Biometric comparison of two parthenogenetic populations of *Artemia* Leach, 1819 from the Urmia Lake basin, Iran (Anostraca: Artemiidae)

by Alireza Asem, Behrooz Atashbar*, Nasrullah Rastegar-Pouyani and Naser Agh

So far, 18 *Artemia* sites were reported from Iran of which 16 belong to the parthenogenetic populations. The Urmia Lake basin includes three populations: a bisexual species, *Artemia urmiana* Günther, which is endemic to the Urmia Lake, and two parthenogenetic *Artemia* populations, one from the lake and the other from its lagoons (see ABATZOPOULOS et al. 2006, VAN STAPPEN 2002). Here we compare the two parthenogenetic populations from a morphological point of view. One of them was the population occurring in the Urmia Lake, the other from the lagoon in the Rashakan region in the south-west of the lake. The lagoon is entirely separated from the lake but it is temporarily and seasonal.

Biometrical parameters such as diameters of untreated and decapsulated cysts, chorion thickness and length of newly hatched nauplii of the two parthenogenetic *Artemia* were studied. Cysts were collected in the Rashekan region with the help of a net, and cysts from the parthenogenetic population living in Urmia Lake were taken from AAARI cyst bank (*Artemia* and Aquatic Animals Research Institute). These two samples were hatched at standard laboratory conditions (LAVENS & SORGELOOS 1996). Nauplii were cultured in 80 ppt salinity. The cysts of adult females were collected and the diameter of untreated and decapsulated cysts and the length of nauplii hatched from these cysts were measured. T-Test was used for analyzing the data. 30 adult females were randomly selected from each population because parthenogenetic populations of *Artemia* rarely produce male sex (MACDONALD & BROWNE 1986). They were then fixed by using %1 lugol solution. 13 morphometrical characters were measured and the number of setae per furca was counted.

There is no significant difference in diameter of decapsulated cyst and the nauplii length between the two samples ($p>0.05$) but untreated cysts of the parthenogenetic *Artemia* from inside Urmia Lake are larger in size than the other population ($p<0.05$) (Table 1). The cyst chorion of the population from inside Urmia Lake (8.31 μm) is also thicker than in specimens from the lagoon (5.53 μm). Ten characters (TL, AL, ED-R, ED-L, LF-R, LF-L, OW, LT, S-R and S-L) show significant differences between the two populations (T-test, $p<0.05$) (Table 2). According to this analysis, the parthenogenetic population within Urmia Lake is larger in size in comparison with the parthenogenetic *Artemia* in the lagoon. On the other hand, the size of furca and number of setae is higher than in the lake parthenogenetic population. In addition, the diameter of decapsulated cyst (embryo) and the nauplii size show no statistical variation between the two parthenogenetic samples, but adult parthenogenetic *Artemia* from in the lake are larger than those frome the lagoon. This can be ascribed to difference growth rates. Study of Table 2 shows that the mean of ED-R shows statistical variation between the two populations, but ED-L does not show any difference. There are significant differences between the length of right/left branches of furca in specimens from the lagoon and also length of right/left antenna in *Artemia* originating from Urmia Lake (pair sample T-test, $p<0.05$). According to these results, there are differences between pair morphometrical characters in *Artemia* but usually only one of these pair characters is used for morphometrical studies. Here, we suggest using of both pair traits such as length of right/left antenna, diameter of left/right eye, length of left/right branch of furca, and

Table 1. Comparison of the diameter of cyst and the length of the nauplii size of two parthenogenetic populations of *Artemia* from the Urmia Lake basin (μm).

Population	Untreated cyst (diameter)	Decapsulated cyst (diameter)	Chorion thickness	Nauplii size (length)
Lake	254.31 (16.90)	237.68 (12.84)	8.31	457.13 (41.37)
Lagoon	245.53 (12.73)	234.46 (12.73)	5.53	459.11 (28.93)
Significance	P<0.05	n.s.	-	n.s.

Table 2.The Mean and S.D. of Body measurement of two parthenogenetic populations of *Artemia* from the Urmia Lake basin (mm). TL= total length, Al = abdominal length, Aw = Abdominal width, HW = Head width, DE = Distance between compound eyes, ED_R = Eye diameter (right), ED_L = Eye diameter (left), LA_R: = Length of right antenna (right), LA_L =: Length of left antenna (left), LF_R = length of furca (Right), LF_L = length of furca (left), OW = Ovisac idth, LT = length of telson, S-R number of setae per furca (right branch), S-L number of setae per furca (left branch).

