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Taxonomic revision of *Loxoconcha muelleri* (Méhes, 1908) and its occurrence in the Neogene of Paratethys and Palaeomediterranean

Elsa GLIOZZI & Costanza FARANDA

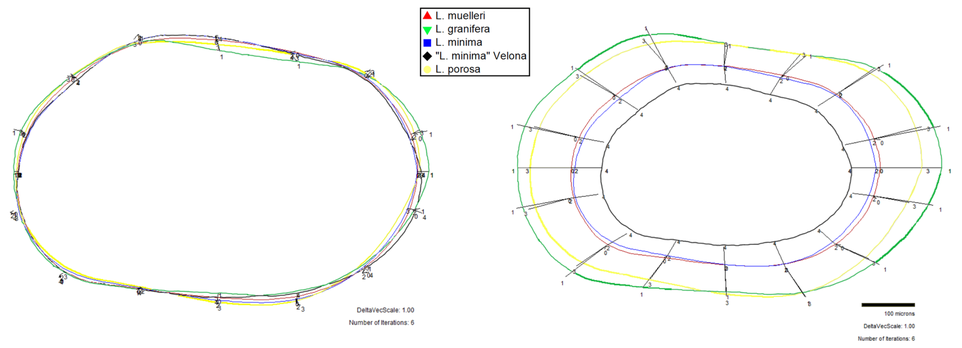
Department of Science, University Roma Tre, Largo S. Leonardo Murialdo 1, 00146 Rome, Italy (elsa.gliozzi@uniroma3.it; costanza.faranda@uniroma3.it)

Loxoconcha muelleri was established by Méhes (1908) on specimens collected from the lower Pannonian of the Pannonian Basin. It became a relevant species when, in 1978 Carbonnel recorded it for the first time in the Palaeomediterranean within the upper Messinian sediments related to the Lago Mare phase of the Messinian Salinity Crisis (MSC). Since then, it was reported from several Lago-Mare Palaeomediterranean localities, from Malaga (Spain) to the west, to Adana (southern Turkey) to the east (Guerra-Merchán et al., 2010; Faranda et al., 2013). Furthermore, biostratigraphic studies claimed its early occurrence in the Lago Mare phase, representing the first Paratethyan immigrant in the Palaeomediterranean (Grossi et al., 2011).

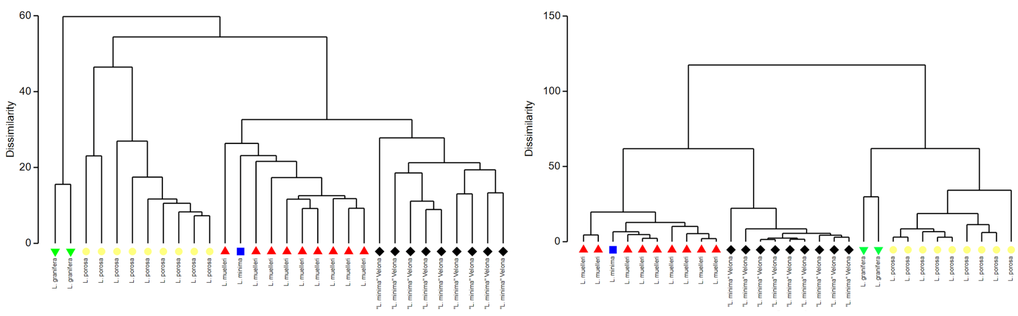
Notwithstanding the great popularity that the species assumed in the MSC, some doubts were expressed by Stoica et al. (2016) about the presence of *L. muelleri* in the Palaeomediterranean during late Messinian, since in Paratethys the species was not recovered in sediments younger than early Maeotian (late Tortonian-early Messinian). Indeed, this observation rises some relevant questions about tempo and mode of its migration in the Palaeomediterranean. It is possible that the Lago-Mare *L. muelleri* was misidentified? To answer this question, we present here the taxonomic revision of *L. muelleri* and some affine species [*Loxoconcha porosa* Méhes, 1908, *Loxoconcha minima* Müller, 1894 and *Loxoconcha granifera* (Reuss, 1850) as well as some Messinian "*L. minima*" valves from the Velona Basin (Ghetti et al., 2002) and Lago-Mare "*L. muelleri*" from several localities] provided through optical stereomicroscope and SEM observation as well as geometric morphometrics using the software MORPHOMATICA (Baltanás & Danielopol 2011).

