Applications of Genomics Selection for Swimming Performance in Large Yellow Croaker

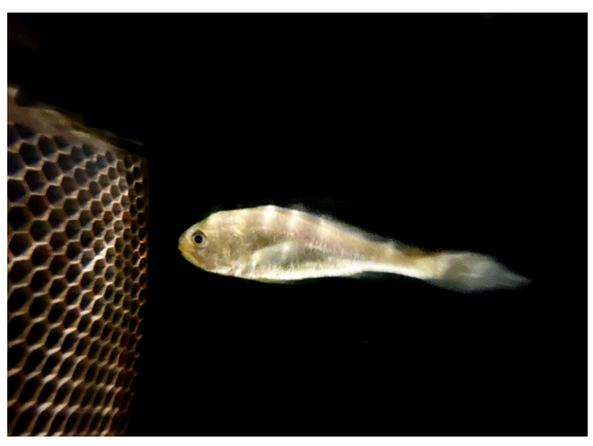
Peng Xu, Ning Li, Junjia Zeng

State key laboratory of Mariculture Breeding

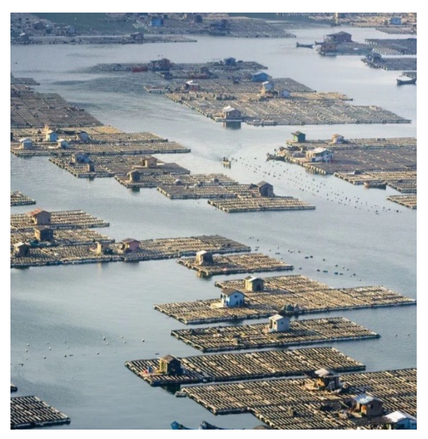
College of Ocean and Earth Sciences

Xiamen University, Xiamen 361102, China

Introduction

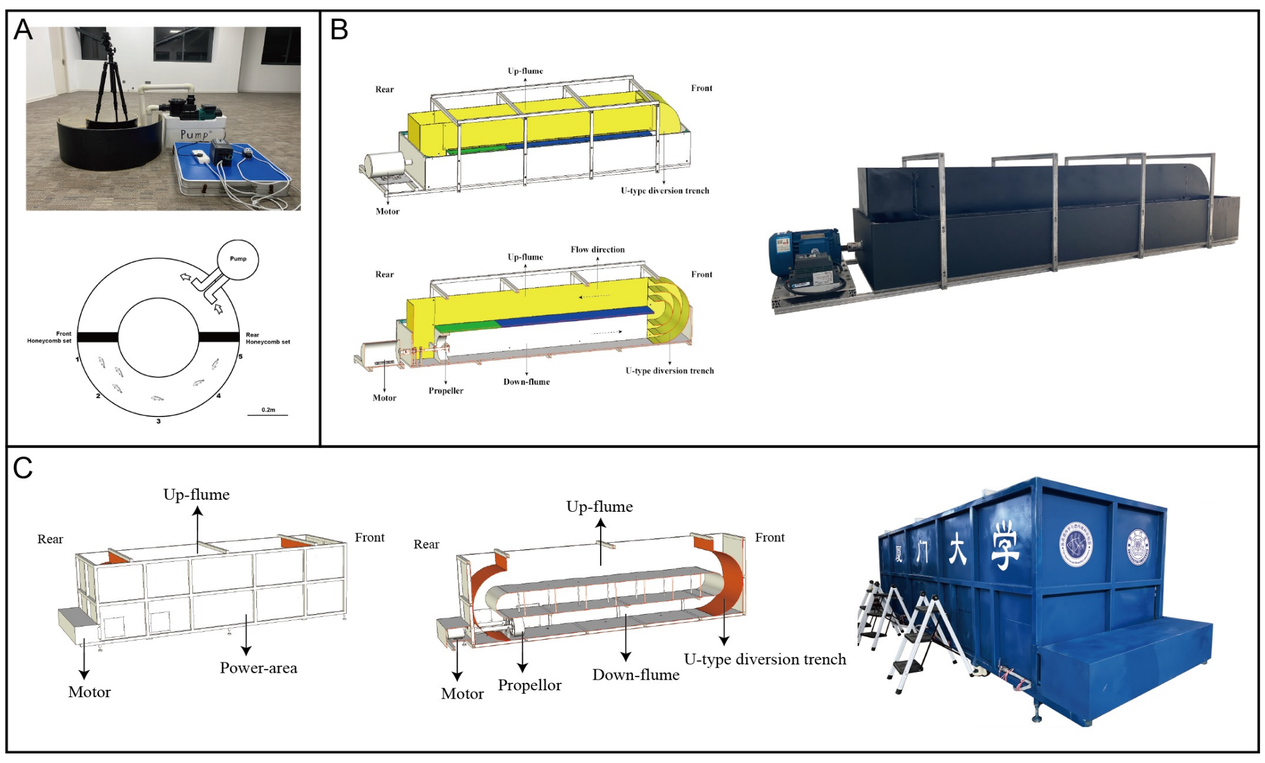


Large yellow croaker (*Larimichthys crocea*) is the largest fish species produced by marine aquaculture in China. Nevertheless, the croaker aquaculture industry is currently confronted with significant challenges, including the prevalence of severe parasite diseases and the inability of cultured species to tolerate rapid currents. In light of these considerations, we conducted studies investigating disease resistance associations and genomic selection (GS) for swimming performance in large yellow croaker.

