Integrative microbiome and metabolome analysis reveals novel insights into sexual size dimorphism in golden pompano (*Trachinotus blochii*) linking gut microbiota and growth

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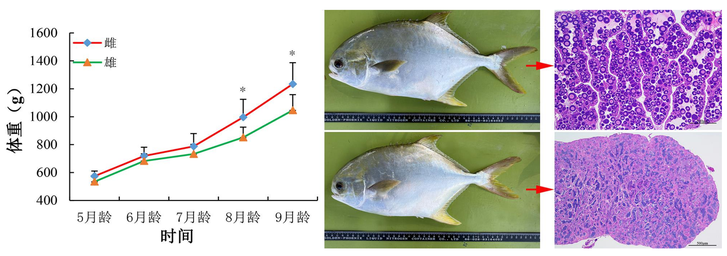
Introduction

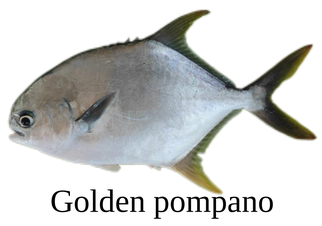
Fish growth is a typical complex trait, with many species exhibiting significant growth dimorphism between males and females. Golden pompano are dioecious, and the growth rate of females is faster than that of males. Under cage culture conditions, observations revealed significant differences in the growth of male and female pompano after seven months of age, with females being 17% larger than males.

To better understand growth dimorphism, it is important to study the growth differences between male and female pompano and analyze the effects of intestinal flora and metabolites on growth. This will help to reveal the regulatory mechanisms underlying growth dimorphism in pompano.



Methods

To determine the sex of golden, a combination of pit electronic markers and SNP-specific sex markers was used to determine males and females. Golden pompano was randomly divided into three groups, Male, Female and Mix.



Golden pompano (*Trachinotus blochii*)

- Pit marler → Intraperitoneal injection → Scan the tag data
- Caudal fin → DNA extraction → PCR amplification
- → The recognition results are bound to the tag data

To explore the gender differences in pomfret metabolism and microbiome, golden pompano were randomly divided into three groups: Male, Female, and Mix.

Golden pompano (*Trachinotus blochii*)

- Male / Female / Mix
- → Intestinal metabolic analysis
- → Intestinal microbiome analysis
- → Sex differences in pomfret metabolism and microorganisms

Results

The microbial diversity of females is higher than that of males, and *Holosporaceae* is female-specific.

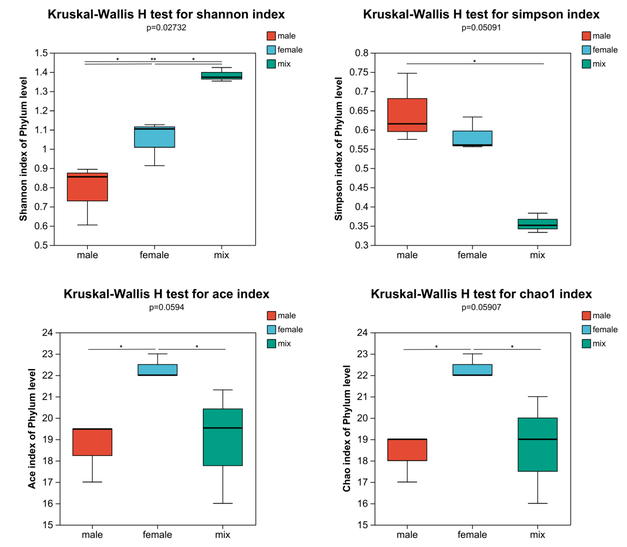


Fig. 1. The Alpha-diversity indices of the bacterial communities in intestine of *T. blochii* under different culture strategy. *Represents significant difference (*$P < 0.05$; **$P < 0.01$).

