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Population variations of the species of *Lepadella patella* based on phenotype plasticity in Arak county, Iran

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Abstract

In the present study inter- and intra-population species of *Lepadella patella* were investigated. For this purpose 110 individual of geographical populations of these rotifers were collected from different parts of Arak county, and for each habitat five ecological factors such as longitude, latitude, elevation, temperature and pH were examined. The ANOVA test and also one-sample t-test showed significant difference for morphological characters. In inter- and intra-population section, 10 individual were selected randomly from each populations, then seven quantitative morphological characters were examined, the individuals were separated from other in the PCA plot and UPGMA tree. Significant correlations negative/positive were found between some of morphological characters with studied ecological factors of habitat, in addition variations in morphological characters were seen between population and they were separated in PCA plot and also UPGMA tree. Ecological factors were different between habitat, therefore in this study, we concluded that variation temperature was most effective among all the ecological factors, on diversification of populations.

Key words: Arak county; Lepadella patella; morphological characters; populations.

Introduction

Rotifers have been widely used as essential food source in raising freshwater and marine fish larvae due to their unique characteristics such as very small size, relatively slow motility which contributed to their usefulness as a good prey for active larvaes.[1] Rotifers are microscopic pseudocoelomates animals that reproduce mainly through parthenogenesis and that are systematically recognized only on morphological characters.[2] In Rotifera there is a large variation in life histories, phenotypic plasticity is the phenomenon of a same genotype producing different phenotypes in response to different ecological factors.[3,4] The genus *Lepadella* belongs to Lepadellidae family comprising of 13 species in Iran.[5] In the present study, in order to compare the effect of different ecological factors on morphological features of these organisms, 110 individual of eleven geographical populations of species *Lepadella patella* were examined at inter- and intra-population levels.

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Material and Method

The rotifers were collected from different regions of the Arak county in Iran, during May to June 2013, then samples were preserved in small bottles including 7% glycol–alcohol and transferred to the biological laboratory of Arak University. The genus *Lepadella* were separated from other genus, and also were identified based on funestical study, the specimens were observed under Olympus-BX51 microscope, based on available references, such as Ward and Whipple,[6] and Sharma and Michel.[7] In this study eleven geographical populations of species *L. patella* with 10 repetitions were collected randomly. Seven quantitative morphological characters were examined between and within populations, also five ecological features such as longitude (E°), latitude (N°), elevation (in meter), average of temperature (in C°) and pH were examined of each habitat. Longitude, latitude and elevation were calculated with Garmin GPS and averages of temperature for each population were extracted from web site of meteorology organization of Arak county. The mean of morphological characters of each populations were determined for populations. For grouping of populations data were standardizes (means=0, variance=1) and used for multivariate analysis including UPGMA (unweighted paired group using average method). Principal coordinate analysis (PCA), analysis of variance (ANOVA) test was performed to assess significant difference in quantitative morphological characters among populations. Pearson's coefficient of correlation was determine between quantitative morphological characters with ecological features of the populations habitat including longitude, latitude, elevation and average temperature per year to show their possible relationship between them.

Result

In the present study, different populations species of the genus *Lepadella* namely *L. patella* were collected with widest distribution from different environments. This study was done in two levels, among (intra) and between (inter) species. Inter species study carried out at inter- and intra-populations levels. Totally seven populations of this species, namely of Amir kabir Pool, Kellaleh Sinkholes, Kelaleh Dam, Shohadaygomnam Pool, Baghvahsh Pool, Marzijaran Fountain, Pheijan Fountain, Terminal Pool, Bagheban Pool, Khakbaz Fountain, Gharekahris River populations, and 10 samples were selected from each populations, totally with 110 individual were examined.

Intra-populations study of L. patella

Quantitative morphological features varied between individuals and ANOVA test performed between these characters showed significant difference ($p<0.05$) for all features, such as lorica length, lorica width, dorsal sinus depth, ventral sinus depth, foot length, length of foot groove and toes length (Table 1). In addition, one- sample t-test showed significant difference for all examined characters (Table 2).

