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Performance evaluation of XY all-male hybrids derived from XX female *Channa argus* and YY super-males *Channa maculate*

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Abstract

Snakeheads are economically important freshwater fish in China, of which males grow much faster than females, and the individual size determines the trading price. All-male NBS (northern snakehead (*Channa argus*, NS) ♀ × blotched snakehead (*Channa maculata*, BS) ♂) were produced by combining sex control, sex-specific molecular marker and hybridization of YY super-male BS and normal XX female NS. In this study, the culture performance of all-male NBS was evaluated, including yield, survival rate, growth rate, sex ratio, size uniformity, feed conversion ratio, and low-temperature resistance. The results showed that all-male NBS exhibited superior productivity traits compared to the existing cultured snakehead varieties. The average body weight of all-male NBS was heavier than that of mixed-sex NBS by 23.1-38.8%, or inbred NS by 16.8-34.0%; the average daily gains of all-male NBS were faster than those of mixed-sex NBS by 28.4-39.3%, or inbred NS by 18.6-34.1%. The male ratio of all-male NBS was more than 93.0%, and there was a small proportion of female or bisexual individuals. The rates of body weight above 1 kg of all-male NBS were 91.3-96.4%, which were far higher than those of mixed-sex NBS or inbred NS, which were only 62.0-75.8%. Therefore, all-male NBS individuals are larger and more uniform. The feed conversion ratios of all-male NBS decreased 12.5-17.6% compared to mixed-sex NBS fed artificial compound feed and 72.3% compared to inbred NS fed iced fresh fish. In addition, the low-temperature resistance of all-male NBS was high, with only 4.1% mortality vs. 28.5-37.4% in other hybrids. In snakeheads trading, large individuals are more favored, and the price of snakeheads above 1 kg is approximately 40% higher than that of individuals in the range of 0.5-2 kg. Therefore, the large and uniform all-male NBS population could bring tremendous economic benefits, because input costs are falling, while output profits are increasing. The large and uniform all-male NBS population is thus quite promising in snakeheads market applications.

Methods

1. Broodstock maintenance and artificial reproduction
2. Fry culture and fingerling rearing
3. Culture in the same earthen pond
4. Culture in different earthen ponds
5. Low-temperature tolerance test

