Morphological differences among the *Cyprinion macrostomus* (Cyprinidae) populations in the Tigris River

Bilici S.[1]*; Cicek T.[2]; Baysal A.[3]; Unlu E.[2]; Alp A.[4]

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Abstract

In this study, by examining the character of the morphometric and meristic in which *Cyprinion macrostomus* samples obtained from different locality in Tigris, morphometric character which are transformed subject to discriminant analysis and depending on grouping model to number of discriminant functions and according to importance of these totally variance, morphogical variance among populations are determined. According to the result of discriminant analysis of *Cyprinion macrostomus* individuals belonging to 5 different locality of Tigris River, it is determined that the individuals belonging to Tigris River are different from other localities both in terms of morphometric and meristic, the samples of Göksu Stream is different from other localities only in terms of meristic Devegeçidi, Kulp and Kayser Stream samples are similar in terms of morphometric and meristic.

Keywords: *Cyrinion macrostomus*, Tigris River, Discriminant analysis, Cyprinidae.

1-Şırnak University, Faculty Of Agrıculture, Zootecni Science Department, 73000, Şırnak, Turkey

2-Dicle University, Faculty of Science, Department of Biology, Section of Hydrobiology, Diyarbakır, Turkey.

3-Kafkas University, Faculty of Science, Department of Biology, Section of Hydrobiology, Kars, Turkey.

4-Kahramanmaraş Sütçü İmam Üniversitesi, Kahramanmaraş, Turkey.

*Corresponding author's email: serbestbilici@hotmail.com

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Introduction

As temperature, salinity, radiation, dissolved oxygen, water depth, current flow with environmental factors, meanwhile Dam sets which are constituted on streams, cause to differences of genotype and phenotypic by hindering fish mobility in stream basin.

There are 5 kinds of Cyprinion, these are *C. macrostomus, C. kais, C. neglectus, C.cypris, C.tenviradius* that shows a large range between Tigris and Euphrates Rivers (Banerescu and Herig Straschil, 1995). From these, *Cyprinion macrostomus* Heckel is a kind of Cyprinidae, has a huge range in Turkey, Iraq, Iran and Syrian between Tigris-Euphrates Rivers and Asi Basin.(Kelle, 1978; Kuru, 1978; Ünlü ve Oymak, 2009; Coad, 2010).

There research that are dealth with differences of morhological among populations aren't encountered as well as characteristic of morphological and meristic related to description of this kind (Heckel, 1843; Kele, 1978; Kuru, 1978; Banarescu ve Herzig-Straschil, 1995; Ünlü, 1999; Coad, 2010). Meristic and morphometric characters are strong means for relationship of measurement among stocks (IHSSEN ve ark, 1981).

In this study, it is tried to identify the morphologic differences by examining the samples of morpholometric and meristic characters, which are obtained from different locality *C.macrostomus* in Tigris River.

Materials and Methods

The samples of *C. macrostomus* in system of Tigris River are obtained from 5 different localities, Devegeçidi Dam, Göksu small stream, Kulp Stream, Kayser Stream and Tigris River by using extension bunt and electro-shocker. fish samples were brought to science lab interior 10% formaldehyde. In order to determine the features of morphological that fish samples are taken stock morphological and meristic measurement.

26 mophological variance which are about morphometric characters are measure by sensitive 0,01 mm electronic compass and in this measurement truss network method has been used (Schaefer, 1991; Turan ve ark., 2004; Tzeng, 2004; Çakmak ve Alp, 2010) (Fig. 1).

In totally 13 different variances have been used about countable meristic characters numbers of dorsal opined fin (DFRS-A) Dorsal furcated fin ray (DFRS-B), Ventral spined fin ray (VFRS-A), Ventral frucrated fin's ray (VFRS-B), Anal opined fin ray (AFRS-A), Anal branched fin ray (AFRS-B), Pectoral fin in left spined ray (PFRSA-L), Pectoral fin in left furcated ray (PFRSB-L), Pectoral fin in right spined ray (PFRSA-R), Pectoral fin in right furcated ray (PFRSB-R), number of gill arch spine (GRS), Lateral line in left number of scale (LLS-L) and Lateral line in right number of scale (LLS-R).

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Figure 1: Outlook of *Cyprinion macrostomus*.

