APPLICATION OF MAHALANOBIS DISTANCE FUNCTION FOR THE MORPHOMETRIC SEPARATION OF SCALDFISH (ARNOGLOSSUS LATERNA WALBAUM) STOCKS IN THE GULF OF MERSIN

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SUMMARY: ***The Generalized Distance of Mahalanobis (1) cited in Weber (2) has been used for the stock differentiation studies of Scaldfish*** (Arnoglossus laterna)***collected in the Bay of Mersin.***

By the application of above function with Cluster Analysis technique (3), it was found that, Scaldfishes of Mersin Bay consisted three different stocks. These are Seyhan—Göksu, Tuzla and Tirtar. Tirtar stock of A. laterna ***formed the main group, while the Tuzla and Seyhan—Göksu stocks showed much heterogenity.***

MERSİN KÖRFEZİ'NDEKİ KÜÇÜK DİLBALIĞI (ARNOGLOSSUS LATERNA WALBAUM) STOKLARININ MORFOMETRİK AYIRIMI İÇİN MAHALANOBIS AYIRIM FONKSİYONUNUN UYGULANMASI

ÖZET: ***Mersin Körfezi'nden toplanan Küçük dilbalıklarının*** (Arnoglossus laterna) ***stok ayırım çalışmaları için Mahalanobis'in Genelleştirilmiş Aralığı (Weber .2'de refere edilen 1) kullanıldı.***

Yukarıdaki fonksiyon ile Cluster Analiz Tekniği (3) beraber uygulandığında Mersin Körfezi'ndeki Küçük dilbalıklarının Seyhan—Göksu, Tuzla ve Tırtar olmak üzere üç farklı stoğu oluşturduğu görüldü. A. laterna ***nın Tırtar stoğu ana grubu oluştururken Tuzla ve Seyhan—Göksu stokları çok heterojenlik gösteriyordu.***

INTRODUCTION

A. laterna has little economic importance and /or economic potential (4) since it grows to a maximum of 15 cm (5) and 19 cm (8) in Mediterranean water system but usually caught in the study region at lengths 6—10 cm (5) and consequently, its biology is poorly known.

Scaldfish spawns from end of spring to the late summer (May—September) in English Channel (9), from March to November in the Mediterranean (10), and from April to June off southern Ireland (6). The inhabit commonly on the muddy and the sandy bottoms, in depth ranges between 10 to 30 metres. According to Daniel (9), eight species of the genus *Arnoglossus* live in the Mediterranean Sea.

On the other hand, existance of two species, namly; *A. laterna* and *A. macrostoma* was strogly demonstrated by Mengi (11), while, both were classified under the same species (synonyms) according to some authors (12, 13, 8, 10). In present study Tortonese' identification sheat was used for the identification of *Arnoglossus laterna*.

This species is the most common flattened fish in the region extending from İskenderun Bay to Anamur Cape. During the fishery investiga-

tions between 1980 and 1982, this species composed of 6.5 % of the individuals in Tuzla, 3.8 % in Tirtar, 3.1 % in Seyhan and 2.6 % in Göksu (5).

Scaldfish was recorded from the Black Sea, Marmara and Aegean Sea, western Mediterranean and Adriatic sea. It is also common from Morocco along the west coast of Europe to Norway.

The demersal flattened fish populations including *C. linquatula* and *A. laterna* have been studied first by Mengi (14) on a classical way along the coasts of Turkey. He found that there were two populations of Scaldfish inhabiting the middle Aegean Sea and the Sea of Marmara. However he didn't obtain the samples of *A. laterna* from southern Aegean and northeastern Mediterranean Sea.

Because of its different rate of abundances in the trawl fishery within the Bay of Mersin, the existance of separate stocks was expected. In the present study, the differentiation of the stocks of *Arnoglossus laterna* was investigated using the technique of Discriminant Analysis (2).

MATERIALS AND METHODS

All specimens used in this study were collected from Göksu river delta. Tirtar, Seyhan and Tuzla, which are located along the coast of Mersin Bay (Figure 1). Seyhan, Tirtar and Göksu were directly influenced by important fresh water imput from (Tarsus and Seyhan), Lamas and Göksu rivers respectively.

Sampling were carried out with two different trawler boats of similar characteristics. Samples were obtained by deep trawl net towed for approximately 1.5 to 4.5 km. The cod—end mesh size of the nets was 28 mm in streched form.

The material collections were done randomly. Sampling was begun on 3.19.1985 and continued at approximately 9 months until 12.20.1985. The trawled fish were sorted by species, transferred into the plastic containers of 10 litres and preserved in 10 % formalin solution (15 — 17) immediately after separation of the capture.

