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Proceeding Book

Edited by

Cemal Turan

Yakup Kutlu

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Dear Colleagues,

Consisting of selected scientific contributions accepted for publication at the International Next Generation Biometry Workshop, it is a pleasure for us to present you this Proceeding.

Morphological characters have commonly been used in analysis of biological contexts. Researchers often use the arrangements of morphological landmarks in their studies to extract shape information from any biological materials and need to get bio-measurements using any computer aided tools, however, it takes a long time. With the Biomorph, family and species identification of a studied landmark of bio-object are automatically be determined from a digital photograph. The Workshop on Next Generation Biometry with BioMorph is a good opportunity for Graduate, Master, PhD students and Academicians to be expert on morphological analysis and make publications on that.

The papers presented from varied countries and regions at the International Next Generation Biometry Workshop have been peer reviewed by national and international experts which are brought together in the proceeding.

We would like to garefully thank to the supporting organisations (Iskenderun Technical University, Mersin University, Düzce University and Nature and Science Society), organization commity, scientific commity and participants for their insightful and timely contributions.

Yours sincerely,

Cemal Turan and Yakup Kutlu

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International Next Generation Biometry Workshop and Course
04-06 October 2019, İskenderun, Turkey

Session 1: Proceeding Articles

LENGTH-WEIGHT RELATIONSHIPS OF STRIPED PIGGY (*POMADASYS STRIDENS* FORSSKAL, 1775) FROM MERSIN BAY, NORTHEASTERN MEDITERRANEAN SEA

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Abstract

In this study, 538 individuals of *Pomadasys stridens* were caught by commercial trawl in 2018-2019 fishing season from the Mersin Bay, Northeastern Mediterranean Sea. The total length ranged from 7.4 to 24.5 cm and total weight 6.25-83.34 g. The length-weight relationship (LWR) of *P. stridens* was analyzed with BioMorph software.

Keywords: *Pomadasys stridens*, Length-weight relationship, Mersin Bay, Northeastern Mediterranean Sea

Introduction

Many non-indigenous fish species since the opening of the Suez Canal have crossed to Mediterranean Sea and these fish species setup dense population in Turkey's eastern coast (Erguden and Turan, 2013, Turan et al., 2018). The striped piggy, *P. stridens* is among these fish species. It belongs to the Haemulidae family and can be found at depths of 30-68 m in the reef-associated tropical regions (Safi et al., 2014).

Length-weight relationships (LWRs) have been extensively measured in many fish around the world. The LWRs of fish are useful in determining weight and biomass and allowing comparison of species life history, morphological aspects of populations inhabiting different regions, length and age structures and estimating condition factor. It is necessary for the management and protection of fisheries (Goncalves et al., 1997; Kholer et al., 1995; Pauly, 1983, Froese, 1998; Koutrakis and Tsikliras, 2003, Oscoz et al., 2005).

No information is available on LWRs for striped piggy from the Gulf of Mersin. This article provides the first comprehensive description of LWRs of striped piggy from the coast of Mersin.

Material and Methods

In total, 538 individuals of *P. stridens* were collected by commercial trawl in 2018-2019 fishing season from the Mersin Bay (Figure 1, 2). The LWRs of striped piggy were analyzed with BioMorph software (Kutlu & Turan, 2018). All fish samples were immediately carried to the laboratory for analysis on crushed ice. Total length (TL) and weight (W) of striped piggy were measured. The LWRs were $W = TL^b$ (Ricker, 1973), the statistical significance levels of r^2 were estimated, and the relationship parameters a and b were estimated by least-square linear regressions. Exponent b values provides essential information on fish growth. In cases where b is equal to 3, the increase in weight is called isometric. If the b value is greater than 3, there is a positive allometric relationship, and if the value is smaller, the link is named to be negative allometric.

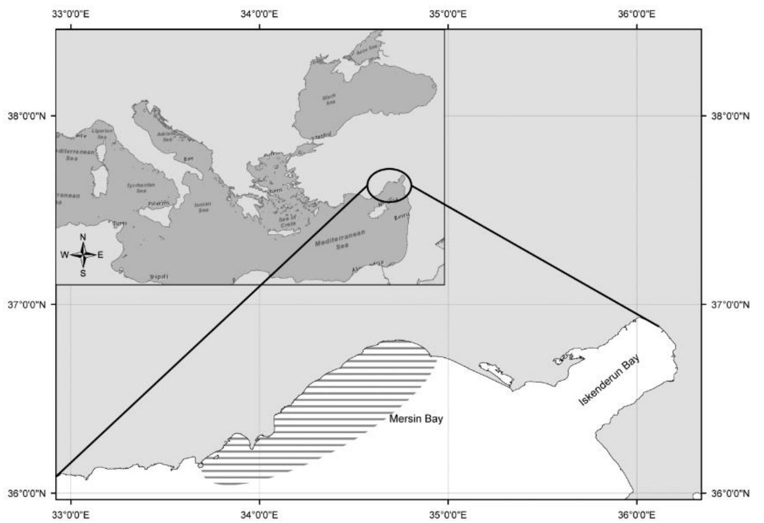

Figure 1. Sampling area

Figure 2. An individual of striped piggy

Results

In total, 538 individuals of *P. stridens* were collected. The estimated parameters of the LWR (a and b), and the determination coefficients (r^2) are given in Table 1.

Table 1. The length-weight relationships for Striped Piggy from Mersin coast of Turkey

		Length (cm)	Weight (g)	Relationship parameters				
Species	**N**	**TL Range**	**W Range**	**a**	**b**	**SE of b**	**95% CI of b**	**r^2**
P. stridens	538	7.4-24.5	625-190	0.0141	2.9822	0.018	2.946-3.019	0.9798

N, sample size; TL, total length; W, total weight; a, intercept; b, slope; r^2, determination coefficients; SE, standard error; CI, confidence interval

In the present study, the b values 2.9822 for *P. stridens* and showed isometric growth. Length–weight curve for striped piggy is plotted in Figure 3.

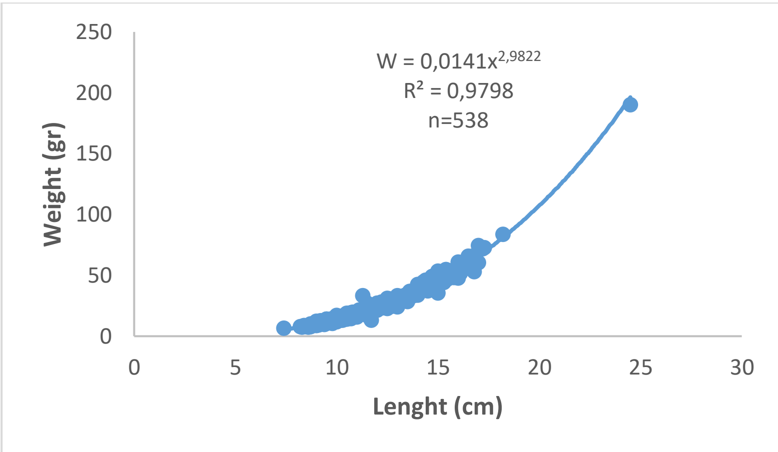

Figure 3. The length-weight relationships for Striped piggy from Mersin coast of Turkey

Table 2 shows the comparison of the length-weight relationships of striped piggy.

Table 2. Comparisons of length-weight relationships for striped piggy

		Relationship parameters					
n	**TL Range (cm)**	**a**	**b**	**r^2**	**Growth Type**	**Country**	**Study**
538	7.4-24.5	0.0141	2.9822	0.9798	I	Turkey	Present study (2019)
125	16.7-63.8	0.01646	3.406	0.974	PA	Turkey	Ergüden et al. (2015)
192	13.8 20.8	0.038887	2.96251	0.9585	NA	Pakistan	Ahmed et al. (2015)
155	5.6-19.8	0.1011	2.73	0.959	NA	Pakistan	Safi et al. (2014)[1]
236	9.9-21.0	0.1023	2.82	0.942	NA	Pakistan	Safi et al. (2014)[2]
201	11.1-23.5	0.000009	3.04	0.890	PA	Iran	Hashemi et al. (2013)
-	-	0.0118	3.000	-	PA	Philippines	Pauly et al. (1998)

n, Sample size; TL, total length; a, intercept; b, slope; r^2, determination coefficientsI: isometric, NA: Negative allometric, PA: positive allometric, Safi et al. (2014)[1] for male, Safi et al. (2014)[2] for female

Negative allometric growth in fish when b value is less than three, positive allometric growth when b value is above three. In our study, the b-values for all individuals are ranging between 2.946 and 3.019. That's why growth type was found to be isometric growth for all individuals of striped piggy. In some similar studies, negative allometric growth was observed for *P. stridens* (Safi et al. 2014, Ahmed et al. 2015). Positive allometric growth for *P. stridens* was observed in some studies by Ergüden et al. (2015), Hashemi et al. (2013), Pauly et al. (1998). The length and weight data collected during the sampling period do not represent a particular season or time of year. That's why, the estimated relationship parameters should be a and b. Various factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques (Bagenal and Tesch, 1978, Karachle & Stergiou, 2008) are known to affect LWRs in fish, and none were considered in this study.

Conclusion

This study provides preliminary information on LWRs of *P.stridens* useful for fisheries biology, sustainable fisheries management and conservation.

Acknowledgements

This study was supported by the Research Fund of Mersin University in Turkey with Project Number: 2017-2-AP2-2353.

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Turan, C., Gürlek, M., Başusta, N., Uyan, A., Doğdu, S., & Karan, S. (2018). A Checklist of the Non-indigenous Fishes in Turkish Marine Waters. *Natural and Engineering Sciences*, 3(3), 333-358.

LENGTH-WEIGHT RELATIONSHIPS OF PUFFERFISH SPECIES (TETRAODONTIDAE BONAPARTE, 1832) FROM MERSIN BAY, NORTHEASTERN MEDITERRANEAN SEA

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Abstract

In this study, four pufferfish species (*Lagocephalus sceleratus, L. spadiceus, L. suezensiz, Torquigener flavimaculosus*) were caught by commercial trawl in 2018-2019 fishing season from the Mersin Bay, Northeastern Mediterranean Sea. In total, 57, 48, 196, 334 individuals of *L. sceleratus, L. spadiceus, L. suezensis, T. flavimaculosus* were collected, respectively. The length-weight relationship (LWR) of four pufferfish species analyzed with BioMorph software.

