cholesterol [mg/100 g]	5	68.8 ± 6.0 60 – 76	64.6 ± 6.4 58 – 74	41.0 ± 8.9 26 - 48	51.6 ± 4.4 47 - 58	48.4 ± 4.4 41 - 52
Moisture [g/100 g]	5	61.6 ± 1.8 59.3 – 64.0	60.6 ± 1.9 57.9 – 62.5	55.3 ± 2.6 51.7 – 58.3	59.9 ± 1,7 58.3 – 62.3	70.7 ± 0.8 69.6 – 71.8
Ash [g/100 g]	5*	2.7	3.2	1.4	1.3	2.1
Raw protein (N x 6.25) [g/100 g]	5	18.1± 0.3 17.8–18.5	18.6 ± 1.5 16.2 – 20.1	18.1 ± 1.8 16.6 – 21.1	23.6 ± 0.8 22.9 – 24.7	17.0 ± 0.4 16.4–17.4
Total lipids [g/100 g]	5*	12.5	11.7	24.3	15.1	6.7
NaCl [g/100 g]	5*	1.3	1.2	0.7	0.5	1.3
Phosphate (P_2O_5) [g/100 g]	5*	0.8	1.0	0.4	0.5	0.4
Sodium [mg/ kg]	5	4379 ± 371 3973 – 4729	4653 ± 507 4272 – 5460	2452 ± 304 2040 – 2811	1911 ± 214 1707 – 2246	4919 ± 572 4226 – 5754
Potassium [mg/ kg]	5	2307 ± 160 2060 – 2450	2282 ± 250 1931– 2535	2604 ± 269 2244 – 2941	2853± 92 2751– 2945	3443 ± 80 3348 – 3566
Magnesium [mg/ kg]	5	286 ± 12 269 – 303	354 ± 9 341– 363	228 ± 27 192 – 264	279 ± 10 269 – 291	217 ± 3 212 – 221
Calcium [mg/ kg]	5	2349 ± 342 1988 – 2734	3601 ± 313 3194 – 4020	nn	nn	nn

*) pooled samples nn< limit of detection 70-100 mg Ca/kg (based on threefold standard deviation of the blanks and an average sample weight)

Fish products are usually not a considerable source for cholesterol via food intake. In raw fish from the Northeast Atlantic an average of approx. 40 mg/100 g was determined. Fish species from temperate areas can have slightly higher values (Oehlenschläger 2006). Levels between 41 and 69 mg cholesterol/100 g in the canned fish species were in the low range and confirm that the cholesterol content does not correlate with the respective lipid values. It could also be confirmed that there is no increase of cholesterol in the fish caused by other ingredients.

Mineral Element Analysis

Marine food serves as a moderate to good source of minerals. Fish flesh generally contains high amounts of potassium (around 0.35 g/100g and low amounts of sodium (around 0.04 g/100g) (Holland et al 1993; Oehlenschläger 1997; Oehlenschläger et al 2009). In the samples investigated the natural amounts of sodium have been increased by the addition of salt to contents between 0.5 and 1.3 gNaCl/100g while potassium remained at its natural content (0.228 -0.344 g/100g, Table 2).

The level of magnesium in the raw and boneless muscle is higher (average 0.025 g/100g) than the calcium content which is confirmed by the results of the canned fillets in Table 2. Only fish eaten with bones like anchovy and sardines is an excellent source for calcium (Holland et al. 1993), in boneless canned fish the calcium content was below the limit of detection.

The phosphorous content is somewhat higher in canned fish, where the bones are in and lower in boneless fillets. From the data in Table 2 it is evident that all phosphorous present is natural (0.4–1.0 g P_2O_5/100g) and no phosphate based additives have been added during production.

Particularly worth mentioning is selenium as an essential micronutrient which plays a vital role in human health. Fish is an important and highly bio-available source of dietary selenium. The content of this element can vary considerably between specimens, but is on average quite constant between species. Marine fish from the Northeast Atlantic waters contains between 0.3 and 0.6 mg selenium/kg, values for freshwater fish can be somewhat lower (Oehlenschläger 2006). The results of this study (Table 3) confirm these findings. The recommended daily allowances of selenium of 0.03-0.07 mg of the German Nutrition Society (2008) are already covered by the consumption of about 100 g of the analysed fish species.

The results for the element traces are presented in Table 3. All cadmium concentrations found were well below the legal Turkish Food Codex and the strictest EU limits (100 µg/kg (Anonymous 2008) and 50 µg/kg wet weight, respectively). The highest amount 20 µg/kg was present in anchovy; the other 4 samples contained only 4-7 µg/kg. The values for anchovy were low compared with literature data that reported for fresh anchovy 650 µg/kg (Uluozlu et al. 2007) and 270 µg/kg (Tuzen 2009). For canned anchovy Tuzen and Soylak (2007) and Celik et al. (2007) published 120 µg/kg and 92 µg/kg, respectively. In contrast, Mol (2011a) found lower cadmium contents in canned anchovy ranging between 1 and 19 µg/kg which are in good agreement with the figures reported in this paper. For canned sardine and tuna 190 µg/kg and 80 µg/kg, respectively, were analyzed (Tuzen et al. 2007). Similar and comparable low cadmium concentrations of 10-20 µg/kg in canned tuna were published in 2011 by Mol (2011b). However, in a recent study about trace elements in vacuum packed smoked Turkish rainbow trout, a cadmium content of 10 µg/kg was found (Sireli et al. 2006). Galitsopoulou (2012) explained a certain increase in cadmium content of anchovies and sardines after canning compared to the raw material used by the water reduction process prior to canning.

The Turkish Food Codex permits 300 µg/kg as maximum lead level in fish (Anonymous 2002). The lead contents were also all below this limit, ranging from 17 µg/kg in bonito fillet to 61 µg/kg in sardine. 90 µg Pb/kg have been reported by Tuzen (2009) in canned sardine which is close to the amount found in this investigation, but the author found a much higher lead content in canned anchovy (400 µg/kg). Mol (2011a) reported in canned anchovies a lead concentration of 188 µg/kg which exceeds the results of this investigation by a factor of 5. In canned tuna a lead content ranging between 90 and 450 µg/kg was reported by Mol (2011b). The significantly higher lead concentration in canned products containing bones can be explained by the fact that lead can be accumulated in bone tissue (Oehlenschläger 2002).

All samples contained zinc ranging from a low content in mackerel (6.9 mg/kg), bonito (5.8 mg/kg) and trout (6.4 mg/kg) to a higher content in anchovy and sardine (27.3 mg/kg and 17.6 mg/kg). This is in good agreement with other findings where 34.0 mg/kg have been found in canned anchovy and 7.5 mg/kg in canned sardine (Tuzen 2009). In canned tuna a zinc concentration between 8.2 and 12.4 mg/kg was given by Mol (2011b).

Copper concentrations were found to be low around 0.5 mg/kg. These values were lower than those reported by Tuzen (2009) (1.8 mg/kg for anchovy and 2 mg/kg for sardine), but in good agreement with the copper content reported for canned tuna (0.45-0.58 mg/kg) by Mol (2011b).

Free Amino Acids

The total content of free amino acids varied clearly among species and between single cans of the same product (Table 4). In cans containing marine fish species individual amino acids such as asparagine, aspartic acid, phenylalanine and isoleucine were found only in minimal quantities. In trout products the levels of asparagine, aspartic acid and particularly glutamic acid were much higher.

In all tested fish cans the high levels of taurine became obvious. Taurine is an amino sulfonic acid that is never incorporated into proteins, but is present in free form only in animal tissues. Humans are limited capable of biosynthesising taurine, but it is of importance for many physiological processes. For example taurine is beneficial for cardiovascular health, reduces blood cholesterol values, and has antioxidant properties (Undeland 2009). Taurine is a heat stable, water soluble compound of low molecular weight. It is a known fact that during processing of fish the concentration of taurine decreased mainly as a result of leaching (Dragnes et al. 2009; Larsen et al. 2010). Because the raw fish was not analysed, a calculation of the loss of taurine and other free amino acids during processing was not possible.

The taurine content in the fish products (except for trout) was only exceeded by the histidine content. Especially marine fish contained high amounts exceeding the limit of the analytical determination procedure. The actual levels are therefore higher. Some free amino acids like histidine or lysine can result in the rapid formation of biogenic amines during microbial spoilage of fish.

Table 3. Trace elements in the edible part of canned fish products from Turkey (arithmetic mean ± standard deviation, range: min-max on a wet weight basis), n = 5 cans, respectively

Component	Anchovy, whole, in oil	Sardine, headed, in oil	Mackerel, fillet in own juice	Bonito, fillet in own juice	Trout, fillet in tomato sauce
Selenium [mg/kg]	0.43 ± 0.06[a] 0.37 – 0.53	0.71 ± 0.21[bc] 0.51 – 1.05	0.40 ± 0.07[a] 0.34 – 0.52	0.63 ± 0.04[c] 0.56 – 0.66	0.20 ± 0.01[d] 0.18 – 0.21
Zinc [mg/kg]	27.3 ± 1.8[a] 25.3 – 30.1	17.6 ± 1.7[b] 15.4 – 20.1	6.9 ± 0.5[c] 6.1 –7.4	5.8 ± 0.3[c] 5.4 – 6.1	6.4 ± 0.5[c] 5.5 – 6.9
Copper [mg/kg]	0.8 ± 0.1[a] 0.6 – 0.9	0.7 ± 0.1[a] 0.6 – 0.9	0.9 ± 0.1[a] 0.7 – 1.1	0.5 ± 0.1[b] 0.5 – 0.6	0.5 ± 0.1[b] 0.4 – 0.6
Cadmium [μg/kg]	19.8 ± 4.2[a] 13.9 – 23.8	6.8 ± 2.8[b] 3.9 – 10.9	5.9 ± 1.0[b] 4.7 – 7.0	4.6 ± 0.7[b] 3.5 – 5.2	4.0 ± 0.5[b] 3.3 – 4.5
Lead [μg/kg]	35.8 ± 3.8[a] 32.9 – 41.9	60.6 ± 14.1[b] 48.4 – 84.5	17.5 ± 1.8[c] 15.6 – 19.9	16.7 ± 3.8[c] 12.7 – 22.4	18.3 ± 3.4[c] 12.8 – 21.9

Different letters in a horizontal block indicate a statistically significant difference in the mean values ($p < 0.05$)

Table 4. Free amino acid content of canned fish products from Turkey (arithmetic mean ± standard deviation on a wet weight basis), n = 5 cans, respectively

Amino acid [mg/g fish]	Anchovy, whole, in oil	Sardine, headed, in oil	Mackerel, fillet in own juice	Bonito, fillet in own juice	Trout, fillet in tomato sauce
Aspartic acid	nn	0.02 ± 0.03	nn	nn	0.16 ± 0.02
Glutamic acid	0.16 ± 0.07	0.05 ± 0.02	0.06 ± 0.02	0.05 ± 0.03	0.35 ± 0.04
Asparagine	nn	nn	nn	nn	0.13 ± 0.02
Serine	0.03 ± 0.02	0.10 ± 0.14	0.02 ± 0.03	0.02 ± 0.02	0.06 ± 0.01
Histidine	2.10 ± 1.07[ab]	1.46 ± 0.55[ab]	1.53 ± 0.41[ab]	4.24 ± 1.11[a]	0.19 ± 0.05[b]
Arginine	0.09 ± 0.02	0.14 ± 0.14	0.03 ± .005	nn	0.05 ± 0.01
Glycine	0.15 ± 0.07	0.11 ± 0.06	0.10 ± 0.02	0.21 ± 0.08	0.17 ± 0.05
Threonine	0.15 ± 0.07	0.09 ± 0.04	0.08 ± 0.02	0.21 ± 0.10	0.06 ± 0.01
Taurine	0.67 ± 0.31[a]	0.46 ± 0.12[ab]	0.50 ± 0.11[a]	0.26 ± 0.08[ab]	0.20 ± 0.04[b]
Tyrosine	0.06 ± 0.03	nn	0.01	nn	0.01 ± 0.01
Alanine	0.36 ± 0.17	0.12 ± 0.03	0.09 ± 0.02	0.05 ± 0.03	0.28 ± 0.03
Methionine	0.09 ± 0.04	0.02 ± 0.03	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
Valine	0.11 ± 0.05	0.06 ± 0.04	0.02 ± 0.01	0.01 ± 0.02	0.02 ± 0.02
Phenylalanine	0.09 ± 0.04	nn	nn	nn	0.02 ± 0.02
Isoleucine	0.09 ± 0.04	nn	nn	nn	0.01 ± 0.01
Leucine	0.17 ± 0.08	0.04 ± 0.03	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
Lysine	0.18 ± 0.06	0.10 ± 0.03	0.15 ± 0.03	0.09 ± 0.06	0.09 ± 0.01
Total	4.49 ± 2.12[ab]	2.80 ± 0.85[ab]	2.61 ± 0.57[ab]	5.17 ± 1.49[a]	1.83 ± 0.27[b]

nn: < limit of detection 0.01 mg/g

Different letters in a horizontal block indicate a statistically significant difference in the mean values ($p < 0.05$)

Conclusions

The canned fish products investigated can be described as products rich in protein and fat with low cholesterol content. They are a good source of magnesium, zinc and selenium and those containing bones also of phosphorous. No phosphates were added as additives. The samples contained high amounts of taurine and histidine. The contents of the heavy metals lead and cadmium were below legal Turkish limits. These canned products produced and marketed in Turkey are from a nutritional point of view recommended to be consumed.

Acknowledgement

The skilful technical assistance of S. Blechner (elements), I. Delgado and H.-J. Knaack (proximate composition), T. Schmidt (amino acids), and I. Wilhelms (cholesterol) is gratefully acknowledged.

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8(1): 27-41 (2014) DOI: 10.3153/jfscom.2014004

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

BATI MARMARA'DA KUM MİDYESİ (*Chamelea gallina* L., 1758) VE KUM ŞIRLANI (*Donax trunculus* L., 1758) POPULASYONLARININ BÜYÜME ÖZELLİKLERİNİN İNCELENMESİ

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Received: 25.01.2013 / Accepted: 23.03.2013 / Published online: 28.12.2013

Öz: Araştırmada, Marmara Denizi'nin batısında doğal stokların bulunduğu alanlardan örneklenen beyaz kum midyesi (*Chamelea gallina*) ve kum şırlanının (*Donax trunculus*) büyüme özellikleri tahmin edilmiştir. Numuneler, ticari avcılığa kapalı bölgelerden 24 ay süre ile aylık olarak dreç yardımıyla toplanmıştır. *C. gallina* populasyonunda bireylerin, boy dağılımı 7-39 mm, ağırlığı 0.3-21.05 g olarak belirlenmiş, *D. trunculus*'un ise boyu 11.5-42 mm ve ağırlığı 0.26-17.22 g arasında değişmiştir. Her iki türün de negatif allometrik büyüme gösterdiği tespit edilmiştir. *C. gallina* bireylerinin ortalama et verimi %19.10; *D. trunculus*'un ise %19.45 olarak belirlenmiştir.

Anahtar Kelimeler: *Chamelea gallina*, *Donax trunculus*, Büyüme, Et verimi, Batı Marmara

Abstract: **Properties Growth of Populations The Striped Venus (*Chamelea gallina* L., 1758) and The Wedge Clam (*Donax trunculus* L., 1758) in The West Marmara Sea**

In this study, of individuals the striped venus (*Chamelea gallina*) and the wedge clam (*Donax trunculus*) sampled from the natural stock in west of the Marmara Sea were estimated properties growth. Samples were collected for a period of 24 consecutive months in zones off commercial fishing by dredging. The distribution length of individuals in populations *C. gallina* and *D. trunculus* were 7-39 mm and 11.5-42 between, weight 0.3-21.05 g and 0.26 -17.22 g between, respectively. Both species showed negative allometric growth. The average meat yield of *C. gallina* and *D. trunculus* were about %19.10 and %19.45, respectively.

Keywords: *Chamelea gallina*, *Donax trunculus*, Growth, Meat yield, West Marmara

*Bu makale "Çanakkale Boğazı İle Batı Marmara'da Kum Midyesi (*Chamelea gallina*, L. 1758) ve Kum Şırlanının (*Donax trunculus*, L. 1758) Stok Tahmini" adlı doktora tezinin bir kısmından oluşmaktadır.

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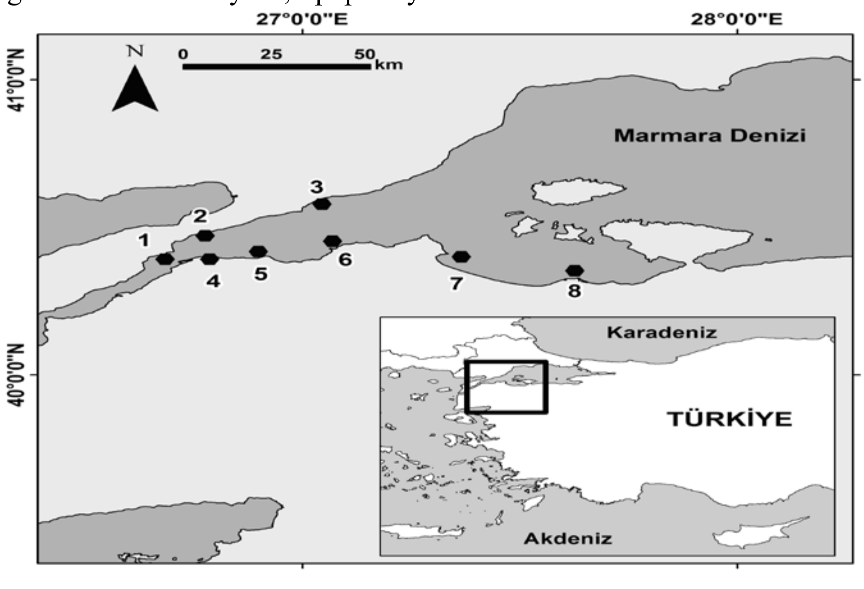
Giriş

Çift kabuklu yumuşakça türleri arasında ekonomik değeri yüksek olan *C. gallina* ve *D. trunculus*, genel olarak intertidal veya sığ subtidal bölgelerde (Ansell vd., 1983), dip yapısı kumsal olan alanlarda dağılım göstermektedirler (Maze ve Laborda, 1988; Oray, 1989). Dünya genelinde, Atlantik Okyanusu (Ansell vd., 1983; Fischer vd., 1987), Adriyatik Denizi, Karadeniz, Akdeniz (Bayed ve Guillou, 1985) ve Marmara Denizi (Deval, 2009) kıyılarında geniş yayılım gösterdikleri bildirilmektedir.

Ülkemizde, son yıllarda *C. gallina*'nın ticari avcılığı Karadeniz'den yapılmakta olup, *D. trunculus*'un ise ticari avcılığı yapılmamaktadır. Her iki türün Marmara Denizi'nde yoğun stoklara sahip olduğu bildirilmektedir (Çolakoğlu, 2011). Bununla beraber, bu bölgede *C. gallina*'nın ticari avcılığı 1998 yılında Tarım ve Köyişleri Bakanlığı'nın su ürünleri avcılığını düzenleyen 32/1 nolu sirküleri ile yasaklanmıştır. *D. trunculus*'un yasaklılığı ise, 2002 yılında 35/1 nolu sirküleri ile belirlenerek yürürlüğe konulmuştur. Halen devam eden avcılık yasağı nedeniyle bu alandaki stokların durumunun bilinmesi ve gelecekteki değerlendirme düzeyleri, populasyon tahmini araştırmalarının yapılmasını zorunlu hale getirmiştir. Yapılan bu araştırma ile Marmara Denizi'ndeki *C. gallina* ve *D. trunculus* türlerinin büyüme özellikleri ortaya konularak stokların durumu hakkında bilgi edinilmeye çalışılmıştır.

Materyal ve Metot

Araştırma materyali Marmara Denizi'nde bulunan çift kabuklu yumuşakçalardan *C. gallina* ve *D. trunculus* türleridir. Türlerin örneklemeleri Marmara Denizi'nin batısında belirlenen doğal stokların bulunduğu 8 istasyondan gerçekleştirilmiş (Şekil.1), örnekler infra-littoral bölgeden (0–10 m) Mayıs 2006 ile Nisan 2008 tarihleri arasında 24 ay süre ile aylık olarak, dreç yardımıyla temin edilmiştir. Temin edilen örneklerin bireysel uzunlukları 0.01 mm hassasiyetli dijital kumpas ile ölçülmüş, ağırlıklar ise 0.01 gr'lık hassas terazide tartılarak kaydedilmiştir. Araştırma süresince ölçüm ve tartımlardan elde edilen veriler kullanılarak örneklerin % boy ve ağırlık frekans dağılımları çıkarılmış, ortalama ± SH (Standart Hata), minimum ve maksimum boy ve ağırlık değerleri belirlenmiştir.



Şekil.1. Araştırma Sahaları (1: Gelibolu (40º26' N - 026º42'E), 2: Bolayıraltı (40º30' N - 026º51' E), 3: Şarköy (40º36' N - 027º05' E), 4: Çardak (40º24' N - 026º44' E), 5: Şevketiye (40º24' N - 026º53' E), 6: Kemer (40º26' N - 027º10' E), 7: Karabiga (40º22' N - 027º20' E), 8: Denizkent (40º19' N - 027º33' E).

Figure 1. Sampling locations

Boy - ağırlık ilişkisi, Ricker'in (1975) eksponansiyel regrasyon (üssel ilişki modeli) formülü ($TW = a\ L^{b}$) kullanılarak hesaplanırken, her iki tarafın logaritması alınarak doğrusal hale getirilmiştir. *C. gallina* ve *D. trunculus*'un büyüme şeklinin belirlenmesi için boy ve ağırlık değerleri regrasyon analizine tabi tutulmuş ve en küçük kareler yöntemine göre a ve b değerleri hesaplanmıştır. Boy-yükseklik ve boy-en ilişkileri, Arneri et al., (1997)'nin bildirdiği $H(W)= a+bL$ doğrusal ilişkisinden faydalanılarak hesaplanmıştır. Yaş et verimi ise, Freeman'ın (1974) bildirdiği *Et Verimi = Yaş Et Ağırlığı / Toplam Ağırlık x 100* formülüne göre hesaplanmıştır.

Bulgular ve Tartışma

Araştırma periyodu boyunca örnekleme istasyonlarından elde edilen *C. gallina* ve *D. trunculus* bireylerine ait boy, genişlik, kalınlık ve ağırlık dağılımları Tablo 1'de verilmiştir. *C. gallina* bireylerinin (N= 3325) boyu, 7-39 mm, ağırlığı 0.3-21.05 g; *D. trunculus*'un (N=4624) ise, boyu 11.5-42 mm ve ağırlığı 0.26-17.22 g arasında değişmiştir.

C. gallina ve *D. trunculus* populasyonlarında bireylerin boy dağılımlarının, yoğun olarak sırasıyla, 17-33 mm ve 20-38 mm arasında değiştiği, 19 mm ve 26 mm boy gruplarının ise en fazla frekansa sahip olduğu belirlenmiştir. Ağırlık - frekans dağılımlarında ise bireyler yoğun olarak 2-10 g (*C. gallina*) ve 2-6 g (*D. trunculus*) arasında değişmiş, her iki türünde 3 g ağırlık grubunda en fazla frekansa sahip olduğu belirlenmiştir (Şekil 2). *C. gallina* bireylerinin yükseklik ve en dağılımlarında en yoğun frekans gruplarını sırasıyla, 15-30 mm (17 mm) ve 8-18 mm (10 mm), *D. trunculus* türü için ise 14-22 mm (16 mm) ve 8-12 mm (9 mm) arasındaki boy gruplarının oluşturdukları tespit edilmiştir (Şekil 3).

Çalışmada, *C. gallina* ve *D. trunculus* bireylerine ait boy–ağırlık ilişkileri incelenmiş ve bulgular Tablo 2'de verilmiştir. Tablo 2'ye göre *C. gallina*'nın boy–ağırlık ilişkisi, $TW= 0.3539L^{2.8908}$ (r=0.98; N=2462), *D. trunculus*'un ise $TW= 0.153L^{2.7373}$ (r= 0.95; N=3428) olarak hesaplanmıştır. Her iki tür için b değeri 3'ten küçük olduğu için büyüme negatif allometrik (b= 2.89; b= 2.74) olduğu tespit edilmiştir. *C. gallina* ve *D. trunculus*'un boy ve yükseklik ile en ve ağırlık bulguları arasında logaritmik bir ilişki olduğu belirlenmiştir (Tablo 2; Şekil 4 ve Şekil 5).