In order to determine morphologic variations between *C. macrostomus* populations, all the morphometric characters are calculated to standard length (SL) and variation that could arise from Length are tried to be eliminated transformed morphometric characters are subjected to discriminant analysis is and according to grouping model discriminant function numbers and morphologic variation between populations with respect to their importance of explaining total variation are determined.

In two dimensions, the place of discriminant functions are determined by taking two different discriminant functions as basis with stepwise analysis the features of classification and their influential functions are determined with the help of canonical discriminant function the limit maps of the groups in a two dimensional platform are created. Among discriminations areas the medial areas of groups (Group Centers) are arrange (Turan ve ark., 2004; Çakmak ve Alp 2010).

The same applications about discriminant analysis are also applied for countable meristic characters. Morphometric and meristic variations between *C. macrostomus* populations are shown on plot charts. Also morphometric differences between populations are analysed with variation analysis and F test.

Results

In order to investigate morphologic differences of *C.macrostomus* populations in Tigris river, 5 from Devegeçidi Dam, 5 from Göksu Stream, 20 from Kulp Stream, 27 from Kayser Stream and 30 from Tigris River in total 94 *C. macrostomus* individual are analyzed. The standard heights belonging to the samples change between 69 - 144 cm and the height difference between population a is seen statistically unsignificant (p>0.05).

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The standard height belonging to populations and morphometric characters calculated as the percentage of standard height are given in Table 1. Of the morphometric characters FL, SL, BD, LD, OVD, PFL, AFL, PRFL, LLCFL has showed difference and this difference originates from FL/SL, SL/OVD, SL/PRFL, SL/LLCFL, BD/LD, PFL/AFL characters and Tigris, Kayser and Kulp populations.

From 13 countable meristic characters belonging to populations are 5 of them showed difference between populations (Table 2). The difference in question originates from DFRSA, DFRSB, VFRSB, GRS, L.L.S.(R) characteristics and populations of Tigris and Göksu Stream. As a result of morphometric characters which are transformed and obtained from 94 items of *C.macrostomus* individuals belonging to five different populations subjected to discriminant analysis, 4 discriminant function provide 100% of total variation. Thus function 4 is considered and the first two form 94.7% of the total variation. According to discriminant functions. 1 .Function (DF1) forms 87.3% of total variation (Canonical Correlation = 0.964).

2.Function (DF2) forms 7.4% (Canonical Correlation=0.725) , 3. Function (DF3) forms 4.2% (Canonical Correlation=0.624) and 4. function (DF4) forms 1,1% (Canonical Correlation=0.369).

Canonical discriminant parameters in DF1 is -31.74, in DF2 is -6.82, DF3 is -27.40 and in DF4 is -7.53.

In discriminant analysis, in 1. function (DF1) SL/PDFL, SL/CPL, SL/HD, SL/SNL, SL/POHL, SL/BW, SL/HL, in 2. function (DF2) BD/LD, SL/BD, OVD/OHD, PFL/PEFL, SL/PPEFL, in 3.function (DF3) SL/LLCFL, SL/OVD, SL/LUCFL, SL/OHD,SL/DFL, SL/LD,PFL/DFL and UJL/LJL, and in 4.function (DF4) PFL/AFL, SL/AFL, SL/PEFL, SL/LJL, SL/PFL, HL/HD, SL/BDA, BD/BDA are significant (Table 3).

Graping chart of DF_1 and DF_2 scoress which are obtained from morphometric characters in discriminant analysis is given in figure 2a. When grouping chort is examined it can be seen that the individuals belonging to Tigris River from a group different from other populations.

The success of discriminant analysis is 83% in terms of morphometric separation of populations. In discriminant analysis, all the Tigris samples are represented in its own group. Accordingly the representation rate of Tigris samples in its own group is 100%. While 16 samples of Kulp are represented in its own group the remaining 4 are represented in Kayser group. That is the representation rate of Kulp samples in its own group is 80%.

While 22 samples of Kayser are represented in its own group (81.5%) the others are mixed with Kulp and Göksu samples. The representation rate of Devegeçidi samples in its own group is 40% and the rate of Göksu samples is determined as 66.7%.