Keywords: Pufferfish species, Length-weight relationship, Mersin Bay, Northeastern Mediterranean Sea

Introduction

Among the tropical fish species in the Mediterranean, Pufferfish attract attention due to their detrimental effects on economic fish species, fisheries, and public health (Streftaris & Zenetos, 2006; Eisenman et al., 2008). The most common species of Tetraodontidae in the Mediterranean Sea are *Lagocephalus sceleratus* (Gmelin 1789), *Lagocephalus spadiceus* (Richardson 1845), *Lagocephalus suezensis* (Hardy and Gohar 1953), and *Torquigener flavimaculosus* (Hardy & Randall 1983) (Ergüden et al., 2017; Turan et al., 2017).

Length-weight relationships (LWRs) of fish are useful in determining weight and biomass. These measurements allow a comparison of the growth of species in different habitats or regions. This aspect is necessary for the management and protection of fisheries (Froese, 1998; Koutrakis & Tsikliras, 2003; Oscoz et al., 2005).

There is no information on LWRs for pufferfish species from Mersin Bay. This paper provides the first comprehensive description of LWRs of pufferfish species from Mersin coast of Turkey.

Materials and Methods

In total, 57, 48, 196, 334 individuals of *L. sceleratus, L. spadiceus, L. suezensis, T. flavimaculosus* were collected, respectively. All individuals collected from Mersin Bay used to commercial trawl in 2018-2019 fishing season (Figure 1). The length-weight relationships (LWRs) of four pufferfish species were analyzed with BioMorph software (Kutlu & Turan, 2018). All fish samples were immediately carried to the laboratory for analysis on crushed ice. Total length (TL) and weight (W) of all specimens of each pufferfish species were measured. The LWRs were $W = TL^b$ (Ricker, 1973), the statistical significance levels of r^2 were estimated, and the relationship parameters a and b were estimated by least-square linear regressions. With the use of the t-test, the b value for each species was tested at the 0.001 significance level for verifying if significantly different from 3. Exponent b values provides essential information on fish growth. In cases where B is equal to 3, the increase in weight is called isometric. If the B value is greater than 3, there is a positive allometric relationship, and if the value is smaller, the link is named to be negative allometric.

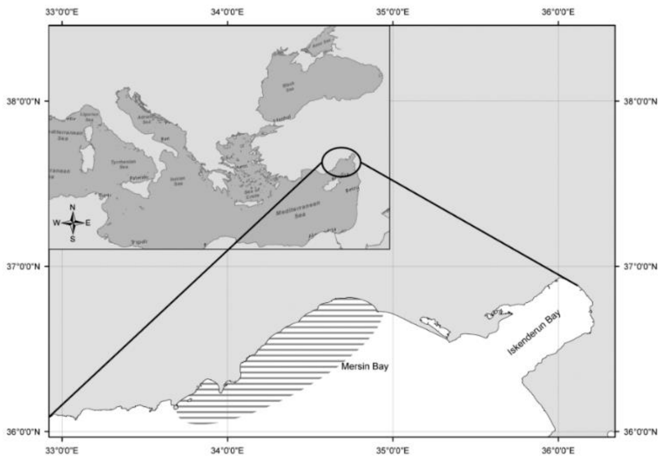

Figure 1. Sampling area.

Results

635 fish specimens representing four species were sampled. Descriptive statistics and length–weight relationship parameters for *L. sceleratus*, *L. spadiceus*, *L. suezensis*, *T. flavimaculosus* caught in the Mersin Bay are given in Table 1.

Table 1. The length-weight relationships for pufferfish species from Mersin coast of Turkey

		Length (cm)	Weight (g)	Relationship parameters				
Species	**N**	**TL Range**	**W Range**	**a**	**b**	**SE of b**	**95% CI of b**	r^2
L. sceleratus	57	9.5-59.0	9.27-2000.0	0.0117	2.9646	0.031	2.902-3.028	0.9938
L. spadiceus	48	10.7-38.5	19.91-702.0	0.0301	2.7637	0.057	2.650-2.877	0.9811
L. suezensis	196	8.0-20.10	5.9-93.26	0.0102	3.027	0.037	2.954-3.100	0.9720
T. flavimaculosus	334	5.9-13.6	3.74-45.0	0.0083	3.3267	0.052	3.224-3.430	0.9238

N, sample size; TL, total length; W, total weight; a, intercept; b, slope; r^2, determination coefficients; SE, standart error; CE, confidence interval

The r^2 values ranged from 0.9238 for *T. flavimaculosus* to 0.9938 for *L. sceleratus*. All regression values were found to be highly significant ($P < 0.001$). In the present study, the b values ranged from 2.7637 for *L. spadiceus* to 3.3267 for *T. flavimaculosus*. *L. sceleratus* and *L. suezensis* showed isometric growth. *L.*

spadiceus showed negative allometric growth, and positive allometric growth seen in *T. flavimaculosus*.

Discussions

Non-indigenous marine fish in Turkish marine waters comprises 101 species of which lessepsian is represented with 89 species (Turan et al., 2018). Pufferfishes are marine fish species that distributed in tropical and subtropical areas of the Atlantic, Indian, and Pacific Ocean. These Lessepsian invasive species have established significant populations along the coasts of Turkey (Mediterranean and Aegean coasts) (Ergüden et al., 2017, Turan et al., 2017). All population characteristics of pufferfish should be known. Length-weight relationship for fish is an essential parameter for fisheries management (Garcia et al., 1989).

The present study was a contribution to our knowledge of length-weight relationships, and of four pufferfish species (*Lagocephalus sceleratus*, *L. spadiceus*, *L. suezensiz, Torquigener flavimaculosus*) from Mersin Bay. Growth type was found to be negative allometric for all individuals of *L. spadiceus*, while it was found to be positive for *T. flavimaculosus*. On the other hand, the growth type of *L. sceleratus* and *L. suezensis* were seen to be isometric in all individuals. The comparison of length-weight relationships of pufferfish species are given in the table below (Table 2).

Table 2. Comparisons of length-weight relationships for pufferfish species

			Length	Relationship Parameters				
Species	N	TL Range (cm)	a	b	r^2	Growth Type	Country	Study
L. sceleratus	57	9.5-59.0	0.0117	2.9646	0.9993	I	Turkey	Present study (2019)
	125	16.7-63.8	0.0164	2.9272	0.9740	NA	Turkey	Bilge et al.. (2017)
	-	5.0-83.0	0.1300	2.9330	0.9960	NA	Egypt	Farrag et al.. (2015)
	28	15.4-52.3	0.1380	2.9150	0.9730	NA	Turkey	Başusta et al.. (2013a)
	49	8.9-78.4	0.0318	2.6450	0.9390	NA	Turkey	Başusta et al.. (2013a)
	94	9.0-72.0	0.0182	2.9240	0.9940	NA	New Caledonia	Kulbicki et al.. (2005)
	67	9.0-71.5	0.0194	2.9040	0.9920	NA	New Caledonia	Letourneur et al.. (1998)
L. spadiceus	48	10.7-38.5	0.0301	2.7637	0.9811	NA	Turkey	Present study (2019)
	117	11.8-27.9	0.0332	2.7315	0.9130	NA	Turkey	Bilge et al.. (2017)
	574	6.8-37.4	0.0388	2.6740	0.8560	NA	Turkey	Başusta et al.. (2013a)
	515	10.6-43.1	0.0343	2.7180	0.8730	NA	Turkey	Başusta et al.. (2013a)
	18	8.7-20.6	0.0206	3.1500	0.9900	PA	China	Wang et al.. (2011)
	89	6.9-26.9	0.0204	2.9010	0.9430	NA	Turkey	Erguden et al.. (2009)

	19	15.9-19.9	0.0186	2.9510	0.9700	NA	Turkey	Taşkavak and Bilecenoğlu (2001)
L. suezensis	196	8.0-20.10	0.0102	3.0270	0.9720	I	Turkey	Present study (2019)
	84	8.6-15.9	0.0213	2.7586	0.8710	NA	Turkey	Bilge et al.. (2017)
	494	6.5-16.7	0.2700	2.6770	0.8320	NA	Turkey	Başusta et al.. (2013b)
	485	7.1-17.1	0.0145	2.9140	0.8830	NA	Turkey	Başusta et al.. (2013b)
	979	6.5-17.1	0.0198	2.7950	0.8580	NA	Turkey	Başusta et al.. (2013b)
	86	10.2-16.7	0.0236	2.7490	0.9570	NA	Turkey	Erguden et al.. (2009)
T. flavimaculosus	334	5.9-13.6	0.0083	3.3267	0.9238	PA	Turkey	Present study (2019)
	28	5.3-10.6	0.0376	2.8363	0.8960	NA	Turkey	Bilge et al.. (2017)
	11	4.8-11.6	0.0403	2.9020	0.9700	NA	Turkey	Erguden et al.. (2015)

N, Sample size; TL, total length; a, intercept; b, slope; r^2, determination coefficients I: isometric, NA: Negative allometric, PA: positive allometric

The b-values in all pufferfish species are ranging between 2.7637 and 3.3267. In all studies, negative allometric growth was seen for *L. sceleratus* except for the present study. Positive allometric growth for *L. spadiceus* was only observed in a study conducted by Wang et al., (2011). Negative allometric growth for *T. flavimaculosus* and *L. suezensis* was observed in all studies except for the present study. In particular, studies in *T. flavimaculosus* show significant differences in growth types. However, negative allometric growth is seen in two of the three studies in the same geography, and positive allometric growth is seen in the other. This species has a relatively small body compared to other species studied. In this case, the more significant the difference between the min-max values of the studied species, the higher the likelihood of a dispute between growth types because juvenile fish and adult fish growth types can vary naturally (Imsland et al., 1996). In studies with *L. spadiceus*, appears to be a significant difference in terms of growth types in Turkey and China. Although genetically identical species are examined; It should be remembered that they are two very distant populations in terms of living area. It is also observed that species belonging to the same species but geographically isolated have gone into speciation in a long time (Polly, 2007).