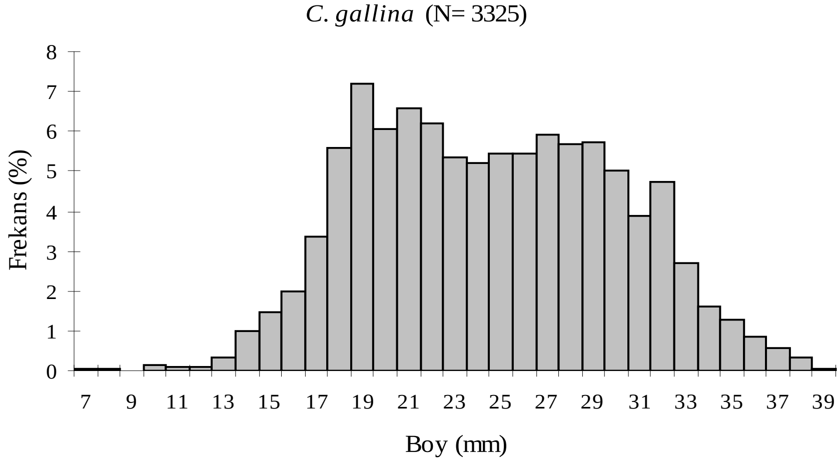
Araştırma sahalarından avlanan *C. gallina* ve *D. trunculus* bireylerine ait boy–yükseklik ve boy–en ilişkileri incelenmiş ve aralarında doğrusal bir ilişki olduğu belirlenmiştir (Tablo 3; Şekil 6).

Her iki türe ait bireylerin ağırlığı, et ağırlığı ve et verimi dağılımları Tablo 4'de verilmiştir. *C. gallina* bireylerinin (N= 1655) ağırlığı 1.19-17.76 g, et ağırlığı 0.09-2.53 g, et verimi %0.78-85.60; *D. trunculus*'un (N=3374) ise ağırlığı 0.26-8.92 g, et ağırlığı 0.02-1.89 g, et verimi %4.28-53.45 arasında değişmiştir.

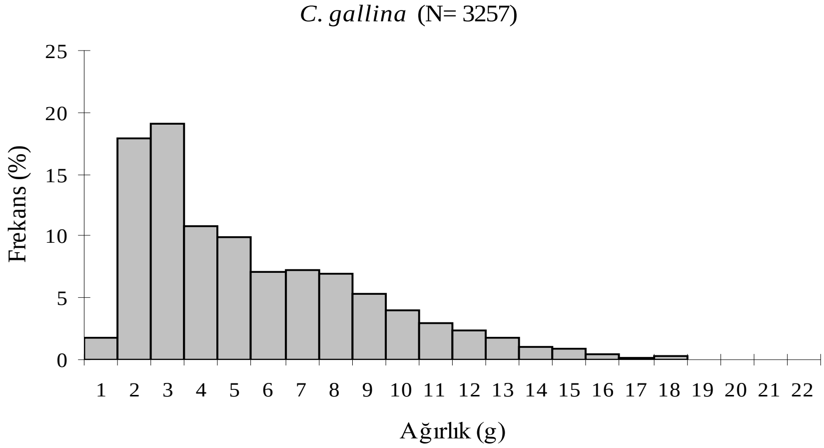
Tablo 1. *C. gallina* ve *D. trunculus* türlerine ait boy ve ağırlık değerleri

Table 1. Distribution of lenght and weight of *C. gallina* and *D. trunculus*

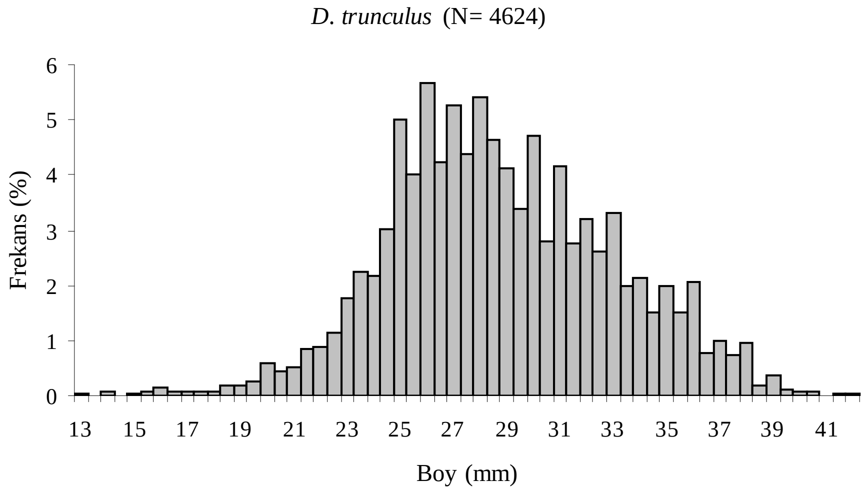
Tür	Özellik	Boy (mm)	Yükseklik (mm)	En (mm)	Ağırlık (g)
	Ort±Std. Hata	23.9±0.01	21.8±0.01	12.3±0.01	4.85±0.06
C. gallina	(Min-Max)	(7–39)	(8–36)	(4–30.5)	(0.3–21.05)
	N	3325	3215	3214	3257
	Ort±Std. Hata	28.7±0.01	17.1±0.002	9.5±0.001	3.04±0.02
D. trunculus	(Min-Max)	(11.5–42)	(7.5–38.5)	(1.8–22)	(0.26–17.22)
	N	4624	4610	4610	4801


C. gallina (N= 3325)
Frekans (%)
0
1
2
3
4
5
6
7
8
7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Boy (mm)

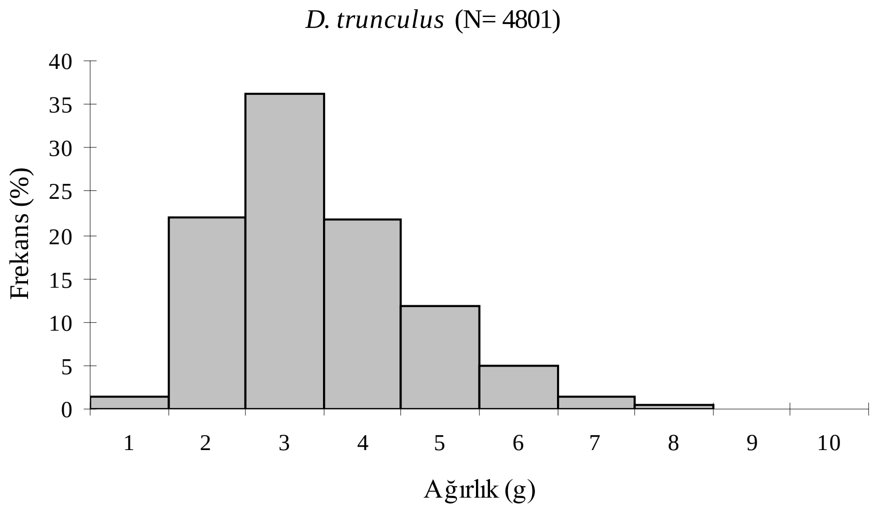
(a)


C. gallina (N= 3257)
Frekans (%)
0
5
10
15
20
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Ağırlık (g)

(b)


D. trunculus (N= 4624)
Frekans (%)
0
1
2
3
4
5
6
13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
Boy (mm)

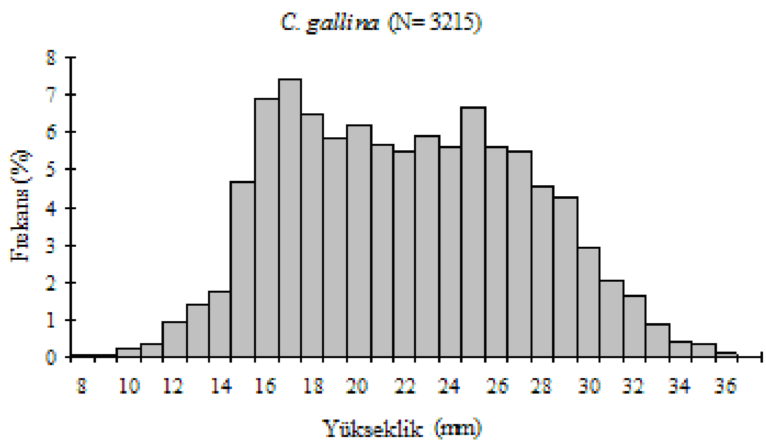
(c)



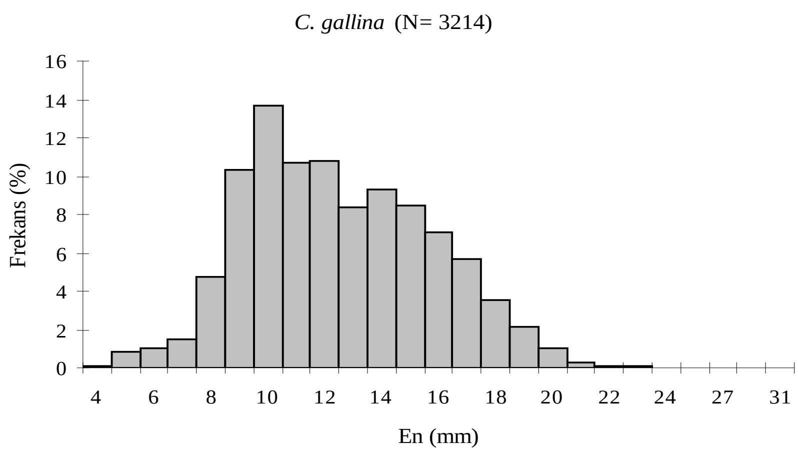
(d)

Şekil 2. *C. gallina* ve *D. trunculus* bireylerinin boy–frekans (a,c) ve ağırlık – frekans (b, d) dağılımları

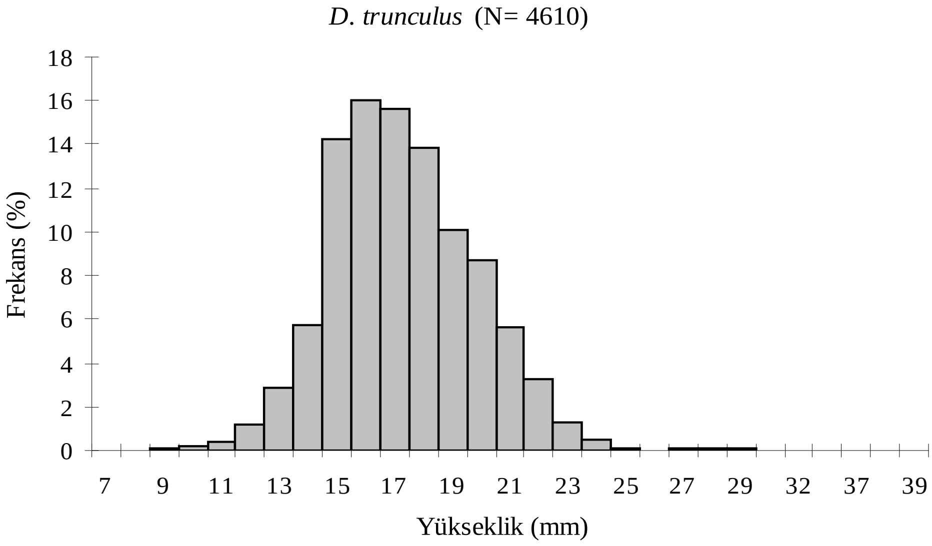
Figure 2. Lenght - frequency (a,c) and weight - frequency (b,d) distribution of individuals *C. gallina* and *D. trunculus*



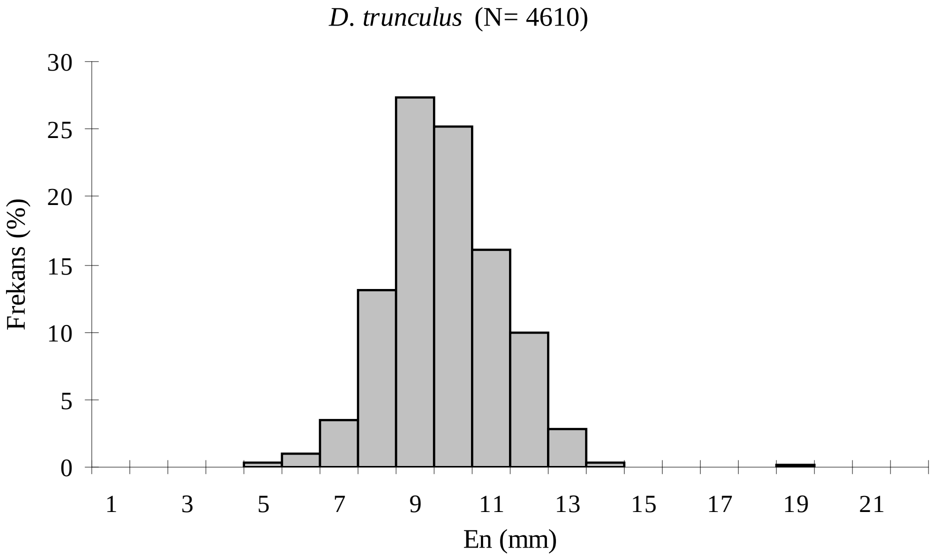
(a)



(b)



(c)



(d)

Şekil 3. *C. gallina* ve *D. trunculus* bireylerinin yükseklik–frekans (a,c) ve en–frekans dağılımları (b,d)

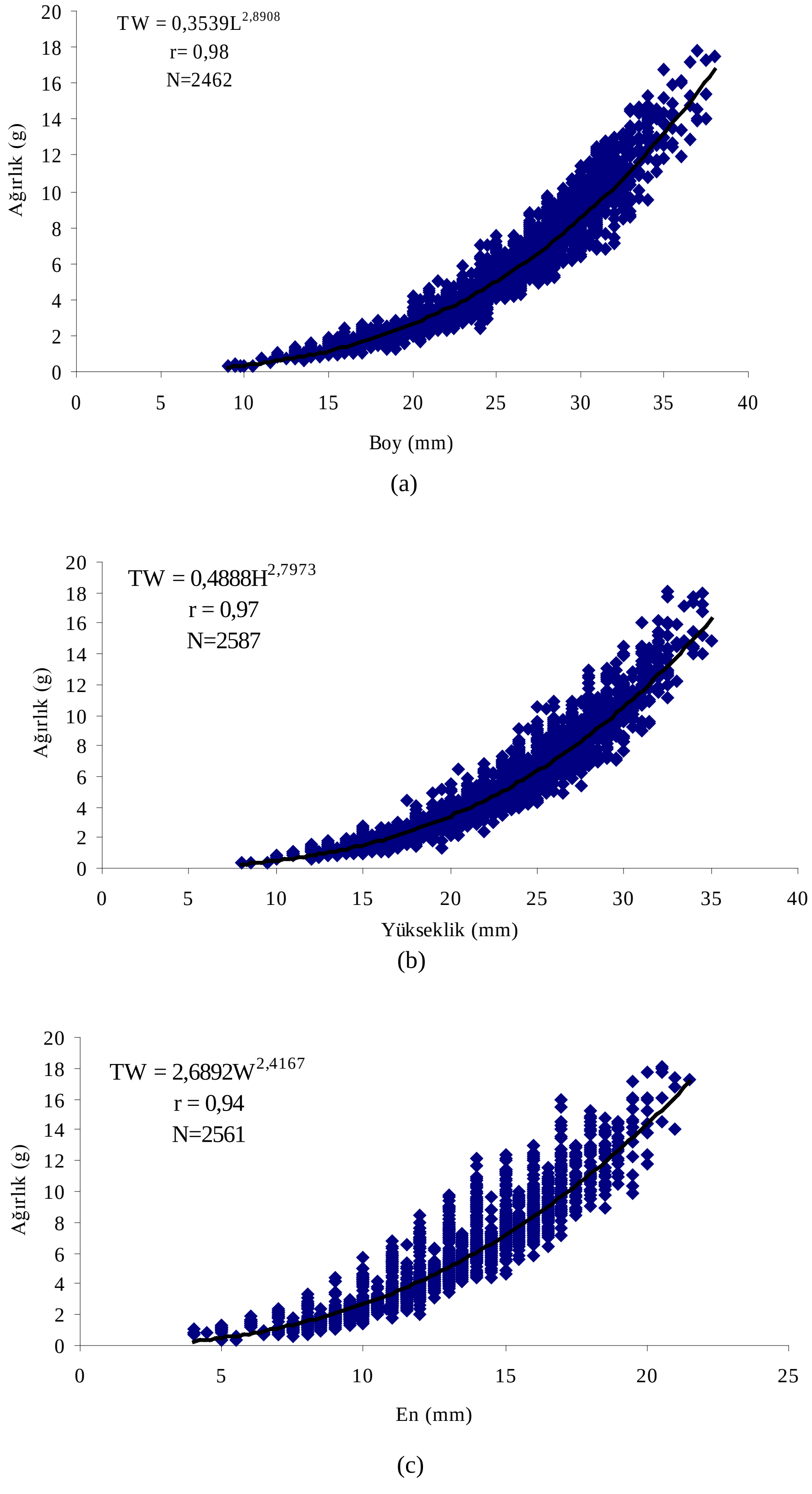
Figure 3. Height- frequency (a,c) and width- frequency (b,d) distribution of individuals *C. gallina* and *D. trunculus*

Tablo 2. Türlere ait boy–ağırlık, yükseklik–ağırlık ve en–ağırlık ilişki parametreleri

Table 2. Parameters of lenght– weight, height- weight and width-weight relationships of species

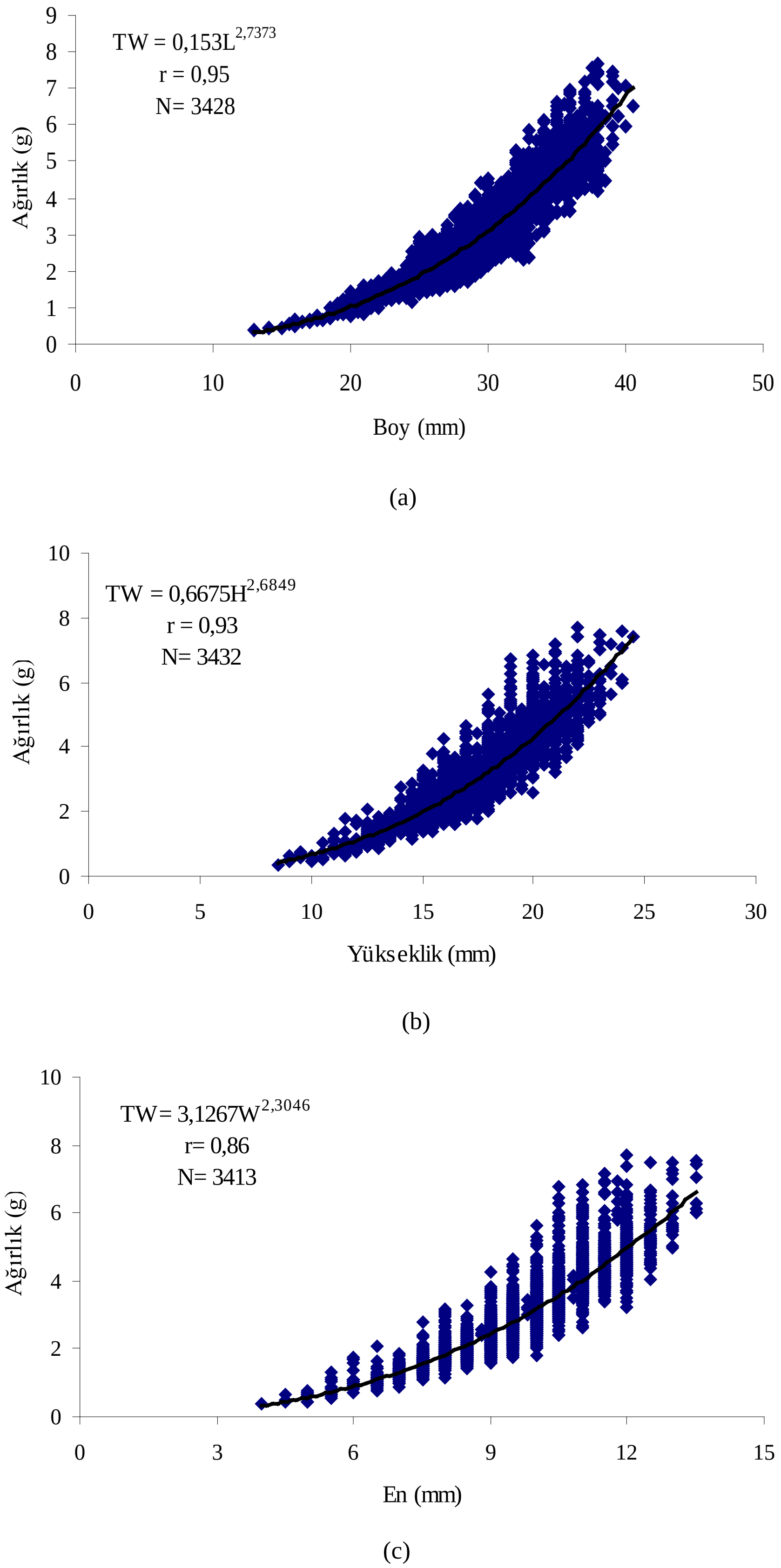
Chamelea gallina	**N**	**Denklem**	**a**	**b**	**r**	**Büyüme**
Boy – Ağırlık	2462	$TW= aL^b$	0.3539	2.8908	0.98	Negatif Allometrik
Yükseklik – Ağırlık	2587	$TW= aH^b$	0.4888	2.7973	0.97	Negatif Allometrik
En - Ağırlık	2561	$TW= aW^b$	2.6892	2.4167	0.94	Negatif Allometrik
Donax trunculus	**N**	**Denklem**	**a**	**b**	**r**	**Büyüme**
Boy – Ağırlık	3428	$TW= aL^b$	0.153	2.7373	0.95	Negatif Allometrik
Yükseklik – Ağırlık	3432	$TW= aH^b$	0.6675	2.6849	0.93	Negatif Allometrik
En - Ağırlık	3413	$TW= aW^b$	3.1267	2.3046	0.86	Negatif Allometrik

L: Boy; H: Yükseklik; W: En; TW: Ağırlık



Şekil 4. *C. gallina* türüne ait boy-ağırlık (a), yükseklik-ağırlık (b) ve en-ağırlık (c) ilişkileri

Figure 4. Lenght– weight (a), height- weight (b) and width-weight (c) relationships of *C. gallina*



Şekil 5. *D. trunculus* türüne ait boy-ağırlık (a), yükseklik-ağırlık (b) ve en-ağırlık (c) ilişkileri

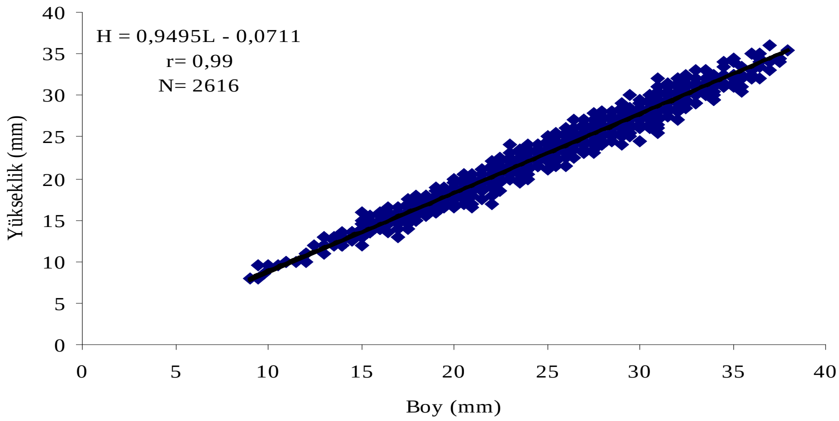
Figure 5. Lenght– weight (a), height- weight (b) and width-weight (c) relationships of *D. trunculus*

Tablo 3. Türlere ait boy–yükseklik ve boy–en ilişki parametreleri

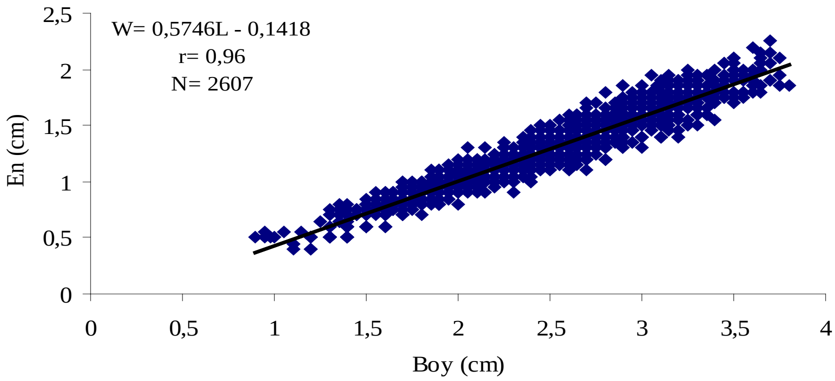
Table 3. Parameters of lenght–height and lenght –width relationships of species

Chamelea gallina	N	Denklem	a	b	r
Boy – Yükseklik	2616	H= a+bL	-0.0711	0.9495	0.99
Boy – En	2607	W= a+bL	-0.1418	0.5746	0.96
Donax trunculus	**N**	**Denklem**	**a**	**b**	**r**
Boy – Yükseklik	3452	H= a+bL	0.0962	0.556	0.95
Boy – En	3400	W= a+bL	0.0425	0.316	0.91

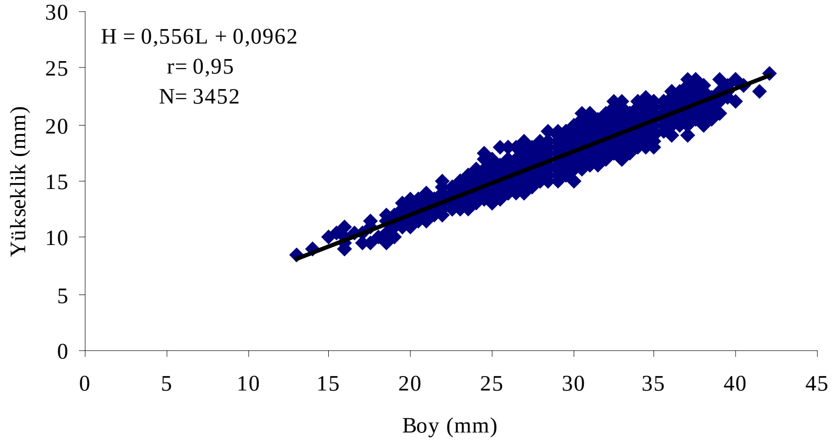
L: Boy; H: Yükseklik; W: En



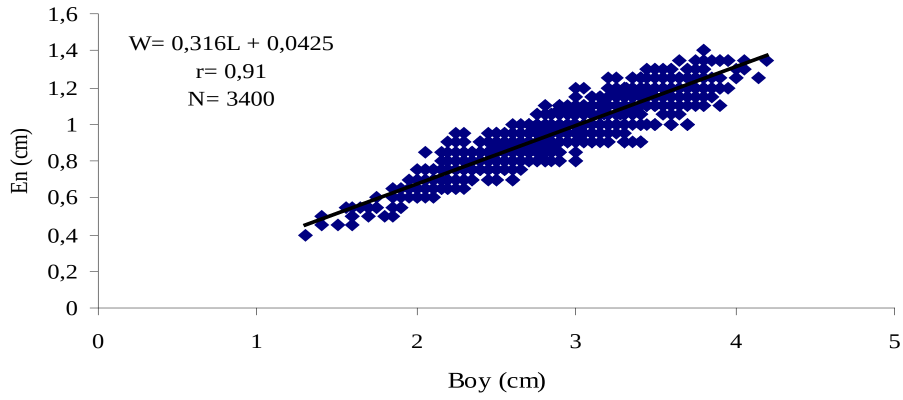
(a)



(b)



(c)



(d)

Şekil 6. *C. gallina* ve *D. trunculus* bireylerinin boy–yükseklik (a, c) ve boy–en ilişkileri (b, d)

Figure 6. Lenght–height and lenght –width relationships of individuals *C. gallina* and *D. trunculus*

Tablo 4. *C. gallina* ve *D. trunculus* türlerine ait birey ağırlığı, et ağırlığı ve et verimi değerleri

Table 4. Values of meat yield and meat weight, individual weight of *C. gallina* and *D. trunculus*

Tür	Özellik	Ağırlık (g)	Et Ağırlığı (g)	Et Verimi (%)
C. gallina	Ort±Std. Hata	5.51±0.08	0.66±0.01	19.10±0.43
	(Min-Max)	(1.19-17.76)	(0.09–2.53)	(0.78–85.60)
	N	1655	1655	1655
D. trunculus	Ort±Std. Hata	2.91±0.02	0.56±0	19.45±0.08
	(Min-Max)	(0.26-8.92)	(0.02–1.89)	(4.28–53.45)
	N	3374	3374	3374

Marmara Denizi'nin batısındaki 8 farklı istasyondan örneklenen *C. gallina* ve *D. trunculus* bireylerinin büyüme özellikleri tahmin edilmiştir.