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As a result of countable meristic characters belonging to *C.macrostomus* individual subjected to discriminant analysis as 3 discriminant function is considered and the first two of that from 99% of total variation. First discriminant function (DF1) forms 88% of total variation (Canonical Correlation=0.987), 2. fonction forms 11% (Canonical Correlation=0.911) and 3.function forms 1% (Canonical Correlation=0.555). In discriminant analysis belonging to meristic characters, canonical parameters are calculated as 11.66 in DF1, -119.57 in DF2, and -37.66 in DF3.

In Discriminant analysis while GSR in 1. function (DF1), DFSRB in 20. Function become significant, the other meristic characters become significant in 3. function (Table 4). Grouping chart formed with scores of DF_1 and DF_2 belonging to meristic characters is given in shape 2b. According to grouping chart it is seen that Göksu and Tigris populations are different from other populations in terms of meristic characters.

The separation success of discriminant analysis of population is 76.6%. While all (100%) samples of Tigris take part in its own group according to the result of the separation analysis evaluation, only 2 of Kulp Stream samples take part in its own group and the others take part in Kayser Stream group.

So the rate of representation of Kulp Stream'a samples is %10, %96 individuals of Kayser Stream, 40% individuals of Devegeçidi, 100% individuals of Göksu Stream are represent in their own grasps. According to these results individuals of Göksu and Tigris in terms of meristic characters are represented in individually groups, Kayser, Devegeçidi and Kulp individuals an form only a single mixed group (Shape 2b).

Consequently, according to the result of discriminant analysis of *C.macrostomus* individuals belonging to five different localities of Tigris River, the individuals belonging to Tigris River are determined to be different from other localities both is terms of morphometric and meristic, samples of Göksu Stream are only different from other localities in terms of meristic, samples of Devegeçidi, Kulp and Kayser are determined to be similar in terms of morphometric and meristic.

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Table 1: Morphometric features of different *Cyprinion macrostomus* populations in Tigris River.

Morphometric Character	Devegeçidi Dam (n=5)	Göksu Stream (n=12)	Kulp Stream (n=20)	Kayser Stream (n=27)	Tigris River (n=30)
SL	1,11	1,17	1,15	1,16	1,28
SNL	13.49	12.19	12.09	12.54	11.27
OHD	20.49	16.82	19.88	19.06	20.07
OVD	21,10	17,24	20,81	19,24	20,11
UJL	14,03	12,58	14,73	14,99	14,1
LJL	8,54	7,63	7,06	7,97	8,06
HL	5,03	4,4	4,5	4,73	4,35
HD	6,85	0,74	6,3	6,5	6,2
POHL	10,8	1,03	9,6	9,98	9,34
PFL	5,75	0,43	5,33	5,48	5,15
BD	3,75	0,299	3,97	3,98	3,35
BW	5,79	0,63	6,18	5,82	4,94
DFL	5,72	0,78	5,29	5,23	5,26
PDFL	2,41	0,199	2,23	2,24	1,99
PEFL	6,52	0,724	5,61	5,75	5,2
PPEFL	2,22	0,26	2,15	2,74	1,9
DPA	4,78	0,45	5,01	4,9	4,2
BDA	6,25	0,478	6,18	8,35	5,16
AFL	7,12	1,31	6,56	6,02	5,068
CPL	7,13	0,64	6,53	6,6	5,75
LD	11,35	0,739	10,49	10,6	9,26
LUCFL	4,34	0,527	3,7	3,6	3,48
LMCFR	8,89	1,74	8,4	8,57	8,27
LLCFL	13,4	20,49	3,78	3,77	3,63

Table 2: Meristic features of different *Cyprinion macrostomus* populations in Tigris River.