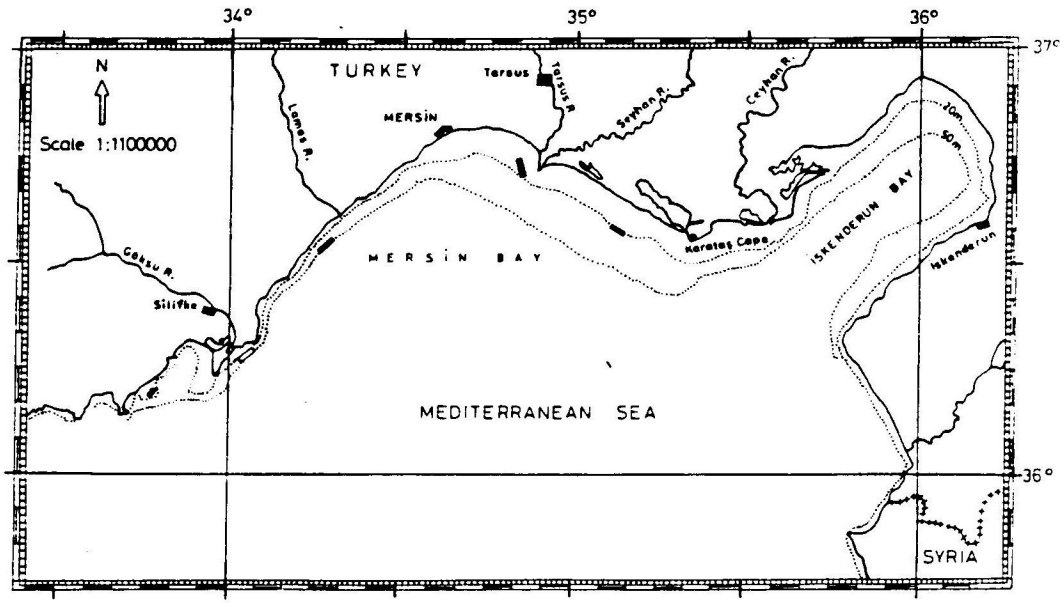

Figure 1. Sampling locations in the Mersin Bay (—: TUZLA, — —: SEYHAN, — —: TIRTAR, — —: GÖKSU)

Replicate samplings performed at each station were assumed to be representative of a single stock. Morphometric emeasurements (Figure 2) and sexes of totally 1469 fish were collected and 1312 fish specimens were used for the discrimination. The number of individuals sampled in four localities, their total length ranges and those used for further statistical analysis are given in Table 1. In order to prevent incorrect differentiation, small immature specimens were eliminated. The percentages of males and females were equalized for the elemination of the differences in percentage ratios of males and females in different stations on the results of Discriminant Analyses.

In laboratory, during the washing of each fish, under cold running tap water, the body of the fish was turned in a tail—to—head direction and washing operation has been done with weakly flowing water. Sub sampling was carried out according to the method, described by Holden and Raitt (18). For the length measurement, each fish was laid on its blind side, the jaws being closed and the length was measured by means of a clipper as a straight line. The distance between the tips of the clipper is read off in milimetric scale. The weighhing was done on an electronic balance (accuracy 0.01 gr).

According to Blackith and Reyment (19), the weight unit can be used for the standardization of the row data. In addition to this, the weight is some power of the length (20). Based on this idea the weight unit was used in this study for the standardization of the material.

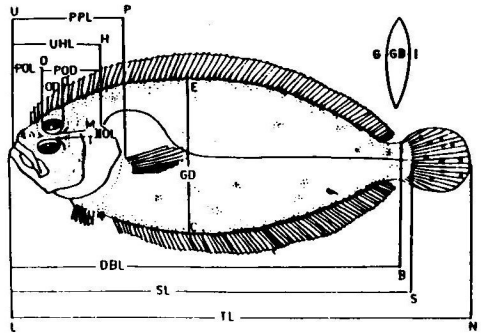

Figure 2. Measured morphometric characteristics of A. laterna TL= Total length, SL= Standard length, DBL= Dorsa body length, UHL= Upper head length, PPL= Pre-Pectoral length, POL= Pre—Orbital length, OD= Orbital diameter, POD= Post—Orbital distance, IOL= Inter—Orbital length, GD= Greatest depth, GB= Greatest breath (Figure is redrawn from (10)

In order to prevent any bias in total weight measurements due to food factor and maturation, the weight after cleaning was used for standardization. Each fish was laid straight on the blind side on a milimetric paper. Much care is payed to fit the axis, which passes through maxillary symphasis (U) to the membranous edge (F) of caudal fin at fork to the straight line drawn in a horizontal plane on the milimetric paper. For dissection through gill—cover notch an angle of 90° between the above given axis and the gil—cover notch wash arranged and dissection was made by one stroke.

Table 1. minimum and maximum total length ranges and the number of specimens collected in four sampling stations

Whole data	STATIONS TUZLA min max	SEYHAN min max	TIRTAR min max	GÖKSU min max
	ROW DATA			
Total length (mm)	68 115	49 126	32 140	71 133
of specimens	223	498	498	250
	EQUALIZED DATA			
total length (mm)	68 115	49 125	44 140	71 122
of specimens	198	468	458	188

In present study, the Generalized Distance of Mahalanobis (1 cited in 2) was used for the quantitative separation of the stocks of the Scaldfish:

$D^2 = (b_1d_1 + b_2d_2 + b_3d_3 + \ldots\ldots + b_md_m) / m$

Where:

m : number of measured characters
D^2 : Generalized Mahalanobis Distance
b_1 : discriminant functions of the (i)' th measurement
d_2 : mean difference of the (i)' the measurement.