Araştırmada, *C. gallina* bireylerinin (N= 3325) boyunun 7–39 mm, ağırlığının 0.3-21.05 g; *D. trunculus*'un (N=4624) ise boyunun 11.5-42 mm ve ağırlığının 0.26-17.22 g arasında değiştiği tespit edilmiştir. *C. gallina* ve *D. trunculus* populasyonlarında bireylerin boy dağılımlarının yoğun olarak sırasıyla, 17-33 mm ve 20-38 mm arasında değiştiği, 19 mm ve 26 mm boy gruplarının ise en fazla frekansa sahip olduğu belirlenmiştir. Her iki tür içinde düşük oranda küçük bireylerin avlanmasının nedeninin, av aracının seçiciliğinden ve bölgede uzun süreden beri süre gelen avlanma yasağının bulunmasından kaynaklandığı düşünülmüştür.

Ülkemizde, Marmara Denizi ve Karadeniz'de yapılan çalışmalarda *C. gallina*'nın boy ve ağırlık dağılımlarına ait tahmin edilen sonuçlar, birbirinden farklılık göstermektedir (Tablo 5). *D. trunculus* ile ilgili yapılan ilk ve tek çalışma, Deval (2009) tarafından Kuzey Marmara'da gerçekleştirilmiş, bireylerin boy dağılımları 3–44.8 mm (Lort= 24.7 mm) aralığında bulunmuştur (Tablo 5). Tablo 5'te görüldüğü üzere bu çalışmada *C. gallina* türü için tespit edilen maksimum boy, denizlerimizde görülen en büyük değeri (39 mm) temsil etmekte, en küçük boy ise Deval (1995) tarafından Kuzey Marmara'da 3.6 mm olarak verilmektedir. Bu çalışmada en büyük boyda bireylerin tespit edilmesi, araştırmanın yapıldığı dönemde bölgenin ticari avcılığa kapalı olmasından, Deval'in (1995) ve (2009)'da en küçük boy da bireylere rastlamasının nedeninin ise av aracının seçiciliğinden kaynaklandığı düşünülmüştür.

Dünyada çeşitli bölgelerde yapılan araştırmalarda *C. gallina* türüne ait maksimum boy dağılımları konusunda farklı bulgular elde edilmiştir. *C. gallina* ile ilgili maksimum boy dağılımları, Akdeniz'de yapılan araştırmada 40 mm (Gaspar vd., 2002b) ve 41 mm (Vives ve Suau, 1962), Karadeniz kıyılarında 31 mm (Boltacheva ve Mazlumyan, 2003) ve 43 mm (Scarlota ve Starobogtav, 1972), Güney Adriyatik'te 46.5 mm (Marano vd., 1982), Orta Adriyatik'te 46 mm (Poggiani vd., 1973) ve Trieste Körfezi'nde 39.6 mm (Valli ve Zecchini-Pinesich, 1981) olarak belirlenmiştir (Tablo 6). *D. trunculus* ile ilgili yapılan bazı araştırmalarda ise, İspanya kıyılarında 45 mm (Huz vd., 2002), Portekiz'in güney kıyılarında 44.27 mm, 44 mm (Gaspar vd., 2002a) ve 31 mm (Gaspar vd., 2003), İtalya'nın Güney Adriyatik kıyılarında 37 mm (Zeichen vd., 2002) olarak tespit edilmiştir (Tablo 6). Bulgulardaki bu farklılıklar, çevresel faktörler, avlanma bölgesi ve avcılıkta kullanılan av aracının seçiciliğinden kaynaklanabilmektedir.

Araştırmada, *C. gallina* ve *D. trunculus* bireylerinin negatif allometrik büyüme gösterdiği belirlenmiştir. Dünyada farklı bölgelerde yapılan bazı çalışmalarda *C. gallina* bireylerinde W/L ilişkisinin, bu çalışma sonuçlarında olduğu gibi, negatif allometrik büyüme gösterdiği bildirilmiştir (Tablo 7) (Marano vd., 1982; Valli vd., 1985; Cano ve Hernandez, 1987; Polenta, 1993; Deval, 1995; Arneri vd., 1997; Stadnichenko ve Zolotarev, 2001; Gaspar vd., 2002b; Köseoğlu, 2005). Bununla beraber, *C. gallina* ile ilgili yapılan diğer çalışmalarda ise bazı araştırıcılar büyümeyi pozitif allometrik (Valli ve Zecchini-Pinesich, 1981; Ramon, 1993), bazıları da izometrik (Dalgıç, 2006) olarak tespit etmişlerdir (Tablo 7). *D. trunculus* ile farklı bölgelerde yapılan araştırmalarda ise, bu çalışmada elde edilen sonuçlara benzer olarak, türün negatif allometrik büyüme gösterdiği belirlenmiştir (Tablo 7) (Maze ve Laborda,1990; Ramon,1993; Bayed, 1990; Gaspar vd., 2002a).

C. gallina ve *D. trunculus* bireylerine ait boy–yükseklik ve boy–en ilişkileri incelendiğinde ise her iki türün aralarında doğrusal bir ilişki olduğu belirlenmiştir. *C. gallina*'nın boy - yükseklik ilişkisi, H= 0.9495L–0.0711 (R^2=0.92), *D. trunculus*'ta ise H= 0.556L+0.0962 (R^2=0.87) olarak bulunmuştur. Farklı bölgelerde yapılan çalışmalarda ise *C.gallina*'nın boy ile yüksekliği arasındaki ilişki; Portekiz'in güney kıyılarında Log H= -0.058+1.013 Log L (R^2=0.94) (Gaspar vd., 2002b), Marmara Denizi'nin batı kıyılarında H=0.9119L–0.3322 (R^2=0.94) (Köseoğlu, 2005), Adriyatik kıyılarında H= 0.8900L+0.035 (R^2=0.99) (Arneri vd., 1997) olarak tespit edilmiştir. *D. trunculus*'la Portekiz'in güney kıyılarında yapılan bir çalışmada, boy ile yükseklik ilişkisi Log H= -0.067+0.888 Log L (R^2= 0.934) olarak belirlenmiştir (Gaspar vd., 2002a). Bu çalışmada elde edilen bulgular yukarıda verilen diğer çalışmaların bulguları ile karşılaştırıldığında, *C. gallina* için benzer, *D. trunculus* için farklılık arz etmektedir. Bunun sebebinin farklı çevre koşullarının türlerin büyüme özellikleri üzerine etkisinden kaynaklanabildiği ifade edilmektedir (Parsons vd., 1990).

Türlerin yaş et verimleri incelendiğinde, *C. gallina* bireylerinin ortalama et verimi %19.10; *D. trunculus*'un ise %19.45 olarak bulunmuştur. Türkiye'de avcılığı yapılan bazı ekonomik çift kabuklu yumuşakçaların sonbahar dönemindeki et verimleri üzerine yapılan araştırmada, kara midye (*Mytilus galloprovincialis*) %25.01, akivades (*Tapes decussatus*) %21.65, istiridye (*Ostrea edulis*) %6.50, kidonya (*Venüs verrucosa*) %16.94 ve kum midyesinin (*Chamelea gallina*) %20.78 olarak belirlenmiştir (Hindioğlu (Lök) vd., 1997). Çift kabuklu yumuşakçalarda et veriminin mevsime bağlı olarak değiştiği, özellikle kış aylarında ortamdaki besin miktarının düşmesi ve ilkbaharda ise üremeden dolayı minimum düzeylere indiğini bildirilmiştir (Hindioğlu (Lök) vd., 1997).

Tablo 5. Türkiye denizlerinde *C. gallina* ve *D. trunculus*'un biyometrik ölçüm değerleri
Table 5. Values biometric measurement of *C. gallina* ve *D. trunculus* in Turkey Seas

Türler	Bölge	L ort. (mm) (min–maks)	TW ort. (g) (min–maks)	Araştırıcılar
C. gallina	Tekirdağ	20.09 (3.6–34.5)	3.1 (0.01–12.1)	Deval (1995)
	Kumbağ	17.3 (7.3–35.5)	3.6 (0.3–16.4)	Cebeci (1994)
	Selimpaşa	19.6 (8.9–35.1)	4.4 (1.4–16.1)	Cebeci (1994)
	Karabiga	28 (21.1–36.9)	6.84 (2.47–15.41)	Tunçer ve Erdemir (2002)
	Gelibolu	26.19 (13–38)	6.54 (1.15–22.16)	Köseoğlu (2005)
	Sinop	19.56 (6.3–31.5)	2.46 (0.08–8.67)	Dalgıç (2006)
	Samsun	18.45 (6.5–28.7)	2.34 (0.09–6.26)	Dalgıç (2006)
	Kastamonu	18.48 (7.4–29.1)	2.16 (0.13–8.43)	Dalgıç (2006)
	Batı Marmara	23.9 (7–39)	4.85 (0.3–21.05)	Bu çalışma
D. trunculus	Kuzey Marmara	24.7 (3-44.8)	-	Deval (2009)
	Batı Marmara	28.7 (11.5-42)	3.04 (0.26–17.22)	Bu çalışma

L: Uzunluk; TW: Ağırlık

Tablo 6. Dünya denizlerinde *C. gallina* ve *D. trunculus* türlerine ait maksimum boy ölçüm değerleri
Table 6. Values maximum length of *C. gallina* ve *D. trunculus* in Seas the world

Türler	L_{maks} (mm)	Bölge	Araştırıcılar
C. gallina	41	Akdeniz	Vives ve Suau, 1962
	43	Karadeniz	Scarlota ve Starobogtav, 1972
	46	Orta Adriyatik	Poggiani vd., 1973
	39.6	Trieste Körfezi	Valli ve Pinesich, 1981
	46.5	Güney Adriyatik	Marano vd., 1982
	40	Atlantik	Gaspar vd., 2002b
	31	Karadeniz	Boltacheva ve Mazlumyan, 2003
D. trunculus	45	Akdeniz	Huz vd., 2002
	44.3	Atlantik	Gaspar vd., 2002a
	44	Atlantik	Gaspar vd., 2002a
	37	Güney Adriyatik	Zeichen vd., 2002
	31	Atlantik	Gaspar vd., 2003

L_{maks}: Maksimum boy

Tablo 7. *C. gallina* ve *D. trunculus*'un boy–ağırlık ilişkilerinin üssel denklemleri

Table 7. Exponential equations length-weight relationship of *C. gallina* and *D. trunculus*

Tür	b	Büyüme	Bölge	Araştırıcılar
C. gallina	2.613	- Allometrik	Adriyatik	Polenta, 1993
	2.902	- Allometrik	Marmara	Deval, 1995
	2.721	- Allometrik	Adriyatik	Arneri vd., 1997
	2.601	- Allometrik	Adriyatik	Arneri vd., 1997
	2.801	- Allometrik	Atlantik	Gaspar vd., 2002b
	2.967	- Allometrik	Marmara	Tunçer ve Erdemir, 2002
	2.892	- Allometrik	Marmara	Köseoğlu, 2005
	2.914	- Allometrik	Karadeniz	Dalgıç, 2006
	3.034	İzometrik	Karadeniz	Dalgıç, 2006
	2.910	- Allometrik	Karadeniz	Dalgıç, 2006
	2.891	- Allometrik	Marmara	Bu çalışma
D.trunculus	2.720	- Allometrik	Akdeniz	Ansell ve Lagardere, 1980
	2.709	- Allometrik	Akdeniz	Maze ve Laborda, 1990
	2.972	- Allometrik	Atlantik	Bayed, 1990
	2.700	- Allometrik	Akdeniz	Ramon, 1993
	2.698	- Allometrik	Atlantik	Gaspar vd., 2002a
	2.740	- Allometrik	Marmara	Bu çalışma

Sonuç

Marmara Denizi'nin batı bölgesinde *C. gallina* ve *D. trunculus* stoklarının boy ve ağırlık dağılımları göz önünde bulundurularak büyüme potansiyelinin yüksek olduğu belirlenmiştir. Bu bölgelerin ticari avcılığa açılarak balıkçılığa kazandırılması ve yöre halkına ekonomik açıdan büyük katkı sağlayacağı düşünülmektedir.

Kaynaklar

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8(1): 42-51 (2014) DOI: 10.3153/jfscom.2013005

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

TRACE METAL CONCENTRATİONS İN THE GREENLİPPED MUSSEL *Perna viridis* (Linnaeus, 1758) COLLECTED FROM MAHESHKHALİ CHANNEL, COX'S BAZAR, BANGLADESH

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Received: 04.01.2013 / Accepted: 20.08.2013 / Published online: 28.12.2013

Abstract: The green-lipped mussel *Perna viridis* (L.) were collected from four sampling locations of the Maheshkhali channel, Cox's Bazar, Bangladesh to determine the concentration level of zinc (Zn), copper (Cu), cadmium (Cd) and lead (Pb). The concentrations (µg/g dry weight) of these trace metals ranged from 28.12 to 33.82 for Zn, 7.26 to 8.81 for Cu, 0.04 to 0.08 for Cd and 0.19 to 0.75 for Pb. The concentrations of trace metals in the mussel tissue were found at lower level than the permissible limits for human consumption. In addition, these metal concentrations are also considered to be low when compared with regional data using *P. viridis* as a bio-monitoring agent.

Keywords: *P. viridis,* Bio-monitoring, Trace metals, Maheshkhali channel, Bangladesh

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Öz:

Maheshkhali Kanalı, Cox's Bazar, Bangladeşten Toplanan Yeşil Dudaklı Midye (*Perna viridis*, Linnaeus, 1758)'de İz Metal Konsantrasyonları

Maheshkhali kanalı (Cox's Bazar, Bangladesh)'te bulunan dört örnekleme istasyonundan, çinko (Zn), bakır (Cu), kadmiyum (Cd) ve kurşun (Pb) konsantrasyon düzeylerinin belirlenmesi amacıyla yeşil dudaklı midye *Perna viridis* (L.) örnekleri toplanmıştır. Bu iz metallerin konsantrasyonları (µg/g kuru ağırlık) Zn için 28.12-33.82, Cu için 7.26-8.81, Cd için 0.04-0.08 ve Pb için 0.19-0.75 aralığında değişmektedir. Midye dokularındaki iz metal konsantrasyonları, insan tüketimi için izin kabul edilebilir limitlerin altında bulunmuştur. Buna ek olarak, bu metal konsantrasyonlarının, *P. viridis*'i biyogözlem ajanı olarak kullanan bölgesel veriler ile karşılaştırıldığında da düşük olduğu söylenebilir.

Anahtar Kelimeler: *P. viridis*, Biyogözlem, İz metaller, Maheshkhali kanalı, Bangladeş

Introduction

Most of the coastal area of the world has been reported to be threatened by different sources of contaminants and the major concerns are included persistent organic pollutants, nutrients, oils, radio-nuclides, trace metals, pathogens, sediments, litters and debris (Williams, 1996). Most of the contaminants are interrelated and jeopardize the environment and aquatic organisms at a same way (Phillips, 1985). Therefore, the control of aquatic pollution has been identified as an immediate need for sustainable management and conservation of the existing fisheries and aquatic resources.

The presence of trace metals in the aquatic ecosystem is of major concern because of their heavy toxicity, bio-accumulating tendency in the biota (Siddique and Aktar, 2012; Siddique et al., 2012). Trace metal pollution could be a threat to the aquatic ecosystems and as well as for human life (Liu and Kueh, 2005). Bio-monitoring of metallic pollution in the aquatic environment has been done by many scientists using different aquatic organisms that have higher metal accumulating tendency. Many intertidal species and benthic fauna have been used as bio-monitor agent of trace metal pollution in worldwide (Liu and Kueh, 2005). These were included the green mussel *Perna viridis* (Phillips, 1985; Chan, 1988; Chong and Wang, 2000; Blackmore and Wang, 2002; Nicholson and Szefer, 2003; Liu and Kueh, 2005), oysters *Saccostrea cucullata* and *Saccostrea glomerata* (Phillips, 1979) and barnacles *Balanus amphitrite* and *Tetraclita squamosa* (Rainbow and Smith, 1992; Blackmore, 1996; Blackmore and Chan, 1998). The green-lipped mussel *P. viridis* is widely distributed in the coastal waters of the Asia-Pacific region (Tanabe, 2000). A good number of studies have been used *P. viridis* as a bio-monitoring agent for trace metals investigation since *P. viridis* are sedentary long-lived organisms, easily identified and sampled, reasonably abundant, have good net accumulation capacities and tolerant ability in environmental fluctuations (Yap et al., 2004).

The determination of contaminant levels in mussel provides a means of assessing the possible toxicant risk to public health. *P. viridis* is widely consumed bivalve in the south Asian countries (Phillips, 1985; Farrington et al., 1987). The local indigenous people of the Maheshkhali Island collect this species for consumption from the inter-tidal zone of this channel system. The Maheshkhali channel is very important as a large fishing ground and a centre for recreation. On the other hand, the Bakkhali River opens into this channel, which brings much of the domestic, agricultural and industrial wastes. A good number of fishing trawler and mechanized boat and speed boats move through this channel every day. Moreover, many passenger boats from different places come to the jetty along the Maheshkhali channel. Therefore, oil spill and unused fuel from these vehicles finally goes into the water and continuously polluted the water which might result in increasing trace metals in the water column of the Maheshkhali Channel. Moreover, *P. viridis* can easily accumulate trace metals in their body from the ambient water and food. Some metals, such as Cd and Pb, have long been known to accumulate within the aquatic food chain. Since

Cd, Cu, Pb and Zn are widely distributed in the coastal environment, both from natural geological processes and anthropogenic activities. Mussels are well known to accumulate a wide range of contaminants in their soft tissues (Goldberg et al., 1978). The intertidal areas are the natural habitats of marine mussels, but they are usually close to estuaries. Therefore, the chance of exposure to several contaminants from the land-based activities is high through the riverine system as well as sea-based sources.

Marine mussels provide a cheap source of protein for human consumption. For *P. viridis*, it had been reported that there was about 60% protein in every 100 g (dry weight) of mussel soft tissues (Choo and Ng, 1990). From the nutritional point of view, the mussel is an important food source for supplying essential trace metals (e.g. Ca, Fe) and certain vitamins such as niacin, thiamine and riboflavin (Cheong and Lee, 1984). From the toxicological point of view, excessive consumption of metal-contaminated seafood may cause toxicity to humans. Since trace metals are inorganic chemicals that are non-biodegradable, cannot be metabolized and will not break down into harmless forms (Kromhout et al., 1985), the measurement of levels of metals in the soft tissues of *P. viridis* is becoming more significant. They can simply accumulate through time, becoming less and more of a toxic threat as their concentrations increase. Levels of metals above the permissible limits would certainly create a notorious food image to the consumers. Chronic exposure to trace metals such as Cu, Pb and Zn is associated with Parkinson's disease and the metals might act alone or together over time to cause the disease (Gorell et al., 1997). However, the major objective of this study was to determine the concentrations of trace metals (Cd, Cu, Pb and Zn) in the soft tissues of *P. viridis* collected from the Maheshkhali channel, Cox's Bazar and the present study was also aimed to investigate whether these metals are within the permissible limits for human consumption.

Materials and Methods

Study Site

The Maheshkhali channel is located at the south-eastern coast of the Bay of Bengal (Figure 1). Maheshkhali channel heavily influenced by monsoonal wind and the geographic location of the study area were 21° 27′ to 21° 31′ N and 91° 54′ to 91°56′ E. Four sampling sites were selected at Guruk Ghata area considering the abundance of green mussel *P. viridis* and due to trace load of domestic effluents and other pollutant sources. The samples were collected from January to February 2012. During the sampling period water temperature were recorded ranged from 21.0-21.5°C, salinity 29.20-30.10 ppt. and water transparency were observed 28.80-29.50 cm.

Sample collection

Temporal variations in the bioavailability of trace metals in the marine environment are affected over time of total ambient metal load. Therefore, trace metal bio-monitoring needs to conform to certain required characteristics, not least being metal accumulators. Sampling was conducted from a rented boat with local boatman to assist collecting green mussel (*P. viridis)*. Green mussels were randomly collected from each sampling sites at the low tide. Mussel samples were cleaned to rid of debris sessile flora and fauna with seawater in sampling area. Total 36 mussels were collected and kept cool in an ice-box in the field. Upon return to the laboratory, specimens were immediately frozen at -20° C prior to tissue preparation.

Sample preparation and analysis

In the laboratory, the whole soft parts of the mussel were separated carefully from the shell to avoid metal contamination. The soft parts of each mussel were homogenized in a glass blender with a stainless steel cutter and divided into two parts. One part was used for determine the moisture content by drying at 80-90^{0}C for 48 hours or until a constant weight was obtained to convert wet weight to dry weight and the other part was used for trace metal analysis by acid digestion.

Extraction of trace metals from mussels

For the digestion of mussel samples, some 10.0 g of dried and homogenized mussels were weighed and placed into an acid washed PTFE digestion vessel. The digestion of total mussel (fraction <63 µm) were performed with a mixture of HNO_3-HCl-HF (concentrated, Merck) at hot plate and cooling system (US EPA, 1999). Sample solutions were analyzed for trace metals following flameless atomic absorption spectrophotometer (Hitachi Z 9000).

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Preparation of working solutions

Dilute the standard solutions to a concentration about ten times that which was determined in samples (Table 1). Dispense measured aliquots of solution (say, 2, 6, 8 and 10) into small volumetric flasks (25 ml) in order to cover the working range for AAS, using a pipette and clean volumetric flask. Make up to the mark with 5% nitric acid as before. Record the concentrations of these in µg/L.