Meristic Character	Devegeçidi Dam (n=5)	Göksu Stream (n=12)	Kulp Stream (n=20)	Kayser Stream (n=27)	Tigris River (n=30)
DFSR-A	3.60±0.55 (min-mak)	4.00±0.00 (min-mak)	4.00±0.04 (min-mak)	3.96±0.19 (min-mak)	3.33± 0.48 (min-mak)
DFSR-B	14.80±0.83 (min-mak)	14.4±0.00 (min-mak)	14.9±0.00 (min-mak)	15.00±0.00 (min-mak)	14.53±0.51 (min-mak)
VFRS-A	1,00±0,00 (min-mak)	1,00±0.00 (min-mak)	1,00±0,00 (min-mak)	1,00±0,00 (min-mak)	1,00±0,00 (min-mak)
VFRS-B	8,20±0,44 (min-mak)	8,00±0.00 (min-mak)	8,00±0,366 (min-mak)	8,00±0,00 (min-mak)	8,00±0,00 (min-mak)
AFRS-A	3,00±0,00 (min-mak)	3,00±0.00 (min-mak)	2,85±0,00 (min-mak)	3,00±0,00 (min-mak)	3,00±0,00 (min-mak)
AFRS-B	7,20±0,44 (min-mak)	7,00±0.00 (min-mak)	7,00±0,00 (min-mak)	7,00±0,00 (min-mak)	7,00±0,00 (min-mak)
PFRSA-L	1,00±0,00 (min-mak)	1,00±0.00 (min-mak)	1,00±0,00 (min-mak)	1,00±0,00 (min-mak)	1,00±0,00 (min-mak)
PFRSB-L	13,00±0,00 (min-mak)	13,00±0.00 (min-mak)	13,00±0,00 (min-mak)	13,00±0,00 (min-mak)	13,00±0,08 (min-mak)
PFRSA-R	1,00±0,00 (min-mak)	1,00±0.00 (min-mak)	1,00±0,00 (min-mak)	1,00±0,00 (min-mak)	1,00±1,33 (min-mak)
PFRSB-R	13,00±0,00 (min-mak)	13,00±0.00 (min-mak)	13,00±0,77 (min-mak)	13,00±0,00 (min-mak)	13,00±1,5 (min-mak)
GRS	32,60±2,61 (min-mak)	40,42±1,24 (min-mak)	30,20±1,07 (min-mak)	30,11±0,8 (min-mak)	26,27±2,86 (min-mak)
LLS-L	43,00±2,83 (min-mak)	40,17±1,03 (min-mak)	40,90±0,99 (min-mak)	40,37±1,27 (min-mak)	41,53±4,15 (min-mak)
LLS-R	43,20±2,17 (min-mak)	30,08±1,31 (min-mak)	41,15±1,037 (min-mak)	41,19±1,07 (min-mak)	41,73±4,35 (min-mak)

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Table 3: **Discriminant functions (DF1, DF2. DF3) formed by wsing morphometric characters in discriminant analysis.**

Morfometric parameter	DF 1	DF2	DF3	DF4
SL/PDFL	-0.345	-0.201	0.115	-0.218
SL/CPL	-0.333	0.220	0.015	0.020
SL/DPA	-0,299	0,172	-0,085	0,165
SL/HD	-0,298	-0,052	0,228	-0,038
SL/SNL	-0,281	0,030	0,002	-0,007
SL/POHL	-0,186	-0,023	0,180	-0,150
SL/BW	-0,183	0,054	0,001	-0,076
SL/HL	-0,181	-0,086	0,123	-0,171
BD/LD	0,016	0,523	0,302	0,351
SL/BD	-0,145	-0,473	-0,126	-0,413
OVD/OHD	0,089	0,388	-0,116	0,045
PFL/PEFL	-0,097	0,344	0,250	-0,176
SL/LMCFR	0,036	-0,159	0,092	-0,085
SL/UJL	-0,076	-0,151	-0,127	-0,039
SL/PPEFL	-0,014	-0,039	0,030	0,037
SL/LLCFL	0,037	0,160	0,544	-0,442
LUCFL/LLCFL	-0,025	0,160	0,527	-0,436
SL/OVD	0,037	-0,454	0,509	-0,416
SL/LUCFL	-0,193	0,053	0,471	-0,203
SL/OHD	0,102	-0,070	0,375	-0,343
SL/DFL	-0,161	-0,200	0,292	-0,245
SL/LD	-0,196	0,033	0,255	-0,111
PFL/DFL	-0,068	-0,140	0,192	0,036
UJL/LJL	0,036	0,042	0,131	-0,016
PFL/AFL	-0,253	-0,142	0,395	0,836
SL/AFL	-0,321	-0,176	0,420	0,578
SL/PEFL	-0,198	0,287	0,340	-0,422
SL/LJL	-0,193	-0,242	0,274	-0,422
SL/PFL	-0,116	-0,077	0,105	-0,334
HL/HD	-0,052	0,053	0,004	0,160
SL/BDA	-0,033	-0,044	-0,098	-0,152
BD/BDA	-0,024	-0,008	-0,089	-0,122

Table 4: Discriminant functions (DF1. DF2. and DF3) formed by using meristic characters in disriminant analysis.