Results

1. The fertilization, hatching and fingerling survival rates of all-male NBS, mixed-sex NBS and inbred NS.

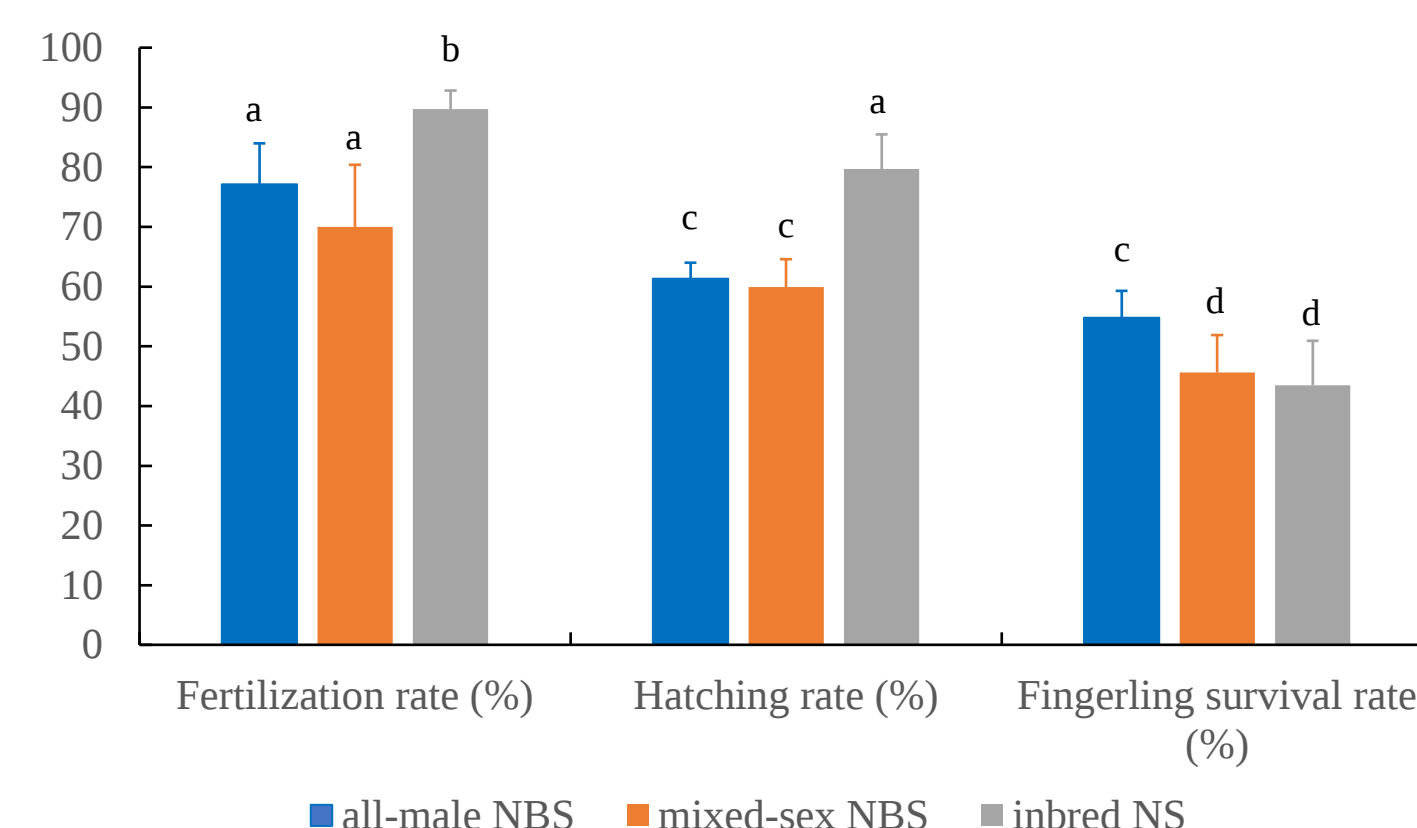


Figure 1. The fingerling survival rate of all-male NBS was the highest in the three types of fish.