Significant correlations positive or negative occurred between morphological features of individuals with ecological factors of habitat, for example a positive significant correlations ($p<0.01$, $r=0.37$) found between lorica length with north distribution, lorica length had significant negative correlations ($p<0.05$, $r=-0.23$) with east distribution and negative significant correlations ($p<0.01$, $r=-0.60$) occurred between lorica length with temperature and also positive significant ($p<0.01$, $r=0.35$) width lorica with north distribution, also lorica width had significant negative ($p<0.01$, $r=-0.19$) with east distribution, lorica width had significant negative correlations ($p<0.01$, $r=-0.60$) with temperature and positive significant correlations ($p<0.01$, $r=0.32$) occurred between dorsal sinus depth with north distribution. A positive significant correlations ($p<0.01$, $r=0.47$) found between dorsal sinus depth with habitat elevation and also positive significant ventral sinus depth with north distribution ($p<0.01$, $r=0.29$), also foot length had

Table1. One-Sample t-test of quantitative morphological, May to June 2013. (Test Value = 0)

Morphological characters	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the difference	
					Lower	Upper
lorica length	93.650	109	.000	106.427	104.17	108.68
lorica width	89.681	109	.000	70.90091	69.3340	72.4678
dorsal sinus depth	66.320	109	.000	15.02455	14.5755	15.4736
ventral sinus depth	68.423	109	.000	19.07273	18.5203	19.6252
foot length	78.260	109	.000	34.93455	34.0498	35.8193
length of foot groove	83.758	109	.000	38.36000	37.4523	39.2677
toes length	77.546	109	.000	26.71000	26.0273	27.3927

Table 2. ANOVA test of quantitative morphological characters, May to June 2013.

Morphological characters		Sum of Squares	df	Mean Square	F	Sig.
lorica length	Between Groups	12293.368	9	1365.930	42.798	.000
	Within Groups	3191.550	100	31.916		
	Total	15484.918	109			
lorica width	Between Groups	5787.374	9	643.042	37.675	.000
	Within Groups	1706.816	100	17.068		
	Total	7494.190	109			
dorsal sinus depth	Between Groups	451.670	9	50.186	30.658	.000
	Within Groups	163.694	100	1.637		
	Total	615.364	109			
ventral sinus depth	Between Groups	501.386	9	55.710	12.949	.000
	Within Groups	430.232	100	4.302		
	Total	931.618	109			
foot length	Between Groups	1895.263	9	210.585	42.637	.000
	Within Groups	493.906	100	4.939		
	Total	2389.169	109			
length of foot groove	Between Groups	1767.670	9	196.408	26.285	.000
	Within Groups	747.234	100	7.472		
	Total	2514.904	109			

	Between Groups	1058.588	9	117.621	32.323	.000
toes length	Within Groups	363.892	100	3.639		
	Total	1422.479	109			

positive significant ($p<0.05$, $r=0.21$) with north distribution, also negative significant correlations ($p<0.01$, $r=-0.47$) with east distribution and temperature ($p<0.01$, $r=-0.37$). A positive significant correlations found between length of foot groove with north distribution ($p<0.05$, $r=0.20$) and with east distribution ($p<0.01$, $r=0.28$), length of foot groove had negative significant correlations ($p<0.01$, $r=-0.40$) with temperature. A negative significant correlations found between toes length with east distribution ($p<0.01$, $r=-0.26$) and with temperature ($p<0.05$, $r=-0.29$). studied individuals were separated from each others in PCA plot of morphological features, which showed high difference between individuals of populations, especially in Khakbaz Fountain population (Figures 1 and 2). Individuals of all populations were far from other in the mention diagrams. This subject confirmed high variations in individuals morphological characters.

Interpopulation study L. patella

In this section average amounts of each morphological character were used for examination of variations between populations. Totally seven quantitative morphological characters were investigated. Some populations had distinct characters which distinguished from others, for example, Marzijaran Fountain and Khakbaz Fountain populations had largest lorica length, lorica width, foot length, length of foot groove, toes length. Significant correlations positive or negative were present between average amounts of morphological characters with ecological factors of habitat, for example a negative significant correlation ($p<0.01$, $r=-0.68$) found between lorica length with temperature, also lorica width had significant negative correlation ($p<0.01$, $r=-0.68$) with temperature. Studied populations were different in morphological characters and separated from each other in UPGMA tree as well as PCA plot (Figures 3 and 4).