Meristic Character	DF1	DF2	DF3
GRS	-0.683	0.370	0.376
LLS-R	0.464	0.305	0.733
VFRSB	-0.002	0.057	0.704
AFRSB	-0.002	0.057	0.704
L.L.S.(L)[a]	0,054	0,121	0,582
DFSRB	0,094	0,310	-0,149
DFSRA	-0,081	0,348	-0,508
AFRSA[a]	0,037	0,071	-0,108

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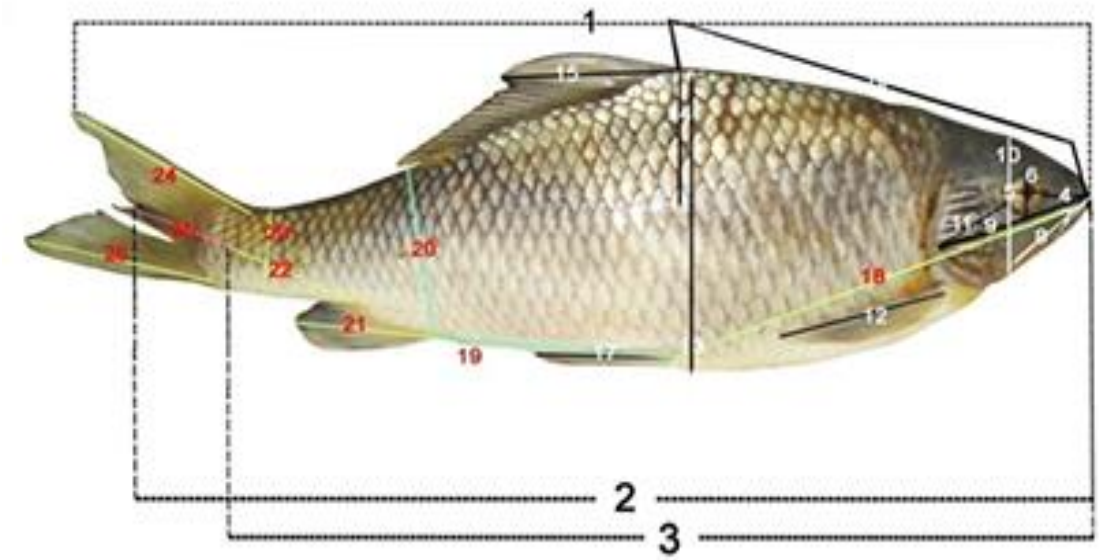

Figure 1-a: Morphometric measurement performed upon *Cyprinion macrostomus*.

1. TL: Total Length 2. FL: Fork Length, 3. SL: Standard Length 4. SNL: Snout Length 5. OHD: Horizontal Ocular Diam 6. OVD: Vertical Ocular Diam 7. USL: Upper Lip Length 8. LJL: Lower lip Length 9. HL: Head Length 10. HD: Head Height 11. POHL: Post Ocular Head Length 12. PFL: Pectoral Fin Length 13. BD: Body Height 14. BW: Body Width 15. DFL: Dorsal Fin Length 16. PDFL: Predorsal Length 17. Pelvic Fin Length 18. PPEFL: Prepelvik Length. 19.DPA:Distance Between Pelvik and Anal Fin 20. BDA Body HeightİIn Anal Level 21. Anal Fin Length 22CPL Caudal Pedunculus Length 23. LD: Body Height in Caudal Pudunculus Area 24. LUCFL: Upper Lab Length of Caudal Fin 25. LMCFR: Caudal Fin's Fork's Length 26. LLCFL: Length of Lower Lab of Caudal Fin.