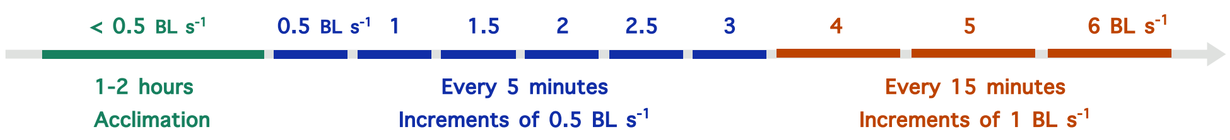


Materials and Methods

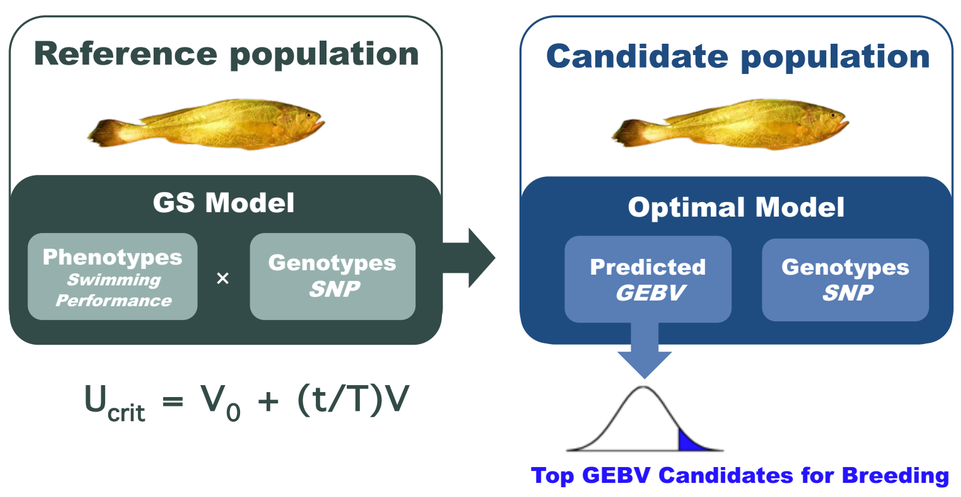
Three version of devices for swimming test



Circular swimming tunnel (A), 2nd flow-straight tunnel (B) and 3rd flow-straight tunnel (C) for swimming test with fish of different sizes. All three version of devices produce lamellar flow with an artificially controlled flow rate and are used to assess the swimming performance of large yellow croaker using a **critical swimming speed (U_{crit}) test:**



Genomic selection scheme



$$U_{crit} = V_0 + (t/T)V$$

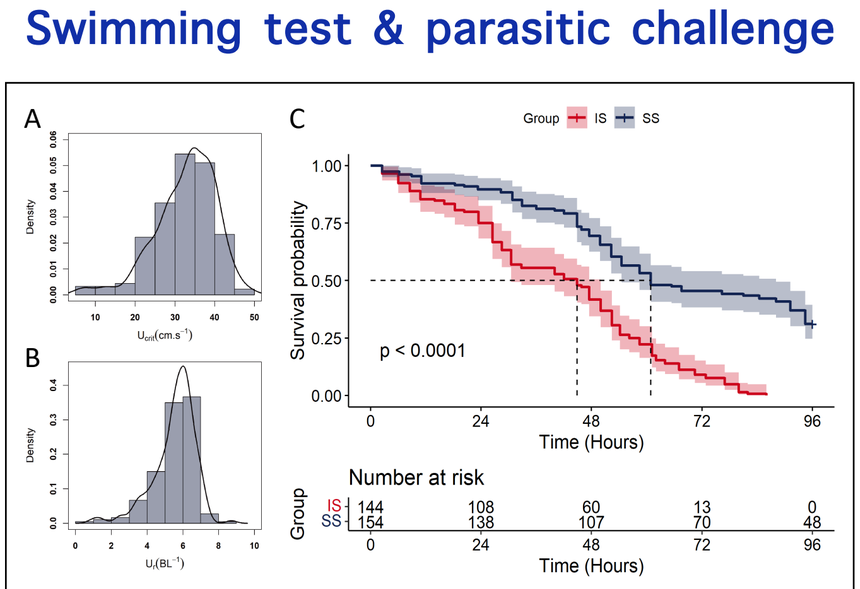
The optimal GS model was selected to calculate the GEBV of the candidate population, and top GEBV candidates were naturally mated. Their offspring were bred as selective line (SL). The remaining individuals were bred as control group (CG).