Table 1. Standard solution for each element

Element	Spectral line/nm	Concentration (ppm)	Method
Zn	248	0.2, 0.6, 1.0	Abs
Cu	279	0.5, 1.0, 1.5	Abs
Cd	229	0.5, 1.0, 1.5	Abs
Pb	325	0.5, 1.0, 1.5	Abs

Table 2. Detection limits for the selected trace elements by Atomic Spectroscopy

Element	Spectral line/nm	Flame	Method	Detection limit (ppm)
Zn	214	C_2H_2-air	Abs	0.008
Cu	325	C_2H_2-air	Abs	0.001
Cd	229	C_2H_2-air	Abs	0.0005
Pb	283	C_2H_2-air	Abs	0.01

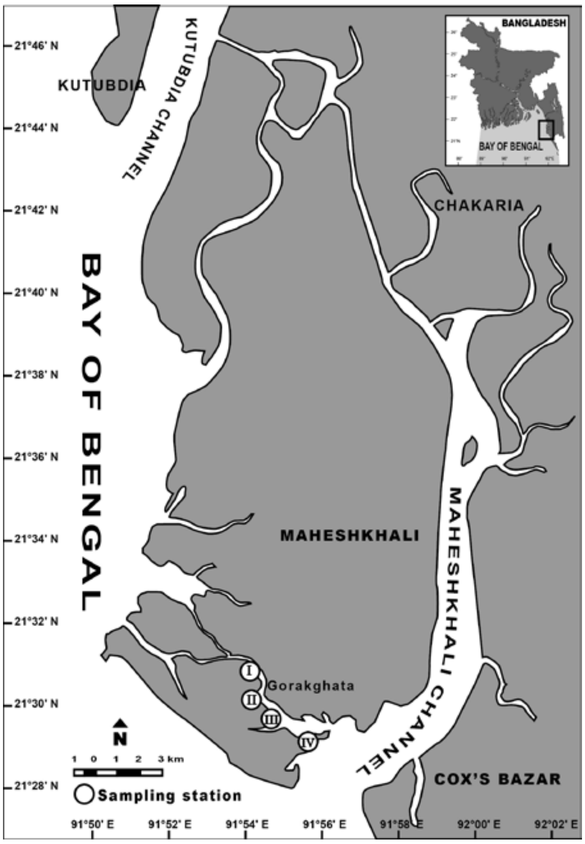

Figure 1. Sampling locations of the study area of Maheshkhali Channel, Cox's Bazar

Construction of calibration plots

For the determination of calibration plot of absorbance flame atomic absorption spectrophotometer (Hitachi Z 8230; the model SSC 300) for Zn and Cu and flameless atomic absorption spectrophotometer (Hitachi Z 9000) for Cd and Pb were used. The wavelengths of the most sensitive lines from the hollow cathode lamps (HCL) were 228.8, 217.0, 213.9 and 324.7 nm for Cd, Pb, Zn and Cu, respectively, and adjusted to the correct sensitivity according to the manufacturers' instructions.

Recovery percentage of analysis

About 2 g homogenized dry meat of green mussels were divided in to two parts. The first sample part (1 g dry weight) was added with 1000 µg of each Cd, Pb, Zn and Cu. The other parts of sample (1 g dry weight) were not added with Cd, Pb, Zn and Cu. Both of sample parts were digested in the process of trace metals extraction in green mussel and the filtrate solutions were measured by flame atomic absorption spectrophotometer (Hitachi Z 8230 the model SSC 300) for Zn, Cu and flameless atomic absorption spectrophotometer (Hitachi Z 9000) for Cd and Pb. The concentrations of each trace metal in both samples were compared to determine the percent recovery of the analysis.

Detection limits and accuracy

Detection limits for a number of common elements were determined by flame atomic absorption and compared them with those obtained with other atomic absorption methods (Table 2). Under usual conditions, the relative error of flame absorption analysis was 1-2%.

Data analysis

All calculations were based on dry weight of tissue. Mean concentration of the metals and standard deviation were estimated using the Statistical Package for Social Science (SPSS 16.0) program. All the statistical significance was tested at 95% confidence level.

Results and Discussion

The trace metal concentrations in the soft tissue of *P. viridis* were slightly varied among the stations. The concentrations of Zn, Cu, Cd and Pb in the mussels collected from different locations of Maheshkhali Channel are shown in table 3. The mean concentrations ranged from 28.12-33.82 µg/g (dry weight basis) for Zn, 7.26-8.81 µg/g (dry weight basis) for Cu, 0.04-0.08 µg/g (dry weight basis) for Cd and 0.19-0.75 µg/g (dry weight basis) for Pb (see table 3). The variation of mean concentrations of trace metals among the stations are shown in Figure 2.

The guideline on trace metals for food safety set by different countries are presented in Table 4. In comparison with the permissible limit set by the Ministry of Public Health of Thailand (MPHT, 1986), all the mean values of the present study (µg/g, dry weight basis) from all the sampling stations were lower than the limits. The concentration levels were also lower than the recommended guidelines for Cd, Pb, Cu and Zn set by the USFDA (1990), the Australian Legal Requirement for food safety (NHMRC, 1987) and the limits established by the Brazilian Ministry of Health (ABIA, 1991) (Table 4). As for the status of the 'increased contamination' reported by ICES (1988), the Cd levels of the present study were lower than the 'increased contamination' level (1.80 µg/g dry weight basis) for Cd and (3.00 µg/g dry weight basis) for Pb (Table 4).

Table 3. Concentrations of zinc (Zn), copper (Cu), cadmium (Cd) and lead (Pb) in the soft tissues of *P. viridis* (dry weight basis) collected from the Maheshkhali Channel, Cox's Bazar, Bangladesh; Replicate, n= 4.

Sampling Location	Zn (µg/g)	Cu (µg/g)	Cd (µg/g)	Pb (µg/g)
Station I	32.19±0.80	8.81±0.67	0.08±0.01	0.68±0.25
Station II	33.82±0.93	7.92±0.49	0.07±0.01	0.75±0.24
Station III	31.43±0.78	7.26+0.31	0.04±0.01	0.31±0.18
Station IV	28.12±0.89	7.33±0.41	0.06±0.01	0.19±0.15
Mean concentration ± SD	31.39±2.29	7.83±0.77	0.07±0.02	0.48±0.31

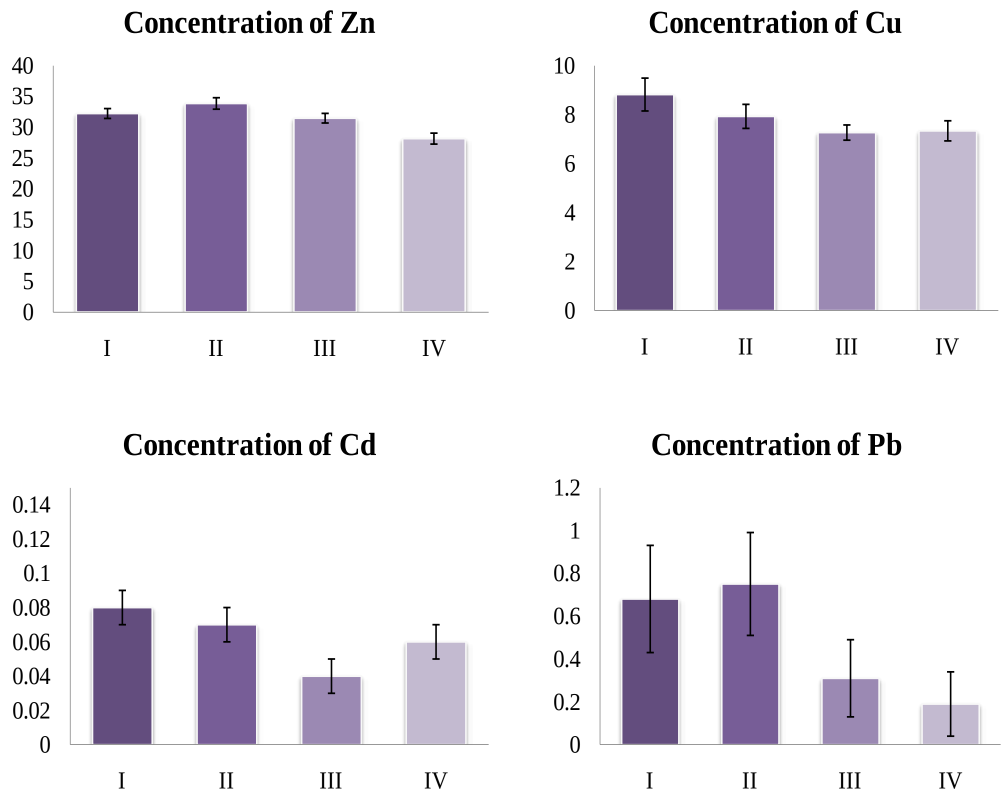

Figure 2. The variation of mean concentrations of the trace metals in *P. viridis* among the sampling stations of the Maheshkhali channel, Cox's Bazar

Table 4. Guidelines on trace metal concentrations for the food safety set by different countries (dry weight basis)

Location	Zn (µg/g)	Cu (µg/g)	Cd (µg/g)	Pb (µg/g)
Permissible limit set by Ministry of Public Health, Thailand (MPHT, 1986)	667.00	133.00	1.00	6.67
International Council for the Exploration of the Sea (ICES, 1988) for status: increased contamination	-	-	1.80	3.00
Food and Drug Administration of the United States (USFDA, 1990)	-	-	25.00	11.50
Australian Legal Requirements (NHMRC, 1987)	750.00	350.00	10.00	-
Maximum permissible levels established by Brazilian Ministry of Health (ABIA, 1991)	250.00	150.00	5.00	10.00
Trace Metal levels of *P. viridis* from the Maheshkhali Channel, Cox's Bazar, Bangladesh (this study)	31.39±2.29	7.83±0.77	0.07±0.02	0.48±0.31

The mean concentrations of Zn (31.39±2.29 µg/g), Cd (0.07±0.02 µg/g) and Pb (0.48±0.31 µg/g) found in this study were lower than the previous investigations on *P. viridis* from Peninsular Malaysia, coastal water of Hong Kong, the gulf of Thailand, southeast coast of India and Tolo Harbour of Hong Kong (Phillips, 1985; Sukasem and Tabucanon, 1993; Senthilnathan et al., 1998; Wong et al., 2000; Yap et al., 2002, 2004). Although the mean concentration of Cu (7.83±0.77 µg/g) was higher than some other previous studies from different part of the world, but this concentration level is lower than Peninsular Malaysia (7.76-20.1 µg/g), coastal water of Hong Kong (16.0-27.90 µg/g) and southeast coast of India (33.6-49.2 µg/g) (Phillips, 1985; Senthilnathan et al., 1998; Yap et al., 2004). A comparison of reported concentration levels of zinc (Zn), copper (Cu), cadmium (Cd) and lead (Pb) in *P. viridis* from regional studies with the present result are presented in Table 5.

According to Hutton (1987), Pb can be responsible for health problems in three major organ systems in human body, namely the haematological, nervous and renal systems. The potential hazards of metals transferred to humans are probably dependent on the amount (g weight) of mussels consumed by an individual. The effects of Pb on the central nervous system are generally seen in children and acute effects of Pb might cause coma and death to the affected person (Hutton, 1987). An adult who consume 10 g/day of *P. viridis* daily from the Maheshkhali channel would intake 4.8 (0.48×10=4.8) µg/g of Pb each day. If the consumer continue to consume this mussel for 7 days, then they would consume 33.6 µg/g Pb, which is still lower than the recommended limit for the provisional tolerable weekly intake of Pb (50.0 µg /adult) (FAO/WHO, 1984).

Similarly, if an adult consumes approximately 10 g of mussels per day, then the person who consumes mussels collected from Maheshkhali channel would intake 0.6 (0.07×10=0.7) µg/g of Cd each day. If the consumers continue to take the mussel for 7 consecutive days, then they would intake 4.9 µg Cd. Again, this consumption level is also lower than the recommended limit for the provisional tolerable weekly intake of Cd (6.70-8.30 µg/adult) (FAO/WHO, 1984). The elimination rate of Cd is very slow (an average 2.00 µg/day) in human body. Moreover, prolonged excessive Cd ingestion would cause Cd accumulation inside the human body (Filov et al., 1993). The acute toxic symptoms of higher concentration of Cd ingestion are nausea, vomiting, diarrhoea, headache, abdominal pain, muscular ache, salivation and shock (Patnaik, 1992).

Table 5. A comparison of reported concentrations of Zinc (Zn), Copper (Cu), Cadmium (Cd) and Lead (Pb) in *P. viridis* from regional studies with the present results (dry weight basis)

Location	Zn (µg/g)	Cu (µg/g)	Cd (µg/g)	Pb (µg/g)	References
Peninsular Malaysia	75.1-129	7.76-20.1	0.68-1.25	2.51-8.76	Yap et al. (2004)
Penang, Malaysia	76.0	8.0	-	7.0	Sivalingam and Bhaskaran (1980)
Coastal waters of Hong Kong	89.0-164	16.0-27.90	0.29-1.43	7.50-60.50	Phillips (1985)
The Gulf of Thailand	25.7-79.0	1.50-11.3	0.02-19.1	-	Sukasem and Tabucanon (1993)
Putai coast of Taiwan	14.4-25.7	1.78-5.41	-	-	Han et al. (1997)
Southeast coast of India	60.4-94.1	33.6-49.2	1.59-4.40	2.48-6.92	Senthilnathan et al. (1998)
The Gulf of Thailand	24.9-213	2.94-15.0	0.17-3.25	0.19-3.75	Ruangwises and Ruangwises (1998)
Tolo Harbour, Hong Kong	90-135	6.02-24	0.45-1.44	.02-4.36	Wong et al. (2000)
Maheshkhali Channel, Bangladesh	31.39±2.29	7.83±0.77	0.07±0.02	0.48±0.31	Present study

Conclusion

By using *P. viridis* as a bio-monitoring agent, the contamination of Cd, Cu, Pb and Zn in the Maheshkhali channel was found not to be serious. The results of the study revealed that the possibility of the occurrence of acute toxicities of Cd, Cu, Pb and Zn is unlikely. However, low-level and chronic toxicities to consumers may still pose an irreversible hazard. Since, *P. viridis* accumulates trace metals in the soft tissues and constitutes one of the important food-chain in the coastal environment; this information is therefore useful for predicting the metal contamination in this coastal communities. In addition, the trace metal concentrations in the mussels from the Maheshkhali channel could be attributed to natural or anthropogenic metal sources affecting their habitats. However, future studies should concentrate on the relative importance of water, sediment and food in the accumulation of metals by the mussel.

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8(1): 52-60 (2014) DOI: 10.3153/jfscom.2014006

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

A CHECK LIST ON DISTRIBUTION OF ORNAMENTAL FISHES IN CHILIKA LAGOON, EAST COAST OF INDIA

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Received: 22.02.2013 / Accepted: 05.05.2013 / Published online: 28.12.2013

Abstract: Chilika Lagoon in the Odisha Coast of India is one of the World's unique biodiversity hot spot having international importance. It is the largest brackish water lagoon with estuarine character having its socioeconomic importance. The present study highlights on diversity of ornamental fish from four sector of Chilika lagoon namely Southern, Central, Northern and outer. A total number of 20 species representing 12 families of class Actinopterygii were identified from four sector of Chilika Lagoon. The order Perciformes having highest occurrence in side the lagoon followed by order Cypriniformes, Siluriformes, Tetraodontiformes and Osteoglossiforms. During study period it was observed that highest number ornamental fishes were found in Northern sector and central sector. These ornamental fishes have high economic value if it is collected and maintained in aquarium then it will help the local fisher folk for their lively hood and development of their family.

Keywords: East Coast, Chilika lagoon, Ornamental fishes

Öz: **Hindistan' nın Doğu Kıyısı Chilika Lagünü'ndeki Süs Balıklarının Dağılımının Kontrol Listesi**

Dünyanın eşsiz biyoçeşitlilik sıcak noktası olan Chilika lagünü uluslararası bir öneme sahiptir. Burası dünyanın en büyük sosyoekonomik öneme sahip haliç karakterindeki acısu lagünüdür. Bu mevcut çalışma Chilika lagününün güney, merkez, kuzey ve dış olarak adlandırılan dört bölgesindeki süs balıklarının çeşitliliğini ortaya koymaktadır. Chilika lagününün dört bölgesinden Actinopterygii sınıfındaki 12 familyayı temsil eden toplam 20 tür tespit edilmiştir. Lagün içinde en fazla gözlenen takım Perciformes olup bunu Cypriniformes, Siluriformes, Tetraodontiformes ve Osteoglossiforms takımları takip etmiştir. Çalışma dönemi boyunca en fazla sayıda süs balığı kuzey ve merkez bölümde gözlenmiştir. Bu süs balıkları yüksek ekonomik değere sahiptir eğer bu balıklar toplanır ve akvaryum içinde muhafaza edilirse yerel balıkçı halkın yaşam alanlarının ve ailelerinin gelişmesine yardımcı olacaktır.

Anahtar Kelimeler: Doğu Kıyısı, Chilika lagünü, Süs balıkları

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Introduction

Ornamental fishes are characterized by a wide diversity of color pattern which is keeping in aquaria to relive pressure on daytoday materialistic life. The ornamental fish keeping is a popular hobby which is gradually replacing outdoor leisure activities and it is the second most hobby after photography Sing and Dey (2006). According to psychiatrists, placing aquaria with ornamental fishes in the patient's viscinity could treat certain type of mental disorders Swain (2008). The marine ornamental fish trade has a significant role in the economy of developed and developing countries both as a foreign exchange earner and as a source of employment. The world ornamental fish trade is about 4.5 billion US $ while India's contribution through export is only about 0.5 million US $. The United States of America alone imports ornamental fishes worth more than 500 million US $. In Holland, 20% of the houses maintain ornamental fishes, 14 % in UK, 8 % in USA, 5 % in Germany and 4 % in Belgium and Italy Sakthivel (2002). Asia is the major exporting region accounting for 56% of the global exports. India has joined the lead 10 Asian exporting countries recently, contributing only 2% of the Asian export Kutty (2008) .According to information available in Global Marine Aquarium data set a total of 1,471 species of marine ornamental fishes are traded around the globe. Most of the species are associated with coral reefs. About 400 species of Ornamental fishes belong to 175 genera and 50 families are reported in Indian water but this figure is on rise as more numbers of survey are made in different location of the country Satheesh, (2002). The brackish waters are home to an amazingly diverse and unique group of fishes, some of which are commonly available to keep in the home aquarium so in this juncture the Chilika Lagoon is the burning example for the occurrences of number of ornamental fishes in sector wise distribution. A number of surveys have been made for the estimation of ichthyofaunal diversity in Lagoonecosystem ZSI (1995), Jhingran and Natarajan (1966), CDA (2004), Mohanty et al., (2007) Mohanty et al., (2006)but till now no research work has been attempted related to the diversity of ornamental fish resources of the lagoon. Therefore the present study is an attempt to make a checklist on occurrences of ornamental fishes in Chilika Lagoon and their distribution.

Materials and Methods

Study Area

Chilika is the largest pear shaped brackish water lagoon of Asia with captivating beauty, abundant biological resources and rich economic attributes and known for its rich source of fish supply. It is situated in latitude 19°28'–19°54'N and longitude 85°06'–85°36'E. The water-spread area of the Chilika Lagoon varies from 1165 to 906 km^2 during the monsoon and summer respectively Siddiqui and Rao, (1995). A significant part of the freshwater and silt input to the lagoon comes from the Mahanadi river and its distributaries Mohanty et al., (1996). Based on its physical and dynamic characteristics, the lagoon is divided into four sectors (Fig.1). The northern sector receives discharge of the flood waters from the rivers. The southern sector is relatively smaller and does not show much seasonal variation in salinity. The central sector has features intermediate between the features of the other sectors. The outer sector of the lagoon comprises of a 24-km narrow and curved channel that runs parallel to the coast to join the Bay of Bengal near Arakhakuda It stretched over three districts namely Puri, Khurda and Ganjam. It is separated from the Bay of Bengal by a barrier spit attached at its southern end (Venkataratnam, 1970). It is one of the hot spot of biodiversity in the country and inhabiting a number of endangered species listed in the IUCN Red list of threatened species (World Bank, 2005).

Methodology

The ornamental fishes are collected by the help of dugout canoes or boat seines. The gears are bag nets, scoopnets and cast nets from the different sector (Table 1). The collected fishes were kept in a bucket with battery operated aerator and transported to the laboratory. They are initially acclimatized to the tank environment. The healthy fishes were transfered to the marine research aquarium for further studies. The fishes were identified by using standard literature Talwar et al., (1992), Talwar and Jhingran, (1991), Fish Base (2003).

Figure 1. Map showing Study areas.

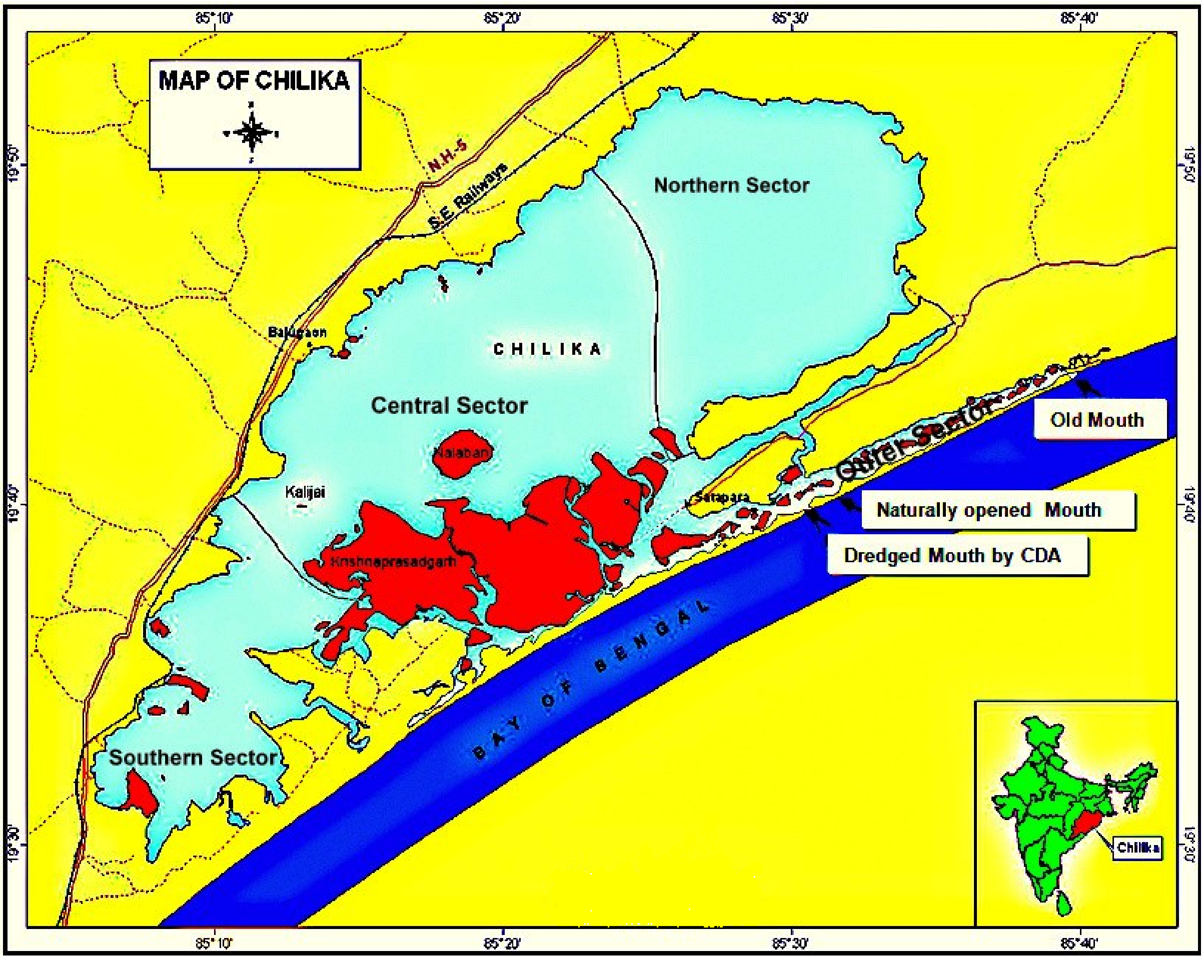

Table 1. Sampling site and total number of Marine ornamental fish recorded Chilika Lagoon

Sampling site	Habitat	Cordinates	Number Species
Southern sector	Marine	85.161, 19.586	Nil
Central sector	Brackish and Marine	85.318, 19.719	7
Northern	Fresh water	85.483,19.805	13
Outer Sector	Marine	85.549,19.692	1

Results and Discussion

A total number of 20 species were recorded during the study period from the Chilika Lagoon. The order Perciformes has emerge as most dominant group and next to order Cypriniformes among these diverse coloured fish community. The maximum numbers were recorded during pre-monsoon, monsoon and post-monsoon around northern sector of the lagoon. Among fishes species 13 species are fresh water in origin and rest 7 species are brackish and marine in nature (Table 2, Figure 2-21).

***Notopterus notopterus* (Pallas,1796)**

Notopterus (Figure 2) is a fresh water fish, which was caught from Northern sector of the lagoon. It is commonly known as Asian knife fish, Ghost knife fish and Bronze feather back. It measured about 18.0 cm in length and 21.0 g in weight. It is very aggressive towards its own species and timid towards other larger fishes. It is a nocturnal sps. It requires a very large well planted aquarium (Aquatic Community, 2009). It is distributed in Southeast Asia. Bangladesh, Cambodia, India, Burma, Nepal, Pakistan, Thailand and Vietnam.