The Generalized distance of Mahalanobis was combined with clustering technique of Davis (3) to obtain qualitative relationship between stocks. Generalized Distance was used to observe the numerical separation. Significant testing of Sneath and Sokal (21) was used to observe, the presence or absence of significancy between the groups for the calculated (D^2) values.

RESULTS AND DISCUSSION

Significant testing results and obtained Generalized distance (D^2) of the pairs of combinations of Scaldfish are given in Table 2.

As it is seen in Table 2. the smallest (D^2) value was found between Seyhan—Göksu. Significant testing results implies that the difference between these two stations is not significant. Likewise, the F values calculated according to the method described by Davis (3), Overall & Klett (22) and Sneath & Sokal (21) for the scaldfish samples, for all pairs of sampling stations showed that the difference at 5 % level was significant between all sampling stations except Seyhan—Göksu. So, the hypothesis, that "there is no difference between the groups" was accepted for the *A. laterna* samples of Seyhan—Göksu, while "there is no difference between the groups" was rejected for the scaldfish samples of Tuzla—Seyhan, Tuzla—Tirtar, Tuzla—Göksu, Seyhan—Tirtar and Tirtar—Göksu. Therefore, under the light of the above mentioned results of significance test, it is clear to say that, three different stocks of scaldfish: namely Seyhan—Göksu. Tuzla and Tirtar inhabit Mersin Bay.

Estuaries in the study region may form a shelter for the preys. Where Scaldfish may inhabit to avoid from their predators. All the rivers flow directly into the sampling stations in the Mersin Bay. This concept would also support the idea of the existance of three *A. laterna* stocks in the region.

(D^2) values may be interpreted as an index of affinity, (23). Calculated (D^2) values for stocks may be representative in the interpretation of the affinity by cluster analysis.

As can be seen in Figure 3 the stock of Tirtar differs appreciably from the Tuzla and Seyhan—Göksu stocks and it forms the main group. Stocks of Seyhan— Göksu and Tuzla exhibit heterogenity with a (D^2) value of 0.4 while all differ from the stock of Tirtar with a (D^2) value of 0.828. On the other hand, individuals of Seyhan and Göksu differ from Tuzla stock with a (D^2) value of 0.261. more similarity exists between the scaldfishes of Seyhan and Göksu than Tuzla and Tirtar stocks. This may be related to the similarities in the ecological conditions. As can be seen from the Figure 1, the run off of two rivers Seyhan and Göksu, into *(A. laterna)* created perhaps similar ecologgical niches for this species.

Table 2. Generalized Mahalanobis distances (D^2) and F Values Calculated (F_{cal}) of A. laterna Above the diagonal. results of the significant testing were given below the diagonal; (+) significant; (—) not significant. (F critical values at 5 % level were between 1.80—1.81)

	TUZLA		SEYHAN		TİRTAR		GÖKSU	
	D^2	F_{cal}	D^2	F_{cal}	D^2	F_{cal}	D^2	F_{cal}
Tuzla			0.272	3.39	0.929	11.49	0.528	4.50
Seyhan	+				0.688	14.32	0.139	1.67
Tırtar	+		+				0.868	10.35
Göksu	+		—		+			

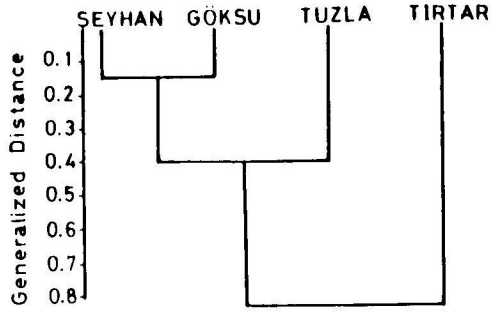

Figure 3. Dendogram of Generalized Distance matrix of A. laterna

As it was mentioned before (Introduction), scaldfish inhabit the shallow water within the depths ranging between 10 to 30 m. However, according to Akşiray (24), adult Bothids migrate to a depth of 50 m for spawning. estuaries are much preferred by *A. laterna* species as a feeding ground and also already hatched juvenile Bothids start to migrate from the spawning ground to the feeding ground in early autumn. Therefore, three different stocks of scaldfish, inhabiting Tuzla, Seyhan—Göksu and Tirtar, may be realized in cases where feeding migrations of each stock take place at a certain limited region and a certain depth which ranges from few meters to 50 m depth. Additionally, due to differences in the rates of input of each river, dissimilarities between the morphometric characters of individual scaldfishes inhabiting different ecological niches my be expected.

Genetic exchange between the stocks of these four stations does not seem to be possible in restricted ecological niches, but a little exchange may be caused by the existing current system during the larval phase. Nevertheless, different stocks of Scaldfishes inhabiting Tuzla, Seyhan—Göksu and Tirtar may be recognized.

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