In all studies for *L. sceleratus*, r^2 values are at least 0.939. Although the results found in *L. spadiceus* are mostly around 0.9, several studies have found values below 0.88. When the studies with *L. suezensis* are examined, it is noteworthy that r^2 value is usually less than 0.9. It was found that *T. flavimaculosus* samples gave the most stable results after *L. sceleratus* samples.

The length and weight data collected during the sampling period do not represent a particular season or time of year. That's why the estimated relationship parameters should be a and b. Various factors, including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques (Bagenal & Tesch, 1978; Karachle & Stergiou, 2008), are known to affect LWRs in fish, and none were considered in this study. As pointed out by Petrakis and Stergiou (1995), the use of the weight–length relationship should be limited to the sizes in the estimation of the parameters. Besides, these differences depend on sample size, fishing equipment, season, fishing pressure and reproduction season, etc.

Conclusions

This study gives preliminary information on LWRs that are useful for fisheries biology, sustainable fisheries management, and conservation.

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APPLICATION OF FOURIER AND TRUSS METHODS FOR OTOLITH SHAPE STRUCTURING OF TURBOT *SCOPHTHALMUS MAXIMUS* POPULATIONS

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Abstract

Fourier and Truss Methods were applied on otolith shapes of Turbot *Scophthalmus maximus* populations. Turbot samples were collected from Bandırma in the Marmara Sea, and Sakarya and Giresun in the Black Sea. Otoliths from these samples were removed and cleaned with glycerol, and images of each otolith were taken with digital camera. Images of each otolith were analysed with BioMorph with Fourier and Measurements applications. The results of both analyzes were in accordance and exhibited that the Marmara Sea (Bandırma) population revealed otolith shape from the West Black Sea (Sakarya) and East Black Sea (Giresun) populations. The Fourier method seems to be more powerful than the otolith Truss method for stock discrimination of turbots.

Keywords: Fourier Shape Analysis, Truss Methods, Otolith, Turbot, *Scophthalmus maximus*.

Introduction

The turbot (*Scophthalmus maximus*; Scophthalmidae) is a flatfish of great commercial value, which has been intensively cultured during the last decade. *S. maximus* live in European water areas, from Northeast Atlantic to the Arctic Circle and commonly found in the Baltic and Mediterranean, as well as in the Black Sea (Turan 2007). There are two more species of the genus Scopthalmus as *Scopthalmus maeoticus* and *Scopthalmus rhombus* for European fisheries and aquaculture (Turan et al., 2016). These three species are closely related congeneric species (Pardo et al., 2005; Turan et al., 2007; Azevedo et al., 2008) which show a similar distributional range (Blanquer et al., 1992; Pardo et al., 2001). One of the most rapidly developing marker for otolith techniques is otolith shape analysis, commonly used for fish population discrimination.

The aim of this study, the utility of Fourier and Truss Methods were evaluated for stock discrimination of Turbot *Scophthalmus maximus* in the Marmara Sea and Black Sea.

Material and Method

Specimens were collected were collected from Bandırma in the Marmara Sea, and Sakarya and Giresun in the Black Sea (Figure 1). Populations were represented by 20 samples, totaling 60 samples.

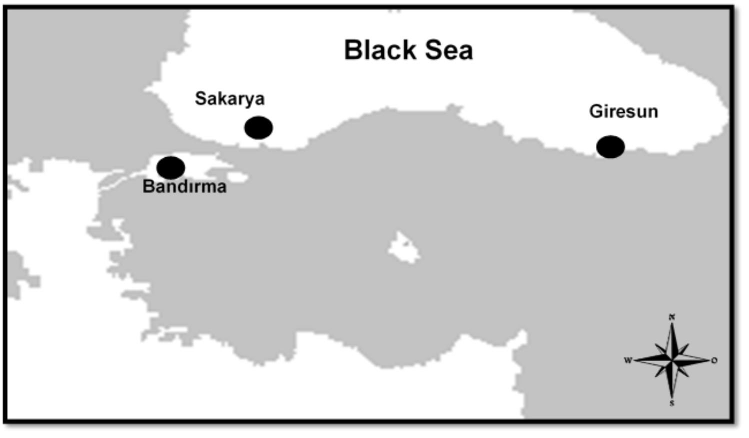

Figure 1. Sampling areas.

Otoliths from these samples were removed and cleaned with glycerol, and images of each otolith were taken with digital camera (Figure 2). BioMorphv3 was used for the Fourier and measurements applications from the images of each otolith relationship images of each individual.

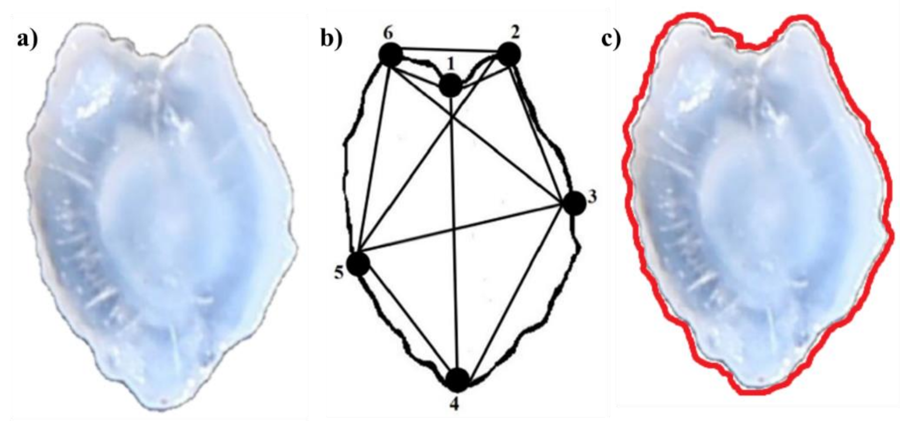

Figure 2. a) Images of *S. maximus* otolith. b) Locations of the six landmarks (●) for constructing the truss network on the *S. maximus* otolith. c) Fourier image.

Results

Fourier

A correct classification of individuals into their original population varied between 20 % and 80 % by discriminant analysis and 69% of individuals could be classified in their correct a priori grouping (Table 1). The proportion of correctly classified the Marmara Sea samples (Bandırma) into their original group was the highest (100 %).

Discriminant function analysis (DFA), 68 % of all samples were correctly classified according to their original group as a result of the numerical and % classification of samples in each population.

Table 1. Classification of samples in each group as their numerical and % as a result of decomposition analysis of otolith.

	Bandırma	**Sakarya**	**Giresun**	**Total**
Bandırma	**20**	0	0	20
Sakarya	0	**16**	4	20
Giresun	6	10	**4**	20
Bandırma	**100 %**	0 %	0 %	100
Sakarya	0 %	**80 %**	20 %	100
Giresun	80 %	10 %	**10 %**	100

A correct classification of individuals into their original population showed the highest classification of the Bandırma with 100 % which indicate that Bandırma population was most distinct population from the other populations.

Truss

A correct classification of individuals into their original population varied between 60 % and 85 % by discriminant analysis and 73 % of individuals could be classified in their correct a priori grouping (Table 2). The proportion of correctly classified the Marmara Sea samples (Bandırma) into their original group was the highest (85 %).

Table 2. Classification of samples in each group as their numerical and % as a result of decomposition analysis of otolith.

	Bandırma	**Sakarya**	**Giresun**	**Total**
Bandırma	**17**	1	2	20
Sakarya	1	**15**	4	20
Giresun	6	2	**12**	20
Bandırma	**85 %**	5	10	100
Sakarya	5	**75 %**	20	100
Giresun	30	10	**60 %**	100

Discussion

Population structure of *S. maximus* from the Marmara and Black Seas were investigated for Fourier and Truss Methods that all analyzes showed similar pattern of differentiation with varying degree which reflect sensivity of the markers for distinguishing different populations.

The results of both analyzes were in accordance and showed that the Marmara Sea (Bandırma) population revealed otolith shape from the West Black Sea (Sakarya) and East Black Sea (Giresun) populations. Karan & Turan (2019) study also investigated the otolith shape of *Scopthalmus maeoticus* and found to be different otolith shape of Marmara Sea populations.

The closed structure of the Marmara Sea and its environmental differences from the Black Sea could generate the detected morphometric and meristic differences of the Marmara population.

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SEX DETERMINATION OF GREEN TURTLE (*CHELONIA MYDAS*) WITH IMAGE ANALYSIS USING BIOMORPH SOFTWARE

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Abstract

One of parameter of population dynamics in sea turtles is knowledge of sex ratio, which is important for the conservation and management of the species. There are different techniques to determine the sex and sex ratio in sea turtles. In order to developed non-destructive alternative techniques for the sex determination and shorten the complicated processes and to be able to detect on live hatchlings, we aimed to develop sex determination based on image analysis in green turtles (*Chelonia mydas*). Four female and four male dead green turtle hatchlings, of which sex was determined by gonad histology, were collected from Yeniyurt beach (Hatay, Turkey) and photographed. The differences between sexes of green turtle hatchlings was tested with BioMorph software which produced 351 landmark measurements from 27 determined landmarks on the carapace of green turtle hatchlings. Univariate analysis of variance revealed that 4 character located on the upper-right side of the carapace were significantly different between sexes. In Principal component analysis (PCA), 7 principal components were produced of which first and second PCs explained 68 % and 8 % of the variation, respectively. Examination of the contribution of each morphometric character to the first PC indicated that the observed differences were mainly from the height and width measurements, demonstrating these characters to be important in the description of the sex specifications. In discriminant function analysis, overall random assignment of individuals into their original population was 50% that 50% of cross-validated grouped individuals of female and male individuals were classified into their original group, respectively.