***Labeo calbasu* (Hamilton,1822)**

Labeo calbasu (Figure 3) is a fresh water fish, which was caught from Northern sector of Chilika. It is commonly known as orange fin labeo. It measured about 32.0 cm and 42.6 g in weight. It is a potamodromous species (Talwar and Jhingran, 1991). It occurs in rivers and Ponds of India. It is distributed in Asia, India, Bangladesh, Nepal, Thailand, Myanmar and South Western China.

***Labeo boga* (Hamilton,1822)**

Labeo boga (Figure 4) is a fresh water fish, caught from northern sector of the lagoon. It is commonly known as Red gilled violet shark. It measured about 35.0 cm and 45.3 g weight. It also occurs in small rivers and ponds (Aquatic Community, 2009). It is found in Asia. Pakistan, Nepal, India and China.

Table 2. Checklist of Ornamental fishes existing in four different sector of Chilika Lagoon

Species	Family	Order	Class	SC	CS	NS	OS
Notopterus notopterus	Notopteride	Osteoglossiforms	Actinopterygii	-	-	†	-
Labeo calbasu	Cyprinidae	Cypriniformes	Actinopterygii	-	-	†	-
Labeo boga	Cyprinidae	Cypriniformes	Actinopterygii	-	-	†	-
Chela cachius	Cyprinidae	Cypriniformes	Actinopterygii	-	†	†	-
Nandus nandus	Nandidae	Perciformes	Actinopterygii	-	†	†	-
Puntius sophore	Cyprinidae	Cypriniformes	Actinopterygii	-	-	†	-
Mystus gulio	Bagridae	Siluriformes	Actinopterygii	-	†		-
Mystus vittatus	Bagridae	Siluriformes	Actinopterygii	-	†	-	-
Chelonodon patoca	Tetraodontidae	Tetradontiformes	Actinopterygii	-	-	-	†
Scatophagus argus	Scatophagidae	Perciformes	Actinopterygii	-	-	†	-
Pseudambassis ranga	Ambassidae	Perciformes	Actinopterygii	-	-	†	-
Ophiocephalus gachua	Channidae	Perciformes	Actinopterygii	-	-	†	-
Ophiocephalus punctatus	Channidae	Perciformes	Actinopterygii	-	-	†	-
Therapon jarbua	Theraponidae	Tetraodontiformes	Actinopterygii	-	-	†	-
Puntius chola	Cyprinidae	Cypriniformes	Actinopterygii	-	-	†	-
Oreochromis mossambis	Cichlidae	Perciformes	Actinopterygii	-	-	†	-
Siganus javus	Siganidae	Perciformes	Actinopterygii	-	†	-	-
Etroplus suratensis	Cichlidae	Perciformes	Actinopterygii		†	-	-
Dantnoide squadrifasciatus	Datnioididae	Perciformes	Actinopterygii		†	-	-
Plotosus arab	Plotosidae	Siluriformes	Actinopterygii		†	-	-

SC-Southern Sector, CS-Central Sector, NS-Northern Sector, OS-Outer Sector

***Chela cachius* (Hamilton,1822)**

Chela cachius (Figure 5) is commonly known as Silver hatchet. It is a benthopelagic in habit. It is found both in northern sector and central sector of Chilika Lagoon. It is also found in rivers and ponds. It occurs both fresh and brackish water. It measures 7.3 cm length and weighed about 12.0 g. though its common name is Silver hatchet, the species seemingly a plain silver fish when viewed in sun light. It helps far mosquito control (Menon, 1999). It is distributed in India, Pakistan and Bangladesh.

***Nandus nandus* (Hamilton,1822)**

Nandus nandus (Figure 6) is commonly known as gangetic leaf fish. It is a high prized fish of its spinous fins and ugly black bands and blotches on the body. It is found most commonly in standing or sluggish waters of lagoon. It is also found in reservoirs and canals (Talwar and Jhingran, 1991). It is a benthopelagic in origin both found in northern and central sector of Chilika lagoon. The fish measured 10.0 cm in total length and weighed 15.6 g. It is found in Pakistan, Thailand and India (Talwar and Jhingran, 1991).

***Puntius sophore* (Hamilton,1822)**

Puntius sophore **(**Figure 7**)** is commonly known as pool barb. It is a fresh water fish which caught from northern sector of the lagoon. The spotted barbs are present in the body. The size of the species is 7 cm in total length and weighed about 13.2 g. It is found in Eastern India, Kerala, Sri Lanka and Nepal (Aquatic Community, 2009).

***Mystus gulio* (Hamilton,1822)**

It is commonly known as mangrove cat fish (Figure 8). The species caught from central sector. It lives in both fresh and brackish water. It is easily differentiated from the other species by the combination of its greyish silver colour and small adipose fins. In aquarium the species always swims above the bottom and feeds by olfactory sense rather than sites (Pethiyagoda, 1991). The size of the species is 8 cm in length and contains 11.0 g in weight. It is found in India, Indonesia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

***Mystus vittatus* (Bloch)**

It is commonly known as striped dwarf cat fish (Figure 9). It caught from central sector. Its size is 12 cm in length and 15.8 g in weight. It can live both in fresh and brackish water. It is a demersal fish. Colour varies with age. It is generally delicate grey silver to shinning golden with several pale blue or dark brown to deep black longitudinal on side. A narrow dusky spot often present on the shoulder (Pethiyagoda, 1991). It is distributed through Indian subcontinent area including Pakistan, India, Sri Lanka, Nepal and Bangladesh.

***Chelonodon patoca* (Hamilton,1822)**

It is commonly known as milk spotted puffer fish or gangetic puffer fish(Figure 10). It is a marine fish. It caught from outer channel. Many of the fishes inhabit brackish and fresh water. Its size is 19 cm in total length and weighed about 25.6 g. Many species are used in aquarium for decorating the room (Kottelat, 1993). It is distributed in tropical and subtropical areas of Atlantic, Indian and Pacific Ocean.

***Scatophagus argus* (Linnaeus)**

Itis commonly known as scat or pavillon tach (Figure 11) . It is a freshwater fish which caught from northern side of the lagoon. The size of the species is 12.3 cm and weighed 18.0 g. It requires large aquarium, which is decorated in open places (Zipcode Zoo. Com). In aquarium it will eat anything, so called dung eater. It is found in Indo Pacific area, Japan, India and Fiji.

***Pseudambassis ranga* (Hamilton,1822)**

It is commonly known as glassfish or Indian glassfish (Figure 12). It is a fresh water fish which caught from northern sector of the lagoon. The size of the species is 10.5 cm and 15.0 g in weight. This species can be kept in small aquarium (Aquatic Community, 2009). It is distributed in Asia, Pakistan, India, Bangladesh and Thailand.

***Ophiocephalus gachua* (Hamilton,1822)**

It is commonly known as Asiatic Snake head (Figure 13). It is a freshwater species, which caught from northern sector of the lagoon. The size of the species is 12.7 cm and 21.3 gm in weight. It requires large aquarium, which is decorated in open places (Aquatic Community, 2009). It is very aggressive in nature. It is distributed in India, Southern part of China, eastern and western part of Pakistan.

***Ophiocephalus punctatus* (Bloch)**

It is commonly known as spotted snake head fish (Figure 14). It is a freshwater and caught from northern side of the lagoon. The size of the species is 12.0 cm and 19.8 g in weight. It requires large aquarium with slow circulation of air. It tolerates low oxygen concentration because they are air breathers from early age. Adult fishes may die due to lack of oxygen. It is distributed in rivers of India, Pakistan, Sri Lanka and Southern part of Nepal.

***Therapon jarbua* (Forskal)**

It is commonly known as crescent Perch (Figure 15). It is found in coastal waters, mangroves and estuaries. It is found in rivers almost to fresh water. It is caught from northern sector of the lagoon. The size of the species is 18.5 cm and 25.6 g in weight. It may also found in marine and brackish water. In aquarium the juveniles are peaceful but active but as they mature become more solitary and aggressive and therefore less popular for aquaria. It is predatory in nature and also it will eat all the marine food from the aquarium. It is found in Japan, Western Pacific, South China sea, the Indian Ocean and the Red sea.

***Puntius chola* (Hamilton,1822)**

It is commonly known as Swamp barb, chola barb (Figure 16). It is a freshwater fish which caught from northern sector of the lagoon. The size of the species is 6.7cm in total length and weighed about 10.0 g. It occurs mainly in shallow waters (Talwar and Jhingran, 1991). It is found in Asia. Pakistan, Nepal, India, Bangladesh, Sri Lanka and Myanmar.

***Oreochromis mossambicus* (Peters)**

It is commonly known as Tilapia species (Figure 17). It is a freshwater origin also seen in rivers. The main colouration is yellow, though colouration is unreliable due to different feeding strategies (Popma, 1999). Tilapia species were released for the control of mosquitoes but failed to grow and stabilize mosquitoes populations and became a nuisance (Moyle, 1976). The size of the species is 15.0 cm in length and 25.2 g in weight. It is found in India, Japan and Pakistan.

***Siganus javus* (Hamilton)**

It is commonly known as Rabbit fish (Figure 18). It is a marine fish which caught from central sector of the lagoon. The size of the species is 11.0 cm in total length and 18.7 g in weight. In aquarium it always swims in group. It also accommodates with the surgeon fishes in the marine reef aquaria. It mostly prefers vegetable feed (Aquatic Community, 2009).It is found in Bangladesh, Sri Lanka and India.

***Etroplus Suratensis* (Bloch)**

It is commonly known as Pearl spot found in brackish water but it known to tolerate fresh or marine water which caught from central sector (Figure 19). The size of the species 18 cm and 40 g weight. Feed on filamentous algae, plant material and insect. It is distributed in western Indian ocean, India and Srilanka (Fish base).

***Dantnoide squadrifasciatus* (Bleeker)**

It is commonly known as known as trigger fish found in brackish water of which is caught from central sector(Figure 20) . The size of fish 60 cm in nature and 30 cm in captivity. The body color is gray white and the head may have an amber iridescence. The body is marked with seven black stripes. The first of these runs from the mouth to the eye where it forks with one part running to the back and the other toward the throat. The base of the caudal fin is marked with two black spots. The fins are transparent except for the pelvic fin which is white and black. It distributed in Asia and Australia; Borneo, Burma (Myanmar), Cambodia, the Ganges of India, Thailand and Sumatra (Fish base).

Plotosus arab (Bleeker)

Itis commonly known as cat fish found in marine and brackish water of outer and central sector (Figure 21). Body chestnut brown with 2 or 3 pale lateral bands, the superior one from above eyes along base of dorsal fin and the lower band from maxilla along middle of side of body. It is found in native to the Indian Ocean, the western Pacific Ocean and New Guinea.

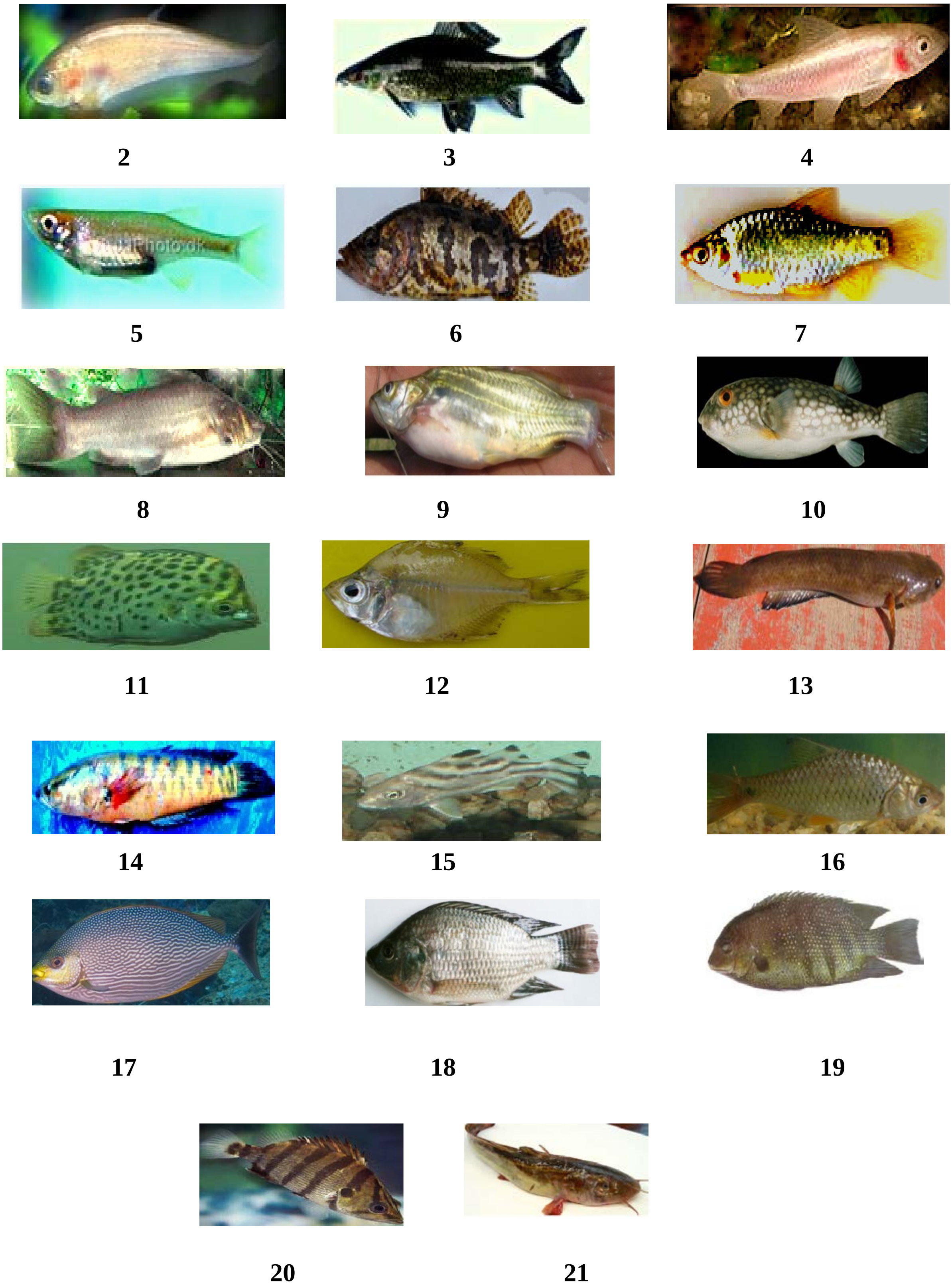

Figure 2-21. List of ornamental fish encounter in different sector of Chilika lagoon

Conclusion

Nature having a large number of ornamental fishes so a judicious exploitation of ornamental fishes from nature is required for sustainable development of the ornamental fishes. There is a warning for South-East Asian Countries, due to over exploitation of many fresh water ornamental fishes are endangered. Detailed studies on breeding, biology and behaviour aspects, nutrition and feed formulations, disease diagnosis and comprehensive health management is highly essential for the conservation and proper management of the ornamental fishes. These would make it possible to exploit the potentials of ornamental fish culture sector in the country to a greater extent in coming decades.

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8(1): 61-66 (2014) DOI: 10.3153/jfscom.2014007

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

PARASITISM BY *Gussevia asota* IN GILLS OF JUVENILES OF *Astronotus ocellatus* CULTURED IN THE PERUVIAN AMAZON

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Received: 20.03.2013 / Accepted: 01.10.2013 / Published online: 28.12.2013

Abstract: The present study aims to evaluate the monogenean infestation in *Astronotus ocellatus* bred in a fish farm in the Peruvian Amazon. Fifty individuals of the species *A. ocellatus* were collected between July and August 2011 from a semi-intensive fish farm, located in the northeast of the State of Loreto, Peru. This study identified a high infestation in gills by monogenean specie of *Gussevia asota* in a cultivation of *A. ocellatus*. The prevalence was 100%, with mortality of all fish. The mean intensity and mean abundance of the parasite were 189.8 of parasites per individual. This is the first report of infestation high by *G. asota*_in juveniles of *A. ocellatus* cultured from the Peruvian Amazon.

Keywords: *Astronotus ocellatus*, *Gussevia asota*, Parasites of fish, Peruvian Amazon

Öz: **Peru Amazonunda Yetiştirilen *Astronotus ocellatus* Balığı Yavrularının Solungaçlarında Karşılaşılan Gussevia *asota* paraziti**

Bu çalışma, peru amazonunda yetiştirilen Astronotus ocellatus balığında görülen monojen istilasını değerlendirmektedir. 2011 senesinde temmuz ve ağustos aylarında 50 adet A. ocellatus, kuzeydoğu Loreto eyaleti Peru'da bulunan yarı intensif balık üretim çiftliğinden alınmıştır. Çalışmada, örneklerin solungaçlarında yoğun olarak Gussevia asota istilasının olduğu görülmüştür. İstila tüm örneklerde (100%) görülmüş ve tamamı ölmüştür. Bireylerde ortalama yoğunluk ve miktar birey başına189.8 parazit olarak hesaplanmıştır. Bu peru amazonunda yetiştirilen A. ocellatus bireylerinde G. asota istilasının ilk raporudur.

Anahtar Kelimeler: *Astronotus ocellatus*, *Gussevia asota, Balık parazitleri,* Peruvian Amazon

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Introduction

In fish farming the intensive exploitation allows the handling of high densities of organisms per unit area. Indeed, this type of management frequently leads to break the balance between pathogen and host, consequently resulting in the emergence of infectious and parasitic diseases that cause various problems ranging from slow up growth, reduced fertility rates, until the appearance of severe epidemics resulting in high mortality (Thatcher 1991; Scholz 1999; Cable et al., 2002).

Cichlids have a wide geographical distribution. Currently there are 1,533 known species, with 320 reported for South America (Kullander 1988). These species inhabit a wide variety of aquatic ecosystems. Moreover, the fish represent high economic importance, given that they are marketed for human nutrition with a promissing potential for intensive and extensive aquaculture (Kullander and Ferreira 2006; Araujo et al., 2009).

The oscar *Astronotus ocellatus* (Agassiz, 1831) can reach up to 45 cm in length and 1.6 kg of total weight (Fracalossi et al., 1998) and Oscar is a much appreciated species for its meat, which has a firm consistency and lacks intramuscular bones with great acceptance on the Amazonian market being regarded as a food fish of the highest quality. The *A. ocellatus* is normally found in Amazon floodplain areas, and is characterized as a hypoxia tolerant species (Almeida-val et al., 1995; Almeida et al., 2000). Recent experiments carried out in laboratory have shown that the adult animals tolerate 6 h anoxia at 28°C by reducing their standard metabolic rates (Muusze et al., 1998). Due to its zootechnical characteristics, the *A. ocellatus* is considered a species with great potential for management in controlled environments aiming human nutrition and ornamental purposes. However, to allow the breeding to become entirely feasible, it turns out the necessity to solve the problem of diseases and parasites upsurge affecting this species in controlled environments, as a consequence of intensive farming under inadequate management (Varella and Malta 1995).

Therefore, with the gradual increase of intensive and semi-intensive fish farming in the Peruvian Amazon, there is a need for constant monitoring of the fish for the diagnosis and timely control of infestations by monogeneans. In this sense, the present study aims to evaluate the monogenean infestation in *A. ocellatus* bred in a fish farm in the Peruvian Amazon.

Materials and Methods

Between July and August 2011, which corresponds to the relative dry season, 50 individuals of the species *A. ocellatus* were collected with drag nets, from a semi-intensive fish farm, located in the northeast of Loreto (Peru), between latitudes 3° 48' 48.9" N and 073° 19' 18.2" W, with average annual temperature of 26.3°C and relative humidity of 85% at 328 mean sea level.

Fish were fed twice daily with extruded diet containing 25% crude protein and 2.6 Mcal/kg of digestible energy and feeding rate of 5% of the biomass of the pond. The sampled fish presented length of 12.60 ±0.10 cm and weight of 50.08 ±0.86 g. Having identified the parasite infestation, the fish were transferred to concrete tanks covered with tiles to undergo long-term baths containing 0.5 to 2.0 ppm of potassium permanganate and 1% formalin during one hour. In the absence of improvement, we sacrificed and burned all the fish from the respective pond.

Using a stereoscope we examined the body surface, fins, nostrils, mouth, opercula and gills, looking for possible injuries and excess of mucus production. By means of a scalpel, we also performed scraping of the skin, fins and gills to observe possible attached parasites.

For examination of the gills, the samples were separated and placed in glass containers with a 1:4,000 formalin solution. After one hour, the gills were stirred in the liquid and then removed from the container. Helminths were allowed to settle on the bottom and were subsequently collected with the aid of a small probe and a dissecting microscope (Nikon SM-30). The identification of the parasites was based on the methodology of Kritsky et al. (1989), Thatcher (2006) and Abdallah et al., (2008).

To study the monogeneans, permanent slides were prepared with total parasites assembly according to Thatcher (1991). For the study of sclerotized structures, parasites were fixed in a solution of ammonium picrate glycerine (GAP) and mounted in Canada balsam. Some specimens were mounted unstained in Gray and Wess' medium. To visualize internal structures, parasites were fixed in hot formaldehyde solution (4%) for staining with Gomori's trichrome. The parasitic indexes calculated for assessing the level of infestation of parasites in the fish were prevalence, mean intensity and mean abundance (Bush et al., 1997).

Results and Discussion

The necropsy of juveniles from *A. ocellatus* bred in controlled environments in the Peruvian Amazon evidenced the infestation by the monogenean *G. asota* in the gill filaments of the fish.

Indeed, the totality of the examined fish showed a high parasitic infestation by *G. asota*. The mean intensity was equal to the mean abundance, provided that the number of parasitized fish was the same as those examined (Table 1).

Several studies report the parasitism of neotropical cichlids by monogeneans belonging to the genus *Gussevia* Kohn and Paperma 1964 (Kritsky et al., 1989; Vidal-Martinez et al., 2001; Mendoza-Franco et al., 2010; Yamada et al., 2011; Mathews et al., 2013a). For south America thirteen species of *Gussevia* have been described for eight species of cichlids (Kritsky et al., 1986), evidencing a high specificity of the genus *Gussevia* in parasitizing cichlids.

In the Central and Peruvian Amazon several species of monogeneans of the genus *Gussevia* have been reported parasitizing cichlid of economic importance for human nutrition and ornamental purposes (Kritsky et al., 1989; Mendoza-Franco et al., 2010; Azevedo et al., 2010). However, little is known about the parasitic Infections of farmed *A. ocellatus*, because these studies have been carried out, in general, in wild fish. In our study we report for the first time the parasitism by the *G. asota* in juveniles of *A. ocellatus* bred in controlled environments in the Peruvian Amazon.

In the study described herein, the juveniles of *A. ocellatus* presented high levels of parasitism by the monogenean *G. asota*. Parasites that have a direct life cycle, such as monogeneans, are more frequently found in lentic environments. Moreover, this type of environment favors the transmission of these parasites (Flores-Crespo et al., 2003; Azevedo et al., 2007), which justifies the fact that the fish had elevated parasite infection, since the same are confined to their culture in earthen ponds where water circulation is almost negligible or nonexistent.

According to Buschmann (2001) and Mariano et al. (2010), intensive fish farming generates a large accumulation of organic matter on the pond bottom produced from the excreta, dead matter and the fraction of uneaten food. This organic matter produces hypoxia and anoxia that creates an unbalance in the homeostasis of the fish, eventually leading to the increase of the oxidative stress of biomolecules, promoting thus various physiological and biochemical alterations, causing cell impairment and death (Sherry 2003; Van der Oost et al., 2003). Therefore, these adverse effects of poor water quality reduce the self resistance of the fish, which turns out as a favorable condition to the parasite proliferation. The *A. ocellatus* is normally found in Amazon floodplain and is characterized as a hypoxia tolerant species (Almeida-Val et al., 1995). However, while adult animals are found in hypoxic waters, juveniles of this species are active and may be easily found in superficial water body layers, where oxygen availability is higher, suggesting a reduced capacity to tolerate hypoxia among juveniles. This fact may justify the high parasitic infestation by *G. asota* in *A. ocellatus* juveniles from fish farming.

Table 1. Parasitic indexes of *Gussevia asota* in juveniles of oscar *Astronotus ocellatus* cultured in the Peruvian Amazon.

Parasitic indexes	*Gussevia asota*
Prevalence (%)	100
Abundance (Count)	9490
Mean abundance ± S.D	189.8 ± 1.7
Mean intensity ± S.D	189.8 ± 1.7
Range of intensity	60-175

The results described herein are in accordance with Kritsky et al. (1989), Azevedo et al., (2010), and Kim et al. (2002), who found the monogenean *G. asota* parasitizing gills of *A. ocellatus* and, being common the setting of this kind of monogenoide parasite in this organ (Kritsky et al., 1989). Indeed, several studies report the parasitism of *G. disparoides* in gills of *H. severus, C. amazonarum* and *C. ocellaris* and all these fish species are currently being raised in confined environments in the Peruvian Amazon.

Furthermore, in a study with *A. ocellatus* captured from the wild, Abdallah et al. (2008) found 62.8% of prevalence and mean intensity of 17.6 monogeneans of *G. asota*. However, the results differ from our study where we found a prevalence of 100% and mean intensity of 189.8 parasites of *G. asota*. A possible reason for the low levels of infestation reported by Abdallah et al. (2008) may be fact that the fish originate from nature. Nevertheless, Kritsky et al. (1989) found 100% prevalence of *G. asota* in *A. ocellatus*, although without informing other parasitic indexes.

