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Citation	北海道大學水産學部研究彙報, 15(4), 213-214
Issue Date	1965-03
Doc URL	http://hdl.handle.net/2115/23235
Type	bulletin (article)
File Information	15(4)_P213-214.pdf



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A PRELIMINARY NOTE ON THE EFFECT OF HYDROSTATIC PRESSURE ON THE BEHAVIOUR OF SOME FISH

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During the course of studies concerning the relation between hydrostatic pressure and physiological aspects in fish, it was recognized that fish artificially exposed to high pressure showed abnormal behaviour. In this note, a brief explanation of the apparatus available for the purpose is given, together with a preliminary description of the resulting behaviour in certain fish.

As shown in the Figure 1, the apparatus consists mainly of a metal press tank (*t*) and a pressure pump (*p*), connected by a brass tube (*b*). The press tank, 30 cm in diameter and 70 cm in depth, contains approximately 50 litres of water. When the bar (*h*) is manipulated to produce high pressure, water from a trough (*s*) is transferred to the press tank through the brass tube. Water pressure is maintained in the tank and adverse currents are prevented, by means of three valves fitted in the tank. By opening an outlet (*o*) at the top, air can be removed and the water-pressure lowered. The behaviour of fish in the tank is watched from two observation windows (*w*), 5 cm in diameter, in the top and side. A pressure gauge (*g*) registers the level of water-pressure at any time. This tank withstands hydrostatic pressure within the limit of 30 Kg/cm². Prior to increasing the water-pressure, every fish was acclimatized to this confined tank for about one hour. In every observation, one to five fish were exposed to high pressure increased at the discretionary rate of between 0.017 Kg/cm²/second and 0.8 Kg/cm²/second. In most cases, the observation of fish behaviour was possible over a 5-day period, though the term depended upon the number of fish used, the quantity of dissolved oxygen, the water temperature and other factors.

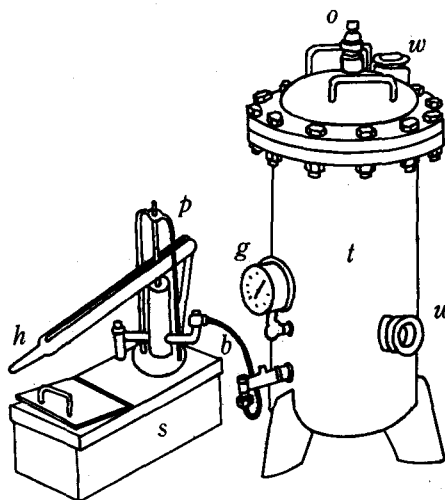


Fig. 1. The outward appearance of the apparatus

Under high hydrostatic pressure, all the specimens of rainbow trout (*Salmo*

irideus: 12 sp., 15 cm in average total length), goldfish (*Carassius auratus*: 7 sp., 8 cm) and bitterling (*Rhodeus ocellatus*: 6 sp., 4.7 cm) revealed abnormal behaviour. The prevailing behaviour of these fish was characterized by an abnormal swimming manner with unnatural posture; the head was directed upward and the body trunk was upright in the water. In brief, if their normal swimming as observed in nature is tentatively termed horizontal posture swimming, the manner observed in this experiment may be called vertical posture swimming. Another type of behaviour, which may be conveniently called 'slipping drift', was observed. That is, the fish appeared to slip downward from the upper level of the water, ceasing their vertical swimming suddenly as if they had fallen into a swoon-like condition. Such abnormal behaviour was often observed during vertical swimming. Ultimately these fish were prostrated agonizingly upon the bottom of the tank, lying on their sides. The primary level of water pressure for bringing about the occurrence of this unnatural behaviour was found to differ according to the species used. In the case of loach (*Misgurnus anguillicaudatus*: 8 sp., 10 cm), the behaviour was somewhat different from the above species. The fish normally stayed at the bottom of the tank, but as soon as the pressure was raised, they instantaneously showed a type of abnormal behaviour which may be described as a sudden leap, accompanied by a very strong shrinking of the whole body. Such shrinking was also observed at a sudden lowering of the pressure. Like the above three species, loach were generally seized with a tonic convulsion of the body when exposed to high pressure. In each species, the respiratory rhythm was also affected; obviously the opercular movement became irregular and faster than usual. Further, it was noted that a 3-day period of exposure to high pressure, for example at 10-20 Kg/cm², brought about contraction of the melanophore; the body colour of rainbow trout became very fuscous. By lowering the pressure to the normal level, one can observe that the fish release air bubbles from gill openings or anus.

It is obvious from these observations that subjection to high hydrostatic pressure is a harmful stimulus on the behaviour of fish, so that they cannot adapt themselves to sudden acute disorders induced within a short period. The abnormality of posture, of body colour, and in the respiratory rhythm also suggests that though it remains unknown whether any sense for participating in the changes of hydrostatic pressure exists or not, so far as the present experiment is concerned, the adaptive mechanism for controlling pressure equilibrium and some endocrine systems are seriously deranged during exposure to such a harmful stimulus, and this may drive the fish further into a state of chronic disorder.

The author is indebted to Professor Shinjiro Kobayashi for his invaluable advice in the course of the present experiment, and to Dr. H. Koto for his kindness in the loan of apparatus.