DISCUSSION

Quantitative morphological characters varied inter and intra-population the ANOVA test and also t-test confirmed significant variations, also significant correlations positive or negative occurred between morphological features of individuals and populations with ecological factors of habitat, this phenomenon confirmed the effect of different environmental characters on species phenotype, variations were occurred in morphological traits of population's individuals, samples populations were separated from others and placed separately. For intra-population investigation seven quantitative morphological characters of ten individual from eleven populations species of *L. patella* were studied quantitative morphological feature varied between individuals Khakbaz Fountain populations, in the other study interpopulations of *L. patella* were observed little variations in quantitative characters between Khakbaz Fountain and Marzijaran Fountain populations, in addition were present the highest variations in Khakbaz Fountain and Marzijaran Fountain populations among the other populations. Inter specific variation in plasticity has been documented, also the term 'self-induced adaptive plasticity was proposed for situations in a behavior induces plastic changes in morphological or physiological traits that enhance in turn the ability to perform the behavior.[8] Phenotypic plasticity is the ability of an organism to express different phenotypes depending on the biotic (e.g. predation, competition and social interactions) or abiotic (e.g. tem-

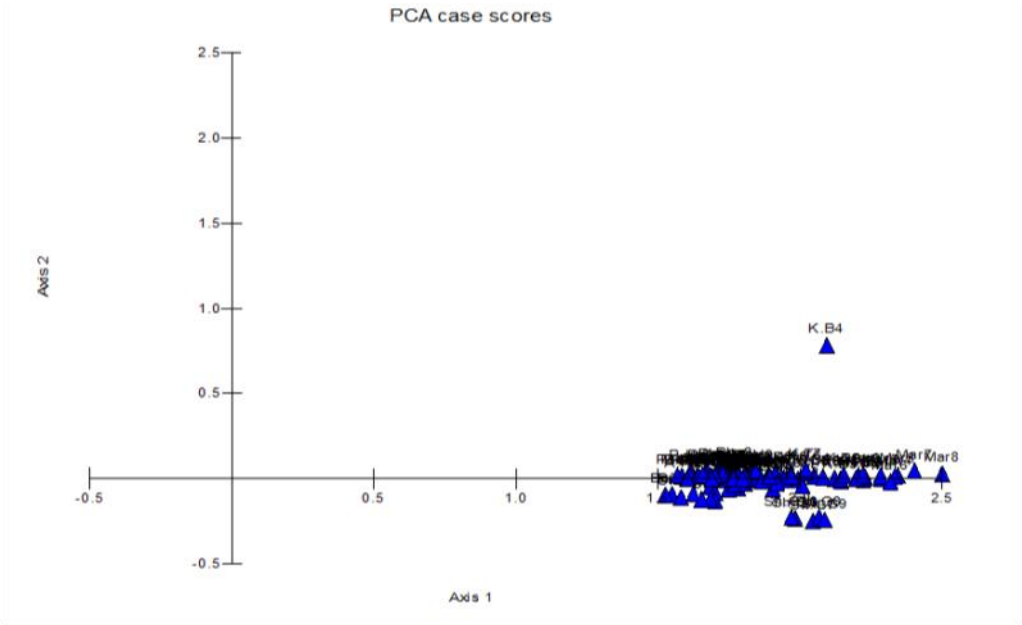

Figure1. PCA plot of individuals of studied populations based on morphological characters, May to June 2013.