Parasites of the genus *Gussevia* are considered specific for cichlids and therefore may show low susceptibility when present in favorable breeding conditions. Kritsky et al. (1989) mentioned that *G. asota* apparently can cause the death of its host, citing the case of an aquarium in Idaho, USA, as an example. This is the first report of *G. asota* parasitizing *A. ocellatus* in fish farming in the Peruvian Amazon. The results of this study and studies addressing various aspects of parasite in other species bred in the same region (Mathews et al., 2007; Dinis et al., 2007; Mathews et al., 2011; Mathews et al., 2013b; Mathews et al., 2013c) confirm the necessity of constant monitoring of fish, seeking the diagnosis and timely control of infestations by monogeneans, in order to reduce fish mortality.

Conclusion

This is the first report of infestation high by *G. asota* in *A. ocellatus* cultured from the Peruvian Amazon. *G. asota* infection probably contributed to the mortality of the captive cichlids.

Acknowledgments

The authors thank Dr. Omar Mertins for reviewing this manuscript.

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8(1): 67-71 (2014) DOI: 10.3153/jfscom.2014008

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

SHORT COMMUNICATION KISA MAKALE

KALAMAR (*Loligo vulgaris* Lamarck, 1798) IN DIŞ GÖRÜNÜŞÜNDEN CİNSİYET TAYİNİ

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Received: 19.07.2012 / Accepted: 27.09.2012 / Published online: 28.12.2013

Öz: Bu çalışmanın amacı, *L. vulgaris*'in erkeklerinde mantonun yanlarında bulunan kromatofor çizgilerinin tespiti ile cinsiyet ayrımının pratik olarak yapılabilirliğini incelemektir. Araştırma için İskele Limanı (Urla, İzmir)'nda bulunan su ürünleri kooperatifine ait mezatta satılan taze cansız kalamarlar ile kalamar oltaları ile yakalanan bireyler kullanılmıştır (toplam 350 adet kalamar, 150 erkek ve 200 dişi; Kasım 2011-Haziran 2012). Cinsiyet ayırımı için erkek bireylerde soldan dördüncü kolun farklılaşmasıyla oluşan erkeklik organı (hektokotil organ), dişilerde ise ağızın altında bulunan spermatafor kesesi kullanılmıştır. Sonuç olarak, bu çalışmada *L. vulgaris*'in dişi ve erkek bireylerini vücut desenlerine bakarak kolayca ayırımının yapılabileceğini gösterilmiştir.

Keywords: *Loligo vulgaris*, Cinsiyet ayırımı, Kromatofor bantları

Abstract: **Sex Distinction By its Morphologic View of European Squid (*Loligo vulgaris* Lamarck, 1798)**

Aim of the present study was to practically investigate sex in *L. vulgaris* using choromotophore stripes in both side of the mantle. For this purpose the landings sold in the local fish market (Iskele Harbour, Izmir, Turkey) and *L. vulgaris* caught by jigging were used (totally 350 squids, 150 males and 200 females; November 2011-June 2012). For sex distinction hectocotylized on the distal third of the left ventral arm in male squids and buccal mass under the mouth of the female were used. Finally, this study showed that female and male of *L. vulgaris* were distinguishable easily based on body pattern.

Anahtar Kelimeler: *Loligo vulgaris*, sex distinction, chromatophor stripes

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Giriş

Kafadanbacaklılar gonokristiktir, yani ayrı eşeylidirler. Diğer yumuşakçalarda olduğu gibi hermafroditizm görülmez ve asla cinsiyet değiştirmezler. Dıştan bakıldığında seksüel dimorfizm genellikle erkeklerde özelleşmiş bir kol (hektokotil) ile sınırlıdır. Cinsiyetler arasında vücut oranları açısından özellikle erginlerde farklılıklar bulunabilir. Bazı türlerde dişiler çok büyük olabilirken diğerlerinde erkekler daha büyük olabilmektedir. Sosyal etkileşim süresince cinsiyetler arasında vücut renk desenlerinde değişimler olabilmektedir. Hatta *Natilius* da her iki cinsiyette de ikincil üreme organları olduğu bilinmektedir (Mangold, 1987).

Loligo vulgaris'te cinsiyet ayırımı ergin bireylerde kolaylıkla yapılabilir; olgun dişilerin şişmanlığı silindir biçimli erkeklerden belirgindir. Naef (1923) dişilerde manto uzunluğunun eninin 5 katı iken erkeklerde bu oranın 6 katı olduğunu bildirmiştir. Cinsiyette boy farklılığının yanında birkaç özellik daha vardır. Erkekler yan taraflarında uzunlamasına turuncu kromatofor çizgileri (*Loligo forbesi*'de olduğu gibi) taşırlar. Bu renk deseni her zaman bulunmaz ve genç bireylerde oldukça nadirdir. Erkeklerde soldan dördüncü kol üçüncü mafsalda hektokotilize olmuştur ve 100 mm manto boyundaki erkeklerde sıklıkla gözlenmiştir. Yeni çiftleşmiş dişiler ağızın hemen altında bulunan kesede beyazımsı bir kütle taşırlar ve bu spermatekadan gelen spermatoforlardan kaynaklanır, hatta olgunlaşmamış dişilerde dahi bu durum gözlenmiştir. 100 mm manto boyunun altındaki bireylerde dışarıdan bakıldığında cinsiyet ayırımı imkânsızdır. Özellikle 50 mm ve altındaki manto boyuna sahip kalamarlarda mikroskobik inceleme yapılmadan cinsiyet tayini mümkün değildir (Worms, 1983).

Literatürde cinsiyet ayırımının mümkün olduğu söylenmesine karşın çoğu yöntem hem karmaşık hem de zaman alıcı olabilmektedir. Özellikle *L. vulgaris*'in canlı temin edilmesi gereken çalışmalarda bireylerin gonadal incelemeleri mümkün olamayacağı gibi manto boyunun enine oranını saptamakta pratik bir yöntem olamayacaktır. Bu çalışmanın amacı, *L. vulgaris*'in erkeklerinde mantonun yanlarında bulunan ve uzunlamasına olan turuncu kromatofor çizgilerinin tespiti ile cinsiyet ayrımının pratik olarak yapılabilirliğini incelemektir.

Materyal ve Metot

Araştırma için İskele Limanı (Urla, İzmir)'nda bulunan su ürünleri kooperatifine ait mezatta satılan taze cansız kalamarlar ile kalamar oltaları ile yakalanan bireyler kullanılmıştır (toplam 350 adet kalamar, 150 erkek ve 200 dişi; Kasım 2011-Haziran 2012). Cinsiyet ayırımı için erkek bireylerde karakteristik olan ve soldan dördüncü kolun farklılaşmasıyla oluşan erkeklik organı (hektokotil organ), dişilerde ise yine karakteristik olan ve ağızın altında bulunan spermatafor kesesi kullanılmıştır. Bireylerin cinsiyetlerini doğru olarak tespit etmek için ayrıca gonadal incelemeleri yapıldı (N=100; 56 dişi, 44 erkek). Çalışmada kullanılan kalamarların boyları (0.1 mm hassasiyetle) ve ağırlıkları (0.1g hassasiyetle) ölçülerek metin içerinde ortalama ± standart sapma olarak verilmiştir.

Bulgular ve Tartışma

Yapılan gözlem ve incelemeler sonucunda vücut deseni olan tüm bireylerin erkek olduğu tespit edilmiştir (Şekil 1, 2, 3). Bu desenlerin iki yanal yüzeyde de asimetrik olarak bulunduğu, <15 cm manto boyundan küçük bireylerde turuncumsu olduğu ve daha büyük bireylerde ise kırmızımsı renkte olduğu, boylarının ve sayılarının kalamarın büyüklüğüne göre değişkenlik gösterdiği saptanmıştır. Hatta yapılan gonadal incelemelerde olgunlaşmamış erkek bireylerde de bu desenlerin olduğu görülmüştür. Çalışmada kullanılan kalamarların boy ve ağırlıkları Tablo da verilmiştir. Erkeklerde ölçülen en küçük manto boyu 88 mm idi ve üzerinde desenler bulunmaktaydı. Dişilerde ölçülen en küçük manto boyu 75 mm idi, ağızın hemen altında bulunan sperm kesesi boştu ve üzerinde desen bulunmamaktaydı.

Tablo 1. *L. vulgaris*'in cinsiyete göre morfometrik ölçümleri.

Table 1. Morphometric measurements of *L. vulgaris* on sex.

	Erkek		**Dişi**	
	Manto Boyu (mm)	**Ağırlık (gr)**	**Manto Boyu (mm)**	**Ağırlık (gr)**
N	44	44	56	56
Min.	88	25	75	20
Mak.	340	656	265	420
$\overline{X}$	190.6	184.4	186.0	177.9
Sd	40.7	100.9	33.2	75.3

Şekil 1. Erkek ve dişi *L. vulgaris*.

Figure 1. Male and female *L. vulgaris*.

Şekil 2. Vücut desenleri belirgin bir erkek *L. vulgaris*.

Figure 2. A male *L. vulgaris* with chromatophore stripes.

Şekil 3. Yeni çiftleşmiş ve spermatofor kesesi dolu bir dişi.

Figure 3. A newly mated female with spermataphore in buccal mass.

Bu çalışmada *L. vulgaris*'in dişi ve erkek bireylerini vücut desenlerine (kromatofor bantları) bakarak kolayca ayırmanın mümkün olabileceği görülmüştür. Worms (1983)'un belirttiği gibi her zaman belirgin olmasa da (ki bu çalışmada hiç rastlanmamıştır) desenli olanların istisnasız erkek bireyler olması kayda değer bir özelliktir. Worms (1983) yapılan araştırmaların olgun olmayan dişi bireylerin ağzının hemen altında bulunan sperm kesesinde spermatofor içeren beyaz kütleciğin görülebildiğini de belirtmiştir. Ne var ki, bu çalışmada araştırıcının bu bulgusunu destekleyen sonuçlara rastlanmamıştır. Ayrıca, Worms (1983) 100 mm manto boyunun altındaki bireylerde cinsiyet tayininin pek mümkün olmadığını söylese de, bu çalışmada saptanan en küçük manto boyu erkek birey için 88 mm ve dişi birey için 75 mm dir. Bu da, vücut desenlerine bakarak *L. vulgaris*'in 100 mm ve altındaki manto boyuna sahip bireylerinin cinsiyetleri hakkında fikir sahibi olunmasını mümkün kılmaktadır.

Sonuç

Sonuç olarak ticari değeri yüksek ve bilimsel araştırmalara (Naef, 1928; Worms, 1983; Roper ve diğ., 1984; Turk ve diğ., 1986; Sen, 2004abc, 2005ab,2006, Sen ve diğ., 2008) konu olmuş *L. vulgaris*'in dış görünüşüne bakarak cinsiyet ayırımının yapılabilmesi mümkündür. Ancak, konuyla ilgili daha detaylı ve uzun vadeli çalışmalara ihtiyaç vardır.

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8(1): 72-82 (2014) DOI: 10.3153/jfscom.2014009

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORİGİNAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

DİP TROL BALIKÇILIĞINDA BARBUNYA (*Mullus barbatus*) VE ISPAROZ (*Diplodus annularis*) BOY SEÇİCİLİĞİNİN GELİŞTİRİLMESİ

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Received: 08.08.2012 / Accepted: 01.10.2013 / Published online: 28.12.2013

Öz: Bu çalışmada, barbunya (*Mullus barbatus*) ve ısparozun (*Diplodus annularis*) boy seçiciliğinin geliştirilmesi amacıyla, düğümsüz altıgen gözlü torba (AGT 44), 40 mm ağ göz açıklığında düğümsüz poliamid torba (PA 40) ve 44 mm ağ gözü açıklığında düğümsüz polietilen torbanın (PE 44) seçicilik parametreleri araştırılmıştır. Denemeler 900 göz kesimli dip trol ağı ile Gülbahçe Körfezi ve Hekim adası civarında 03.02.2009 ile 27.08.2009 tarihleri arasında "EGESÜF" araştırma gemisi ile yürütülmüştür. Seçicilik parametrelerin hesaplanmasında çemberli örtü torba tekniğinden yararlanılmıştır. Bireysel ve çekimlerin birleştirilmesi ile elde edilen veriler CC2000, ortalama seçicilik eğrileri ise ECModeller programı ile yapılmıştır. AGT 44 ile 12, PA 40 ile 19, PE 44 ile 3 geçerli çekim gerçekleştirilmiştir. Barbunya için L_{50} değerleri AGT 44, PA 40 ve PE 44'de sırası ile 15.2 ± 0.0 cm, 14.2 ± 0.0 cm ve 13.5 ±0.1cm'dir. Isparoz için L_{50} değerleri AGT 44, PA 40 ve PE 44'de sırası ile 10.6 ± 0.0 cm, 9.8 ±0.0cm ve 9.3 ± 0.1 cm'dir. Morfolojik özellikleri farklı çok sayıda türün bir arada yakalandığı Ege denizi trol balıkçılığında bir tür için elde edilen başarılı sonuçlar diğer tür veya türler için olumsuz olabilmektedir. Bu nedenle trol balıkçılığında boy seçiciliğinin yanında tür seçiciliği ve davranış çalışmalarının yapılması gerekmektedir.

Anahtar Kelimeler: Trol, Torba boy seçiciliği, Altıgen gözlü torba, Barbunya, Isparoz

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Abstract: **Improving Size Selectivity of Red Mullet *(Mullus barbatus)* and Annular Sea Bream (*Diplodus annularis*) in Bottom Trawl Net**

In this study, In order to improve size selectivity of red mullet (*Mullus barbatus*) and annular seabream (*Diplodus annularis*), 44 mm knotless hexagonal mesh codend (AGT 44), 40 mm knotless poliamid codend (PA 40) and 44 mm knotless polyethylene codend (PE 44) were investigated in bottom trawls net. Experiments were carried out by R/V 'EGESÜF' between 03.02.2009 and 27.08.2009 with 900 meshes modified trawl net in around of Gülbahçe Bay and Hekim Island. A hooped covered codend technique was used for estimating selectivity parameters. Individual and pooled data selectivity parameters were determined with CC2000, mean selectivity parameters were calculated with EC Modeller programmer. Twelve with AGT 44, 10 with PA 40, 3 with PE 44 valid trials were carried out. For red mullet L_{50} values were estimated 15.2 ± 0.0 cm, 14.2 ± 0.0 cm and 13.5 ± 0.1 cm in AGT 44, PA 40 and PE 44, respectively. For annular sea bream L_{50} values were determined 10.6 ± 0.0 cm, 9.8 ± 0.0 cm and 9.3 ± 0.1 cm in AGT 44, PA 40 and PE 44, respectively. As a result, a lot of fish which have different morphological characters can be caught in Aegean Sea trawl fishery. A mesh size and type appropriate for one species will be unsuitable for many others. Therefore, in addition to size selectivity, species selectivity and fish behavior studies need to be investigated.

Keywords: Trawl, Codend size selectivity, Hexagonal mesh codend, Red mullet, Annular sea bream.

Giriş

Balık stoklarının korunması ve balıkçılık yöntemi açısından iyi bir av aracı ilk yakalama boyunun üstündeki balıkları avlamalı, altındakilerin ise kaçmasına olanak sağlamalıdır (Armstrong ve diğ., 1990). Dip trolleri demersal balık avcılığının yaygın olarak yapıldığı av araçlarıdır. Bu av takımında seçicilik en fazla torba kısmında gerçekleşmektedir (Wileman ve diğ., 1996). Bu nedenle seçicilik çalışmaları trolün torba kısmında yoğunlaşmıştır. Uzun süreden beri devam eden bu çalışmalardan bazıları; ağ göz açıklığının arttırılması (Cooper ve Hickey, 1989; Stergiou ve diğ., 1997), ağ göz şeklinin değiştirilmesi (Petrakis ve Stergiou, 1997; Aydın ve Tosunoğlu, 2010), kendinden daha kısa halata donatılan torbalar (Hickey ve diğ., 1993), torba etrafındaki göz sayısının düşürülmesi Lök ve diğ.,1997) ve torbada kullanılan ağ materyali (Holden, 1971; Tokaç ve diğ., 2004) üzerine yoğunlaşmıştır.

Türkiye trol balıkçılığı, Ticari Amaçlı Su Ürünleri Avcılığını Düzenleyen Tebliğ ile düzenlenmektedir (SÜRKOP, 2008). 2/1 Numaralı Tebliğ'de Ege ve Akdeniz'de kullanılacak dip trol ağlarının torba ağ gözü açıklığı baklava (rombik) gözlü ağlarda 44 mm'den, kare gözlü ağlarda 40 mm' den, torba dışına konulan muhafazanın ağ göz açıklıkları ise bu ölçülerin iki katından küçük olamaz hükmü yer almaktadır. Son dönemlerde yapılan araştırmalarda Türkiye demersal trol balıkçılığında ticari olarak kullanılan polietilen (PE) torbaların seçiciliğinin oldukça düşük olduğu ortaya konmuştur (Özbilgin and Tosunoğlu, 2003; Tosunoğlu ve diğ., 2003a,b; Tokaç ve diğ., 2004).

Diğer taraftan seçicilikte önemli konulardan bir tanesi torba çevresindeki ağ göz sayısıdır. Torba ağ gözü sayısının artması, ağ gözlerinin kapanmasına neden olmakta ve seçiciliği düşürmektedir (Tosunoğlu ve diğ., 2008). Avrupa Birliği balıkçığını düzenleyen yasalarda torba çevresindeki göz sayısı ile ilgili düzenlemeler mevcuttur (E.C., 2006). Türkiye' de ticari balıkçılığı düzenleyen tebliğde torba etrafındaki ağ göz sayısı ile ilgili herhangi bir düzenleme bulunmamaktadır. Bu nedenle, balıkçılar torba etrafındaki ağ gözünü, tünel etrafındaki göz sayısına nazaran 2-3 kat arttırmaktadır (Tosunoğlu ve diğ., 2008).

Bu çalışmada, seçiciliğin geliştirilmesi amacıyla farklı morfolojik özelliklerdeki barbunya (*Mullus barbatus*) ve ısparozun (*Diplodus annularis*) farklı ağ göz şekli ve materyaline sahip; düğümsüz altıgen gözlü torba (AGT 44), 40 mm ağ göz açıklığında düğümsüz poliamid torba (PA 40) ve 44 mm ağ gözü açıklığında düğümsüz polietilen torbanın (PE 44) seçicilik parametreleri araştırılmıştır. Tüm torbalar; tünel sonundaki çevre göz sayısı 200 göz, torba çevresi 100 göz olacak şeklide donatılmıştır.

Materyal ve Metot

Araştırma Gülbahçe Körfezi ve Hekim adası civarında 03.02.2009 ile 27.08.2009 tarihleri arasında yürütülmüştür. Trol çekim süresi bütün çekimlerde 1 saat olarak standardize edilmiştir. Çekim hızı 2.6–3.4 mil/saat (ortalama 3.0 mil/saat), derinlik ise 24.2–57.8 m (ortalama 34 m) arasında değişmektedir (Tablo 1). Denemeler Ege Üniversitesi Su Ürünleri Fakültesi'ne ait 27 m boy, 500 BG motor gücüne sahip "EGESÜF" araştırma gemisi ile yapılmıştır.

Örneklemeler, ticari balıkçılar tarafından yaygın olarak kullanılan 900 göz büyüklüğündeki modifiye (kesimli) trol ağı ile gerçekleştirilmiştir (Tosunoğlu ve Aydın, 2007). Üç farklı trol torbası denemeye alınmıştır. Denemeye alınan torbaların özellikleri; Altıgen gözlü torba (AGT 44): Poliamid (PA) + polietilen (PE) kombine düğümsüz ağ, 44 mm nominal ağ göz boyu, 210 d/27 iplik kalınlığı. PA torba (PA 40): düğümsüz 40 mm nominal ağ göz boyu, 210 d/ 72 no iplik kalınlığındadır. PE torba (PE 44): düğümsüz 44 mm nominal mm ağ göz boyu, 210 d/ 27 no iplik kalınlığıdır. Bütün torbalar 5 m uzunluğunda ve çevre göz sayısı 100 dür.

Torba ağ gözü ölçümleri, 4 kg'lık ağırlık eklenmiş dijital kumpas ile yapılmıştır Ağ göz ölçümü yapılan her bir torba için, 3 farklı bölgeden birbirini takip eden 20'şer olmak üzere toplam da 60 ağ gözü ölçümü yapılmıştır.

Torbaların seçiciliğin ölçümünde çemberli örtü torba tekniğinden yararlanılmıştır (Wileman ve diğ., 1996). Örtü torba 7.5 m uzunluğunda olup, düğümsüz PA malzemeye sahip, 24 mm göz açıklığındadır. Örtü torbanın örnekleme torbalarına maskeleme etkisini azaltmak amacıyla 1.6 m çapında iki adet çember, trol torbasının 2. ve 4. metresinde olacak şekilde donatılmıştır. Çember yapımında kullanılan yüksek yoğunluklu PE (HDPE) malzemenin çapı 5 cm' dir.

Her çekimden sonra türler torba ve örtü olarak ayrılmış, tür bazında sayı ve ağırlıkları alınmıştır. Seçicilik parametreleri barbunya ve ısparoz 0.5 cm hassasiyet ile tam örnekleme metoduyla, total boy olarak PVC ölçüm tahtaları ile ölçülmüştür. Türlerin; torba ve örtüdeki türlerin boy frekansları % ve oransal dağılımları hesaplanmıştır.

Barbunya ve ısparoz için her çekime ait veriler değerlendirmeye alınmıştır (PE 44 torba ile ısparoz için elde edilen verileler aşırı yayılım gösterdiği için seçicilik parametreleri birleştirilerek elde edilmiştir). Seçicilik eğrilerinin çizimi ve parametrelerinin hesaplanmasında lojistik eşitliğin maksimum olabilirlik yöntemi kullanılmıştır (Wileman ve diğ., 1996).

Bireysel çekimler ve birleştirilmiş (pooled) çekimlerin seçicilik parametrelerinin tahmini CC2000 ile (Constat, Danimarka), ortalama seçicilik ve Fryer'e (Fryer, 1991) göre çekimler arası varyasyon hesaplanması ise EC Modeller (Constat, Danimarka) programları ile yapılmıştır.

Barbunya (13 cm) için yasal yakalanma boyutuna (YYB) göre yapılan değerlendirmeler Su Ürünleri Kooperatifleri Merkez Birliğinin Yayınladığı 2/1 Numaralı Ticari Amaçlı Su Ürünleri Avcılığını Düzenleyen Tebliğde belirtilen boy yasağı sınırlamasına göre yapılmıştır (SÜRKOP, 2008). Bu tebliğde ısparoz için herhangi bir boy sınırlaması yoktur. Isparoz için yapılan değerlendirmelerde Kınacıgil ve diğ. (2008) tarafından % 50 üreme boyu (ÜB) olarak bildirilen 10,5 cm temel alınmıştır.

Bulgular ve Tartışma

Av Kompozisyonu

AGT 44 ile 12, PA 40 ile 19, PE 44 ile 3 geçerli çekim gerçekleştirilmiştir. PE 44 torba ile yapılan denemelerde aynı özelliklere sahip birbirine benzer iki torbada farklı günlerde denemeler esnasında sualtında kalmıştır. PE 44 torba ile sadece 3 geçerli çekime ait seçicilik parametreleri hesaplanabilmiştir. Bu nedenle Pe 44 torbanın seçicilik parametreleri ve eğrileri verilerin birleştirilmesi ile elde edilmiştir. Denemeler sonrası yapılan ağ gözü ölçümlerinde AGT 44; 44.7 ±0.1 cm, PA; T90: 40.6 ± 0.1 cm olarak tespit edilmiştir. PE 44 torbanın ağ gözü ölçümleri ise yapılamamıştır.

Deneysel torbalara ilişkin türlerin torba, örtüde ve toplamda yakalananların ağırlık olarak oransal dağılımı ise Tablo 2' de verilmiştir.

Torba Seçiciliği

Barbunya

AGT 44 ile barbunya için 12 geçerli çekim sonucu toplam 5435 birey yakalanmış olup oransal dağılımı; torbada %24, örtüde %76 şeklindedir. PA 40 torbada ise 19 geçerli çekimde toplam 16693 birey yakalanmış olup, bunun % 65'i torba %35'i ise örtüdür. PE 44 torbada ise geçerli 3 çekim sonucu toplam 4242 adet birey yakalanmış olup, oransal dağılımı %77 torba, %25 örtüdür (Şekil 1). Deneme torbaları içerisinden en yüksek

L_{50} değeri 15.2 ±0.0 cm ile AGT 44 torbadan elde edilmiştir (Tablo 3). Bu değeri sırası ile PA 40 (14.2 ±0.0 cm) ve PE 44 (13.5 ±0.1 cm) torba takip etmektedir. Her bir torbanın birbiri ile yapılan karşılaştırmasında; ortalama SR'ler açısından fark bulunmuştur ($p<0.05$). Ortalama L_{50} değerleri açısından AGT 44, PA 40 ve PE 44 arasında fark bulunurken ($p<0.05$), PA 40 ve PE 44 arasında fark bulunmamıştır ($p>0.05$).

Tablo 1. Trol operasyonlarına ilişkin detaylar.

Table 1. Details of trawl operataions.