Keywords: Sex, Green turtle, morphometric, sex determination, BioMorph

Introduction

The differentiation of an embryo as a male or female brings about significant consequences of its life history, behavior, physiology, morphology and adaptability. Identifying sex, which is the richest source of phenotypic variation within the population, is particularly important in ecology, behavior, conservation and genetic studies. Therefore, the factors governing sex development is an important field of study that is at the focus of scientific interest (Mittwoch, 2000; Warner, 2011). Knowing the sex and the sex ratio in sea turtles is a necessary parameter for determining population dynamics within their life history. However, they may be adversely affected by global climate change due to their temperature-dependent sex within their life cycle, which may affect the existing population as well as the future population. The sex ratio of nesting beaches is important for the prediction of the future of them as well as for effective conservation planning because long-term survival depends on both female and male production (Janzen, 1994). There are some different techniques to determine the sex and sex ratio in sea turtles. These techniques are gonadal histology (Yntema & Mrosovsky, 1980; Godfrey & Mrosovsky, 2006), radioimmunoassay to measure testosterone levels in blood or chorioallantoic fluid laparoscopy on live post-hatchlings (Gross et al., 1995), direct observations of the gonads in situ (van der Heiden et al., 1985) or nest temperature and incubation duration, which are indirect techniques (Kaska et al., 1998). However; these techniques require long laboratory processes or sometimes sacrifice animals, which are endangered, and under protection globally. Therefore, it is need to be developed non-invasive alternative techniques for the sex determination.

A different approach to sex determination is that there may be morphological differences between male and female hatchlings that are not seen with the naked eye (Valenzuela et al., 2004). Typically, linear measurements and statistical differences can be demonstrated with these differences between female and male hatchlings (Valenzuela et al., 2004). On the other hand, some researchers have stated that the main reason for sex discrimination in hatchlings is the lack of morphological differences and the lack of a technique used for this (Lubiana & Ferreira-Junior, 2009). Some researchers have obtained clues suggesting that morphological differences between male and female may occur in both classical and geometric morphometry studies in sea turtle hatchlings (Michel-Morfin et al., 2001; Sönmez et al., 2016; Sönmez et al., 2019).

Therefore, we aimed to develop a technique of sex determination based on image analysis of green turtles hatchlings (*Chelonia mydas*) with BioMorph software.

Material and Methods

The research area is Yeniyurt beach in Dörtyol district of Hatay province, which has been recently found and proposed a new green turtle (*C. mydas*) nesting beach (Turan et al., 2019).

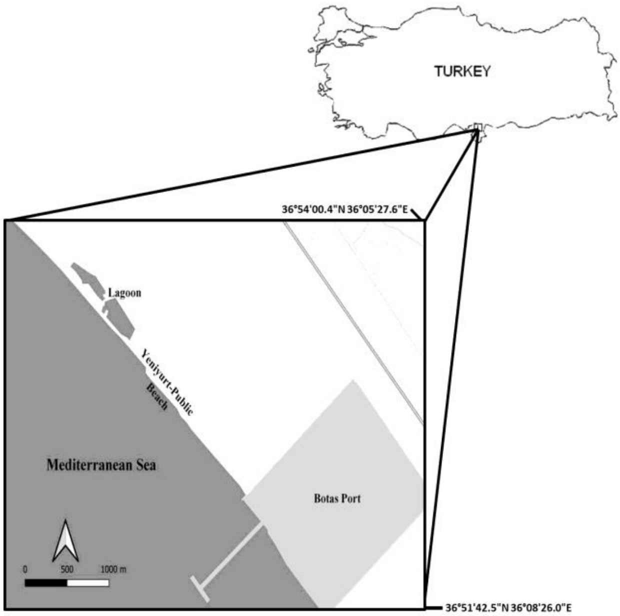

Figure 1. Map of the sampling locations of *Chelonia mydas*

Samples were collected during 2019 nesting season. Dead hatchlings were collected on the way to the sea. Fresh carcasses of hatchlings without any decomposition and bending were chosen in the field. After then, samples were transferred to the laboratory for gonad examine. Firstly, they photographed with a high resolution camera on dorsal view. Later, dead hatchlings were dissected, and their gonads were preserved in 4% buffered para-formaldehyde for gonadal histology. The sex of a hatchling was identified using a microscopic examination of gonad sections by checking the differentiation in gonadal medulla and cortex or the absence of seminiferous tubules (Yntema & Mrosovsky, 1980).

After sex determination with gonad histology, four female and four male dead green turtle hatchlings were used for identification of morphological differences between sexes with BioMorph software (Kutlu & Turan 2018).

Morphological data were generated from each sampled individual photos. Twenty-seven morphometric landmarks were obtained as descriptive on the green turtles' image with the BioMorph (Figure 2).

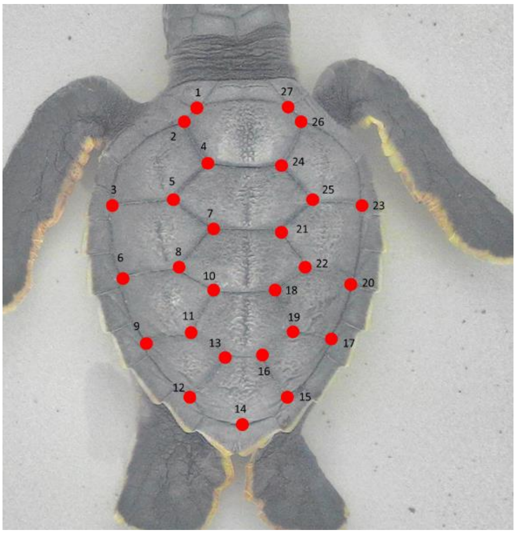

Figure 2. Twenty-seven morphometric landmarks obtained as descriptive on the carapace of *Chelonia mydas.*

In order to determine the biometric measurements, digital photographs from *C. mydas* were taken first, then these images were transferred to the computer from which measurements were made using computer aided software. The landmarks were determined on *C. mydas's* carapace surface on digital photo. In order to eliminate the process of marking manual land marking for each individual, automated predictions of the 27 landmarks were determined by BioMorph (Kutlu & Turan, 2018) for each sample after the first determination of the landmarks on the *C. mydas's* image.

Univariate analysis of variance (ANOVA) was used to test the significance of morphological differences. Created data from the BioMorph were submitted to Principal Component Analysis (PCA) and Discriminant Function Analysis (DFA) using SPSS.

Results

BioMorph produced 351 landmark distance measurements from the combination of 27 determined landmarks on the carapace of green turtle hatchlings. In the Variance Analysis Technique using BioMorph, morphometric characters (22-23, 23-25, 20-25, 20-26) revealed significant differences (P<0.05) between the sexes (Figure 2).

In PCA, 7 principal components were produced of which the first principal components (PC) explained 77% of morphometric variation and the second principal component explained 5% of morphometric variation (Table 1).

Table 1. Distribution of variance explained for each component by principal components analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	241.628	68.840	68.840	241.628	68.840	68.840
2	31.059	8.849	77.689	31.059	8.849	77.689
3	26.107	7.438	85.127	26.107	7.438	85.127
4	18.473	5.263	90.390	18.473	5.263	90.390
5	14.047	4.002	94.392	14.047	4.002	94.392
6	12.059	3.436	97.827	12.059	3.436	97.827
7	7.626	2.173	100	7.626	2.173	100

Examination of the contribution of each morphometric character to the first PC indicated that the characters such as 14_27, 6_20, 1_14, 14_26, 5_15, 1_15 have high loadings to the first PC (Table 2).

Table 2. Loadings of first principal component of morphometric characters. Variables were ordered by size of contribution to the differentiation.

Landmark	PC 1	Landmark	PC 1	Landmark	PC 1	Landmark	PC 1	Landmark	PC 1
14_27	0.992	**7_11**	0.966	**16_27**	0.917	**3_9**	0.850	**6_8**	0.686
6_20	0.990	**3_13**	0.966	**13_27**	0.915	**5_8**	0.850	**20_22**	0.684
1_14	0.988	**4_13**	0.966	**2_12**	0.914	**7_17**	0.848	**10_17**	0.683
14_26	0.987	**15_27**	0.965	**8_13**	0.913	**5_18**	0.848	**4_7**	0.681
5_15	0.987	**16_24**	0.962	**13_24**	0.912	**5_10**	0.848	**9_11**	0.681
1_15	0.987	**15_24**	0.962	**1_18**	0.912	**9_14**	0.847	**4_23**	0.681
5_14	0.987	**14_20**	0.961	**14_19**	0.911	**22_24**	0.846	**10_21**	0.677
9_25	0.987	**5_19**	0.960	**10_23**	0.910	**13_17**	0.845	**11_12**	0.672

2_14	0.986	**10_24**	0.960	**1_11**	0.907	**4_22**	0.844	**8_11**	0.668
3_14	0.985	**14_23**	0.959	**3_10**	0.907	**19_21**	0.842	**9_13**	0.667
6_14	0.985	**11_27**	0.958	**18_25**	0.906	**17_18**	0.841	**6_11**	0.665
15_25	0.984	**1_17**	0.958	**15_19**	0.906	**14_15**	0.840	**9_16**	0.662
6_25	0.984	**8_15**	0.957	**15_22**	0.905	**7_27**	0.840	**5_7**	0.659
9_20	0.982	**19_26**	0.956	**6_10**	0.905	**14_17**	0.838	**7_10**	0.651
14_25	0.981	**15_23**	0.955	**6_24**	0.904	**17_21**	0.837	**8_21**	0.642
2_13	0.981	**4_15**	0.955	**1_16**	0.903	**16_23**	0.835	**20_26**	0.637
18_24	0.981	**12_27**	0.954	**16_25**	0.902	**19_23**	0.835	**4_21**	0.636
1_19	0.980	**5_13**	0.954	**7_12**	0.902	**20_24**	0.833	**10_11**	0.630
3_16	0.979	**2_21**	0.953	**5_12**	0.898	**2_4**	0.831	**7_24**	0.628
4_14	0.978	**11_20**	0.953	**5_6**	0.897	**22_27**	0.827	**13_19**	0.627
2_15	0.978	**6_26**	0.951	**10_26**	0.896	**4_18**	0.827	**10_12**	0.624
3_19	0.977	**8_23**	0.951	**12_26**	0.895	**8_9**	0.826	**2_24**	0.623
15_26	0.976	**5_20**	0.951	**10_14**	0.892	**18_21**	0.826	**5_24**	0.621
3_15	0.976	**11_26**	0.950	**2_10**	0.891	**3_4**	0.825	**21_23**	0.617
4_16	0.976	**5_26**	0.949	**6_18**	0.890	**1_8**	0.825	**1_4**	0.614
6_23	0.975	**2_23**	0.948	**7_19**	0.889	**4_8**	0.821	**1_24**	0.612
3_26	0.975	**9_10**	0.948	**1_23**	0.888	**7_25**	0.820	**25_27**	0.574
9_27	0.975	**15_20**	0.948	**2_9**	0.888	**3_6**	0.818	**12_14**	0.567
3_20	0.975	**7_13**	0.947	**3_12**	0.887	**6_12**	0.816	**23_25**	0.562
6_19	0.974	**5_9**	0.946	**12_25**	0.886	**17_20**	0.815	**2_5**	0.561
6_16	0.972	**9_26**	0.945	**13_25**	0.885	**4_10**	0.814	**8_18**	0.557
6_15	0.971	**9_22**	0.945	**3_18**	0.885	**5_22**	0.814	**11_16**	0.547
6_13	0.971	**6_22**	0.943	**2_7**	0.884	**4_20**	0.811	**4_27**	0.520
9_23	0.970	**14_21**	0.942	**9_19**	0.883	**11_17**	0.811	**13_16**	0.211
7_14	0.970	**3_22**	0.942	**12_20**	0.883	**8_19**	0.805	**10_22**	0.541
2_16	0.970	**2_20**	0.942	**14_18**	0.882	**1_10**	0.799	**2_27**	0.472
6_27	0.970	**2_17**	0.942	**13_21**	0.882	**11_21**	0.798	**1_27**	0.506

