Changes in oceanographic fronts affect the gene flow among marine crab populations

June 29 2022

The team focused the study on the harbour crab (Liocarcinus depurator), a decapod crustacean of commercial interest. Credit: *Scientific Reports* (2022). DOI: 10.1038/s41598-022-13941-4

In the Mediterranean and the Atlantic, the intensity and location of the oceanographic fronts that limit the gene connectivity among populations

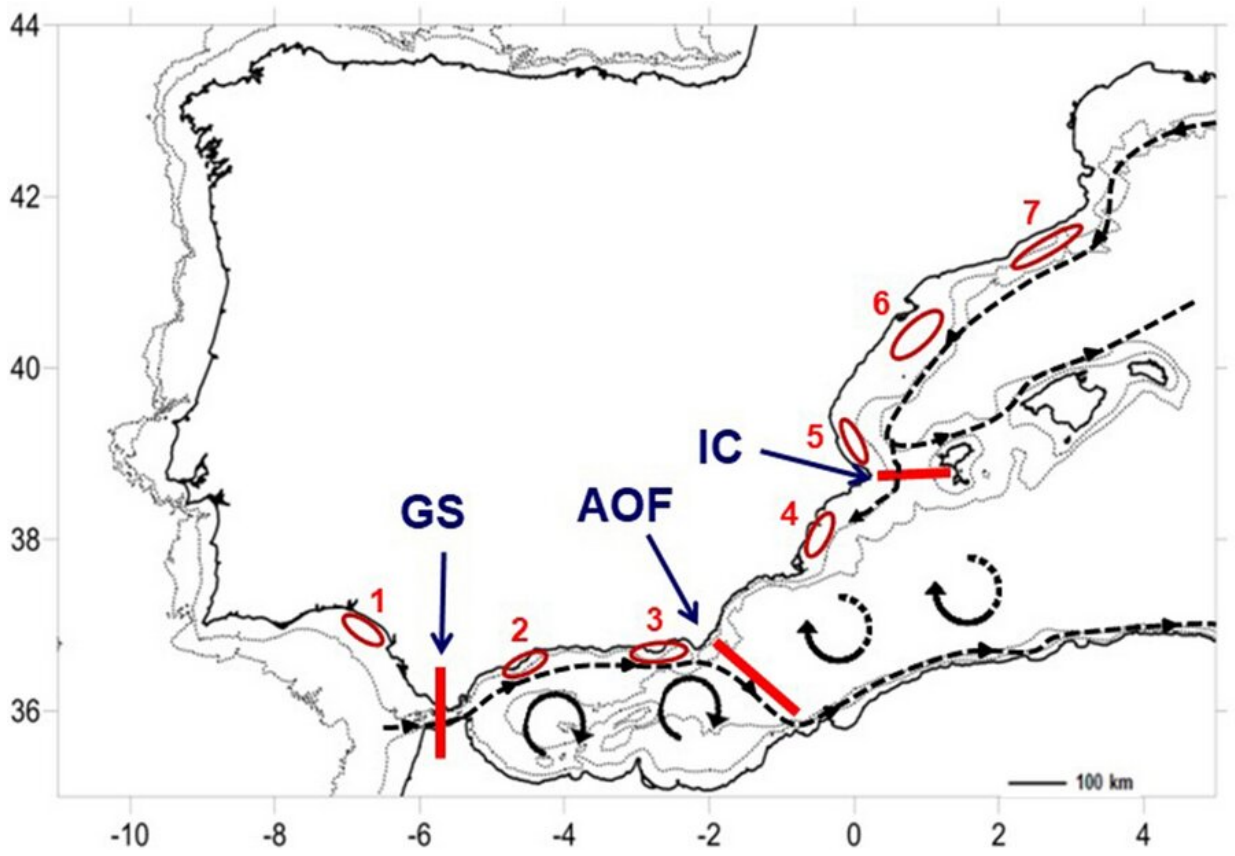
of marine crabs vary over time. These dynamic changes, described in an article published in the journal *Scientific Reports*, alter the gene structure of the populations of marine crabs of commercial and gastronomic interest.

The new study is led by the experts Francesc Mestres, from the Faculty of Biology and the Biodiversity Research Institute of the UB (IRBio), and Pere Abelló, from the Institute of Marine Sciences (ICM-CSIC), and it provides data of scientific interest to improve the policies on the conservation and commercial exploitation of these crustaceans.

Among the coauthors of the study are the lecturer Concepción Arenas and the bachelor and master's degree students Víctor Ojeda, Bruna Serra, Clàudia Lagares, Eva Rojo-Francàs and Maria Sellés, from the Faculty of Biology of the UB, as well as other experts from the Spanish Institute of Oceanography (IEO-CSIC).