Deneme torbası	Çekim no	Tarih	Çekim başlangıç koordinatları	Çekim bitiş koordinatları	Derinlik (m)	Çekim hızı (knot)
AGT 44	1	11.06.2009	38°26'915" N 26°41'661" E	38°24'777" N 26°40'176" E	31.3 - 28.3	2.8
	2	11.06.2009	38°26'900" N 26°40'121" E	38°25'169" N 26°37'867" E	28.0 - 28.0	2.9
	3	11.06.2009	38°27'260"N 26°37'983"E	38°24'992"N 26°38'558" E	26.3 - 27.5	3.1
	4	19.08.2009	38°29'184" N 26°45'683" E	38°27'115" N 26°44'954" E	47.6 - 40.8	3.0
	5	19.08.2009	38°29'064" N 26°45'727" E	38°26'819" N 26°45'014" E	47.6 - 30.8	2.9
	6	26.08.2009	38°27'003" N 26°41'736" E	38°24'931" N 26°40'242" E	30.4 - 28.3	3.0
	7	26.08.2009	38°26'971" N 26°39'889" E	38°24'575" N 26°39'727" E	26.9 - 28.2	2.9
	8	26.08.2009	38°26'801" N 26°39'032" E	38°24'701" N 26°39'773" E	26.9 - 27.8	2.6
	9	26.08.2009	38°26'929" N 26°41'497" E	38°24'761" N 26°39'946" E	30.2 - 27.9	2.8
	10	27.08.2009	38°27'191" N 26°41'579" E	38°25'092" N 26°40'409" E	28.1 - 28.2	2.7
	11	27.08.2009	38°26'955" N 26°41'234" E	38°24'539" N 26°40'149" E	29.7 - 27.0	2.7
	12	27.08.2009	38°27'125" N 26°41'568" E	38°24'726" N 26°39'170" E	29.0 - 27.7	2.7
PA 40	1	18.02.2009	38°27'018" N 26°40'083" E	38°25'593" N 26°37'871" E	27.2 - 29.1	3.1
	2	18.02.2009	38°25'585" N 26°37'927" E	38°27'085" N 26°40'269" E	29.2 - 26.7	3.2
	3	18.02.2009	38°26'881" N 26°40'021" E	38°24'765" N 26°38'806" E	28.1 - 27.5	3.0
	4	18.02.2009	38°25'163" N 26°38'240" E	38°26'963" N 26°39'704" E	28.3 - 26.8	3.0
	5	17.03.2009	38°26'834" N 26°41'159" E	38°24'932" N 26°38'978" E	30.1 - 27.8	2.8
	6	17.03.2009	38°24'990" N 26°38'082" E	38°28'018" N 26°38'921" E	27.2 - 27.5	3.1
	7	17.03.2009	38°27'172" N 26°44'686" E	38°29'800" N 26°45'437" E	33.4 - 48.2	2.8
	8	18.03.2009	38°27'735" N 26°45'076" E	38°32'334" N 26°44'202" E	34.0 - 56.8	3.4
	9	18.03.2009	38°33'142" N 26°42'634" E	38°29'654" N 26°45'533" E	57.8 - 48.5	2.9
	10	18.03.2009	38°31'017" N 26°45'281" E	38°27'976" N 26°45'949" E	50.0 - 36.0	2.8
	11	20.03.2009	38°27'045" N 26°45'157" E	38°29'535" N 26°45'561" E	30.5 - 48.4	3.1
	12	20.03.2009	38°29'823" N 26°45'860" E	38°32'278" N 26°44'319" E	50.2 - 56.7	2.9
	13	20.03.2009	38°30'023" N 26°45'556"E	38°27'329" N 26°45'040" E	42.2 - 40.3	3.2
	14	22.05.2009	38°27'021" N 26°40'604" E	38°24'844" N 26°39'534" E	28.1 - 28.7	3.2
	15	22.05.2009	38°29'639" N 26°45'791" E	38°27'135" N 26°44'813" E	49.4 - 34.9	3.3
	16	22.05.2009	38°29'581" N 26°45'917" E	38°27'317" N 26°45'288" E	50.0 - 33.2	3.1
	17	23.05.2009	38°26'926" N 26°40'027" E	38°24'819" N 26°39'592" E	27.7 - 28.6	2.7
	18	23.05.2009	38°25'051" N 26°59'535" E	38°27'151" N 26°40'765" E	24.2 - 26.9	3.1
	19	23.05.2009	38°26'735" N 26°41'396" E	38°24'598" N 26°39'259" E	30.2 - 28.2	2.8
PE 44	1	03.02.2009	38°26'025" N 26°44'970" E	38°29'645" N 26°45'707" E	36.5 - 49.8	3.2
	2	17.02.2009	38°27'101" N 26°41'402" E	38°25'740" N 26°33'093" E	28.8 - 29.6	3.1
	3	17.02.2009	38°25'629" N 26°37'925" E	38°26'956" N 26°40'982" E	29.4 - 29.4	3.3

Tablo 2. Toplam av ürününün deneme torbalarındaki oransal dağılımı.

Table 2. Proportional distribution of total catch in investigated codends.

	AGT 40			PA 40			PE 40			
	Toplam	Torba	Örtü	Toplam	Torba	Örtü	Toplam	Torba	Örtü	Genel toplam
Toplam (kg)	1297.7	426.3	871.4	2871.4	1857.9	1013.5	382.0	232.7	149.3	4551.1
Isparoz (%)	12	27	5	35	50	7	5	29	5	27
Barbunya (%)	12	15	11	13	7	25	41	16	41	14
Kırma mercan (%)	2	4	0	2	2	1	0	2	0	2
Yabani mercan (%)	10	2	14	3	3	2	0	1	0	5
İzmarit (%)	6	2	8	4	1	12	12	1	12	5
Diğerleri (%)	58	50	62	43	37	53	42	51	42	47

Barbunya için toplamda (torba+örtü) minimum yakalanma boyunun altındaki bireylerin oranı AGT 44, PA 40 ve PE 44 için sırası ile % 59, % 58 ve % 51 ile birbirine yakındır. Torba ve örtüde yakalanan YYB altındaki bireylerin oranı AGT 44 için % 21 ve % 71, PA 40 için % 15 ve % 71, PE 44 için % 22 ve % 79' dur. Torba ve örtüde yakalanan ve YYB altındaki bireylerin toplam avcılıktaki oranları sırası ile AGT 44, için % 4 ve % 54, PA 40 için % 5 ve % 54, PE 44 için % 4 ve % 46' dır.

Isparoz

AGT 44 ile ısparoz için 12 geçerli çekim sonucu toplamda 6034 birey yakalanmış olup; oransal dağılımı %57 torba, %43 örtü şeklindedir. PA 40 torbada ise 19 geçerli çekimde toplam 27836 birey yakalanmış olup; bunların % 86'sı torbada %14'i ise örtüde yakalanmıştır. PE 44 torbada ise geçerli 3 çekim sonucu toplam 4242 adet birey yakalanmış olup; oransal dağılımı torbada %25, örtüde %75'dir. Şekil 2'deki torbalara ait boy-frekans grafikleri incelendiğinde her 3 torbada yakalanan bireylerin boy gruplarının birbirine benzer özellikler gösterdiği tespit edilmiştir.

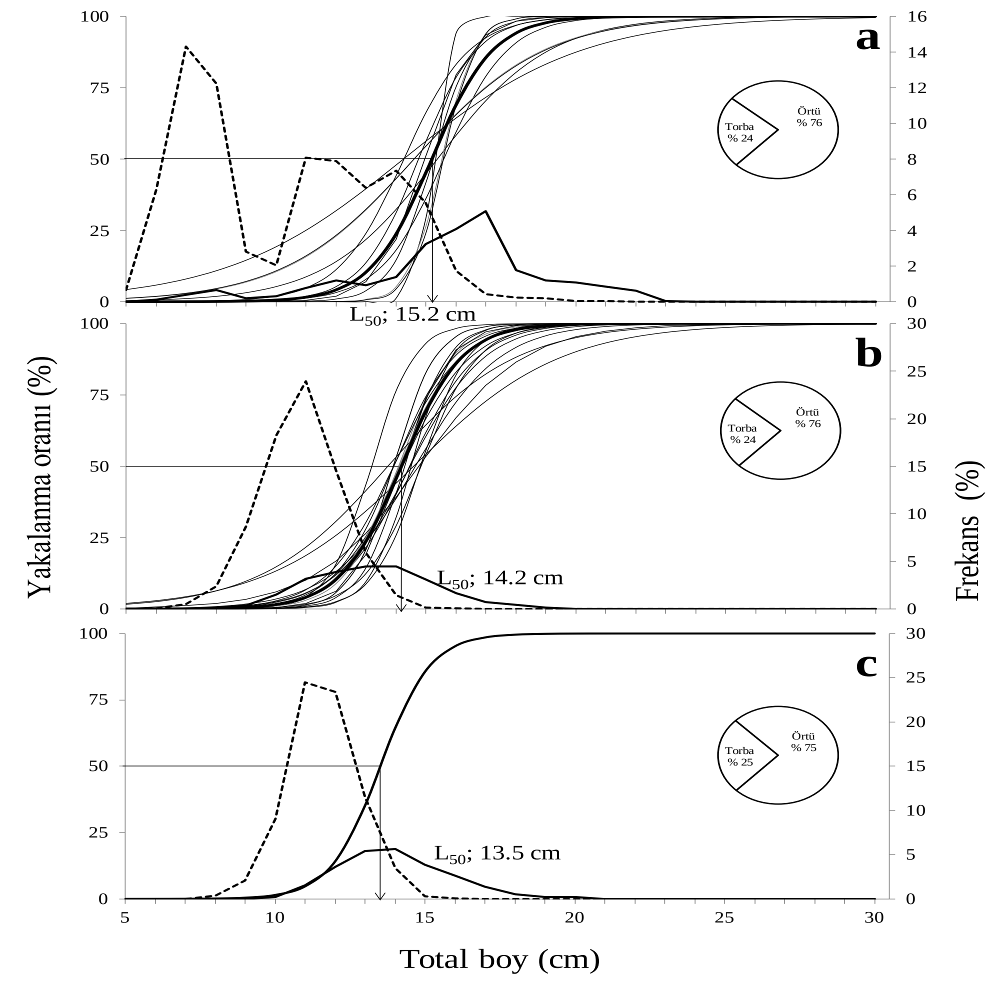
Denemeleri gerçekleştirilen her üç torba arasında AGT 44 torbanın ortalama L_{50} değerinin 10.6 ±0.0 cm ile en yüksek olduğu tespit edilmiştir (Tablo 4). Bu değeri sırası ile PA 40 torba (9.8 ±0.0 cm) ve PE 44 (9.5 ±0.6 cm) takip etmektedir. Her bir torbanın birbiri ile yapılan karşılaştırmasında; ortalama SR' ler açısından fark bulunmuştur ($p<0.05$). Ortalama L_{50} değerleri açısından AGT 44 ile PA 40 ve PE 44 arasında fark bulunurken ($p<0.05$), PA 40 ve PE 44 arasında fark bulunmamıştır ($p>0.05$).

Isparoz için toplamda (torba + örtü) ilk üreme boyu altındaki bireylerin oranı AGT 44, PA 40 ve PE 44 için sırası ile % 19, % 9 ve % 30'dur. Torba ve örtüde yakalanan ilk üreme boyu altındaki bireylerin oranı AGT 44 için % 3 ve % 41, PA 40 için % 2 ve % 51, PE 44 için % 13 ve % 89'dur. Torba ve örtüde yakalanan ve ilk üreme boyu altındaki bireylerin toplam avcılıktaki oranları AGT 44 için, % 2 ve % 18, PA 40 için % 2 ve % 7, PE 44 için % 10 ve % 20'dir.

Bu çalışma, altıgen gözlü torba (AGT 44), 40 mm ağ göz açıklığında düğümsüz poliamid torba (PA 40) ve 44 mm ağ gözü açıklığında düğümsüz polietilen torbanın (PE 44) seçicilik parametrelerini kapsamaktadır. Deneme torbalarından barbunya ve ısparozun her ikisi için en yüksek seçicilik altıgen torbadan elde edilmiştir. Bunun muhtemel nedeni altıgen torbanın göz boyunun ele alınan türlerin vücut yapılarına diğer torbalara göre uygun ve daha büyük gözlü oluşu olarak düşünülmektedir. Nominal 40 mm polietilen torba, 40 mm ticari trol balıkçıları tarafından yoğun olarak kullanılmaktadır. Bu torba ticari çekim şartlarında esnemekte ve yasal ağ göz boyu olan 44 mm' ye yaklaşmaktadır (Tokaç ve diğ., 2010). Fakat yine de bu torbanın seçiciliği oldukça düşüktür (Özbilgin ve diğ., 2003; Tosunoğlu et. al., 2003a,b). Otuz altı mm göz açıklığındaki PA torba 40 mm PE torbaya göre barbunya türü için daha yüksek, ısparoz içinse benzer L_{50} sağladığı bildirilmiştir (Tokaç ve diğ., 2004). Bu özellik göz önünde bulundurulduğundan PA 40 torbanın ağ göz açıklığı 40 mm olarak tercih edilmiştir.

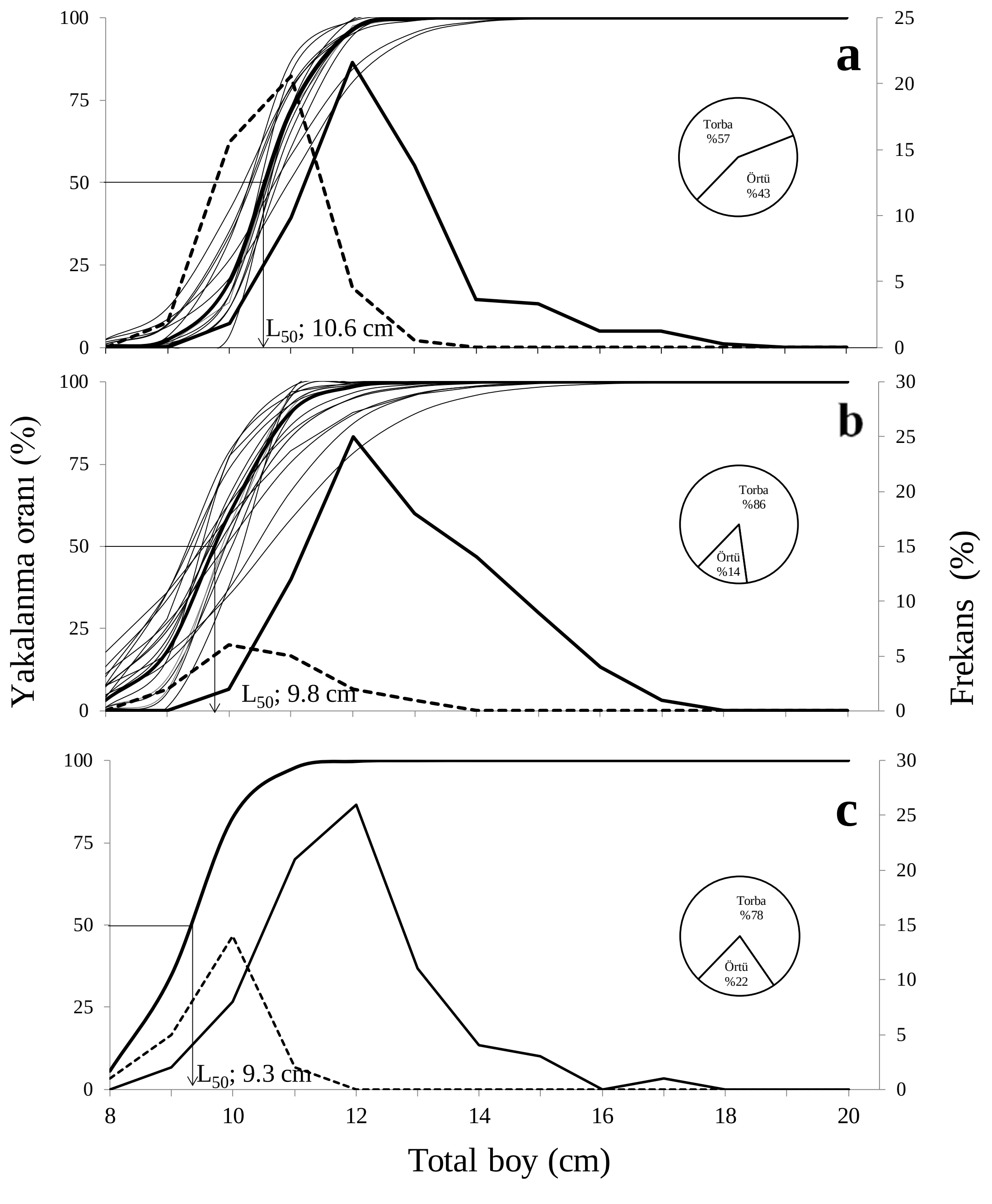
Denemeye alınan torbadan elde edilen seçicilik sonuçlarına göre barbunya ve ısparoz için PA 40 torba L_{50} değeri, PE 44 torbaya göre daha yüksek bulunmuştur.

Kare gözlü torba seçiciliği barbunya gibi fusiform yapıya sahip balıkların seçiciliğinde baklava gözlü torbalara nazaran daha iyidir (Tosunoğlu,1998). Bununla birlikte altıgen gözlü torba (L_{50}: 15.2 cm) ile, kare gözlü 40 mm PA (L_{50}: 13.3 cm) (Metin, 1995) ve 44 mm PA (L_{50}: 14.7 cm) (Tokaç ve diğ., 1998), üst paneli kare gözlü 40 mm PE (L_{50}: 10.6 cm) Tosunoğlu ve diğ., 2003a) ve 44 mm PE (L_{50}: 13.7 cm) (Tosunoğlu, 1998) torbalarından daha yüksek L_{50} değeri elde edilmiştir. Bunun en önemli sebeplerinden biri, kaçış için AGT 44' nin barbunyanın vücut şeklinin kaçması için uygun olduğu ve torbanın donatıldığı yerdeki oranın (200göz/100göz) düşük olması olarak yorumlanmaktadır. Çünkü bu oranı arttırdığımızda ağ gözlerinin açılımı azalmakta ve seçicilik olumsuz etkilemektedir (Tosunoğlu ve diğ., 2008).



Şekil 1. Barbunyaya ait seçicilik eğrileri, boy-frekans dağılımı ve torba ve örtüdeki birey sayıları (a: AGT 44; b:PA 40, c: PE 44. Sol Y ekseni: Yakalanma oranı; ince düz çizgi; bireysel çekimlerin seçicilik eğrisi, kalın düz çizgi; ortalama (Fryer (1991)'e göre) seçicilik eğrisi. Sol Y ekseni: boy-frekans dağılımı; kesikli çizgi; örtüdeki birey sayısı, düz çizgi; torbadaki birey sayısı).

Figure 1. Selection curves and length distribution of red mullet and percentages of the species in terms of number (circle diagrams) in codend and in cover (a: AGT 44; b:PA 40, c: PE 44. Y-axis left, percentage retained; thin drawn lines: individual selection curves, thick drawn lines: mean selection curve according to Fryer (1991). Y-axis right, normalized length-frequency distribution: thin dashed lines; cover specimens, drawn line; codend specimens.



Şekil 2. Isparoza ait seçicilik eğrileri, boy-frekans dağılımı ve torba ve örtüdeki birey sayıları (a: AGT 44; b: PA 40, c: PE 44. Sol Y ekseni: Yakalanma oranı; ince düz çizgi; bireysel çekimlerin seçicilik eğrisi, kalın düz çizgi; ortalama (Fryer (1991)'e göre) seçicilik eğrisi. Sol Y ekseni: boy-frekans dağılımı; kesikli çizgi; örtüdeki birey sayısı, düz çizgi; torbadaki birey sayısı).

Figure 2. Selection curves and length distribution of annular sea bream and percentages of the species in terms of number (circle diagrams) in codend and in cover ((a: AGT 44; b:PA 40, c: PE 44. Y-axis left, percentage retained; thin drawn lines: individual selection curves, thick drawn lines: mean selection curve according to Fryer (1991). Y-axis right, normalized length-frequency distribution: thin dashed lines; cover specimens, drawn line; codend specimens.

Tablo 3. Barbunya'ya ait seçicilik parametreleri (P; birleştirilmiş veri, F; Fryer (1991)'e göre ortalama L_{50} değeri, L_{50}; % 50 yakalama boyu, sh; standart hata, GA; güven aralığı, SA; seçicilik aralığı, R_1, R_2, R_3; kovaryans matriks değerleri, a ve b; regresyon parametreleri, df; serbestlik derecesi).

Table 3. Selectivity parameters for red mullet (P; pooled data, F; L_{50} values according to Fryer (1991), L_{50}; %50 retaition length, sh; standart error, GA; confidence interval, S: selection range, R_1, R_2, R_3; Covarience matrix values, a and b; regression parameters, df; degree of fredom).

			sh.	95% GA		sh.	95%GA											Miktar (kg)			Sayı	
		L_{50}	L_{50}	L_{50}	SA	SA	SA.	R_1	R_2	R_3	a	b	R_1	R_2	R_3	Deviance	df.	Toplam	Torba	Tür	Torba	Örtü
AGT 44	1	14.3	0.4	13.4-15.1	2.4	0.5	1.2-3.6	0.1259	0.1441	0.2727	-13.038	0.914	6.6913	-0.5115	0.0393	17.51	7	61.7	15.4	3.8	90	366
	2	15.2	0.3	14.5-15.9	1.5	0.3	0.9-2.3	0.0858	0.0603	0.0739	-21.922	1.439	12.9264	-0.9187	0.0657	7.72	7	78.7	8.6	0.5	20	303
	3	15.2	0.2	14.8-15.7	0.6	0.2	0.2-1.0	0.0465	0.0084	0.0285	-54.840	3.597	224.4269	-14.8585	0.9862	1.88	8	53.0	8.3	1.3	18	250
	4	15.4	0.6	14.0-16.7	4.1	1.6	0.5-7.8	0.3611	0.0426	2.6049	-8.246	0.536	10.5602	-0.6829	0.0446	22.9	9	116.8	5.9	3.7	56	63
	5	15.5	0.3	14.8-16.3	1.2	0.3	0.4-2.0	0.1004	0.0024	0.1145	-29.258	1.882	72.0302	-4.6183	0.2976	3.07	7	52.3	2.5	1.3	23	26
	6	15.6	0.2	15.2-16.0	1.1	0.2	0.7-1.6	0.0262	0.0118	0.0404	-30.071	1.928	26.9856	-1.7624	0.1155	37.79	9	139.9	24.2	9.5	167	539
	7	14.3	0.9	12.3-16.2	6.5	2.1	2.0-11.0	0.7917	-0.3342	4.2467	-4.805	0.337	2.5655	-0.1679	0.0114	46.9	12	98.2	15.8	6.5	116	117
	8	14.8	0.3	14.2-15.5	2.1	0.5	1.1-3.1	0.0655	-0.0628	0.2037	-15.429	1.045	12.0041	-0.7756	0.0503	6.01	8	100.0	9.2	5.0	89	44
	9	15.0	0.2	15.6-15.4	1.7	0.3	0.9-2.5	0.0300	-0.0237	0.1111	-19.626	1.311	15.9978	-1.0405	0.0679	10.08	8	109.1	13.6	5.1	101	58
	10	15.6	0.2	15.2-16.0	2.3	0.4	1.5-3.2	0.0320	-0.0123	0.1467	-14.761	0.946	6.1033	-0.3846	0.0243	16.93	13	145.2	20.4	6.5	111	100
	11	14.6	0.4	13.7-15.6	4.7	0.4	3.9-5.6	0.1924	0.1102	0.1636	-6.794	0.465	0.2321	-0.0181	0.0016	38.6	13	170.8	21.6	9.5	215	1816
	12	14.6	0.3	14.1-15.2	4.8	0.4	4.0-5.6	0.0665	0.0465	0.1233	-6.691	0.458	0.1945	-0.0144	0.0011	12.99	13	171.5	14.4	11.2	290	457
	P	*15.3*	*0.3*	*14.6-16.1*	*4.1*	*0.5*	*3.0-5.1*	*0.1126*	*0.0709*	*0.2473*	*-8.309*	*0.542*	*0.9130*	*-0.0625*	*0.0044*	*272.66*	*17*	*1290.5*	*158.8*	*63.9*	*1296*	*4139*
	F	**15.2**	**0.0**	**15.1-15.3**	**2.5**	**0.1**	**2.2-2.7**				**-14.938**	**0.983**					**19**					
PA 40	1	13.2	0.1	13.0-13.3	1.5	0.1	1.3-1.8	0.0042	0.0026	0.0088	-18.743	1.422	1.2155	-0.0950	0.0075	15.53	10	66.3	26.2	10.2	376	892
	2	14.2	0.3	13.6-14.8	2.5	0.4	1.6-3.3	0.0767	0.0734	0.1510	-12.568	0.884	3.2616	-0.2483	0.0191	64.77	11	99.4	35.3	7.5	320	1166
	3	14.5	0.3	13.8-15.2	2.5	0.4	1.7-3.3	0.1011	0.0768	0.1249	-12.837	0.888	2.7316	-0.2078	0.0161	34.7	12	93.2	13.9	4.0	124	698
	4	14.1	0.2	13.7-14.5	2.0	0.2	1.4-2.5	0.0374	0.0293	0.0549	-15.745	1.118	3.0438	-0.2314	0.0178	39.29	10	128.4	31.0	7.7	268	1258
	5	14.8	0.3	14.1-15.6	2.1	0.4	1.2-2.9	0.1047	0.0741	0.1380	-15.709	1.058	6.8258	-0.4916	0.0358	50.29	8	80.6	23.8	6.0	162	917
	6	13.9	0.2	13.5-14.4	2.4	0.3	1.9-3.0	0.0377	0.0279	0.0675	-12.505	0.898	1.5363	-0.1173	0.0091	13.26	9	173.1	3.6	21.8	101	329
	7	13.3	0.3	12.6-13.9	3.2	0.6	2.0-4.5	0.0906	0.0956	0.3323	-8.977	0.677	2.2286	-0.1786	0.0145	96.76	11	218.5	20.0	40.0	595	1180
	8	13.9	0.1	13.6-14.2	1.5	0.2	1.2-1.9	0.0207	0.0106	0.0264	-20.214	1.452	4.3329	-0.3228	0.0242	51.4	12	280.6	47.9	14.5	396	1417
	9	14.2	0.2	13.8-14.6	1.8	0.2	1.2-2.3	0.0305	0.0107	0.0567	-17.682	1.248	5.5066	-0.3949	0.0285	37.04	11	373.4	13.5	8.7	267	420
	10	13.9	0.2	13.6-14.3	2.2	0.2	1.8-2.6	0.0260	0.0195	0.0383	-13.992	1.004	1.3416	-0.1034	0.0081	20.83	11	191.4	25.5	8.3	257	909
	11	14.3	0.1	14.1-14.5	1.6	0.1	1.3-1.8	0.0091	0.0049	0.0141	-19.879	1.392	2.0780	-0.1503	0.0109	9.18	11	143.0	22.2	9.7	210	560
	12	14.5	0.1	14.2-14.8	1.5	0.1	1.2-1.8	0.0168	0.0091	0.0193	-21.549	1.485	3.7330	-0.2682	0.0194	5.17	12	91.3	15.8	3.8	90	596
	13	14.7	0.6	13.3-16.0	3.1	0.8	1.2-5.0	0.3436	0.391	0.7143	-10.447	0.713	6.4965	-0.4961	0.0383	63.19	9	72.5	18.7	4.9	162	618
	14	14.8	0.5	13.6-16.0	3.8	1.1	1.4-6.3	0.2727	0.3720	1.1160	-8.552	0.577	4.7530	-0.3470	0.0256	42.72	8	112.5	13.7	3.9	186	403
	15	13.7	0.6	12.4-15.0	4.7	1.5	1.1-8.2	0.3146	0.3036	2.3846	-6.455	0.470	4.2255	-0.3171	0.0241	25.1	8	196.5	7.2	4.0	103	141
	16	14.6	0.7	12.7-16.5	5.4	2.5	-1.0-11.8	0.5396	1.1751	6.2496	-5.954	0.408	6.6687	-0.4871	0.0359	8.01	5	127.5	2.5	1.2	33	51
	17	14.1	0.2	13.8-14.5	2.2	0.2	1.7-2.8	0.0231	0.0194	0.0563	-13.910	0.986	1.9760	-0.1469	0.0110	12.91	10	71.3	15.2	7.7	141	305
	18	14.5	0.3	13.9-15.1	2.7	0.5	1.6-3.8	0.0701	0.0820	0.2230	-11.710	0.809	3.6208	-0.2668	0.0198	25.88	8	229.8	20.0	7.5	211	548
	19	14.8	0.3	14.1-15.6	1.7	0.3	0.8-2.6	0.0928	0.0880	0.1157	-19.040	1.284	11.9612	-0.8810	0.0651	7.24	5	122.5	6.5	0.8	31	252
	P	*14.1*	*0.1*	*13.9-14.4*	*2.4*	*0.2*	*2.0-2.7*	*0.0145*	*0.0120*	*0.0282*	*-12.050*	*0.924*	*0.7397*	*-0.0558*	*0.0043*	*225.02*	*14*	*2871.4*	*390.6*	*134.0*	*4033*	*12660*
	F	**14.2**	0.0	**14.1-14.2**	2.0	**0.0**	2.0-2.0				**-14.066**	**0.992**					**33**					
PE 44	*P*	*13.5*	*0.1*	*13.4-13.7*	*1.8*	*0.1*	*1.6-2.1*	*0.0050*	*0.0037*	*0.0092*	*-16.159*	*1.196*	*0.6411*	*-0.0498*	*0.0039*	*26.26*	*11*	*382.9*	*97.4*	*36.7*	*1073*	*3169*