2_19	0.968	**14_22**	0.940	**23_24**	0.881	**17_23**	0.797	**20_23**	0.503
3_23	0.968	**10_20**	0.940	**8_27**	0.881	**5_27**	0.796	**8_22**	0.541
14_24	0.967	**7_15**	0.939	**9_17**	0.881	**12_24**	0.796	**13_18**	0.595
7_11	0.966	**8_20**	0.939	**20_21**	0.881	**1_21**	0.795	**16_18**	0.482
3_13	0.966	**8_26**	0.939	**3_7**	0.879	**2_25**	0.794	**1_3**	0.317
4_13	0.966	**19_24**	0.938	**12_23**	0.878	**5_25**	0.789	**9_12**	0.452
15_27	0.965	**11_25**	0.938	**5_21**	0.877	**2_3**	0.788	**26_27**	0.553
16_24	0.962	**8_14**	0.937	**2_22**	0.876	**16_22**	0.786	**12_18**	0.441
15_24	0.962	**7_23**	0.937	**6_21**	0.875	**7_8**	0.785	**1_5**	0.272
14_20	0.961	**11_23**	0.936	**14_16**	0.875	**8_24**	0.780	**10_18**	-0.13
5_19	0.960	**10_25**	0.935	**16_20**	0.875	**1_22**	0.773	**24_27**	0.448
10_24	0.960	**16_21**	0.935	**2_8**	0.874	**1_6**	0.771	**12_13**	0.022
14_23	0.959	**6_17**	0.935	**4_6**	0.874	**12_17**	0.770	**11_18**	0.404
11_27	0.958	**3_25**	0.934	**7_16**	0.874	**20_27**	0.769	**21_22**	0.499
1_17	0.958	**8_17**	0.934	**4_12**	0.872	**18_19**	0.769	**21_25**	0.427
8_15	0.957	**13_15**	0.933	**13_20**	0.872	**20_25**	0.761	**10_19**	0.631
19_26	0.956	**5_17**	0.932	**18_23**	0.872	**11_19**	0.758	**24_26**	0.399
15_23	0.955	**9_24**	0.932	**17_27**	0.872	**9_18**	0.757	**10_16**	0.414
4_15	0.955	**19_25**	0.932	**3_27**	0.870	**13_14**	0.755	**16_19**	0.558
12_27	0.954	**1_20**	0.931	**22_25**	0.870	**22_26**	0.755	**15_17**	0.405
5_13	0.954	**2_18**	0.931	**4_9**	0.870	**3_8**	0.751	**21_26**	0.513
2_21	0.953	**19_27**	0.929	**18_26**	0.870	**11_13**	0.750	**4_5**	0.443
11_20	0.953	**17_24**	0.928	**3_24**	0.869	**1_7**	0.750	**24_25**	0.465
6_26	0.951	**5_23**	0.928	**10_27**	0.868	**2_26**	0.748	**4_24**	-0.03
8_23	0.951	**18_20**	0.926	**7_21**	0.868	**7_22**	0.745	**4_26**	0.502
5_20	0.951	**9_15**	0.925	**3_11**	0.867	**22_23**	0.741	**17_19**	0.541
11_26	0.950	**3_21**	0.925	**10_13**	0.866	**12_21**	0.735	**8_10**	0.506
5_26	0.949	**2_6**	0.924	**13_23**	0.866	**16_17**	0.734	**1_2**	-0.41
2_23	0.948	**2_11**	0.924	**10_15**	0.865	**11_22**	0.724	**12_15**	0.603

9_10	0.948	**3_17**	0.923	**7_26**	0.864	**13_22**	0.718	**12_19**	0.513
15_20	0.948	**16_26**	0.922	**3_5**	0.864	**1_26**	0.716	**4_25**	0.412
7_13	0.947	**4_11**	0.922	**1_9**	0.863	**17_22**	0.715	**12_16**	0.237
5_9	0.946	**7_20**	0.921	**9_21**	0.862	**21_24**	0.710	**25_26**	0.093
9_26	0.945	**5_16**	0.921	**6_7**	0.862	**8_12**	0.710	**23_26**	0.540
9_22	0.945	**15_21**	0.920	**7_9**	0.861	**23_27**	0.709		
6_22	0.943	**11_15**	0.919	**4_17**	0.861	**21_27**	0.705		
14_21	0.942	**1_13**	0.919	**17_25**	0.860	**7_18**	0.704		
3_22	0.942	**5_11**	0.919	**17_26**	0.859	**18_22**	0.703		
2_20	0.942	**15_18**	0.918	**11_24**	0.859	**8_16**	0.696		
2_17	0.942	**13_26**	0.918	**19_20**	0.859	**19_22**	0.695		
14_22	0.940	**1_12**	0.917	**18_27**	0.857	**6_9**	0.693		
10_20	0.940	**4_19**	0.917	**15_16**	0.857	**12_22**	0.690		
7_15	0.939	**11_14**	0.917	**8_25**	0.851	**1_25**	0.690		

In discriminant function analysis, overall random assignment of individuals into their original population was 50% that 50% of cross-validated grouped individuals of female and male were classified into their original group.

Table 3. Cross-validated grouped individuals of populations classified into its original group.

			Predicted Group Membership		
		Gender	**Female**	**Male**	**Total**
Cross-validated	Count	Female	2	2	4
		Male	2	2	4
	%	Female	50	50	100
		Male	50	50	100

Discussion

Traditional classical morphology and geometric morphology tests have been used to determine the morphological differences between female and male turtles (Michel-Morfin et al., 2001; Valenzuela et al., 2004; Lubiana & Ferreira-Junior, 2009; Delgado et al., 2010; Türkecan, 2010; Ceballos & Valenzuela, 2011;

Ferreira Junior et al., 2011; Sönmez et al., 2016; 2019). The geometric morphometry test, which gives more accurate results than traditional classical morphology, has been successful in determining the sex among non-sea turtle species (Valenzuela et al., 2004; Lubiana & Ferreira-Junior, 2009; Ceballos & Valenzuela, 2011). However, this test was tried on green turtle and it was failed results (Sönmez et al., 2019). On the other hand, in the *Caretta caretta*, the difference between the sexes was demonstrated by geometric morphometry (Türkecan, 2010; Ferreira Junior et al. 2011). However, in these studies, sex was indirectly defined by using incubation time and distance from nest to the sea to differentiate between male and female hatchlings. In the present study, the sexes were determined directly by gonad histology and the possible differences between male and female hatchlings were first revealed by image analysis in BioMorph software.

Significant morphometric variation was detected between individuals of female and male *C. mydas* from the Yeniyurt beach in the present study. The detected pattern of morphometric differences gives promises for further analysis with high number of individuals. Examination of the contribution of each morphometric character to the first PC indicates that the observed differences were mainly from the height and width measurements, demonstrating these characters to be important in the description of the sex specifications. Variance analysis techniques revealed that 4 character located on the upper-right side of the carapace were significantly different between sexes which also gives promises for further analyses with high sample size.

In conclusion, the landmark based morphometric measurements with highly increased number of measurements give promises on the sex determination based on image analysis of the carapace of green turtle hatchlings with BioMorph software.

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LENGTH-WEIGHT RELATIONSHIP AND FULTON'S CONDITION FACTOR OF ALBURNOIDES COSKUNCELEBII IN ASARSUYU STREAM (DÜZCE, TURKEY)

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Abstract

The length-weight relationship (LWR) is an important tool in fish biology, ecology and fisheries management, while the condition factor is a quantitative parameter of the state of well-being of a fish. The aim of the present study is to provide information about growth model and condition of *A. coskuncelebii* population living in Asarsuyu Stream which is moderately polluted stream in Düzce. A total of 295 fish specimens were caught by electrofishing from July 2018 to June 2019. The coefficient *b* of the LWR was 3.35 in females and 3.18 in males. These values suggest positive allometric growth for both males and females. There was a statistically significant difference in the slope of LWR regressions between the sexes (Student's *t*-test, $t = 12.63$, $P < 0.05$). Fulton's condition factors were estimated as 1.055 for females, 1.039 for males. This results provides information which can be useful for fishery biologists in developing conservation plan of the species through habitat protection.

Keywords: *Alburnoides coskuncelebii*, spirlin, length-weigh relationship, condition factor, Asarsuyu Stream, Büyük Melen River Basin

Introduction

The length-weight relationship (LWR) is an important tool in fish biology, ecology and fisheries management, while the condition factor (*K*) is a quantitative parameter of the state of well-being of a fish (Wooton, 1990). The relationships between body weight and length of fish are important for converting length observations into weight estimates (Froese, 2006), for estimating growth rates and biomass from length frequency data (Petrakis and Stergiou, 1995; Goncalves et al., 1997). Additionally, these relationships contribute to the comparison of life history and morphological aspects of populations between different regions of the same country (Bibak et al., 2012). Although length-weight relationships (LWRs) and condition factor can easily obtained, such relationships are still scarce for many species.