	TL	Al	AW	HW	DE	ED-R	ED-L	LA-R	LA-L	LF-R	LF-L	OW	LT	S-R	S-L
Lake	9.09 (0.63)	4.68 (0.28)	0.52 (0.04)	0.64 (0.07)	1.36 (0.06)	0.241 (0.02)	0.243 (0.02)	0.89 (0.07)	0.91 (0.06)	0.26 (0.05)	0.26 (0.05)	1.45 (0.24)	1.21 (0.19)	8.57 (1.61)	8.7 (1.34)
Lagoon	8.37 (0.79)	4.27 (0.52)	0.54 (0.06)	0.61 (0.07)	1.38 (0.09)	0.252 (0.02)	0.252 (0.02)	0.89 (0.08)	0.89 (0.09)	0.33 (0.05)	0.34 (0.05)	1.48 (0.15)	0.98 (0.13)	9.97 (1.59)	10.23 (1.94)
Signific.	P<0.05	P<0.05	n.s.	n.s.	n.s.	P<0.05	P<0.05	n.s.	n.s.	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05

number of setae in left/right branch of furca. Principle Components Analysis (PCA) and Discriminant Analysis were used to separate the specimens. The PCA shows that the first and second components respectively contain 35/76% and 21.5% separation respectively and collectively these two components show 57.2% of the total variation. The two populations were almost divided with regards to factor 1 (Fig.1). In the first component, LF-L, LF-R and ED-R, and in the second component TL and AL, have the most important role in separation of the two parthenogenetic groups of specimens. Accordingly, 98.3% of the original female group was correctly recognized in the DA. Moreover, 100% of the Urmia Lake population and 96.7% of the lagoon population were placed in their groups. The parthenogenetic population in the lake is thus more homogenous than the lagoons population. As regards to the results obtained by SORGELOOS & VAN HAECHE (1980), the largest cyst and nauplii belong to the parthenogenetic population from Margarita di Savoia from Italy (284.9±14.6 μm; 517±29.5 μm), whilst the cyst and its nauplii harvested from San Francisco Bay had the smallest cyst biometry (223.9±11.7 μm; 428±28.8 μm). According to these studies, the diameter of the cyst and nauplii of parthenogenetic population are larger than those of the bisexual populations. These findings are confirmed by the result of ZHENQIU et al. (1991) who have shown that the cyst biometry of parthenogenetic populations from Xinjrana Uygur and Shandong are larger than bisexual populations.

In two parthenogenetic populations of *Artemia* studied in Namibia and Madagascar by TRIANTAPHYLLIDIS et al. (1996), the biometry of cyst and nauplii from Namibia were significantly smaller compared ith the cyst and nauplii from Madagascar. These differences have been attributed to the ploidy level; because the population from Namibia is mainly diploid (2n= 42) but the other population from Madagascar was found to be triploid (3n= 63).

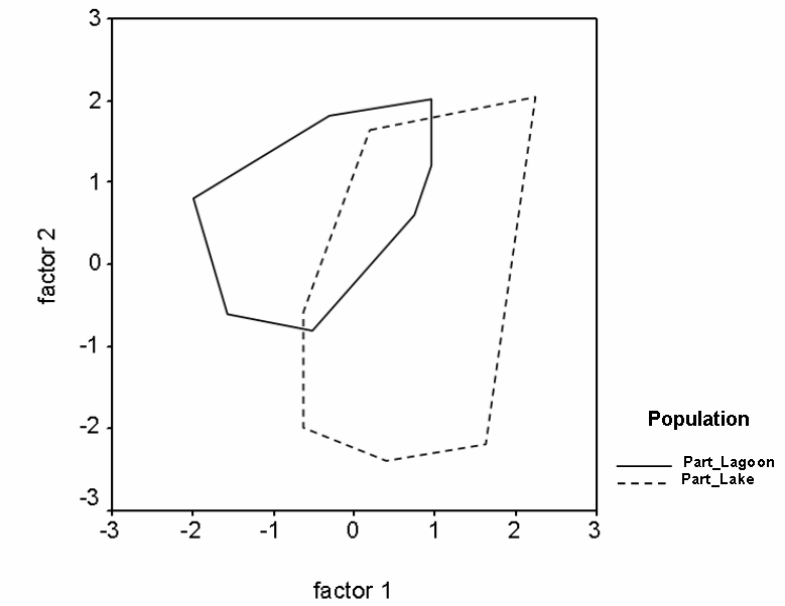

Fig. 1. Principle Component Analysis for parthenogenetic *Artemia* populations from the Urmia Lake basin (part = parthenogenetic population).

