INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-3, Issue-1, Jan-Mar-2013 ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

Received: 12th Jan-2013 *Revised: 18th Jan-2013* *Accepted: 19th Jan -2013*

Research article

PRINCIPAL COMPONENTS ANALYSIS OF *ALBURNUS MOSSULENSIS* MORPHOLOGY

Mehdi Yousefian, Kelara Keshavarz and Yeganeh Yagoubi Kafshkari

Department of Fishery, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran
Corresponding Author: Email: yousefianeco@yahoo.com

ABSTRACT: The aim of the present work was to study the level of population structuring and differences among populations of *Alburnus mossulensis* in four river at west of Iran. Sampling was performed in summer of 2010 lasting one year, giving rise to 225 samples. Morphological characters were made on 29 characters. Principal components analysis is used to reduce the dimensionality of data, and to transform interdependent variables into significant and independent components. After logarithmic transformation of the variables, the PCA first and second axis accounted for 63.76 % of the total variance. Considering correlation and contributions, the first axis showed an opposition between morphological variation length parameter and length of fins. The second axis showed an opposition between scales in upper and down of lateral line. The third component consists of scale around the tail and forth component scales along lateral line. In present study, PCA revealed that morphometric differentiation between samples was largely located in meristic characters such as number of scale in upper and down part of lateral line, scales of the tail, soft and hard fin ray of dorsal and anal fin.
Key words: PCA, *Alburnus mossulensis,* meristic characters, Morphology

INTRODUCTION

Alburnus mossulensis are a species of conservation interest and are currently present in *Tigris-Euophrates,* rivers connected to it and several rivers in Iraq and in west and central rivers and lakes of Iran and mainly in Gamasiab River. The Gamasiab River is a remarkable Spring water-fed stream flowing through several provinces and ultimately reach to Arvand Roud in south west of Iran release to Persian Gulf. Understanding and conserving the genetic and life history diversity of *A. mossulensis* is essential for its conservation, management, and recovery plans are developed. In addition to point up of their genetic diversity, maintenance of life history diversity may illustrate the flexibility and adaptation of *A. mossulensis*. Their high distribution in Middle East is linked to high reproductive potential and increased population persistence in unstable environments. The *A. mossulensis* is one of the most important fish species in the west of Iran. However it is not in top of commercial fish but is utilized as a food by many peoples. The *A. mossulensis* is considered reproductively active, but due to the change in their habitat degradation creates a lot of problems for natural reproduction of this fish. In west this fish is living mainly in Gamasiab River and its branch. Rivers Gamasiab in central part of Iran, sustain a number of *A. mossulensis* but, as with most rivers, the level of population structuring and differences among populations is unknown. To address this and to assist fish stock management in the region, the population structure of *A. mossulensis* collected from 4 sampling sites in rivers flowing into Gamasiab. Globally, the population structure of fish species is shaped by the combined of morphology and behavioral traits and environmental factors. To evaluate the morphological variation there are several method in many cases, PCA has been used as a source or supporting analysis in the performance of more complex analysis, in this case we may refer to the study of adaptive fish radiation, strongly influenced by trophic niches and water depth [5], predicting the potential spatial extent of species invasion [2] and multi-trait analysis of intra- and interspecific variability of plant traits [1].

In another study [4] performed PCA and hierarchical ascendant classification to evaluate environmental data, on the one hand, and human and dog population density data, on the other, in order to detect possible ranking of regions differently threatened by leishmaniasis. The aim of the present study was to investigate the structural population of *Alburnus mossulensis* living in four river with different environmental condition connected to Gamasiab River in west of Iran.

MATERIAL AND METHODS

Study site and sampling

Studies were carried out on four river branches of Gamasiab River, that is located in the south-west of Iran. The Gamasiab River is the longest river in Iran originated from a spring with the same name in Nahavand city in west part of Iran. Gamasiab river after passing several province enter the Arvand River and ultimately to Persian Gulf. Geographic attitude of Gamasiab river is *N 34°20´_58.88´ E 47° 59.355´ and* Geographic attitude of Dehno River that is one of the river have been investigated is *N 34°25.76´ E 48°21.63´* .