The genus *Alburnoides* is represented by several species which are widely distributed in the freshwater ecosystems in Europe, the Caucasus, Anatolia and Central Asia (Kottelat&Freyhof, 2007). Recently, 12 species of the genus *Alburnoides* were identified from Turkey: *Alburnoides symrnae, A. tzanevi, A. coskuncelebiii, A. fasciatus, A. eichwaldii, A. manyasensis, A. emineae, A. velioglui, A. diclensis, A. kosswigi, A. freyhofi, A. kurui* (Bektaş et al., 2019). *A. coskuncelebii* is newly described species from the Büyük Melen River in the Southern Black Sea Basin (Bektaş et al., 2019) (Figure 1).

Alburnoides spp. are small-sized cyprinid fish, and they inhabit fast flowing, well-oxygenated, clear waters with a low tolerance to pollution and due to its low tolerance, it is considered as a biological indicator of environmental quality (Kottelat&Freyhof 2007; Patimar et al. 2012; Abbasi et al. 2013). Since it has no commercial value, there is limited information about life-history traits about many *Alburnoides* species including *A. coskuncelebii*. The aim of this study is to reveal LWR and Fulton's condition factor of *A. coskuncelebii* in Asarsuyu which is a moderately polluted stream in Büyük Melen River Basin.

Figure 1. *Alburnoides coskuncelebii* (Photo: Ş.G. Kırankaya)

Materials and Methods

Asarsuyu Stream is one of the tributaries of Melen River located in the Western Black Sea Region in Turkey. It has been exposed to intensive industrial activities as well as agricultural run-off and urban discharges. Ichthyofauna of the stream consists of *Squalius pursakensis*, *Barbus tauricus*, *Alburnoides coskuncelebii*, *Rhodeus amarus*, *Alburnus derjugini*, *Gobio baliki*, *Cobitis splendens*, *Oxynoemacheilus banarescui*, *Gambusia holbrooki* (Saruhan&Kırankaya, 2019).

A. coskuncelebii specimens were collected using electrofishing from Asarsuyu Stream (Figure 2) between July 2018 and June 2019. Fish specimens were anesthetized using MS222, preserved in 4% formaldehyde solution and then transported to the laboratory for further analysis. Total length (*TL*) was measured to the nearest 0.05 mm, and weight (*W*) was measured to the nearest 0.001 g. The length-weight relationships (LWRs) were determined using linear regression analysis (Le Cren, 1951). *Log*-transformed data were used to establish the LWR. The parameters *a* and *b* were calculated using least-squares regression. Fulton's condition factor (K) was calculated using the equation $K = (W/ L^3) \times 100$, where W is total body weight (g) and L is total length (cm) (Ricker, 1975).

Both comparison of the slopes of the length-weight regression between sexes and variation in coefficient *b* from 3 were tested using Student's *t*-test (Zar, 1999). ANOVA I was used to determine if *K* differed significantly between sexes (Zar, 1999).

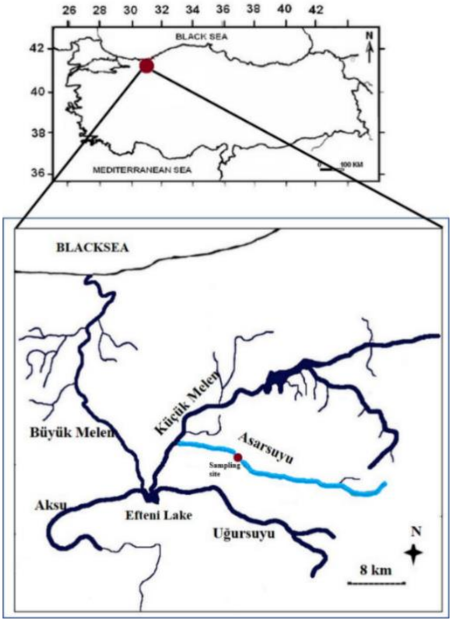

Figure 2. Melen River Basin and sampling site on Asarsuyu Stream (modified from Saruhan&Kırankaya, 2019)

Results and Discussion

A total of 295 specimens (146 females, 137 males and 12 juveniles) were examined during the study period. The *b* exponent of the LWRs was found as for 3.18 males, 3.35 for females (Table 1). There was a statistically significant difference in the slope of LWR regressions between females and males (Student *t* test, t = 12.63, P <0.05). Therfore, the difference in the LWR between sexes can be accepted as the significant influence of the sex on relative weight. The LWR exponent *b* was often a value close to 3; value of 3 indicates isometric growth and values other than 3 indicate allometric growth (Tesch, 1971). In the present study, positive allometry (b>3) was observed in the population (Table 1). Although no information about the LWRs of other populations of this species was reported, it would be appear that isometric and positive allometric growth seem to be common in the genus *Alburnoides* (Treer et al., 2008; Erk'akan et al., 2014; Mousavi-Sabet et al., 2016; Mousavi-Sabet et al., 2017; Saç et al., 2017).

Table 1. Estimated parameters of the LWR for *A. coskuncelebii* (N: Number of individuals, r^2: coefficient of determination, a and *b*: the parameters of the length-weight relation, SE: standard error)

		Total Length (mm)		**Parameters of The LWR**					
	N	**Min**	**Max**	**a**	**SE(a)**	***b***	**SE(*b*)**	**r^2**	**t-value**
Female	146	78.91	117.51	-2.296	0.0481	3.355	0.053	0.9642	6.48*
Male	137	76.39	111.52	-2.151	0.0687	3.187	0.077	0.9252	2.25*
Total	295	28.4	117.51	-2.182	0.0329	3.227	0.037	0.9621	6.1*

*Exponent *b* differed significantly from 3.

The mean condition factor (*K*) was 1.055 for females and 1.039 for males (Table 2). A similar somatic condition was as 1.055 for females and 1.039 for males (Table 2). Variations in *K* between sexes were not statistically significant. The mean condition factor was calculated as 0.94 for *A. tzanevi* (Saç et al., 2017), 0.890 for *A. eichwaldi* (Zamani Faradonbeh et al., 2015), 0.76-2.76 for *A. samiii* (Mousavi-Sabet et al., 2016) and 0.85-1.00 for *A. bipunctatus* (Treer et al., 2006). Spatial and temporal differences in the condition factor have been considered indicative of various biological features, such as fatness or environmental conditions such as water temperature, habitat and food availability (Le Cren, 1951; Wootton, 1990; Blackwell et al. 2000).

Table 2. Fulton's condition factor (*K*) for *A. coskuncelebii* (Min: minimum, Max: maximum, SD: Standard deviation)

	Min	**Max**	**Mean (±)SD**	**ANOVA**
Female	0.624	1.471	1.055(±) 0.140	F=1.004
Male	0.812	1.471	1.039(±) 0.128	p> 0.05

Total	0.625	1.518	1.048(±) 0.138

In conclusion, this study provides basic information on LWRs and condition factor of new identified species, and the obtained information can be useful for fishery biologist in order to develop conservation strategies for this species through habitat protection.

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A PRELIMINARY STUDY ON LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *COBITIS SPLENDENS* IN ÇAYAĞZI STREAM, DÜZCE-TURKEY

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Abstract

Splendid spined loach, *Cobitis splendens* Erk'akan, Atalay-Ekmekçi & Nalbant, is an endemic loach species distributed throughout the Anatolian Blacksea watersheds. This study describes the preliminary results of length-weight relationship (LWR) and Fulton's condition factor of *C. splendes* in its native habitat. Totally 135 fish specimens were caught using a dip net with 1 mm mesh size. Fish samples were anesthetized using MS222 in order to measure total length and body weight, and all specimens were released back into the stream. The *b* values in the LWR were estimated as 3.39, and the coefficient of determination (r^2) is 0.98. Students's *t*-test results indicated that the *b* value deviated from 3 and positive allometric growth was observed for *C. splendens*. Mean Fulton's condition factor was 0.57±0.07. The somatic condition shown similar pattern during spring and summer. Furher studies are planned to reveal growth properties of *C. splendens* in Çayağzı Stream.

Keywords: *Cobitis splendens*, length-weight relationship, endemic fish, Fulton's condition factor.

Introduction

The genus *Cobitis* includes short-lived, small benthic freshwater fish with a large distribution area in north-west Africa and most of Eurasia. It is a Palaearctic genus of ray-finned fish of the family Cobitidae (Halacka& Pekárik, 2015). The genus *Cobitis* is represented by more than 200 species (Froese&Pauly, 2019), 20 of which are in Turkey, and with many endemic to Anatolia (Erk'akan et al., 2008). *Cobitis splendens* (Figure 1) is an endemic loach distributed throughout western Blacksea Region in Turkey (Freyhof et al., 2018). Although it is included in the IUCN Red List as Critically Endangered (CR) due to some threats such as habitat loss, pollution, water abstraction, there is no information about life history-traits of *C. splendens* (Froese&Pauly, 2019).

Figure 1. *Cobitis splendens* (Photo: Ş.G. Kırankaya)

Length–weight relationships (LWRs) are important for fisheries biologists, since it provides information about the structure and function of fish populations (Lemma et al., 2015). Additionally, condition factor is accepted as an indicator reflecting the interactions between biotic and abiotic factors to the physiological condition of fish (Lemma et al., 2015).

In this study, it is aimed to described the length-weight relationship (LWR) and condition factor (*K*) of *C. splendens* and provide useful information for developing conservation plan of this species in its native habitat.

Materials and Methods

Fish specimens were collected from Çayağzı Stream (41° 5'0.80"N, 31°13'45.09"E) in Akçakoca (Düzce). Monthly sampling was performed between March and August 2019, using a dip net with 1 mm mesh size. Fish samples were anesthetized with MS222 in order to measure total length and body weight, and after measurements all specimens were released back into the stream. Total length (*TL*) was measured to the nearest 0.05 mm, and weight (*W*) was measured to the nearest 0.001 g. Linear regression analysis were used to determine the relationship between total length and body weight via log-transformed data. The parameters *a* and *b* of the length-weight relationship (*LWR*) were estimated using least-squares regression method suggested by Le Cren (1951). The null hypothesis of the isometric growth was tested with the Student's *t*-test (Zar, 1999). Fulton's condition factor (*K*) was calculated based on the equation $K = (W10^5 / L^3) \times 100$ (Ricker, 1975). ANOVA I was used to test if K differed significantly between seasons (Zar, 1999).

