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Breaking biogeographic barriers: Molecular and morphological evidences for the Lessepsian invasion of soritid foraminifers to the Mediterranean Sea

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In recent years we have been witnessing a large-scale invasion (tropicalization) into the Eastern Mediterranean of many alien tropical species. The main factors that promote this process includes: 1. The ongoing warming of sea surface temperatures in the last decades. 2. The opening of the Suez Canal in 1869 that created an artificial connection between the Mediterranean and the Indo-Pacific realm of the Red Sea. This connection resulted in an ongoing unidirectional migration (termed the Lessepsian migration) of hundreds of species from Red Sea to the Mediterranean Sea. 3. The closure of the Nile River by the High Aswan Dam that blocked its nutrient discharge and created hyper-oligotrophic conditions in the Eastern Mediterranean.

Larger symbiont-bearing benthic foraminifera were chosen in this study as an ideal target group for documenting this process. Their main advantage is that some of these species are clearly Indo-Pacific migrants while others represent re-encountering of allopatric populations that were isolated for at least 5.5 m.y.

The first stage of this study involved the genetic characterization of soritids. Living specimens of Sorites and Amphisorus morphospecies were collected from the Red Sea and the Mediterranean and their ribosomal DNA (rDNA) sequences were determined in order to see the genetic relation between these two "recently connected" locations. The morphological characteristics of each specimen were documented by Scanning Electron Microscope micrographs and digital imaging. In the Red Sea, the specimens were collected from two shallow stations (5-6 m water depth) in the Gulf of Elat, representing different habitats: 1. Tur-Yam, characterizes by abundant Halophila sea grass. 2. The Inter University Institution in Elat, characterizes by pebbles with no sea grass. In the Mediterranean, specimens were collected along the shore of Northern Israel at Shikmona, Haifa, one of the few locations along the Israeli Mediterranean coast where living soritids are found. At this location, specimens are found attached to rocks at water depth of a few centimeters. The genetic data collected was compared to available data from GeneBank database and phylogenetic trees of the soritids were constructed.

Three distinct soritid species were found in the Gulf of Elat: Sorites spp. Amphisorus hemprichii and another species, which is genetically related to Amphisorus but morphologically similar to Sorites (has one row of apertures on the rim). Only one distinct genetic variant of Sorites was found in Shikmona, The fact that all Sorites from Shikmona share the same sequence would suggest that all of them originated from the same genotype that probably migrated to the Mediterranean from the Red Sea. This means that the Sorites in the eastern Mediterranean is probably a Lessepsian migrant originated from one of the Sorites variants from the Indo-Pacific province and not a relict of the tropical Atlantic interglacial periods.