2. Results of growth performance in the same earthen pond.

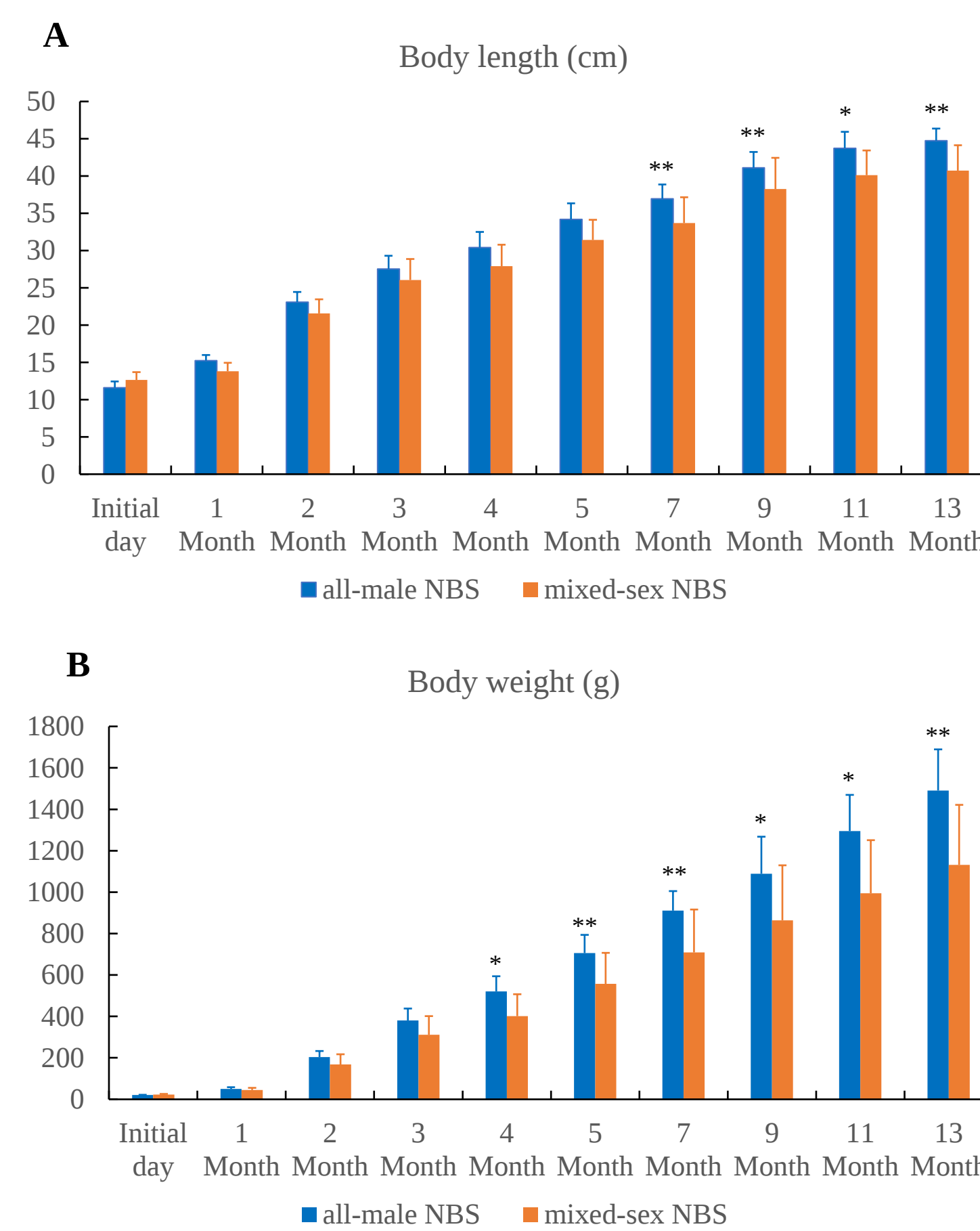


Figure 2. The results of growth performance of all-male NBS and mixed-sex NBS in the same earthen pond at Danzao base from July 2019 to August 2020. (A) The average body length of all-male NBS and mixed-sex NBS; (B) The average body weight of all-male NBS and mixed-sex NBS. ** indicates that there was an extremely significant difference between the two groups ($P < 0.01$), and * indicates that there was a significant difference between the two groups ($P < 0.05$).

3. The male ratio of all-male NBS was more than 93.0%, and there was a small proportion of female or bisexual individuals.