Result and Discussion

In total, *C. splendens* 135 specimens were collected from Çayağzı Stream. Length range, *LWR* parameters *a* and *b*, regression statistics of *LWR* and the coefficient of determination (r^2) of specimens are given in Table 1. The *b* value was estimated as 3.39 for *C. splendens*. The LWR exponent *b* varies between 2 and 4; value of 3 indicates isometric growth and values other than 3 indicate allometric growth (Tesch, 1971). Students's *t*-test results indicated that the *b* value significantly deviated from 3 and positive allometric growth was observed for *C. splendens*. It means growth in weight was faster than in length. Erk'akan et al. (2014) also reported positive allometric growth for *C. splendens* from Boğazköy Creek in Bartın. The estimated *b* value of *C. splendens* in the present study was similar to reports about other *Cobitis* species (Robotham, 1981; Przybylski&Valladolid, 2000; Ritterbusch&Bohlen, 2000; Ekmekçi&Erk'akan, 2003; Zanella et al., 2003).

Table 1. Estimated parameters of the LWR for *Cobitis splendens* (N: Number of individuals, r^2: coefficient of determination, a and *b*: the parameters of the length-weight relation, SE: standard error)

N	Total Length (mm)		Parameters of LWR					*t*-value
	Min	**Max**	***a***	**SE(*a*)**	***b***	**SE(*b*)**	**r^2**	
135	37.35	99.79	-2.5604	0.029	3.3924	0.0363	0.985	10.83*

* Exponent *b* differed significantly from 3

Mean Fulton's condition factor was calculated as 0.57 for *C. splendens* samples (Table 2). Somatic condition was significantly different between spring and summer seasons (ANOVA I, $F = 11.312$, $p < 0.05$). The somatic condition reflects seasonality, and is related to feeding and reproduction. The condition factor range values observed in the present study are similar to those given for *Cobitis* in Europe (Ritterbusch&Bohlen, 2000; Eros, 2003; Zanella et al., 2003; Ivelic et al., 2007).

Table 2. Fulton's condition factor for *Cobitis splendens* (N: Numbers of specimens, Min: minimum, Max: maximum, SD: Standard deviation)

	N	Min	Max	Mean ± SD
Spring	100	0.43	0.80	0.58±0.08
Summer	35	0.44	0.63	0.54±0.05
Total	135	0.43	0.80	0.57±0.07

Both LWR and K could be indicative of spatial and temporal variations of environmental conditions such as water temperature, habitat and food availability (Wootton, 1990; Blackwell et al. 2000). The results of this ongoing study provide important information that can contribute to enlightening the bilogical properties of the threatened endemic fish species and use for developing conservation plan of the species.

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Session 2: Abstracts for Oral Presentations

BIOMETRIC RELATIONSHIPS BETWEEN BODY AND OTOLITH MEASUREMENTS OF COMMON PANDORA *PAGELLUS ERYTHRINUS* (LINNAEUS, 1758) IN ANTALYA BAY

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Abstract

In this study, relationships between the length of otoliths (sagittae) and the body size of common pandora in Antalya Bay were investigated. A total of 537 common pandora individuals were collected by bottom trawl with monthly intervals between July 2016 and June 2017. Total Length measurements were ranged from 65 mm to 238 mm, with an average total length of 147.48 ± 33.53 (SD) mm. 81% of the fish samples were female and the smallest was 65 mm, the largest was 195 mm while the mean total length was 137.55±28.55 (SD) mm. Since the common pandora is a hermaphrodite protogynous fish, only 19% of the specimens were male and the smallest one was 165 mm, the largest one 238 mm, mean total length was 189.86± 14.96 (SD) mm. The relationships between total length (TL)-otolith length (OL) and total length (TL)-otolith weight (OW) were analysed. More robust relationship was found between TL and OL for females TL=23.09+16.41*OL (R^2=0.75) than males TL=114.82+7.97*OL (R^2=0.40). However, TL-OW relationships were quite similar and TL=88.02+1284.04*OW (R^2=0.83) for females and TL= 141.30+541. 27*OW (R^2=0.72) for males.

Keywords: Antalya Bay, Common Pandora, Total Length, Otolith Length, Otolith Weight.

OTOLITH BIOMETRY-TOTAL LENGTH RELATIONSHIPS OF ATLANTIC STARGAZER (*URANOSCOPUS SCABER* LINNAEUS, 1758) CAPTURED FROM NORTHEASTERN MEDITERRANEAN

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Abstract

Atlantic stargazer, *Uranoscopus scaber* is caught in large numbers by bottom trawl but has minor commercial value in Turkey. This study provides the first information on the otolith biometry-fish length relationships of *U. scaber* inhabiting Iskenderun Bay, northeastern Mediterranean Sea. Fish specimens were captured by commercial trawler at a depth of 80 to 100 m from the Iskenderun Bay (Hatay, Turkey) between May 2015 and June 2016. A total of 150 fish specimens (67 females and 83 males) were collected. Mean lengths were 17.21 cm in the all individuals, 18.67 cm in the females and 16.04 cm in the males; mean weights were 89.61 g in the whole population, 115.59 g in the females and 66.78 g in the males. The difference of the total length and weight between the female and male fishes was not statistically significant (P>0.05). The relationships among total length-otolith length and total length-otolith breadth and total length-otolit weight were as y=0.4173x+0,2048 (R^2=8617), y=0,1923x+0,6715 (R^2=7186), y=0.0102x+0,1045 (R^2=7096), respectively. The relationships among body mass-otolith length and body mass-otolith breadth and body mass-otolith weight were as y=0.0211x+5,6323 (R^2=8617), y=0,0098x+3,1177 (R^2=6139), y=0.0005x+0,0237 (R^2=6577), respectively. According to the regression analysis results, a moderate or strong positive relationships among the fish length and weight and otolith dimensions was determined.

Keywords: *Uranoscopus scaber*, Atlantic stargazer, otolith biometry, Iskenderun Bay, North-eastern Mediterranean

Acknowledgement: This work was supported by Scientific Research Projects Coordination Unit of Firat University. Project Number: SUF.15.04.

ASSESSMENT OF DNA DAMAGE BY COMET ASSAY IN *TRACHINOTUS OVATUS* CELLS FROM MERSIN BAY IN THE NORTHEASTERN MEDITERRANEAN

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Abstract

The aim of this study is to get database to elucidate the quantity of DNA damage in *Trachinotus ovatus* from Mersin Bay in the North-eastern Mediterranean. Primarily, we have used the single-cell gel electrophoresis, commonly known as Comet assay to detect the strand breaks in DNA. This technique was performed on liver and gill tissues of *T. ovatus* captured from the Mersin Bay. The single cell gel electrophoresis was executed under alkaline conditions. The slides were neutralized with ice cold 0.4 M Tris buffer (pH 7.5) and stained with 80 ml ethidium bromide (20 mg/ml) and imaged with attachment of Leica fluorescent microscope integrated CC camera. DNA damage levels were determined from 100 cells for each sample. As a result of the COMET analysis; tail length, tail ıntensity and tail migration were 39.718±6.826 µm, 32.752±9.281% and 30.089±9.930 in gill tissues while they were 29.440±9.889 µm, 30.010±6.222 % and 19.119±5.025 in liver tissues respectively. it can be concluded that COMET analysis in *T. ovatus* from Mersin Bay can be a useful tool for screening genotoxic pollutants in the recipient environment.

Keywords: Comet assay, DNA damage, *Trachinotus ovatus*

GENETIC AND MORPHOLOGICAL ANALYSIS OF COMMON PANDORA *PAGELLUS ERYTHRINUS* FROM THE EASTERN MEDITERRANEAN COAST OF TURKEY

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Abstract

In this study, genetic analysis as sequencing of mtDNA D-loop region and morphological data as the age and growth relationship, Fourier and Truss methods were applied for the common pandora, *Pagellus erythrinus* populations. *P. erythrinus* samples were collected from Iskenderun, Mersin and Antalya Bays. BioMorphv3 was used for the age and growth relationship, Fourier and measurements applications from the images of fish and otolith samples. The applications of genetic, age and growth relationship, Fourier and Truss methods were evaluated for stocks discrimination of *P. erythrinus*.

Keywords: *Pagellus erythrinus*, Fourier Shape Analysis, Truss Methods, Otolith, Stock Identification, mtDNA D-loop

Acknowledgements: Thanks to the General Directorate of Agricultural Research and Policies department of Republic of Turkey Ministry of Agriculture and Forestry (TAGEM 16/AR-GE/21) for financial support.

RANDALL'S THREADFIN BREAM *NEMIPTERUS RANDALLI* FROM GENETIC, MORPHOLOGIC AND BIO-ECOLOGICAL PERSPECTIVES IN THE EASTERN MEDITERRANEAN COAST OF TURKEY

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Abstract

Morphological analyses of population has been widely used as a tool to stock identifications. In this study, genetic analysis of mtDNA COI gen region and morphological data as the age and growth relationship, Fourier and Truss Methods were applied on otolith shapes of Randall's threadfin bream, *Nemipterus randalli* Russell, 1986 populations. Threadfin bream samples were collected from Gulf of İskenderun, Gulf of Mersin and Gulf of Antalya. Otoliths from collected *Nemipterus randalli* were removed and cleaned with glycerol, and images of each otolith were taken with camera. BioMorphv3 was used for the Fourier and measurements applications from the images of each otolith and age and growth relationship images of each individual. The utility of Fourier and Truss methods were evaluated for stocks discrimination of *Nemipterus randalli*.

Keywords: Fourier Shape Analysis, Truss Methods, Bio-ecological Perspectives, mtDNA COI, *Nemipterus randalli.*

Acknowledgments: Thanks to the General Directorate of Agricultural Research and Policies department of Republic of Turkey Ministry of Agriculture and Forestry (TAGEM 16/AR-GE/21) for financial support.