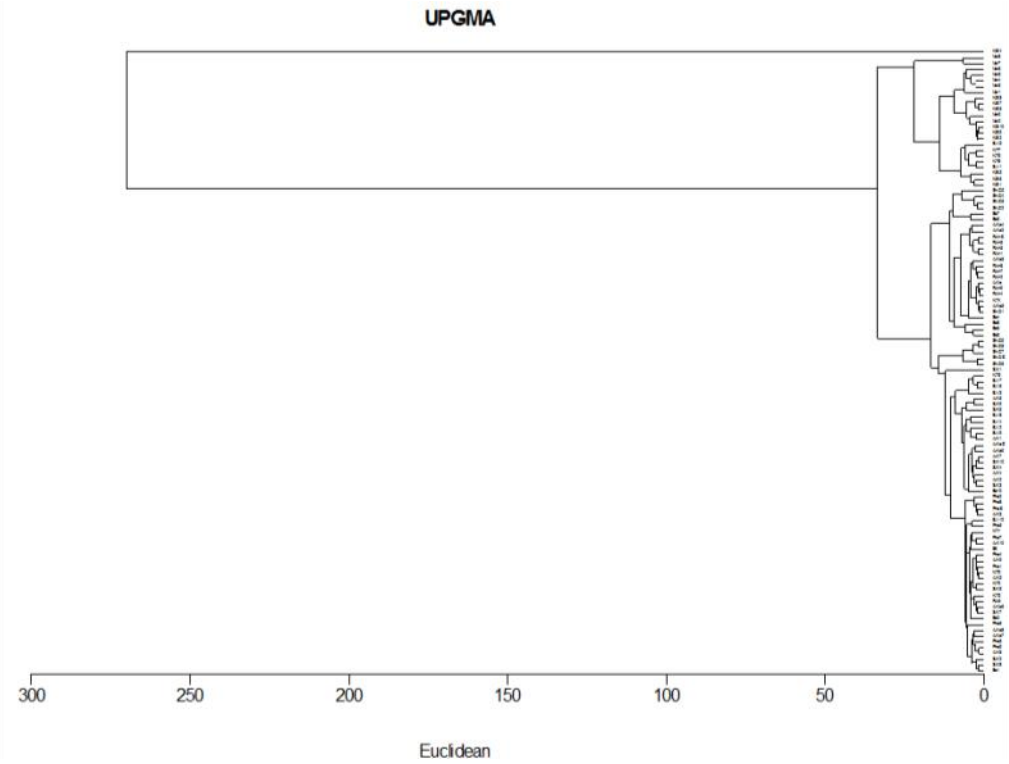

Figure 2. Morphological UPGMA tree of studied individual populations, May to June 2013.

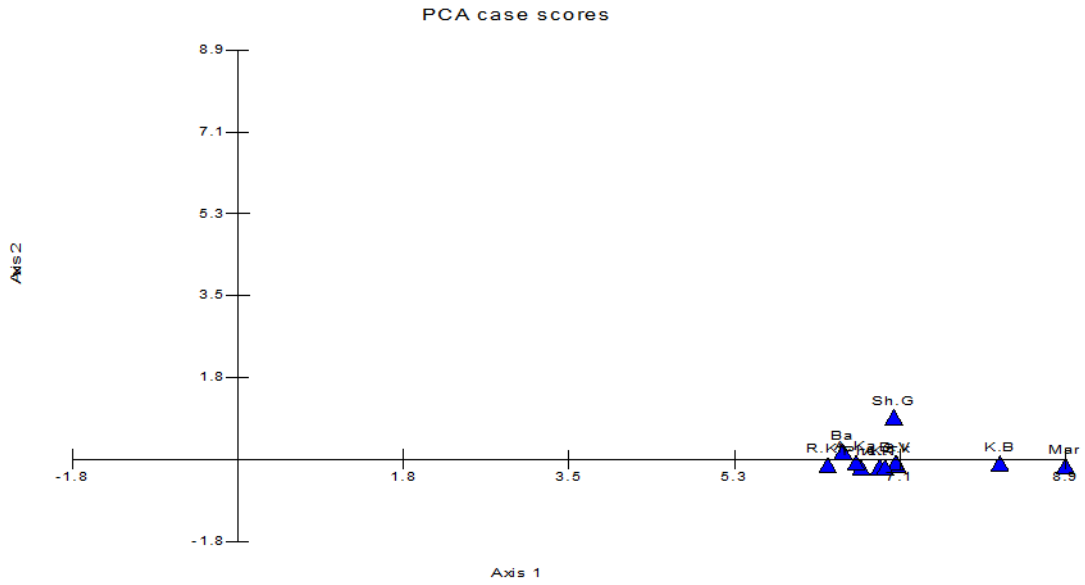

Figure 3. PCA plot of studied populations based on morphological characters, May to June 2013.