Torba ağ gözleriyle yapılan denemelerde ısparozun vücut yapısından dolayı rombik gözlü torbaların kare gözlü torbalara nazaran daha iyi sonuçlar verdiği ortaya konmuştur. Bu çalışmada ısparoz için AGT 44 ile elde edilen seçicilik sonucunun ısparoz seçiciliği için oldukça uygun olduğu görülmektedir. Bu durum ilk üreme boyu (10.5 cm) göz önüne alındığında AGT 44' ile elde edilen L_{50} boyunun (10.6 cm) uygunluğunda görülmektedir.

Altıgen torba ile elde edilen L_{50} değeri (10,6 cm) farklı tasarım ve ağ gözü büyüklüğünde yapılan çalışmalardan yüksek bulunurken, PA 40 (L_{50}: 9.8 cm) ve PE 44'den (L_{50}: 9.5 cm) elde edilen değerler; 40 mm PE rombik (L_{50}: 9.2) (Kaykaç, 2007), 36 mm (L_{50}: 8.4 cm) ve 44 mm PA (10.3 cm) (Tokaç ve diğ., 2004), 40 mm PE (L_{50}: 8.7 cm) (Özbilgin ve Tosunoğlu, 2003) ve (L_{50}: 8.6 cm) (Tosunoğlu ve diğ., 2003a) ile elde edilen değerlerle karşılaştırılabilir niteliktedir.

Tablo 4. Isparoza ait seçicilik parametreleri (P; birleştirilmiş veri, F; Fryer (1991)'e göre ortalama L_{50} değeri, L_{50}; % 50 yakalama boyu, sh; standart hata, GA; güven aralığı, SA; seçicilik aralığı, R_1, R_2, R_3; kovaryans matriks değerleri, a ve b; regresyon parametreleri, df; serbestlik derecesi).

Table 4. Selectivity parameters for annular sea bream (P; pooled data, F; L_{50} values according to Fryer (1991), L_{50}; %50 retaition length, sh; standart error, GA; confidence interval, S: selection range, R_1, R_2, R_3; Covarience matrix values, a and b; regression parameters, df; degree of fredom).

			sh	95% GA		sh	95%GA											Miktar (kg)			Sayı	
		L_{50}	L_{50}	L_{50}	SA	SA	S.A	R_1	R_2	R_3	a	b	R_1	R_2	R_3	Deviance	d.f.	Toplam	Torba	Tür	Torba	Örtü
AGT 44	1	10.5	0.0	10.4-10.6	0.7	0.1	0.6-0.8	0.0016	-0.0002	0.0028	-34.316	3.265	7.2571	-0.6864	0.0651	9.67	14	61.7	20.7	15.8	470	284
	2	10.2	0.1	10.0-10.4	1.3	0.2	1.0-1.7	0.0079	-0.0037	0.0265	-16.851	1.651	4.4276	-0.4243	0.0408	40.85	16	78.7	32.8	27.7	625	297
	3	10.3	0.1	10.2-10.5	1.1	0.1	0.7-1.4	0.0040	-0.0011	0.0114	-20.059	1.945	3.6668	-0.3506	0.0337	29.57	20	53.0	19.5	16.5	459	184
	4	10.8	0.1	10.5-11.0	1.6	0.2	1.2-2.0	0.0112	0.0032	0.0358	-14.517	1.350	2.7932	-0.2614	0.0246	14.85	12	116.8	5.2	3.9	147	165
	5	10.8	0.1	10.6-11.1	0.9	0.2	0.6-1.3	0.0144	0.0061	0.0232	-26.205	2.421	18.5810	-1.7487	0.1653	8.92	9	52.3	2.7	1.2	46	86
	6	10.8	0.1	10.6-10.9	0.8	0.1	0.6-1.1	0.0059	0.0006	0.0101	-28.435	2.643	11.8017	-1.0980	0.1025	31.53	14	139.9	11.8	7.6	272	266
	7	11.0	0.1	10.8-11.2	1.6	0.2	1.2-2.0	0.0069	0.0015	0.0288	-15.036	1.371	2.5058	-0.2291	0.0211	13.11	11	98.2	10.3	5.5	206	228
	8	10.3	0.1	10.1-10.6	1.1	0.1	0.9-1.4	0.0078	-0.0045	0.0165	-20.032	1.936	5.4627	-0.5102	0.0479	19.84	14	100.0	8.3	6.5	249	93
	9	10.7	0.1	10.5-10.9	0.8	0.2	0.5-1.1	0.0087	0.0000	0.0225	-29.507	2.766	31.0972	-2.9090	0.2727	31.11	11	109.1	6.8	4.3	173	145
	10	10.8	0.0	10.7-10.9	0.5	0.1	0.4-0.6	0.0014	0.0003	0.0028	-46.418	4.309	23.2861	-2.1688	0.2022	11.58	11	145.2	13.0	8.0	210	235
	11	10.7	0.1	10.4-10.9	0.9	0.2	0.6-1.2	0.0147	0.0035	0.0244	-26.151	2.449	20.3083	-1.9174	0.1818	65.82	12	170.8	17.0	8.0	270	423
	12	10.3	0.1	10.1-10.5	0.8	0.1	0.6-1.1	0.0071	0.0000	0.0148	-26.924	2.619	15.3309	-1.4862	0.1445	24.08	9	171.5	14.4	9.0	303	198
	P	*10.6*	*0.0*	*10.5-10.6*	*1.0*	*0.1*	*0.9-1.2*	*0.0013*	*0.0000*	*0.003*	*-22.236*	*2.107*	*1.3975*	*-0.1318*	*0.013*	*88.11*	*21*	*1290.5*	*162.4*	*114.0*	*3430*	*2604*
	F	**10.6**	**0.0**	**10.6-10.6**	**1.0**	**0.0**	**0.9-1.1**				**-24.673**	**2.328**										
PA 40	1	9.9	0.1	9.8-10.1	0.9	0.1	0.76-1.1	0.0046	-0.0023	0.0079	-23.104	2.323	4.9712	-0.4844	0.0474	17.18	19	66.3	20.4	18.0	492	124
	2	10.0	0.1	9.9-10.2	1.0	0.1	0.8-1.5	0.0037	-0.0016	0.0071	-22.730	2.266	4.0827	-0.3965	0.0387	14.3	17	99.4	17.3	14.3	459	170
	3	10.1	0.1	10.0-10.2	0.6	0.1	0.4-0.7	0.0029	-0.0008	0.0039	-39.814	3.933	20.2299	-1.9708	0.1924	13.84	16	93.2	16.4	14.1	453	138
	4	9.9	0.0	9.8-10.0	0.8	0.0	0.7-0.9	0.0016	0.0000	0.0022	-28.885	2.911	3.1866	-0.3203	0.0323	10.57	15	128.4	24.7	19.2	693	490
	5	9.7	0.3	9.357-10.1	1.5	0.2	0.9-2.1	0.0300	-0.0190	0.0788	-14.360	1.477	7.9487	-0.7828	0.0776	154.73	16	80.6	32.9	27.4	1005	375
	6	9.9	0.2	9.5-10.4	2.1	0.4	1.3-2.8	0.0433	-0.0457	0.1273	-10.585	1.065	3.9043	-0.3629	0.0340	70.56	16	173.1	31.4	26.8	815	246
	7	9.3	0.2	8.9-9.7	1.1	0.2	0.7-1.5	0.0332	-0.0206	0.0332	-18.330	1.964	10.3757	-1.0270	0.1024	56.9	14	218.5	42.6	37.1	1246	90
	8	9.8	0.2	9.5-10.2	1.6	0.2	1.1-2.1	0.0235	-0.0225	0.0506	-13.413	1.365	4.0688	-0.3836	0.0364	75.41	15	280.6	55.0	48.0	1459	330
	9	9.6	0.3	8.9-10.4	2.3	0.5	1.2-3.4	0.1209	-0.1409	0.2553	-9.156	0.953	5.2010	-0.4744	0.0436	180.34	15	373.4	72.7	60.2	1995	439
	10	10.4	0.1	10.2-10.6	1.8	0.2	1.4-2.2	0.0097	-0.0062	0.0290	-12.763	1.224	1.5895	-0.1458	0.0135	28.91	19	191.4	46.9	43.0	382	174
	11	9.6	0.3	9.0-10.5	1.8	0.3	1.2-2.5	0.0771	-0.0658	0.0943	-11.439	1.197	4.7559	-0.4347	0.0401	18.45	15	143.0	69.0	68.6	284	32
	12	10.6	0.3	10.1-11.2	2.3	0.5	1.2-3.5	0.0703	-0.0798	0.2729	-10.048	0.944	5.7977	-0.5082	0.0449	58.25	13	91.3	46.4	45.0	418	191
	13	9.6	0.1	9.3-9.8	0.8	0.1	0.5-1.0	0.0143	-0.0083	0.0125	-27.744	2.896	18.548	-1.8313	0.1815	5.53	14	72.5	19.2	18.9	603	27
	14	9.4	0.1	9.3-9.6	1.0	0.1	0.8-1.2	0.0045	-0.0035	0.0070	-20.661	2.190	3.3142	-0.3322	0.0334	29.55	17	112.5	73.2	70.0	2120	228
	15	9.7	0.1	9.5-10.0	1.2	0.1	0.9-1.5	0.0149	-0.0106	0.0178	-17.523	1.806	4.2970	-0.4096	0.0393	98.12	18	196.5	150.8	146.3	4082	326
	16	9.3	0.2	8.8-9.8	1.2	0.2	0.7-1.6	0.0484	-0.0321	0.0421	-17.520	1.883	11.4843	-1.1185	0.1097	77.17	15	127.5	67.1	65.5	1830	96
	17	10.0	0.1	9.8-10.1	0.1	0.1	0.6-0.9	0.0038	-0.0008	0.0082	-29.442	2.955	13.0110	-1.2926	0.1287	5.61	16	71.3	26.4	24.9	294	107
	18	9.4	0.2	8.9-9.8	1.4	0.2	0.9-1.9	0.0506	-0.0425	0.0571	-14.866	1.589	8.1788	-0.7830	0.0754	126.69	16	229.8	122.6	118.3	3419	226
	19	9.7	0.1	9.4-10.0	1.1	0.2	0.8-1.4	0.0175	-0.0134	0.0259	-19.344	1.998	9.0288	-0.8768	0.0855	72.31	15	122.5	65.8	63.0	1776	202
	P	*9.7*	*0.1*	*9.6-9.9*	*1.4*	*0.1*	*1.2-1.6*	*0.0076*	*-0.0058*	*0.0125*	*-15.241*	*1.567*	*1.6941*	*-0.1620*	*0.0156*	*630.06*	*24*	*2871.4*	*1000.7*	*72.2*	*23825*	*4011*
	F	**9.8**	**0.0**	**9.8-9.9**	**1.2**	**0.0**	**1.1-1.3**				**-18.575**	**1.897**										
PE 44	*P*	*9.3*	*0.1*	*9.1-9.5*	*1.0*	*0.1*	*0.8-1.2*	*0.0060*	*-0.0025*	*0.0115*	*-20.383*	*2.195*	*5.0209*	*-0.5254*	*0.0553*	*112.66*	*18*	*382.9*	*97.4*	*36.7*	*2162*	*606*

Trol balıkçılığında toplam av oranının boy seçiciliğe etki ettiği ortaya konmuştur (Erickson ve diğ., 1996; Campos ve diğ., 2003; Herrmann 2005). Bu çalışmada ele alınan türler (Barbunya ve ısparoz) toplam avın yaklaşık ¼ ünü oluşturmaktadır. İleriki çalışmalarda diğer türlerin ve toplam avın seçiciliğe olan etkileri araştırılmalıdır. Ayrıca, torba ip materyalinin (Tokaç ve diğ., 2004) ve kalınlığının (Sala, 2007) seçiciliğe etkileri ortaya konmuştur. Bu çalışmada, aynı ip kalınlığına sahip malzeme temin edilemediği için farklı kalınlıktaki torbaların seçiciliği araştırılmıştır. Daha net sonuçlara ulaşmak için aynı ip kalınlığına sahip, farklı şekil büyüklükteki torba ağ gözleri ile denemeler yapılmalıdır.

Sonuç

Bu çalışmada, ele alınan torbalar standart torba (40 mm PE ve torbanın donatıldığı yerdeki oran 1:1) ile karşılaştırıldığında araştırılması yapılan türlerin boy seçiciliği geliştirilmiştir. Bunun yanı sıra Ege denizi trol avcılığında 40'ın üzerinde ticari öneme sahip türün yakalandığı bilinmektedir. Morfolojik özellikleri farklı bu kadar çok türü içinde barındıran balıkçılıkta, bir tür için kabul edilen seçicilik değeri diğer türler için olumsuz sonuçlar verebilmektedir. Bu amaçla ticari trol balıkçılığında tür bazında boy seçiciliğinin yanında tür seçiciliğinin ve balıkların trol ağına gösterdiği davranış çalışmalarının yapılması gerekmektedir.

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8(1): 83-87 (2014) DOI: 10.3153/jfscom.2014010

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

SHORT COMMUNICATION KISA MAKALE

THE FIRST RECORD OF PINK GLASS SHRIMP (*Pasiphaea multidentata*) FROM IN THE GULF OF ANTALYA / TURKEY

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Received: 17.022013 / Accepted: 17.06.2013 / Published online: 28.12.2013

Abstract: A different kind of shrimp species having 10.430 g weight, 45 mm carapace width and 130 mm total length was recognized during shrimp catching with deep sea trawl net. It was identified that this species was Pink Glass Shrimp (*Pasiphaea multidentata*) and there is no record of this specimen in the Gulf of Antalya/ Turkey.

Keywords: First Records, Gulf of Antalya, *Pasiphaea multidentata*

Öz: **Antalya Körfezi'nden Derinsu Pembe Cam Karidesi'nin *(Pasiphaea multidentata)* İlk Kaydı**

Antalya Körfezi'nin derin sularında trolle yapılan karides avcılığı sırasında 10.430 g, karapaks boyu 45 mm ve total boyu 130 mm olan farklı bir karides türü tespit edilmiştir. Bu karidesin yapılan tür tayininde *Derin Su Pembe Cam Karidesi* (*Pasiphaea multidentata*) olduğu ve daha önce bu türün Antalya Körfezi'nden bildirilmediği tespit edilmiştir.

Anahtar Kelimeler: İlk kayıt, Antalya körfezi, *Pasiphaea multidentata*

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Introduction

Trammel and trawl net are used for shrimp catching in the Gulf of Antalya. Deep sea and shallow water trawls are applied in this region, where many kinds of economically important shrimp species are caught. Generally species of Penaeidae family are caught from shallow water between the depths of 0-90 m. These species are *Penaeus semisulcatus*, *P. kerathurus*, *P. japonicus*, *Metapenaeus monoceros* (Gokoglu & Ozden, 1991, Gokoglu & Kaya 2005). Red Sea immigrant *Melicertus hathor* has been harvested from shallow waters (0-40 m) of this region since 2005 (Kaya & Gokoglu, 2005). The first record of this species in Mediterranean Sea was reported by Galil (1998) from the coast of Israel. The habitat of *Melicertus hathor* has expanded and the presence in Aegean Sea was declared (Yokes *et al*. 2007). The other migrant prawn is *Farfantepenaeus aztecus* the depth of 10-90 m in the Gulf of Antalya (Deval *et al*. 2010). Uneconomical *Metapenaeopsis aegyptia* is also caught from the Gulf of Antalya with small net size trammel nets and trawl nets. In addition to this species, Yokes and Galil (2006) reported the presence of *Metapenaeopsis moigensis consobrina* and *Trachysa lambria palaestinensis* in the Gulf of Antalya.

Parapenaeus longirostris, Aristomorpha folicea, Aristeus antennatus, Plesionika edwardsii, Plesionika martia, Parapandalus narval are caught from deeper waters of the Gulf of Antalya (Kaya & Gökoğlu 2005). *Parapenaeus longirostris* is mostly caught from the depths between 60 m and 200 m.

Many researchers such as Polunin *et al.* (2001), Politou *et al.* (2005), Ungaro *et al*. (2005), Fanelli *et al.* (2007) reported the presence of these shrimp species in deep waters of Mediterranean Sea.

A different kind of shrimp species was caught by deep trawl net between the depths of 400-700 m from the Gulf of Antalya. It was identified that this species was Pink Glass Shrimp (*Pasiphaea multidentata*) and there is no record of this specimen in the Gulf of Antalya/Turkey.

This species is a deep-water caridean shirimp living between 200 and 2000 m deep in Mediterranean and Atlantic waters (Gonzalez-Gurriaran and Olaso, 1987). *P. multidentata* undergoes diel vertical migration and predates on gammarids, amphipods and isopods on the bentic boundary layer and is the prey of a variety of decapod crustaceans and fishes (Cartes 1993).

Materials and Methods

The shrimp was collected off Serik depths of 400-700 m within the framework of a monthly sampling program of the trawling grounds of Antalya Bay. Trawling was carried out in stable weather and sea conditions, by the R/V "Akdeniz Su" at an average speed of 2.6 nautical miles/h [approx. 4.7 Km/h] with a conventional bottom trawl (1100 meshes at mouth opening; cod end in polyethylene, mesh opening 44 mm, equipped with a polyamide cover, mesh opening 22 mm).

Figure 1. Study area in the Gulf of Antalya

Results and Discussion

Pasiphaea multidentata

Description

A different kind of shrimp species was caught on 10.01.2012 in the Gulf of Antalya. Its weight: 10.430 g, carapace length: 45 mm. total length: 130 mm. Rostrum is short, slender, and spinous with wide base and inferior margin concave, rising from dorsal carina of the carapace. Pleura of the second abdominal segment are overlapping those of the first and third segment. There are no chelae on the third legs. Basis of leg 2 has 12 spines and immovable finger. Color of the shrimp is pink and semi-transparent. Telson is narrow and has deeply cleft at apex. There are two carinas (spine) on each side of the cephalothorax. The body is laterally compressed (Figure 3 and Figure 4).

The coordinates of the first record in the Levantine was made 35°59'N 28°14'E by Stephensen in 1923 (Galil and Goren 1994). The second record was reported by Galil and Goren (1994).

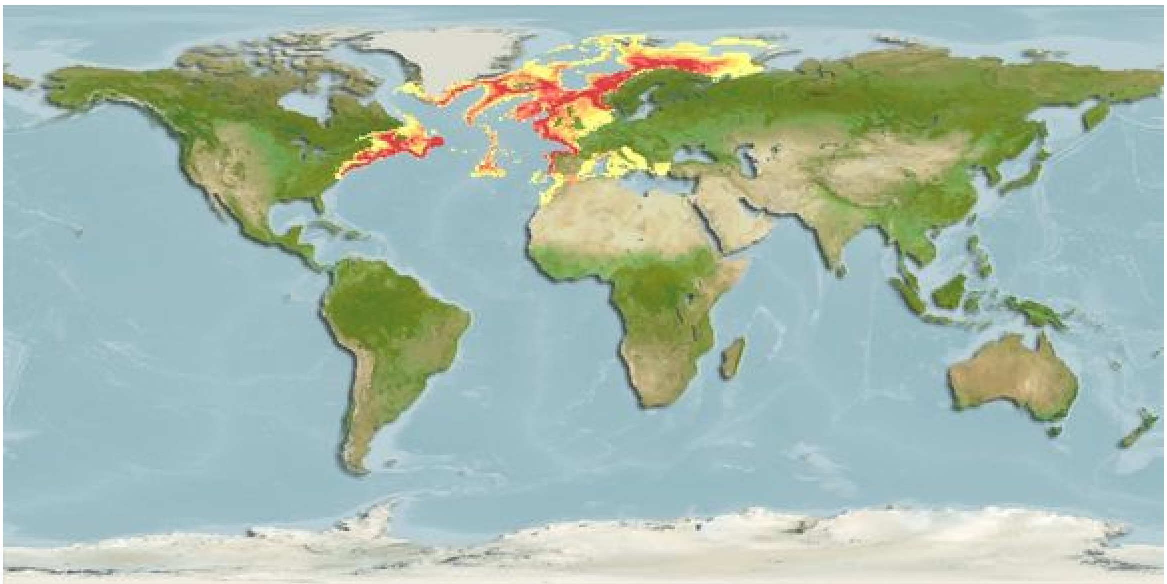

Figure 2. Geographical distribution of *Pasiphaea multidentata* (http://eol.org/pages/311383/overview)

Figure 3. *Pasiphaea multidentata* (from the Gulf of Antalya)

Figure 4. Carapax of *Pasiphaea multidentata* (from the Gulf of Antalya)

The sample is deposited in Akdeniz University, Fisheries faculty museum collection (Crustacean ID: 020).

Conclusion

Atlanto-Mediterranean species has been spatially bio-diversified increasingly with the reoccurrence of the shrimp, *Pasipheae multidentata* in the deep sea zone of in the Gulf of Antalya.

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