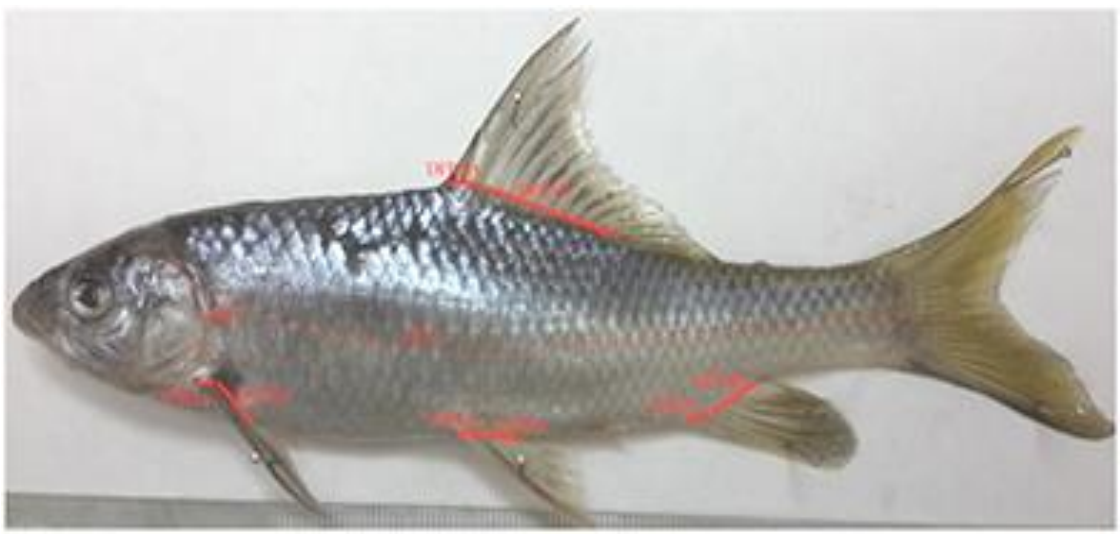

Figure 1-b: Metristic characters performed upon *Cyprinion macrostomus*.

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DFRS(A): Dorsal Ray Score (spine), DFRS(A): Dorsal Ray Score (branched), VFRS(A): Ventral Ray Score (spine), VFRS(B): Ventral Ray Score (branched), AFRS(A): Anal Ray Score (Spine), AFRS(B):Anal Ray Score (Branched), PFRSA(L): Pectoral Ray Score (Left part branched), PFRSA(R): Pectoral Ray Score (Right Part Spine), PFRSB(R): Pectoral Ray Score (Right Part Branched), GRS: Spine Score of Gill Arch, L.L.S.(L): Lateral Line Score (Left Part), L.L.S.(R): Lateral Line Score (Right part).

