Short Paper

**Displacement Behavior of Japanese
Flounder *Paralichthys olivaceus*
Estimated by the Difference of
Oxygen Consumption Rate**

Haruo Honda*

(Received December 1, 1987)

In Japanese flounder rearing under absence of bottom sand, the behavior overlapping each other is always observed, although the bottom area of aquarium is enough extent for reared fish. This overlapping behavior, however, is scarcely observed when the bottom of aquarium is covered with a certain thickness of sand allowing to burrow.

To elucidate this behavioral difference, the effect of existence and absence of bottom sand on the oxygen consumption were studied with the flounder of 438.2 ± 3.7 g (body weight: mean $\pm$ s.e.) at 20°C water temperature. And the effect of overlapping behavior on the oxygen consumption were also studied. Oxygen consumption was measured by the constant flow method with acrilate respiration chambers ($40 \times 20 \times 20$ cm) under dark condition. The chambers were connected to closed recirculating sea water system (water volume: ca. 830 l) having submerged filters and a heating-cooling unit. In all experiments the oxygen saturation of the effluent water was maintained at more than 70%, and fish were not fed for ca. 70 h before the experiment. To determine the oxygen consumption rate, 3 measurements were carried out between 4 to 8 h after placement of fish into the respiration chamber.

As showing Table 1, oxygen consumption per unit weight measured individually under absence of bottom sand was ca. 17% higher than that measured individually with the respiration chamber which bottom was

Table 1. Effect of bottom sand on the oxygen consumption of Japanese flounder

Bottom sand	oxygen consumption (ml/kg·h)	
	range	mean $\pm$ s.e.
Absence	29.9 ~ 32.7	30.8 $\pm$ 0.5
Existence	23.5 ~ 27.8	25.4 $\pm$ 0.4

Each 5 fish were tested. s.e.: standard error. Mann-Whitney test: $p < 0.02$.

Table 2. Group effect on the oxygen consumption of Japanese flounder measured under absence of bottom sand

Number of fish in a respiration chamber	oxygen consumption (ml/kg·h)	
	range	mean $\pm$ s.e.
1	26.2 ~ 32.7	29.3 $\pm$ 1.0
2	24.9 ~ 28.1	26.2 $\pm$ 0.7
3	22.8 ~ 28.6	24.3 $\pm$ 1.1
5	25.2 ~ 26.6	25.9 $\pm$ 0.3

mean: mean of 5 times experiments.

s.e.: standard error. Kruskal-Wallis test: $p < 0.01$.

covered with ca. 5 cm of sand allowing to burrow. The results imply that an isolated fish prevented from burrowing feel uneasy and exhibit a higher rate of oxygen consumption.

On the contrary, notwithstanding under absence of bottom sand, oxygen consumption was 11~17% lower in grouped fish (2, 3 and 5 fish) overlapping each other in the respiration chamber than that in an isolated fish, and the group effect^{1,2)} was recognized as showing Table 2. Since conditioned water made by keeping 20 fish in the recirculating system did not lower oxygen consumption of an isolated fish (mean $\dot{V}O_2$ of 3 fish: 30.3 ml/kg·h) and there was no difference from the oxygen consumption rate of an isolated fish in running fresh sea water (mean $\dot{V}O_2$ of 2 fish: 30.9 ml/kg·h), the group effect is not due to chemical sense. And also the effect is not due to vision because the inside of respiration chamber was under dark condition. The results imply that grouped fish feel easy mainly by mechanical contact with fellow fish and reduce their oxygen consumption to the level of fish allowed to burrow into bottom sand. And from these results, it is estimated that the overlapping behavior of the flounder, observed when the bottom of aquarium is not covered with sand, is one of displacement behavior for the behavior burrowing themselves into the sand.

References

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* Abiko Research Laboratory, Central Research Institute of Electric Power Industry, Abiko, Chiba 270-11, Japan (本田晴朗: 電力中央研究所, 我孫子研究所).