Comparison of the results of the biometry of cysts and the adult population from Çamaltı, Turkey (SAYGI 2004) with our results show that the cyst and total length of the parthenogenetic populations from the Urmia lake basin are smaller than the parthenogenetic population from Çamalti, Turkey. In another study on the parthenogenetic cysts from lagoons around Urmia Lake (ABATZOPOULOS et al. 2006), the mean value of untreated cysts was found to be 243.1 (22.8) µm; decapsulated cyst 232.6 (22.5) µm, and chorion thickness 5.2 µm. This study fully confirms our results. According to biometrical study of *A. urmiana* cysts from Urmia Lake, and contrary to VAN HAECHE & SORGELOOS's results in 1980, the cysts diameter of the two parthenogenetic *Artemia* (untreated and decapsulated) match with low range of *A. urmiana* cysts diameter (ASEM et al. 2007). In conclusion, as regards to the present morphometrical study, the two parthenogenetic *Artemia* from the Urmia Lake basin (costal lagoon and in the lake) can be attributed to two isolated populations which are not completely separated. There are two main reasons which may be very important in this particular case: overlapping of habitats and territories through the rise and fall of the Urmia Lake level in different seasons, and gene flow between the two populations via birds.

References

ABATZOPOULOS, T. J.,N. AGH G. VAN STAPPEN, S. M. RAZAVI ROUHANI & P. SORGELOOS (2006): *Artemia* sites in Iran. – Journal of the Marine Biological Association of the United Kingdom 86: 299–307.

ASEM, A., N. RASTEGAR-POUYANI & N. AGH (2007): Biometrical study of *Artemia urmiana* (Anostraca: Artemiidae) cysts harvested from Lake Urmia (West Azerbaijan, Iran). – Turkish Journal of Zoology 31: 171–180.

LAVENS, P. & P. SORGELOOS (1996): Manual on the production and use of live food for aquaculture. – FAO Fisheries Technical Paper, Roma.

MacDonald G. H. & R. A. Browne (1986) Inheritance and reproductive role of rare males in a parthenogenetic population of the brine shrimp, *Artemia parthenogenetica*. – Genetica 75: 47–53.

SAYGI, Y. (2004): Characterization of parthenogenetic *Artemia* populations from Çamaltı (Izmir, Turkey) and Kalloni (Lesbos, Greece): Survival, growth, maturation, biometrics, fatty acid profiles and hatching characteristics. – Hydrobiologia 527: 227–239.

TRIANTAPHYLLIDIS, G. V., T. J. ABATZOPOULOS, E. MIASA & P. SORGELOOS (1996): International study on *Artemia* population from Namibia and Madagascar: cytogenetics, biometry, hatchin characteristics and fatty acid profiles. – Hydrobiologia 335: 97–106.

Van Haecke, P. and Sorgeloos, P. (1980). International study on *Artemia* IV, The Biometrics of *Artemia* strains from different geographical origin. In: The brine shrimp *Artemia*. Vol. 3, (eds. G. Persoone, P. Sorgeloos, O. Roels, E. Jaspers), pp. 393-405, Universa press, Wettern.

Van Stappen, G. (2002): Zoogeography. p. 171–224. In: T. J. ABATZOPOULOS, J.A. BEARDMORE, J. S. CLEGG, & P. SORGELOOS (Eds), Artemia basic and applied biology. – Dordrecht.

ZHENQIU, P., S. JIANHUA, L. MINGREN & B. BOZHONG (1991): The biometry of *Artemia parthenogenetica* from different localities in Shandong and Xinjiang. – Transactions of Oceanology and Limnology (Beijing) 2: 62–69.

Authors' addresses: Alireza Asem, Protectors of Urmia Lake National Park Society (NGO), Urmia, Iran. – Behrooz Atashbar and Naser Agh, *Artemia* and Aquatic Animals Research Institute, Urmia University, Iran. – Nasrullah Rastegar-Pouyani, Department of Biology, Faculty of Science, Razi University, 67149 Kermanshah, Iran. – Email contact: atashbarb@yahoo.com.