Sampling was performed in summer of 2010 lasting one year, giving rise to 225 samples.

For each sample, fish were counted and determined at the species level. For each fish species, individuals recorded were divided into ages: young of the year (0+) and more than one year determined by scale analysis. The fish were fixed in 10% formalin and preservation in 70% ethanol.

Morphological analysis

Morphological characters were examined in Lab of fisheries department of Islamic Azad University of Qaemshahr Branch, Iran. Measurements were made on 29 morphological characters, including standard length, Fork length, head length, head length(without scale), head width, Mouth width, inter-orbital width, postorbital length, Eye diameter, pre-dorsal length, post-dorsal length, pre-anal length, pectoral to anal fin, pectoral to pelvic fin, Pelvic to anal fin, dorsal-fin length, dorsal-fin base length, pectoral-fin length, pectoral-fin length, pelvic-fin length, lower peduncle length (mm), hard spine dorsal-fin, soft spine dorsal-fin, hard spine anal-fin, Scale on lateral line, Scale upper lateral line, Scale lower lateral line, Scale around the caudal, weight.

Data analyses

Principal components analysis (PCA), is used to reduce the dimensionality of data, and to transform interdependent variables into significant and independent components. This statistical method has been extensively described elsewhere (e.g. Gauch, 1982; Legendre and Legendre, 1998). The analysis was therefore conducted on the correlation matrix. PCA was carried out using version 18 of SPSS.

RESULTS

The distribution of fishes in the river based on their mean and standard deviation are presented in table 1. It was marked illustrated that fish in upper-stream were generally smaller than those in down-stream. The Razavar and Dehno River are originated in mountain, whoever in Godarkhosh River, which is located in field, due to higher nutrient available for fry and grass as shelter there are numerous small fish.

The PCA allowed to the morphological analysis of the fish species in 4 stations to be taken into account simultaneously aiming to visualize the difference in population structure within the studied area. After logarithmic transformation of the variables, the PCA first and second axis accounted for 63.76 % of the total variance. A principal component analysis (PCA) performed in isometric free shape space allowed us to explore variation in shape. The results suggested the first three principal components (PC) which explained 80.13% of the total variance in the data (Table 2). Considering correlation and contributions, the first axis showed an opposition between morphological variation length parameter and length of fins. The second axis showed an opposition between scales in upper and down of lateral line. The third component consists of scale around the tail and forth component scales along lateral line.