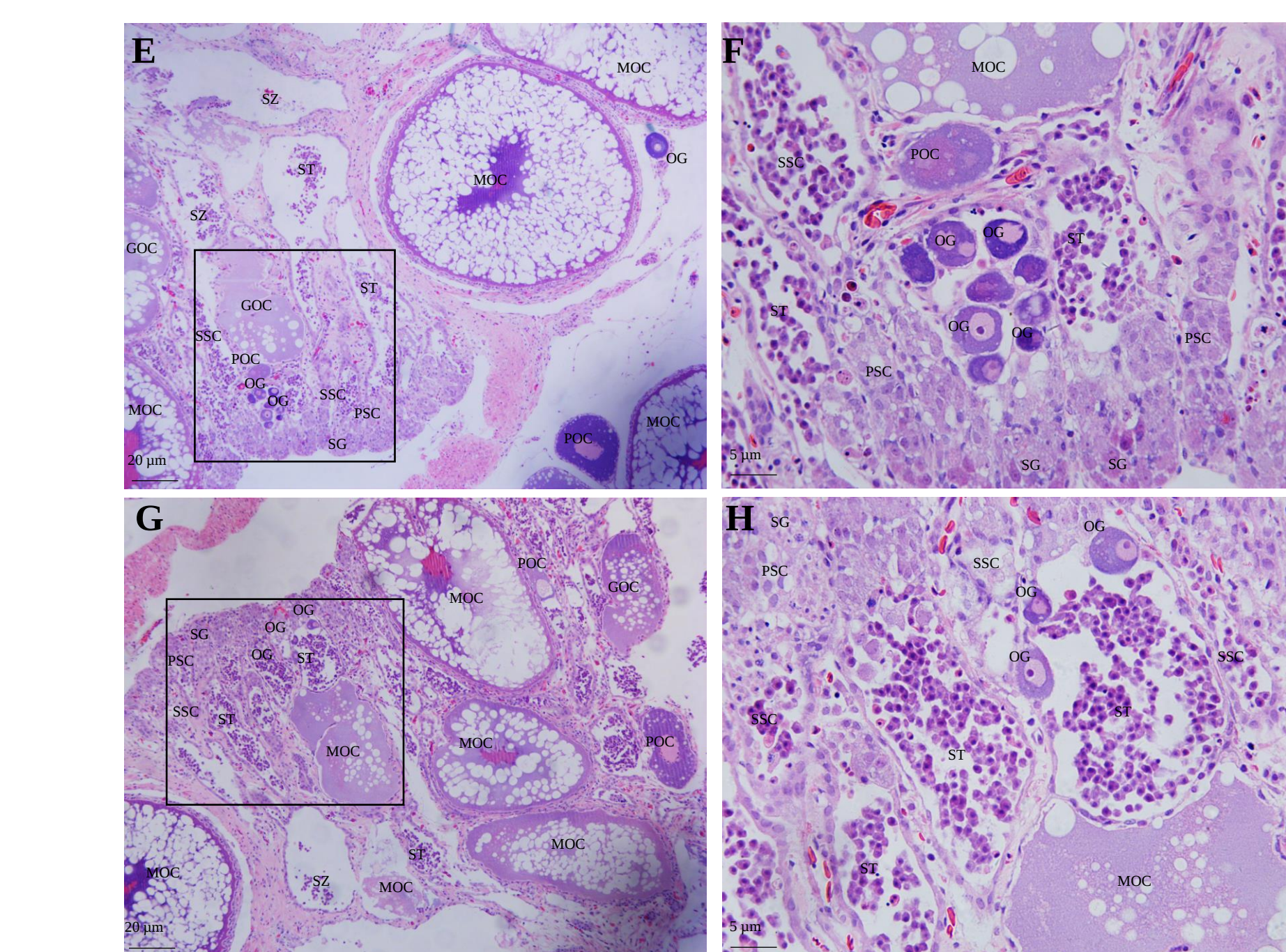
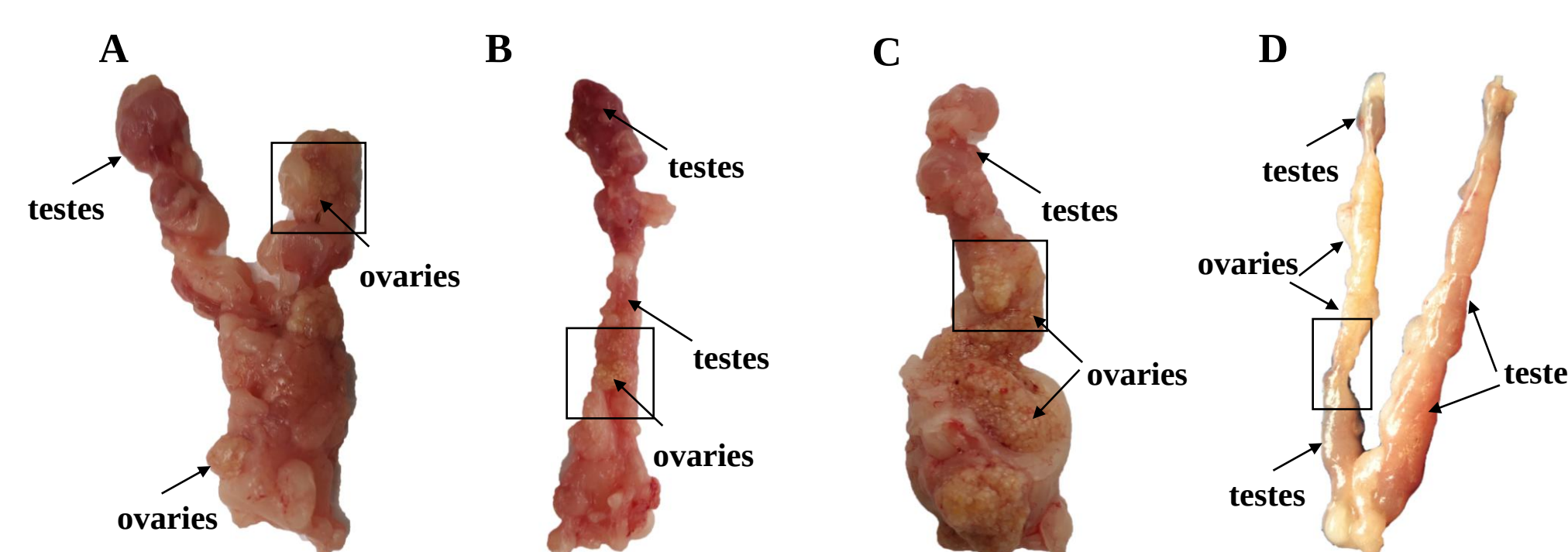


Figure 3. Morphological (A-D) and histological (E-H) observation of gonads from bisexual individuals in all-male NBS. (F) and (H) show the magnification of the boxed areas in (E) and (G). OG: oogonia; POC: primary oocytes; GOC: growing oocytes; MOC: mature oocytes; SG: spermatogonia; PSC: primary spermatocyte; SSC: secondary spermatocyte; ST: spermatids; SZ: spermatozoa.