normalised for area *NOT normalised for area*

MORPHOMATICA output (mean outlines female right valve)



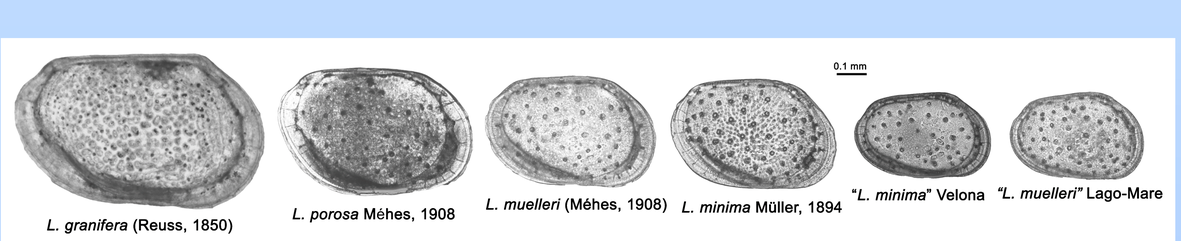
Cluster Analysis (Euclidean's distance)



ANOSIM pairwise tests R

	L. muelleri	*L. granifera*	*L. minima*	*"L. minima"* Velona	*L. porosa*
L. muelleri					
L. granifera	0,997				
L. minima	0,673	1			
"L. minima" Velona	0,818	1	0,877		
L. porosa	0,770	0,916	0,537	0,976	

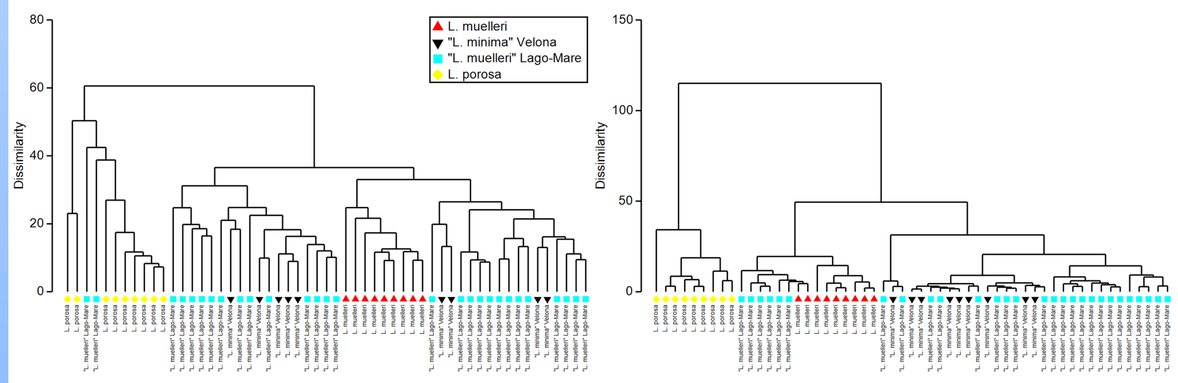
	L. muelleri	*L. granifera*	*L. minima*	*"L. minima" Velona*	*L. porosa*
L. muelleri					
L. granifera	1				
L. minima	-0,065	1			
"L. minima" Velona	1	1	1		
L. porosa	0,993	0,970	1	1	



L. granifera (Reuss, 1850) *L. porosa* Méhes, 1908 *L. muelleri* (Méhes, 1908) *L. minima* Müller, 1894 "*L. minima*" Velona "*L. muelleri*" Lago-Mare

normalised for area *NOT normalised for area*

Cluster Analysis (Euclidean's distance)



ANOSIM pairwise tests R

	L. muelleri	*"L. minima"* Velona	*"L. muelleri"* Lago-Mare	*L. porosa*
L. muelleri				
"L. minima" Velona	0,82			
"L. muelleri" Lago-Mare	0,20	-0,05		
L. porosa	0,77	0,98	0,85	

	L. muelleri	*"L. minima"* Velona	*"L. muelleri"* Lago-Mare	*L. porosa*
L. muelleri				
"L. minima" Velona	1,00			
"L. muelleri" Lago-Mare	0,51	0,01		
L. porosa	0,99	1,00	1,00	