IDENTIFICATION OF SHARK SPECIES WITH BIOMORPH SOFTWARE

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Abstract

Shark species are generally vulnerable and threatened due to overfishing and other anthropogenic activities and largely aimed to be protected. There are many species of sharks given endangered status by the International Union for Conservation of Nature (IUCN) which categorized 43 shark species as endangered from 519 bony fishes found in the Mediterranean. The difficulty to identify shark species in public even though scientist weaken protection of endangered shark species. The goal of this study is to make a machine learning model for identification shark species using Fourier analysis method with BioMorph software.

Keywords: Fourier analysis, shark species identification, BioMorph Software

EVALUATION OF THE MORPHOMETRIC METHOD FOR COUNTING YELLOW SPOTTED PUFFER *TORQUIGENER FLAVIMACULOSUS* (OSTEICHTHYES: TETRAODONTIDAE)'S EGGS

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Abstract

The morphometric method was evaluated for counting of fish oocytes. The method has been applied to Yellow spotted Puffer (*Torquigener flavimaculosus*) fish, which caught from Iskenderun Bay, North-eastern Mediterranean. Marine pufferfish of the family Tetraodontidae accumulate the highest levels of tetrodotoxin (TTX) in the ovary. It is stripping of eggs and counting them is quite dangerous. That was the main reason for evaluating of the morphometric method. The advantage of the morphometric method is that it is relatively fast method without significant loss in accuracy and it is cheaper most importantly safer than that the other currently used methods.

Keywords: Yellow spotted Puffer, Fecundity, Histology, Iskenderun Bay, and Morphometry

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ANALYSIS OF BIOMETRIC DIFFERENCE USING HILBERT TRANSFORM OF CONTOUR

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Abstract

In this presentation, it is difficult to define the morphological structure of objects in ways that are quite similar to analysts' vision with the naked eye. For this aim, the counter line is extracted from image of biological object. This shows the outline shape. Hilbert Transform model was used for describe the object. It is a technique that permits comprehensive quantification of outline shape. The result of reconstruction shows that it can be used to analyze of biometric diversity in ecosystem.

Keywords: Diversity, Hilbert Transform, Morphology

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Session 3: Abstracts for Poster Presentations

COMPARISON OF LENGTH-WEIGHT RELATIONSHIP AND FULTON'S CONDITION FACTOR OF GIBEL CARP FROM THREE LAKES IN SAKARYA (TURKEY)

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Abstract

Gibel carp, *Carassius gibelio* (Bloch, 1782), is one of the most successful invasive species in inland waters in Turkey. Although, it has rapidly invaded many freshwater systems in Anatolia during the last decades, there is limited information about its biological features in these new environments. In this study, we aimed to compare lenght-weight relationship (LWR) and Fulton's condition factor of invasive gibel carp in order to evaluate its performance in three natural lakes located on Sakarya province. Fish specimens were obtained between February and August 2019 using gill nets varying mesh size from 24x24 mm up to 50x50 mm with the aid of local professional fishermen. Both comparison of the slopes of the length-weight regression between different populations and variation in coefficient *b* from 3 were tested using Student's *t*-test. The *b* values in the LWR were estimated as 3.24 in Büyük Akgöl, 3.35 in Lake Sapanca and 3.05 in Lake Küçük Boğaz. The LWR with high coefficient of determination (r^2) is significant for all populations. The r^2 values ranged from 0.959 to 0.976. The *b* value deviated from 3 and positive allometric growth was observed for gibel carp in Büyük Akgöl and Lake Sapanca. Fulton's condition factor were 1.65±0.18 in Büyük Akgöl, 1.75±0.24 in Lake Sapanca and 1.63±0.17 in Lake Küçükboğaz. According to obtained results, gibel carp had best performance in Lake Sapanca.

Keywords: *Carassius gibelio*, invasive fish, length-weigh relationship, condition factor

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THE NEW MAXIMUM LENGTH OF THE INVASIVE LESSEPSIAN FISH, BLUESPOTTED CORNETFISH *FISTULARIA COMMERSONII* RÜPPELL, 1738 IN THE EASTERN MEDITERRANEAN SEA

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Abstract

Fourty-two fishes of the *Fistularia commersonii* species were caught by trawl hauls from Iskenderun Bay in the year of December, 2017, in the base of a project which have been conducted for three years. One of the fish caught during the investigation was a female with 116.5 cm long, 1216.0 g. These measurements make *F. commersonii* specimen the largest fish to have been collected in the Eastern Mediterranean Sea, so far.

Keywords: *Fistularia commersonii*, maximum length, Eastern Mediterranean Sea

MORPHOLOGICAL DISCRIMINATION IN COMMON CARP (*CYPRINUS CARPIO*) POPULATIONS IN SOME TURKISH LAKES

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Abstract

This research aimed to make a comparison of common carp (*Cyprinus carpio*) populations in some Turkish inland waters based on morphological characteristics. The water bodies were selected by taking into consideration carp stocking frequencies by Mediterranean Fisheries Research Production and Training Institute, Antalya, Turkey. For this purpose, 2 lakes (Iznik Lake and Gala Lake) that were continuously stocked, and 5 lakes (Keban Dam Lake, Cıldır Lake, Belevi Pond, Payamlı Lake, and Yukarı Kartal Pond) that were never or only a few times stocked. After photographing each specimen, 12 landmarks were determined to understand the morphological structure of all populations by the tpsDig 232 Software program. The data collected were tested the univariate analysis of variance (UniANOVA), Discriminant Function Analysis (DFA), Factor Analysis (FA), Principal Component Analysis (PCA) in JMP 8 and STATISTICA 8 software. The UniANOVA showed that there were significant differences between the populations in terms of the measured linear variables. DFA clearly discriminated the populations in terms of carp stocking frequencies. FA explained three-quarters of the total variation (75.2%), with the first five factors loading by a total of 18 linear variables. PCA carried out using these 18 linear variables revealed that more than half of the total variation (56.2%) was possible to be explained with the first two axes. Axis 1 was negatively loaded by the variations of the linear variables related to the head while positively loaded by variations of the linear variables associated with the area between operculum and anal and dorsal fins. On the other hand, Axis 2 was positively loaded by variations of the linear variables related to the caudal peduncle. The study revealed the variations between common carp populations depending on stock enhancement severity and underlined some significant linear variables in characterization of the populations. The results will help to understand the influences of stocking on morphological characteristics of carp populations and to determine the sources of broodstock for the regional stock enhancement programs.

Keywords: Common Carp (*Cyprinus carpio*), Morphology, Landmark

MORPHOLOGICAL COMPARISON OF GOLDEN MULLET *LIZA RAMADO* POPULATIONS

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Abstract

The development of image analysis systems has facilitated progress and diversification of morphological methods and expands the potential for using morphometry as a tool for fisheries management. This study aims to elucidate morphological structure of Golden mullet *Liza ramado* from Samandağ and Arsuz Coasts in Northeastern Mediterranean between August and September 2019 using BioMorph software. The morphometric data set were generated from each sampled individual photos and, obtained from the morphometric landmarks on fish image to identify morphometric parameters.

Keywords: Mullet, *Liza ramado*, morphological comparison, image analysis.

FOURIER SHAPE ANALYSIS OF LAUREL PLANT LEAF (*Laurus nobilis* L)

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Abstract

Laurus nobilis is one of the 40 species of the family, which is an important species of the genus Lauraceae, grows naturally in the Aegean, Mediterranean and Black Sea coastal areas of the Turkey. Laurel leaf is traditionally used in areas such as herbal medicine and cosmetics. In this study, we aimed to compare the morphological structure of laurel leaves collected from different areas of the province of Hatay. Therefore, leaves specimens were obtained from Harbiye, Belen, Iskenderun and Arsuz. Digital images from the collected samples were acquired with a good quality digital camera. The morphometric distances of the images obtained using BioMorph developed specifically for morphometric measurements were analyzed.

Keywords: Laurel, *Laurus nobilis,* Fourier Shape Analysis.

OTOLITH SHAPE ANALYSIS OF ANCHOVY (*ENGRAULIS ENCRASICOLUS*) IN THE BLACK, MARMARA AND AEGEAN SEAS

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Abstract

Otolith shape analysis is widely used for fish species identification and stock classification. The morphological structure of anchovy populations was examined with otolith characters using Truss network system. A total of 300 anchovy specimens were collected by commercial fishing vessels from six fishing areas, three from the Black Sea (Trabzon, Sinop, Istanbul), one from the Marmara Sea (Bandırma Gulf) and two from the Aegean Sea (Edremit Gulf, Izmir Gulf) between November 2001 and January 2002. Our data were subjected to univariate statistics of variance (ANOVA) and discriminant function analysis (DFA) by using SPSS 21 software version. Plotting DF1 and DF2 revealed that the Marmara stock was clearly separated from others in the discriminant space. The proportion of specimens correctly classified into their original group was the highest (70%) for the Marmara Sea samples. The most important discriminative otolith characters in distinguishing between the groups for the first and second discriminant functions were otolith width and otolith length. The Marmara Sea is the passageway between the Black Sea and Aegean Sea, and currents or water masses play an important role in its environmental conditions (e.g. temperature, salinity, food). Significant difference in the Marmara sea population may be attributed to geographical and environmental conditions suggesting separate management strategies for the resource sustainability.

Keywords: *Engraulis encrasicolus*, anchovy, otolith shape analysis, stock discrimination

GENETIC AND MORPHOLOGICAL STRUCTURING ANALYSIS OF ROUND SARDINELLA *SARDINELLA AURITA* FROM THE EASTERN MEDITERRANEAN COAST OF TURKEY

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Abstract

In this study, genetic analysis as sequencing of mtDNA COI region and morphological data as the age and growth relationship, Fourier and Truss methods were applied for round sardinella, *Sardinella aurita* populations. Round sardinella samples were collected from Gulf of İskenderun, Gulf of Mersin and Gulf of Antalya. BioMorphv3 was used for the age and growth relationship, Fourier and measurements applications from the images of fish and otolith samples. The applications of genetic, age and growth relationship, Fourier and Truss methods were evaluated for stocks discrimination of *Sardinella aurita*.

Keywords: *Sardinella aurita*, Fourier Shape Analysis, Truss Methods, Otolith, Stock Identification

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