Short Paper

Group Effect on Swimming
Speed of FishGunzo Kawamura,* Chon Darusu,*
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A fish school is, in a dynamic statistical sense, a closely knit cohesive group of individuals of the same species, regularly spaced and moving at an uniform speed and in a common direction.^{1,2)} The characteristic geometry of a school is based on the mutual attraction among schooling companions, and somewhat permanent.³⁾

According to the examination of the swimming speed and stamina of fish in a tank with a circulating system and open water, Yonemori⁴⁾ found that individuals of the same species showed considerable variations in the speed and stamina even though there were no differences in fish size. The question thus arises: How, then, are fish able to form a somewhat permanent school despite the individually different swimming ability among schooling companions? A possible answer to this question is that schooling companions regulate their swimming speed so as to move at an uniform speed. The regulation could be that faster swimmers are retarded by slower swimmers and slower swimmers are accelerated by faster swimmers in a school.

To examine such a possibility, an experiment was conducted in a water circulating tank which produced current speeds up to 100 cm/s. Four groups of killifish *Oryzias latipes* (22–36 mm in FL), three groups of tilapia *Tilapia nilotica* (31–43 mm in FL), and one group of mullet *Mugil cephalus* (246–256 mm in FL) captured in rivers were used for the experiment. Each group consisted of three specimens of slightly different length. We determined the maximum current velocity which was sustainable by the individual specimens (called maximum sustainable velocity hereafter) by increasing the current velocity at half-minute intervals until the fish ceased to swim and lost the ground. Afterwards, three specimens of the same species were placed together in the observation chamber of the water circulating tank, and the maximum sustainable velocity for each group was determined.

It is evident from Fig. 1 that in all groups examined, slower fish swam faster when they were in a school. The velocity increment was 25–42% for the killifish, 14–30% for the tilapia, and 20% for the mullet. It is well known that the oxygen consumption of fish is often smaller in a school than in a solitary condition.^{5,6)} This group effect on the oxygen consumption might be part of the physiological mechanisms involved in the acceleration of swimming speed of slower swimmers in a school. Since the fast swimmers were forced to swim until they were exhausted, the retardation by the slower swimmers was not observed. However the

Fig. 1. Maximum sustainable velocity for three individuals of each of three species of fish determined when they are solitary (solid line) and when they are in a school (broken line). L, M, and S indicate sizes; large, intermediate, and small specimens, respectively. The fish that is exhausted first in the school is indicated by its size symbol beside the broken line.

retardation must exist in a school, otherwise the school would not be maintained.

References

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