4. Results of growth performance in the different earthen ponds.

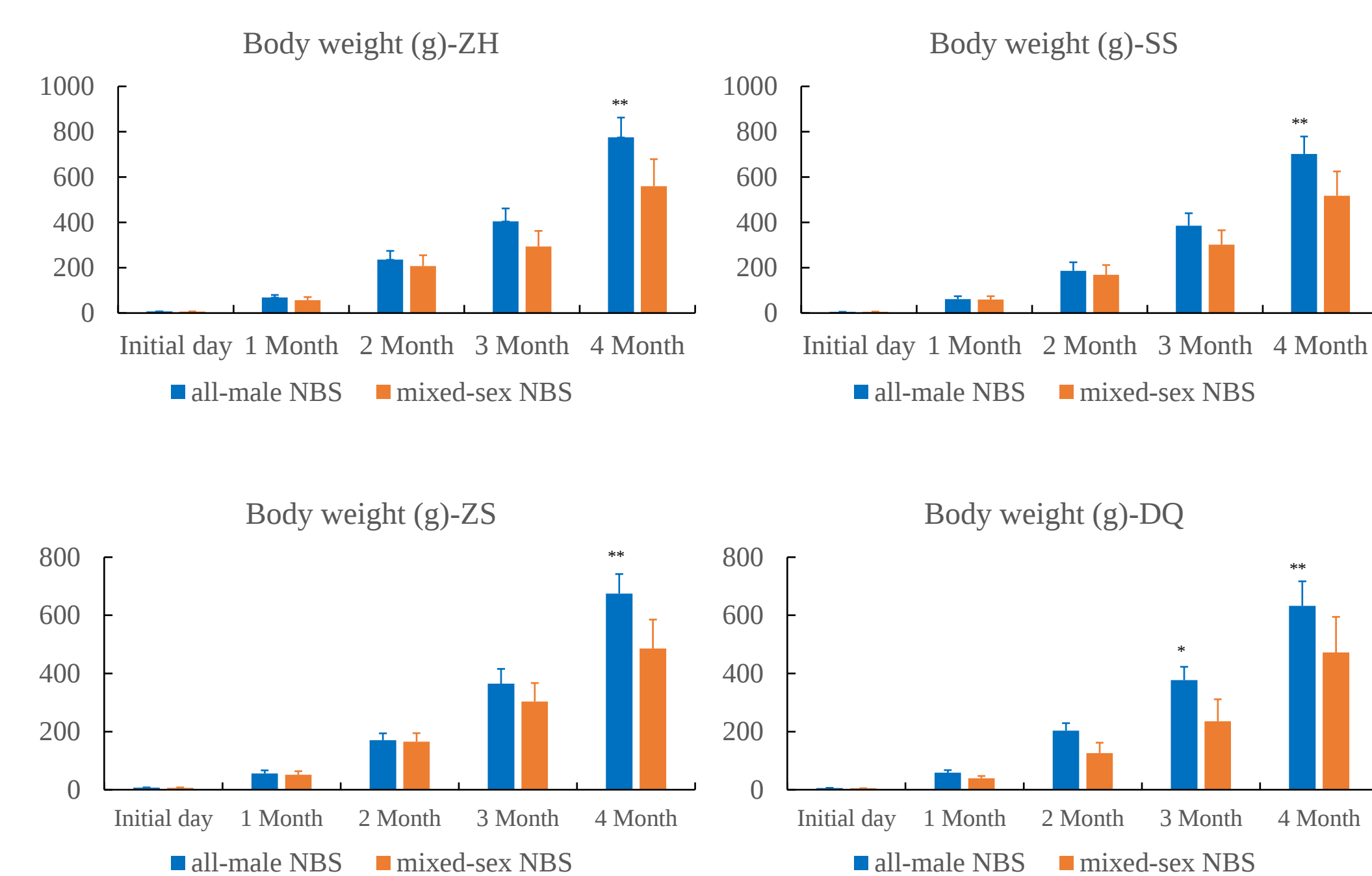


Figure 4. The average body weight of all-male NBS, mixed-sex NBS and inbred NS in different earthen ponds in four aquaculture fisheries from July to November 2020. ** indicates that there was an extremely significant difference between the two groups ($P < 0.01$), and * indicates that there was a significant difference between the two groups ($P < 0.05$).