The results of the geometric morphometric analysis on the female right valves reported in the figure above, show that, notwithstanding the similar morphometric characters shared by all the specimens, both the cluster analyses in "normalised for area" and "not normalised for area" modes (cophenetic correlation coefficients, respectively, 0.86 and 0.82) clearly separate the species *L. muelleri*, *L. porosa*, and *L. granifera*. Unexpectedly, the only one specimen of *L. minima* from the Gulf of Naples falls into the group of *L. muelleri*, whereas the fossil specimens labelled "*L. minima*" from the Velona Basin group separately. Following the ANOSIM pairwise tests (global R=0.82 for "normalised for area" and 0.97 for "not normalised for area", p<0.1%), the cluster groups are confirmed, as all the taxa result statistically different from each other, except for *L. minima* and *L. muelleri*.

The figure above illustrates the results of the geometric morphometric analysis of the female right valves of *L. porosa, L. muelleri*, "*L. minima*" Velona and "*L. muelleri*" Lago-Mare. In both dendrograms in "normalised for area" and "not normalised for area" modes (cophenetic correlation coefficient, respectively 0.82 and 0.90), *L. porosa* valves are grouped in a well separated cluster (particularly in "not normalised for area" mode), whereas *L. muelleri*, "*L. minima*" Velona and "*L. muelleri*" Lago-Mare are all included in the second cluster.

The ANOSIM pairwise tests (global R=0.42 for "normalised for area" and 0.64 for "not normalised for area", p<0.1%) are coherent with the cluster analyses, since *L. porosa* shows a R statistic near or equal to 1 respect to the three other taxa, while *L. muelleri* and "*L. minima*" Velona are quite well separated, but there is no significant separation between *L. muelleri* and "*L. muelleri*" Lago-Mare and between "*L. muelleri*" Lago-Mare and "*L. minima*" Velona.

CONCLUSION

1) *L. muelleri*, *L. porosa*, and *L. granifera* are distinct valid species;
2) *L. muelleri*, "*L. minima*" Velona and "*L. muelleri*" Lago-Mare could all be referred only to the species *L. muelleri* and the slightly different outlines and dimensions of the valves could be due to environmentally cued polymorphism (decreasing salinity at Velona and Lago-Mare basins)

or

3) *L. muelleri*, "*L. minima*" Velona and "*L. muelleri*" Lago-Mare are part of the same phyletic lineage started with *L. muelleri* in the Pannonian of the Paratethys. Somehow in the Tortonian, *L. muelleri* colonised the Palaeomediterranean (oligohaline Velona Basin) and gave origin to a different species that, later on, diffused in the late Messinian Lago-Mare oligo-mesohaline basins.

From a palaeobiogeographic point of view, the "typical" *L. muelleri* remained confined in the Paratethys domain until the Maeotian, whereas "*L. muelleri*" Lago-Mare did not spread in the Palaeomediterranean at the beginning of the Lago-Mare phase from the Paratethys, but was already present in the Palaeomediterranean area since, at least, the early Messinian.

REFERENCES

Baltanás, A., Danielopol, D.L., 2011. Joannea Geologie und Palaeontologie 11, 235–272. **Carbonnel, G.**, 1978. Revue de Micropaléontologie 21, 106–118. **Faranda, C., Gliozzi, E., Cipollari, P., Grossi, F., Darbaş, G., Gürbüz, K., Nazik, A., Gennari, R., Cosentino, D.**, 2013. Turkish Journal of Earth Sciences 22, 839–863. **Ghetti, P., Anádon, P., Bertini, A., Esu, D., Gliozzi, E., Rook, L., Soulié-Märsche, I.**, 2002. Palaeo3 285, 1-33. **Grossi, F., Gliozzi, E., Cosentino, D.**, 2011. Joannea Geologie und Palaeontologie. 11, 66–68. **Guerra-Merchán, A., Serrano, F., Garcés, M., Gofas, S., Esu, D., Gliozzi, E., Grossi, F.**, 2010. Palaeo3 285, 264–276. **Méhes, G.**, 1908. Földtani Közlöni, suppl., 38, 601- 635. **Stoica, M., Krijgsman, M., Fortuin, A., Gliozzi, E.**, 2016. Palaeo3 441, 854–870.