The turbot: The first vertebrate to be sequenced in Spain

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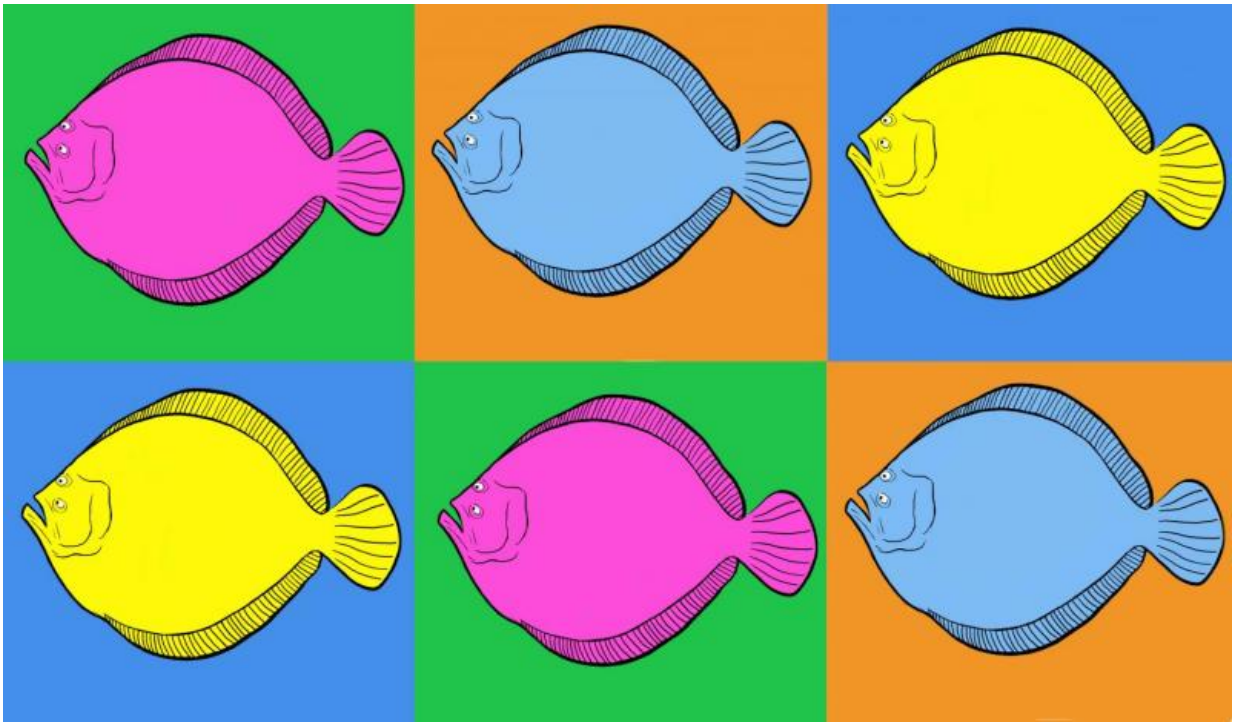

The turbot lives on the sea-bed, which means it has had to adapt to an environment of very little light and chillier waters. Credit: CSIC Communications Department

The first vertebrate to be genetically sequenced in Spain, the Turbot (*Scophthalmus maximus*), has a much more highly developed sense of sight than other fish, since it has evolved in order to adapt itself to the

lack of light on the sea bed. In addition, its genes show us that the levels of fat in its cellular membranes are far higher than in other species, so as to be able to withstand the low water temperatures in its habitat.

The complete genome sequencing of this fish, carried out by scientists from the Spanish National Research Council (CSIC), the University of Santiago de Compostela, and Spain's National Centre for Genome Analysis in Barcelona have brought this and other conclusions to light. The work opens the way for further investigation, not only into the Turbot's resistance to different illnesses, but also to look more deeply into how other fish respond to these pathologies. The results, published in the magazine DNA Research, could be used in the future design of genetic selection programmes, or in possible vaccines.

The flat-bodied Turbot, rhomboid-shaped, and with both eyes found on its left side, underwent a process of metamorphosis during its development, which is when it began to develop a body distribution which is atypical in flat fish. And it's because of this circumstance it lives on the sea-bed, which means it has had to adapt to an environment of very little light and chillier waters.

"We have seen that many of the genes which are involved in sight, mainly those which carry pigment codes, and others involved in forming the crystalline, are repeated in this vertebrate with respect to other fish. This would indicate that they have evolved, refining their sense of sight to adapt to the low levels of light which surrounds them", says CSIC investigator, Antonio Figueras, from the Institute of Marine Investigation in Vigo.

In order to tolerate these low temperatures, the Turbot has a number of genes related to fatty acids in the repeated cellular membranes, when compared with other organisms which live at higher temperatures. The lipid composition of these membranes is a key factor when it comes to

withstanding cold.

Spain: a leading producer in Europe

Scientists have managed to identify the most important genes involved in growth, sexual differentiation, and disease resistance, including which specific parts of the genome affect these production traits. "This information is essential to the development of more efficient genetic selection projects, with the aim of identifying the breeding fish with the best production traits", highlights Figueras.

Spain is the number one producer of farmed turbot in Europe, with 99% of the total harvest produced in Galicia. According to a report by The Business Association of Marine Aquaculture Producers (APROMAR), European Turbot production reached 11,000 tonnes in 2014, 38% up on 2013. In the same year, the estimated value of the catch across Europe was €75.6m.

According to Paulino Martínez, a researcher at the University of Santiago de Compostela, although present day turbot farming is well established, the main problems fish farmers face are related to the species' susceptibility to a range of bacterial, viral, or parasitic diseases and illnesses. As yet, no vaccines or effective treatment exist for many of these pathologies.

Another of the challenges facing the sector is how to shorten the time required for the fish to reach a marketable size. "This could be improved by selecting those genes which are involved in growth and sexual differentiation, given that females show far better growth rates compared with males", adds Martínez.

More information: dx.doi.org/10.1093/dnares/dsw007

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