5. The low-temperature resistance of all-male NBS was high, with only 4.1% mortality vs. 28.5-37.4% in other hybrids.

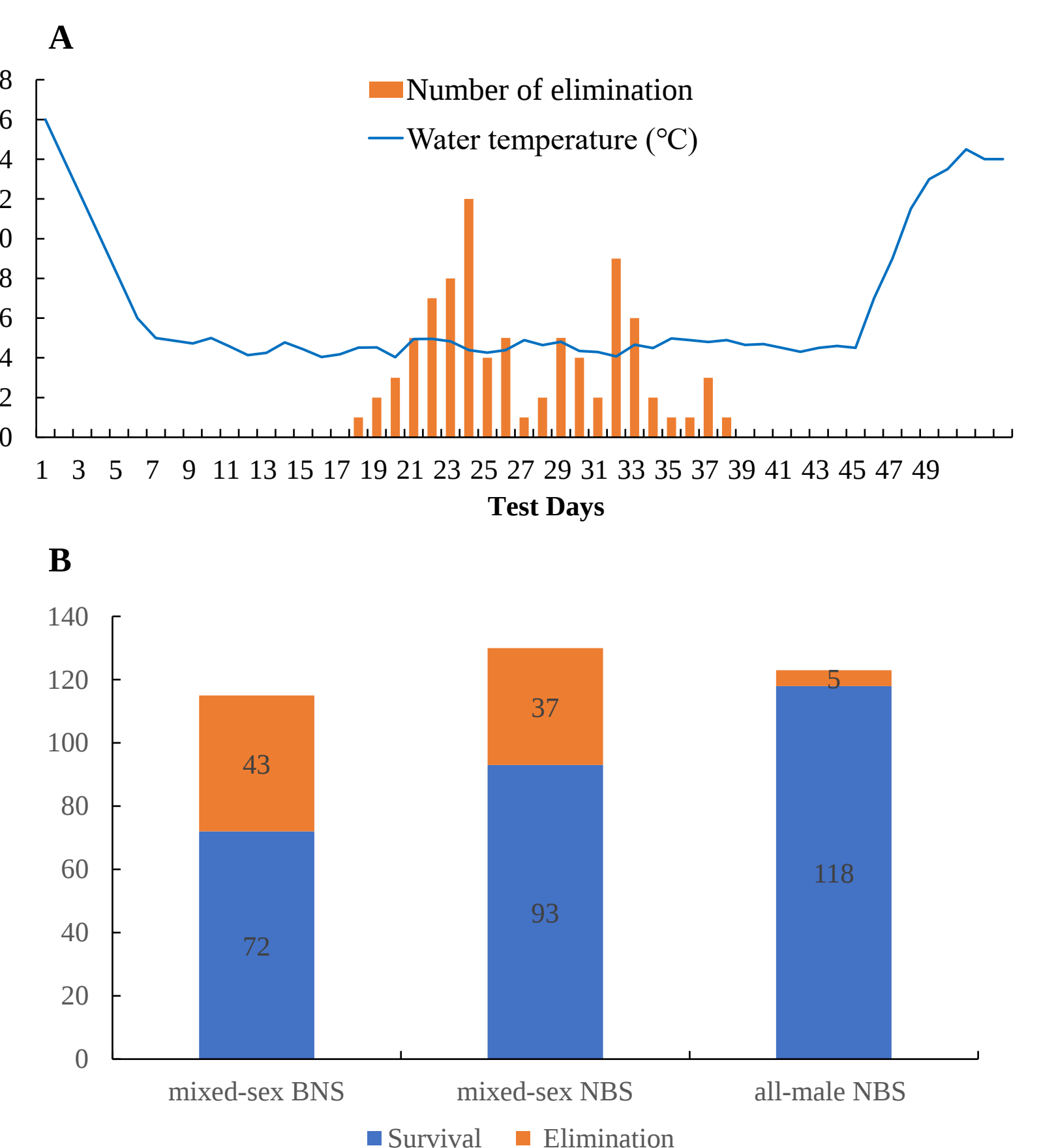


Figure 5. The results of low-temperature tolerance of three group fish. (A) Changes in water temperature and amount of mortality during the low-temperature tolerance test; (B) The status of three hybrid species in the low-temperature tolerance test.

Acknowledgements

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