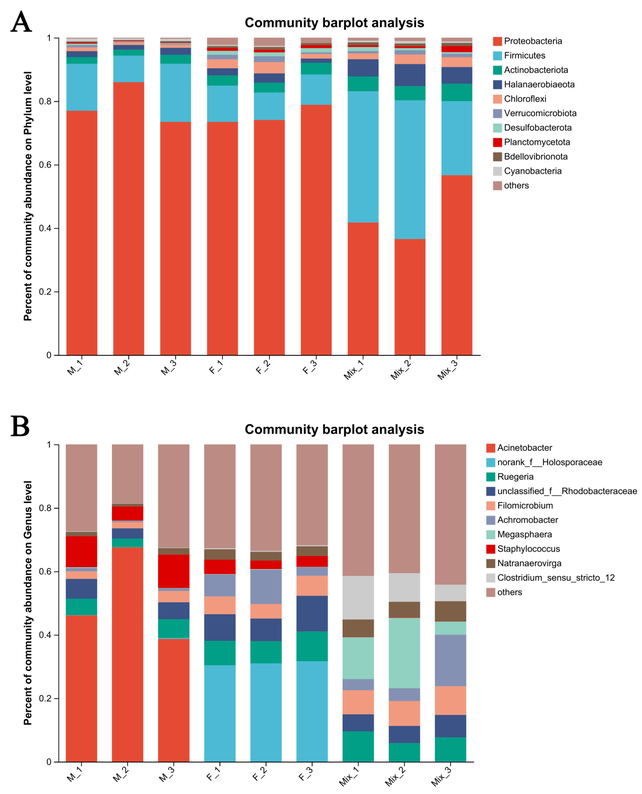


Fig. 2. Relative abundances of the dominant bacteria at the phylum level (A) and genus level (B) of *T. blochii* intestinal microbiota in different culture strategy.

Fig. 3. Effect of culture strategy on the key species of *T. blochii* (LDA score > 4, $P < 0.05$).

The differentially expressed metabolites, such as glycerophosphocholine, were closely related to the changes in the intestinal microbiota of *T. blochii*

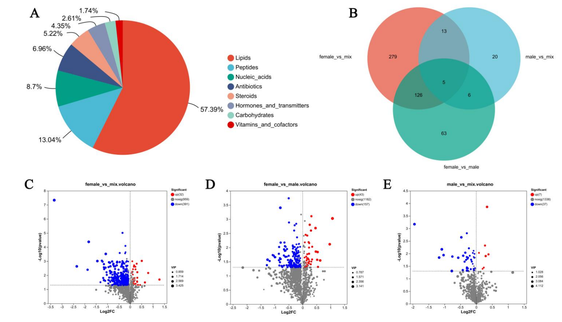


Fig. 4. Distribution of metabolite species (A). Venn diagram showing shared and unique metabolite (B) and differential metabolic volcano diagram. (C) female vs mix. (D) female vs male. (E) male vs mix.

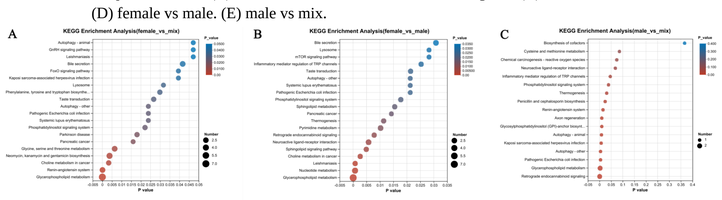


Fig. 5. Functional annotation and enrichment analysis of differential metabolite KEGG. (A) female vs mix, (B) female vs male, (C) male vs mix.

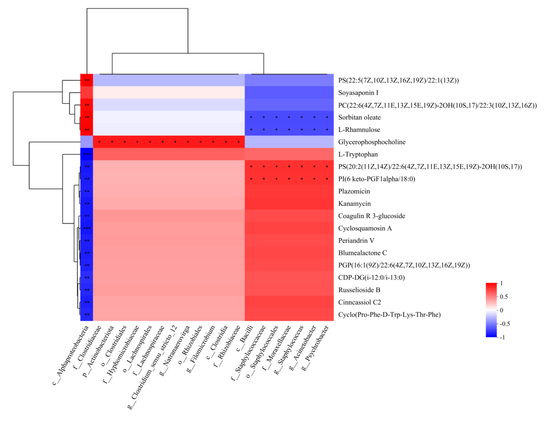


Fig. 6. Significant correlation between intestinal bacteria and DMs. The correlation coefficient is represented by different colors (red, positive correlation; blue, negative correlation). *Represents significantly negative or positive correlations (*$P < 0.05$; **$P < 0.01$).

Conclusion

- Sexual differences were found in the compositions of the intestinal microbiota. *Holosporaceae* exhibited female-specific enrichment, promoting female growth and driving sexual dimorphism.
- Substantial differences were discovered in the intestinal metabolic profiles of male and female *T. blochii*, glycerophosphocholine was closely related to the changes in the intestinal microbiota.

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