Table 1. The morphometric and meristic data (Mean ±SD) of four station

Station / Characters (mm)	Razavar mean n-30	Razavar SD	Godarkhoas mean n-30	Godarkhoas SD	Dehno mean n-30	Dehno SD	Maran mean n-30	Maran SD
Fork length (mm)	81.4	26.8	79.3	20	104.1	25.7	120.3	22.2
standard length (mm)	74	24.6	73.4	17.5	94.3	22	111.9	21.5
head length (mm)	17.9	5.8	18.2	4	22.2	10	26	4.5
head length(without scale) (mm)	12.9	3.7	12.6	3.3	15.5	3.3	18.2	3.3
head width (mm)	7.8	2.8	8.6	2.1	10.1	2.3	11.3	2.5
Mouth width (mm)	4.9	1.5	5.1	0.9	6.1	1.4	6.5	1.3
interorbital width (mm)	4.3	1.6	4.5	1	5.7	1.4	5.7	1
postorbital length (mm)	8.3	2.9	8.7	2.3	9.6	2.1	12.8	2.3
Eye diameter (mm)	5.2	1.1	5.1	0.6	5.8	1	6.7	0.9
predorsal length (mm)	27.8	9	27.1	6.1	34.5	8.1	41.1	9.7
postdorsal length (mm)	25.7	8.3	25.2	6.6	32.8	7.6	41	7.7
preanal length (mm)	5.8	3.8	5.3	4.3	7.1	2.6	8.3	2.4
pectoral -to-anal fin (mm)	29.6	12.6	28	8	39.8	10.7	46.5	11.1
pectoral -to- pelvic fin (mm)	15.3	6.6	15	5.1	22.2	6.5	25.1	6.3
Pelvic -to-anal fin (mm)	12.4	5.6	11.8	4	17.6	5.3	20.9	5.5
dorsal-fin length (mm)	8.6	2.5	8.9	2.8	10	2.7	11.4	2.1
dorsal-fin base length (mm)	13.6	4	14.4	3.5	14.6	2.9	19.2	3.1
pectoral-fin length (mm)	13	15.8	9.2	2.6	10.8	3	13.1	2.7
pectoral-fin length (mm)	14.6	3.4	15.1	2.7	16.3	3.4	19.6	3.7
pelvic-fin length (mm)	11	3	10.9	2.1	13.3	2.7	15.6	2.9
lower peduncle length (mm)	6.6	2.3	6.7	1.6	8.8	2.7	9.9	2.1
hard spine dorsal-fin	3	…	3	…	3	…	3	…
soft spine dorsal-fin	7.6	0.4	7.5	0.5	8.5	0.5	8	0.1
hard spine anal-fin	3	…	3	…	3.3	0.4	3	…
Scale on lateral line	88.1	1.7	85.5	0.6	85.5	11.6	87.7	0.9
Scale upper lateral line	89.5	2.4	87.8	0.7	94.1	2	88.6	2.2
Scale lower lateral line	92.1	2.4	92.2	0.7	95.3	1.8	91.8	1.4
Scale around the caudal	36	1.4	43.7	1.8	35.1	1.8	43.4	2.8
Weight (g)	10.5	9.6	8.1	7.1	16.8	11.3	15.4	7.1

Table 2.The percent of alteration by Principle component analysis

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total
1	23.6	63.8	63.8	23.6
2	3.6	9.8	73.6	3.6
3	1.4	3.7	77.3	1.4
4	1.1	2.9	80.1	1.1

The analysis variance of the first component shows there are not significant differences between the Razavar and Godarkhosh but between the other station it is significant (P<0.05). The statistics information of the first component is showed in Table 3.

Table 3.Descriptive statistics of the first factor at four stations

Stations	NO	mean	SD	SEM	Lower limit	Upper limit
Razavar River	30	18.1	6.1	1.1	15.8	20.3
Godarkhosh	32	17.7	4.3	0.0	16.6	19.3
Dehno River	82	22.7	5.5	0.15	21.5	23.9
Maran River	81	26.8	4.9	0.54	25.7	27.9
Total	225	22.8	6.3	0.42	22.1	23

The same result of analysis of variance was obtained for second component. No significant differences between the Razavar and Godarkhosh but significant differences were obtained between the other stations (P<0.05). Table 4. Shows second factor statistical comparison between 4 stations.

Table 4. The statistical comparison between 4 station based on second

Stations	NO	mean	SD	SEM	Lower limit	Upper limit
Razavar River	30	41.2	0.5	0.09	41.0	41.4
Godarkhosh	32	40.4	0.5	0.05	40.3	40.5
Dehno River	82	43.03	0.5	0.06	43.0	43.1
Maran River	81	40.4	0.5	0.06	40.3	40.5
Total	225	41.5	1.3	0.09	41.3	41.6

The statistical comparison of the third component is shows in table 5. In this component in all the staions show significant differences (P<0.05).

