

Surrogate technology: The future of aquaculture

Seafood is an important source of protein as well as a food source. With the global population expected to exceed nine billion in 2050, demand is likely to increase. Many fish are already on the brink of extinction due to overfishing, consequently, aquafarming has become important to the challenge of securing food resources.

This project aims to develop new aquaculture technology, such as surrogate broodstock technology. In surrogate technology, one fish species is used to hold another species' offspring. If the host species is small, they are more efficient, because they can be maintained using less space and food. In addition, the time to reach maturity can be shortened using small fish (usually, large fish take longer to reach maturity). In our research our small species is the Yellowtail kingfish (*Seriola lalandi*) (YTK) (order Perciforms) as a possible host for tuna.

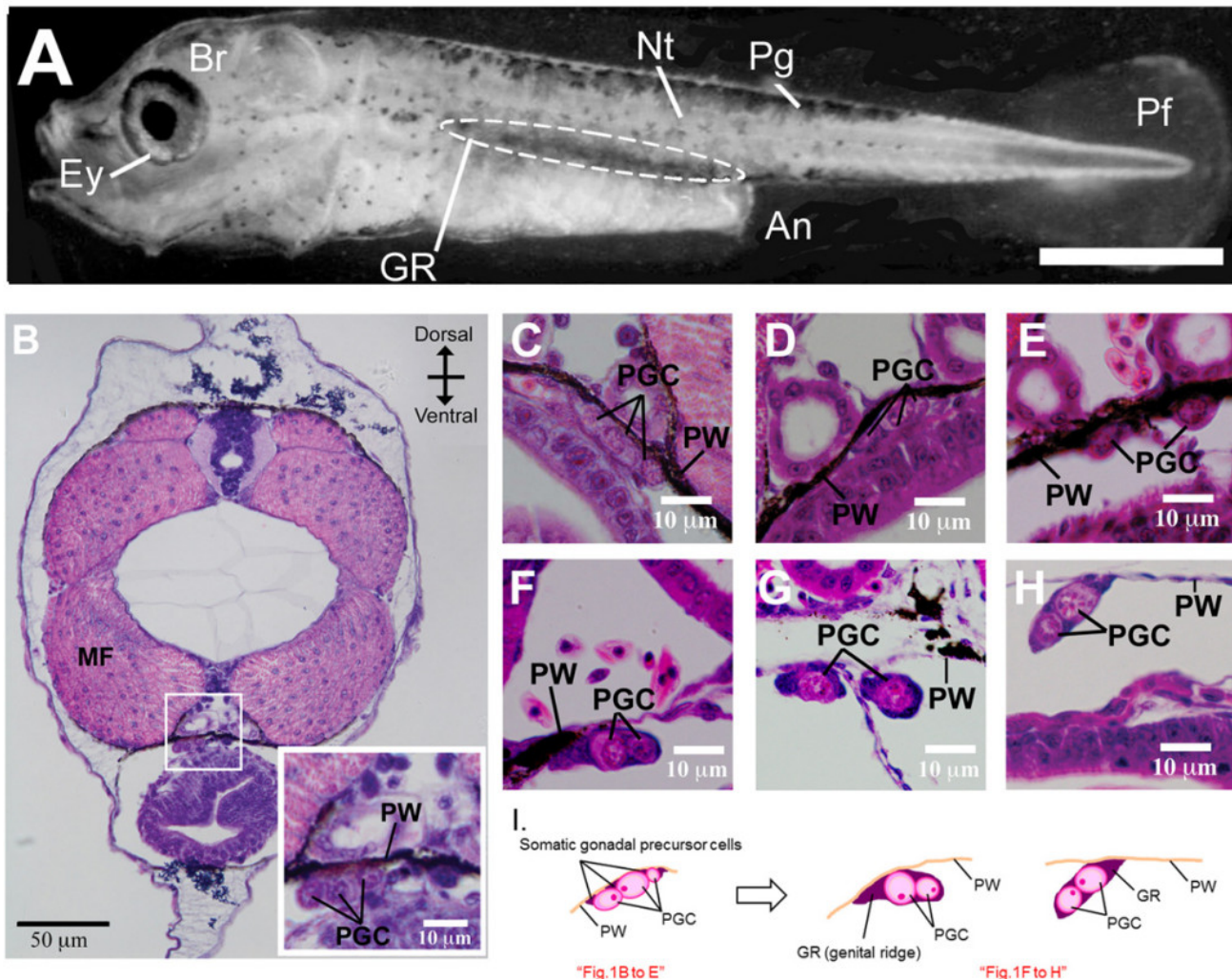


Fig. 1. Whole-mount and transverse sections of yellowtail kingfish larvae showing migration of

primordial germ cells during early gonad development. (A) Whole-mount larvae at 7 DPH showing anatomical structures. Dashed circular region defines the region where primordial germ cells are found migrating to the genital ridge. (B-H) Sagittal sections through the gonadal regions stained with H&E at 3, 5, 7, 10, 15, 18 and 20 DPH, respectively. (I) Schematic representation of the PGCs positioned along the peritoneal wall on their migration towards the genital ridge. An = anus, Br = Brain, Ey = eye, GR = genital ridge, Pf = pectoral fin, Pg = pigment, Nt = notochord. PGC = primordial germ cell, PW = peritoneal wall, SC = somatic cell, I = intestine, MF = muscle fibres.