Oceanographic fronts are dynamic and changing

Marine currents can modulate gene flow—i.e., the passing of genes among populations of a same species—in the oceanic environment. This genetic connectivity is a fundamental factor in the biological evolution.



Sampling populations of Liocarcinus depurator in the Atlantic-Mediterranean transition. Most populations were sampled in the period 2014–2019 (see text for details). Sampling areas appear in red color. Location numbers and acronyms are: 1. Cadiz (CADI), 2. West Alboran Sea (WALB), 3. East Alboran Sea (EALB), 4. Alacant (ALAC), 5. Valencia (VALE), 6. Ebro Delta (DELT) and 7. North Catalonia (NCAT). Dashed lines identify the main currents and gyres in the studied area. Oceanographic fronts appear as solid red lines: Gibraltar Strait (GS), Almeria-Oran Front (AOF) and Ibiza Channel (IC). Credit: Víctor Ojeda et al, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-13941-4; Surfer/Golden software Inc.

In terrestrial animals, the different natural barriers—mountains, rivers, deserts, etc.— can reduce this gene migration among populations. In the case of the marine environment, the classic view was that organisms, in

adult or larval stages, could move freely in the water and transfer their genes without interferences. However, there is growing evidence of the role of oceanographic fronts—marine discontinuities that result from the movement of the water mass—when limiting the movement and dispersal of marine species.

"Marine currents can move the organisms to great distances, but they can produce eddies and gyres, which generate oceanographic fronts and limit gene flow among populations, even if they are close on a geographical scale," notes Professor Francesc Mestres, from the Department of Genetics, Microbiology and Statistics of the UB.

"The study," he continues, "highlights that the intensity and location of these fronts can vary over time, and this oceanographic dynamic and generate a great temporary variability in the connectivity patterns among species."

Harbour crabs as a study model

The team focused the study on the harbour crab (Liocarcinus depurator), a decapod crustacean of commercial interest—a common element in fish soup and rice dishes—which lives in the muddy sea bottoms of the continental shelf, between 50 and 200 meters deep.

The populations of this crab were sampled from 2014 to 2019 during the IEO-CSIC MEDITS and ARSA fishing and oceanographic campaigns, in a total of seven marine populations of the Atlantic-Mediterranean transition: Cadiz, West and East Alboran Sea, Alicante, Valencia, Ebro Delta and North Catalonia. Some of the crab populations were in both sides of the oceanographic barriers of the western Mediterranean basin: specifically, the Gibraltar Strait (GS), the Almeria-Oran front (AOF) and the Ibiza Chanel (IC).

To analyze the gene flow and the genetic variability of populations, the team studied a fragment of the mitochondrial gene cytochrome oxidase subunit I (COI), one of the most used in ecological and evolutionary studies. In total, 966 sequences of the gene were analyzed in marine crabs from the above-mentioned populations.

"Specifically, the adult crabs analyzed in a particular year had dispersed the previous year, when they were in a larval form, so they could provide information on the state of currents and fronts of the previous year," notes the expert Pere Abelló (ICM-CSIC).

The analysis of the temporal series data reveals that there are two well-defined hablogroups of gene sequences in the study area: the Atlantic (ATL) and the Mediterranean (MED), which are more abundant in Atlantic waters and Mediterranean waters, respectively.

"The population distribution of haplotypes (combinations of alleles) varies over the analyzed time period as a consequence of the existence of oceanographic barriers. For instance, in the case of the Gibraltar Strait, a statistically significant effect on the reduction of gene flow has been found in four of the six studied years. The Almeria-Oran front is also a key barrier, but its location and effects on gene flow varied over the years. Specifically, just in the year in which the front was displaced towards the center of the Alboran Sea, a significant effect on the reduction of gene flow was detected in the Ibiza channel, another oceanographic front," says Francesc Mestres.

Therefore, the joint study of all the populations over the different years made it possible to define three areas according to the genetic content of the crabs found in the Atlantic-Mediterranean transition region: the Gulf of Cadiz, the Alboran Sea and the Levantine-Catalan populations.

"These results are of special interest for the proper definition of the

Marine Protected Areas and also to improve conservation and fisheries management policies for this marine crab. Especially in a context of global change with increasingly higher temperatures that could threaten this animal populations," concludes the research team.

More information: Víctor Ojeda et al, Interannual fluctuations in connectivity among crab populations (Liocarcinus depurator) along the Atlantic-Mediterranean transition, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-13941-4

Provided by University of Barcelona