Table 5. The statistical comparison between 4 station based on third

Stations	NO	mean	SD	SEM	Lower limit	Upper limit
Razavar River	30	40.6	41.0	40.3	0.2	0.1
Godarkhosh	32	49.4	49.7	49.0	0.2	1.0
Dehno River	82	43.1	43.4	42.8	0.1	1.3
Maran River	81	46.9	47.7	46.2	0.4	3.4
Total	225	45.1	45.5	44.6	0.2	3.6

The statistical statistical comparison of the forth component is shows in table 6. In this component all the stations show not significant differences (P<0.05), except for Godarkhosh River samples. Number of lateral line scales hardly varied among samples analyzed

Table 6. The statistical comparison between 4 station based on fourth factor

Stations	NO	mean	SD	SEM	Lower limit	Upper limit
Razavar River	30	88.8	87.58	0.3	1.7	88.1
Godarkhosh	32	85.7	85.3	0.1	0.7	85.5
Dehno River	82	88.1	82.9	1.3	11.7	85.5
Maran River	81	87.9	87.5	0.1	0.9	87.7
Total	225	87.6	85.7	0.5	7.1	86.6

DISCUSSION

The present morphometric analysis of the *A.mossulensis* in Iran Rivers revealed three considerably distinct groups with varying degrees, though not necessarily with any clear geographic pattern. The Dehno and Godarkhosh river sample was the most divergent from the others. Dehno River is a cold region in west while in the other hand Godarkhosh is located in warmer situation and consequence with higher density of plankton and nutrient. The morphometric characters can show high plasticity in response to differences in environmental conditions, such as food abundance and temperature [14]. Therefore, the distinct environmental structure of the Dehno and Godarkhosh River may cause the detected high morphometric variation of *A. mossulensis* though it is a widely tolerant fish to acute environmental conditions.

The presence of highly variable in some morphology characters make *A. mossulensis* as an interesting fish for biological study, because, comprehensive genetic or morphological studies have been lacking to date. Exhibiting a relatively high diversity in number of closely related species made it an interesting species as previously denoted by [10], in their study in marine fish that these kind of fish has long attracted the attention of evolutionary biologists.

In this work we used PCA for analyzing the data, because there we collected tremendous data of more than 33 characters. PCA enables condensation of data on a multivariate phenomenon into its main, representative features by projection of the data into a two-dimensional presentation. The two created resource axes are independent, and although they reduce the number of dimensions, they maintain much of the original relationship between the variables information or explained variance [9]. This is helpful in focusing attention on the main characteristics of the phenomenon under study [7].

In present study, PCA revealed that morphometric differentiation between samples was largely located in meristics characters such as number of scale in upper and down part of lateral line, scales around the tail, soft and hard fin ray of dorsal and anal fin.

The fishes of Maran River samples had elongated abdominal and pectoral fins, while in Razavar River fishes the head length and the width of mouth were both shorter. Such differences between the populations maybe related to different habitat characteristics, such as temperature, food availability and type of food.

In a study by [13] they used only the otolith element to study the population of fish. In their study The diversity of the migratory environmental history of freshwater resident flathead mullet *Mugil cephalus* was examined by analyzing the otolith elemental composition of mullet (n = 31) collected in midstream of the Tanshui River, northern Taiwan by laser-ablation inductively coupled plasma mass spectrometry. In another study [11], to calculate principal components on their simulated data, they used bi-allelic loci and include only the frequency of one of the two alleles. In a method for creating PCA maps, they applied PCA directly to the observed allele-frequency matrix. Therefore if we have a special characteristics of fish it can be directly used by PCA for identify population structure. Component 2 and 3 that was about some meristic characteristics can be regard as special marker for analyzing by PCA.

PCA can be used for analyzing the data obtained by microsatellite loci, for understanding the level of population genetic structuring as done before by [12] for studying brown trout, *Salmo trutta* in rivers draining into (Lake) Inarijarvi, northern Finland. The author suggested this technique is suitable for DNA analysis.