To achieve a successful surrogate technology is necessary to understand the mechanism involved in gonad development. Gonads develop from a specific type of cell called Primordial Germ Cell (PGC), giving rise to either spermatogonia or oogonia (future male testis or female ovaries). Currently, there is little information on the mechanism of PGCs development in Perciform fish like the YTK, but this study aims at being able to find out these mechanisms. Our fish model species, YTK, *Seriola lalandi* (order Perciforms), which inhabits tropical and temperate waters in the southern hemisphere, therefore it can be easily studied in Australia, as they are commercially available. In this study, histological analysis of YTK larvae revealed critical time points for the migration of PGCs, these time points are crucial since they reveal the exact time in which to carry out a successful implant of PGCs from a donor species, like tuna, allowing the gonad formation of the donor gonad inside the YTK host specimen. In early stages of YTK larvae around 3 to 10 Days post hatch (DPH), PGCs were not yet enclosed by somatic cells (Cells not involved in gonad formation), indicating the primordial gonad had not yet started to form. While at 15 to 20 DPH PGCs had already settled at the genital ridge and started to become enclosed by somatic cells indicating the primordial gonad had started to develop. A higher number of PGCs were observed in the larvae at 15 and 18 DPH indicating PGCs proliferation, which corresponds with them becoming enclosed by the somatic cells. Directional migration of PGCs towards the genital ridge is a critical event in the subsequent development of a gonad. In all species investigated to date, PGCs migrate from the position where they are specified towards the region where the prospective primordial gonad will form and develop.

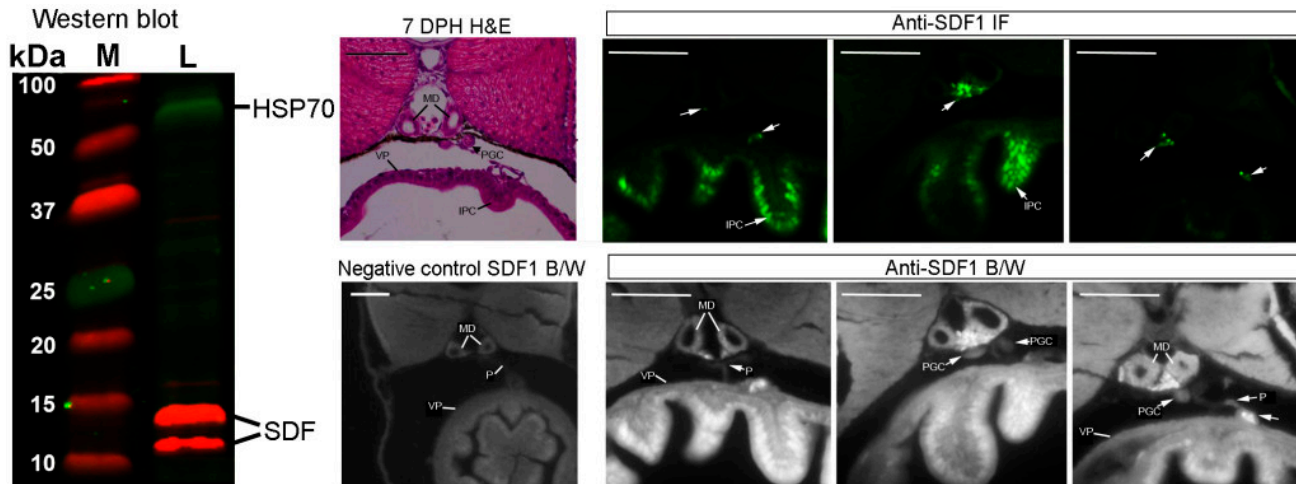


Fig. 2. Western blot analysis and Immunofluorescent localisation of YTK SDF1 protein at 7 DPH. Western blot shows specific staining of YTK SDF1 between 10 and 15 kDa and HSP70 in the region of 70 kDa. M = marker, L = larvae. A representative paraffin transverse section through a larvae at 7 DPH (H&E stained), shows region of interest. Immunofluorescence showing localisation of SDF1 antibody (green) on paraffin sections. Expression is detected in the peritoneum where the PGC are observed as well as in the intestinal epithelial cells. Arrows point to sites of immunolocalisation, negative control shows no immunolocalisation. Corresponding B/W images are provided for better visualisation of cell structure. PGC = Primordial germ cells, P = Peritoneum, IPC = intestinal epithelial cells, VP = Visceral peritoneum, MD = Mesonephric ducts.

In zebrafish, mouse and chicken, stromal-cell derived factor (SDF1) signalling gene is one of the key molecules for PGCs migration, emitting a signal to the PGCs allowing them to go from their initial point to the target area, the gonad region. We subsequently isolated the SDF1 (Slal-SDF1) gene of the YTK, and conservation between fish species was observed when compared with zebrafish (*Orizias latipes*), medaka (*Danio rerio*), salmon (*Salmon salar*), among others. In summary, this study established the time of PGC migration in YTK, and examined one of the key molecules involved in PGC migration (SDF1) using PCR, immunohistochemistry, in situ hybridisation and structural modelling. These results support findings in other fish species and provide a platform for further studies into the molecular machinery of PGC migration in YTK, as well as other perciform fish species. This information formed the basis for a trial assessing YTK as a surrogate for the Southern bluefin tuna.

Jorge Amat Fernandez
*Genecology Research Centre, Faculty of Science, Health, Education and Engineering,
University of the Sunshine Coast, Maroochydore, Queensland, Australia*

Publication

[Primordial germ cell migration in the yellowtail kingfish \(*Seriola lalandi*\) and identification of stromal cell-derived factor 1.](#)

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