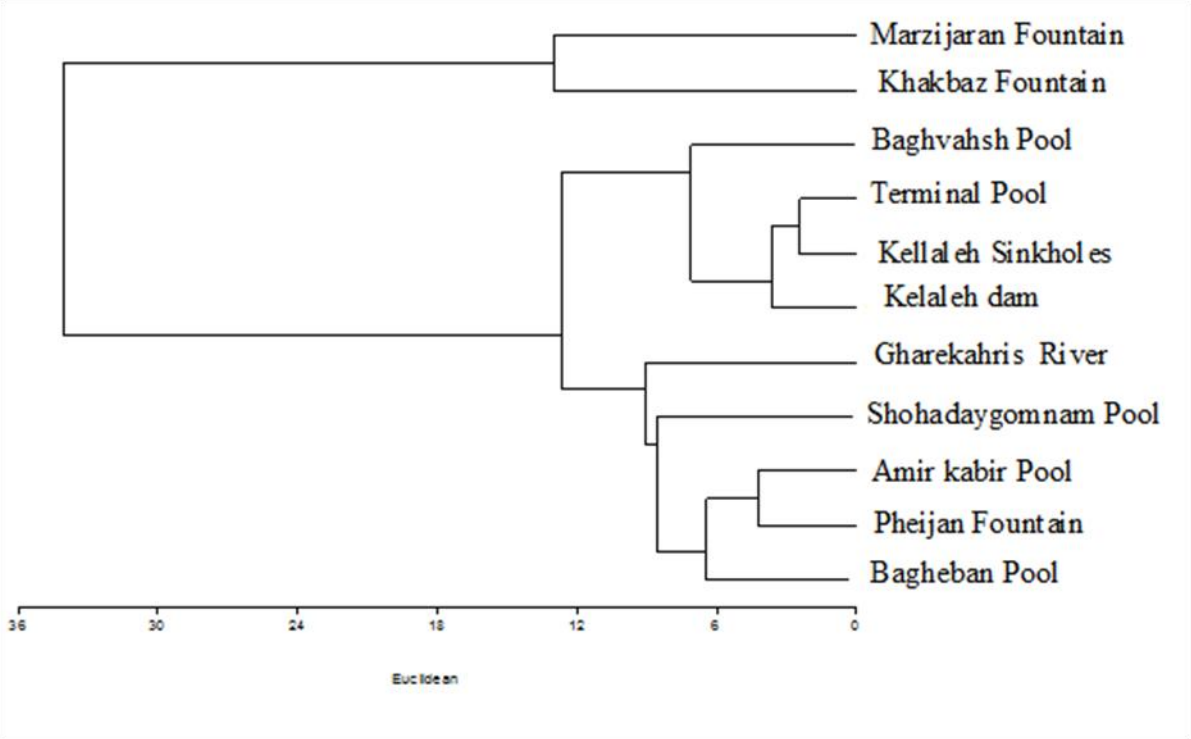

Figure 4. Morphological UPGMA tree of studied populations, May to June 2013.

perature) environmental in a variety of way and in a wide range of taxa, both ecological and genetic costs of plasticity may impose an evolutionary constraint on responses to natural selection favoring plasticity, although little empirical progress has been made in this area.[9] The inter-population variations may be related to habitat of populations, in some case, the arrangements of populations in morphological character and ecological factor, Gharekahris River, Shohadaygomnam Pool and Bagheban Pool populations were far from others in the mention diagrams, Variations on morphology show that temperature has special effect on phenotype plasticity. Gharekahris River, Shohadaygomnam Pool and Bagheban Pool populations were collected in temperature (above 30°C), but other populations were collected in regions with lower temperature (under 28°C), also the study of these populations based on similarity and diversity of quantitative characters shown that Khakbaz Fountain and Marzijaran Fountain were more similar and much together rather than other populations, therefore this subject confirmed high variations in morphological character with ecological factors.

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