In order to test the efficiency of SOM on complex ecological data gathered in the natural environment, [3] made a comparison between PCA and SOM capabilities to analyses the spatial occupancy of several European freshwater fish species in the littoral zone of a large French lake. The same data matrix consisting of 710 samples and 15 species was analyzed using PCA and SOM. Both methods provided insights on the major trends in fish spatial occupancy [3]. These examples of using PCA in a variety of genetics and environmental work illustrate that the PCA method that we used for population structure of fish is a appropriate and suitable method for this purposes.

This study demonstrated significant population structure in *Alburnus mossulensis* collected from different rivers, with especially large differences occurring in meristic characters. The Information was clustered into four separate components, corresponding to morphometric and meristic values. The significant differentiation observed between samples between each rivers also implies that individual groups can be recognized as separate units and the results of this study further indicate that the *Alburnus mossulensis* from each of these rivers may have different biological characteristics. As a consequence, further research of other river and molecular study is warranted to better understand genetic structure of this fish.

REFERENCES

[1]. Albert C.H., Thuiller W., Yoccoz N.G., Douzet R., Aubert S. and S. Lavorel 2010. A multitrait approach reveals the structure and the relative importance of intra- vs. interspecific variability in plant traits. Functional Ecology, 24: 1192–1201.

[2]. Broennimann O., Treier U.A., Müller-Schärer H., Thiuller W., Peterson A.T. and A. Giusan 2007. Evidence of climatic niche shift during biological invasion. Ecology Letters, 10: 701–709.

[3]. Brosse S., Giraudel J.L. and S. Lek 2001. Utilisation of non-supervised neural networks and principal component analysis to study fish assemblages. Ecological Modelling 146: 159–166

[4]. Chamaillé L., Tran A., Meunier A., Bourdoiseau G., Ready P. and J.P. Dedet 2010. Environmental risk mapping of canine leishmaniasis in France. Parasites & Vectors, 3(31), pp. 8.

[5]. Clabaut C., Bunje P.M.E., Salzburger W. and A. Meyer 2006. Geometric morphometrical analyses provide evidence for the adaptive character of the Tanganyikan cichlid fish radiation. Evolution, 61: 560−578.

[6]. Gauch H.G., 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, Cambridge.

[7]. Janžekovič F. and T. Novak 2012. PCA – A Powerful Method for Analyze Ecological Niches, Principal Component Analysis - Multidisciplinary Applications, Dr. Parinya Sanguansat (Ed.), ISBN: 978-953-51-0129-1, InTech, Available from: http://www.intechopen.com

[8]. Legendre P. and L. Legendre 1998. Numerical Ecology. Elsevier. Amsterdam, 853p.

[9]. Litvak M.K. and R.I.C. Hansell 1990. A community perspective on the multidimensional niche. Journal of Animal Ecology, 59: 931−940.

[10]. Love M.S., Yoklavich M. and L. Thorsteinson 2002. The rockfishes of the northeast Pacific, 405 p. Univ. California Press, Los Angeles, CA.

[11]. Patterson N.J., Price A.L. and D. Reich 2006. Population structure and eigenanalysis. PLoS Genet. 2:190.

[12]. Swatdipong A., Vasemagi A., Niva T., Koljonen M.L and C. R. Primmer 2010. High level of population genetic structuring in lake-run. brown trout, *Salmo trutta*, of the Inari Basin, northern Finland.doi:10.1111/j.1095-8649.2010.02784.x, available online at wileyonlinelibrary.com. Journal of Fish Biology, 77: 2048–2071.

[13]. Wang C.H., Hsu C.C., Chang C.W., You C.F. and W.N. Tzeng 2010. The Migratory Environmental History of Freshwater Resident Flathead Mullet *Mugil cephalus* L. in the Tanshui River, Northern Taiwan. Zoological Studies, 49(4): 504-514.

[14]. Wimberger P. H. 1992. Plasticity of fish body shape – the effects of diet, development, family and age in two species of Geophagus (Pisces: Cichlidae). Biol. J. Linn. Soc., 45: 197–218.