Timeline

2021.06	→	2022.01	→	2022.06
Swimming test		Genomic selection		Offspring testing
Reference population		Candidate population		Selective line Control group

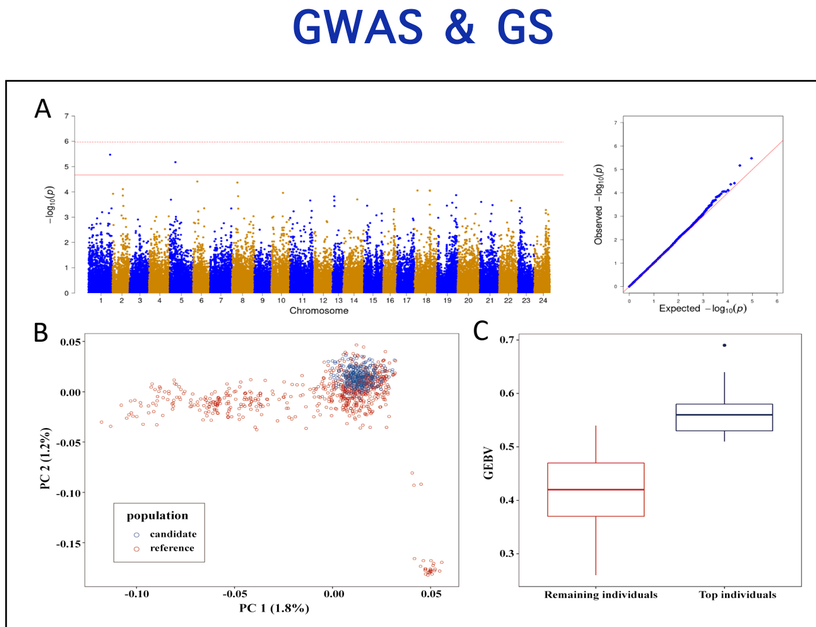
Results

Swimming test & parasitic challenge



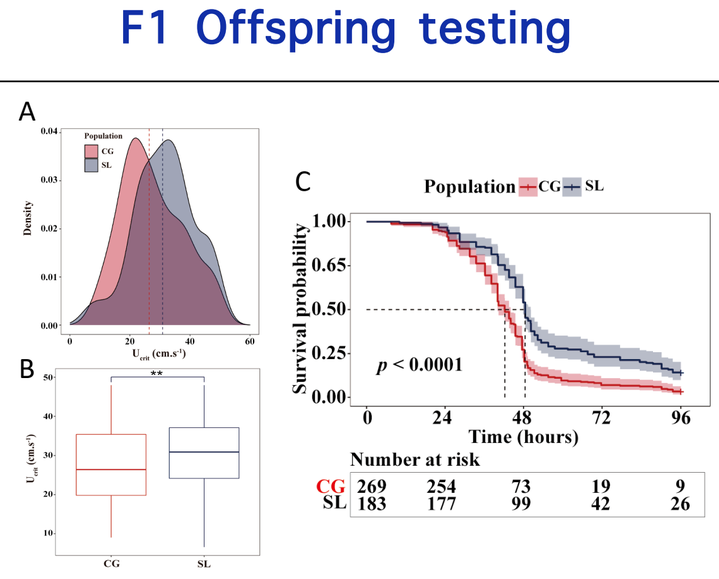
There were individual differences in the U_{crit} of large yellow croaker. And individuals exhibiting superior U_{crit} (SS) significantly more resistant to parasite disease than those with inferior U_{crit} (IS): all IS were dead after 86h, while the survival rate of SS remained at 31% after 96h.

GWAS & GS



U_{crit} in large yellow croaker is a complex trait, with a heritability of 0.21. BayesB method was used to calculate GEBV and selected the 46 candidates ranking in the top 12 % of GEBVs as the parental breeding SL, the remaining candidates were bred as the CG.

F1 Offspring testing



GS for U_{crit} in large yellow croaker to produce offspring with both improved swimming performance and resistance to parasite disease: The average U_{crit} of SL was 14.7% higher than that of CG; the survival rate of SL was 10.8% higher than that of CG after 96h of parasite infection.

Conclusions

1. This study is the first GS for swimming performance in fish, which proves that this breeding strategy can achieve the genetic improvement of flow resistance in large yellow croaker, and also has the potential of breeding for disease resistance in fish.
2. Our work show that swimming performance is critical to "Robustness breeding", as we aim to develop stock strains that are strong enough to survive in offshore areas tolerating rapid currents, and simultaneously resistant to diverse diseases.

Acknowledgement

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References

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