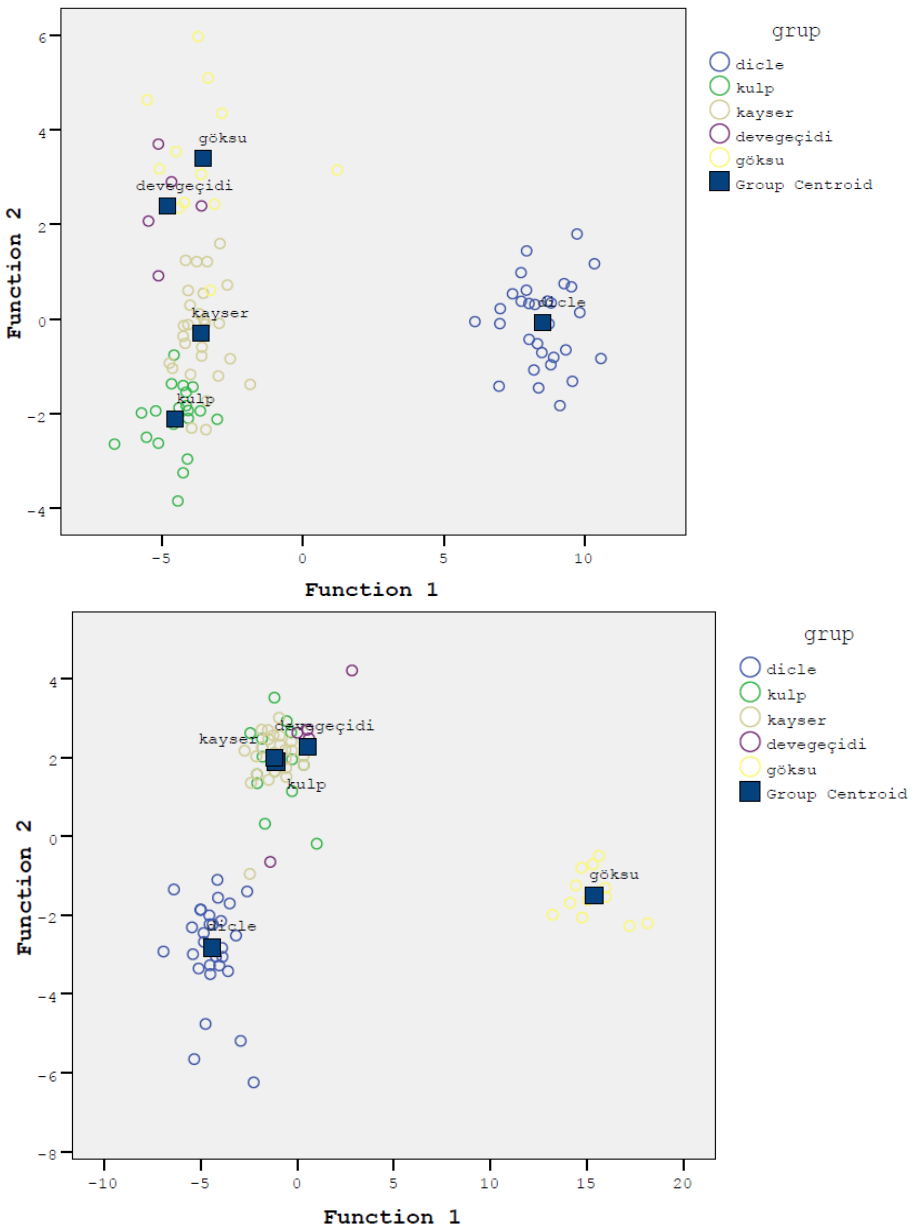

Figure 2: The difference between Granping charts of function 1 and function 2 found as a result of discriminant analysis and populations.

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a) Discriminant analysis results belonging to morphometric characters
b) Discriminant analysis results belonging to meristic scores.

Figure 1-a

In the analysis which is performed according to the morphometric features of 94 *C.macrostomus* (Heckel. 1843) which are brought from 5 different regions the separation success rate of localities group in term of meristic features is 83%.

In the result of evaluation fo separation analysis: Of the 30 all samples brought from Tigris the 30 stayed its own group.

Samples brought from Tigris in terms of studied characters are 100% as percentage, and as possibility P=1.

While of 20 samples brought from Kulp 16 of them stay in its own group 4 of them passed to Kayser group. Samples brought from Kulp in terms of studied characters get involved in its own group as percentage is 80%, as possibility P=0,8.

Of 27 samples brought from Kayser 22 of them stayed in its own group and 2 of them passed to Göksu group. Samples brought from Kayser in terms of studied characters get involved in its own group as percentage is 81,5% and as possibility P=0,85.

Of the 5 samples brought from Devegeçidi 2 of them stayed in own group and 1 of them passed to Göksu group. Samples brought from Devegeçidi in terms of studied characters get involved in its own group as percentage is 40% and as possibility P=0,40.

Of 12 samples brought from Göksu 8 of them stayed in ıts own group and them pased to Kayser and 1 of them passed to Tigris group. Sampels brought from Göksu in terms of studied characters get involved in own group as percentage 66.7% and as possibility p=0.667.

Figure 1-b

In the analysis which is performed according to the meristic features of *C.macrostomus* (Heckel, 1843) samples brought from 5 different regions the success rate is 76.6% in terms of separating locality groups meristically.

In the result of separation analysis; of the 30 samples brought from Tigris the all 30 stayed in its own group, samples brought from Tigris in terms of studied characters are 100% probably P=1.

While of 20 samples brought from Kulp Stream 20 of them stay in its own group the rest 18 stayed in Kayser group. Samples brought from Kulp in terms of studied characters get involved in its own group as percentage is10% probably P=0.1.

Of 27 samples brought from Kayser 26 of them stayed in its own group the remaining 1 passed to Tigris group. Samples brought from Kayser Stream in terms of studied characters get involved in its own group as percentage is 96,3% probably P=0.963.

Of the five samples brought from Devegeçidi 2 of them stayed in its own

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group and 1 passed to Kayser and 1 passed to Kulp group. Samples brought from Devegeçidi in terms of studied characters get involved in its own group is 40% probably P=0.4.

Of the 12 samples brought from Göksu 12 of them stayed in its own group samples brought from Göksu in terms of studied characters get involved in its own group is 100% probably P=1.

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