A PRELIMINARY TEST FOR RECORDING THE FEEDING ACTIVITY IN FISH

Shinjiro KOBAYASHI, Ryogo YUKI and Hachiro HIRATA
Faculty of Fisheries, Hokkaido University

A great many reports have been published on the feeding activity of various kinds of animals, especially of mammals and of insects. On fish, a number of studies have also been reported by many authors. However, they were almost all reports on feeding habits which were studied by means of examinations, evaluations and analyses of the stomach content of fishes sampled. By such methods it seems difficult to prove any correlations between feeding activity in fish and the environmental factors in either natural habitat or some experimental conditions.

Hoar[1] has reported on the feeding activity of young salmon and trout by counting the earthworm pieces or *Gammarus* sp. eaten by the fish in aquarium during a given time. Although his method is excellent as the feeding frequency could be exactly determined, yet it is not suitable when it is desired to observe fluctuations of an activity such as feeding frequency per hour over a prolonged period. A direct observation, for example, performed by Hsiao and Tester[2] seems also to be not a suitable method for the same reason, and further in this case, fish behaviour might be disturbed by the observers as they themselves have admitted. So, the present authors devised an automatic method for recording the feeding activity of fish. A simple type of apparatus and a few examples recorded by it are described below. All the experiments were performed in the tanks set in a greenhouse of the Faculty of Fisheries.

Description of the recording apparatus

A schematic view of the apparatus is presented in Fig. 1. The body of an old chemical balance was utilized as its main part. A small square cage of fine brass wire was used as a bait box (Fig. 1, A). Its size used in most cases was about $3\times3\times1$ cm. Both upper and bottom sides of the box are made of transparent celluloid. To the upper side of the box is stuck a slender and flat stalk of celluloid (B), like a peduncle, of a length of about 10 cm. The pointer of the balance (D) is cut at the portion of about its lower one third, and its cut tip is inserted solidly into a cylindrical rubber block (C). To the opposite under side of the block, the head of a large hair-pin-like holder of brass is inserted firmly. The stalk of the bait box is settled tightly by deep insertion into the holder and by winding a rubber string around the neck of the inserted portion. Both tips of the pointer and holder are inserted into the rubber block at a slight distance from each other to insulate the electric current. At each end of the balance bar, a needle of platinum (F) is settled; but, in most cases only one side was actually used. When a fish pecks the bait box, the needle vibrates and contacts with the surface of

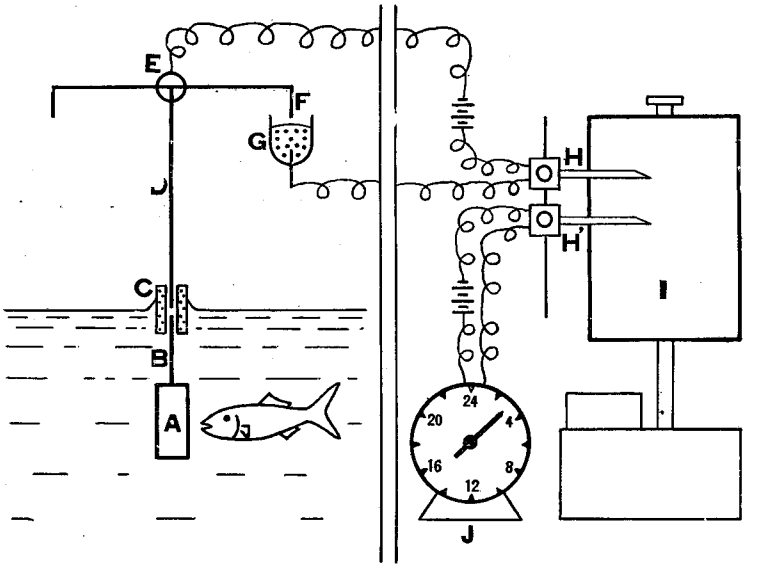

Fig. 1. A schematic view of the apparatus for recording the feeding activity in fish
A: bait box. B: stalk attached to bait box. C: insulated portion of rubber block. D: pointer of a chemical balance. E: fulcrum. F: platinum needle. G: mercury. H: electro-magnet with recording lever. H′: electro-magnet of time marker. I: kymograph. J: time marker.

mercury within the glass dish (G). Then, the circuit closes and the electro-magnet (H) with the recording lever functions as an indication of the feeding. Thus, the feeding activity of 24 hours is recorded on the kymograph (I). By preliminary experiments the distance between the tip of the platinum needle and the surface of mercury was adjusted to ensure a good contact, according to the species and body size of the experimental fishes.

From the construction of the present apparatus, it was impossible to suspend the bait box deeply in the water of the tank. In most cases, the box was hung in the water so that its bottom was at a depth of about 13 cm, the surface of the water being at about the insulated portion of the pointer.

To avoid any disturbance of the experimental fishes, some precautions were taken. For exapmle, the kymographic recordings were made in a separate room from the experimental tank at a distance of about 8 metres; the experimental tank was surrounded by a wooden wall; several straw-mats were spread on the concrete floor near the experimental tank to diminish disturbance by the noise of footsteps.

Examples of the feeding records of some fishes

All the feeding records shown in the present report were made by young fishes. Those of the three species, (A) carp, *Cyprinus carpio* (*L.*), (B) goldfish, *Carassius*

auratus (*L.*) and (C) rainbow trout, *Salmo irideus* (*G.*) are given in Fig. 2. Even from these figures only, the feeding activity and periodicity of each species may approximately be understood. Among the marks on a kymographic record may be included

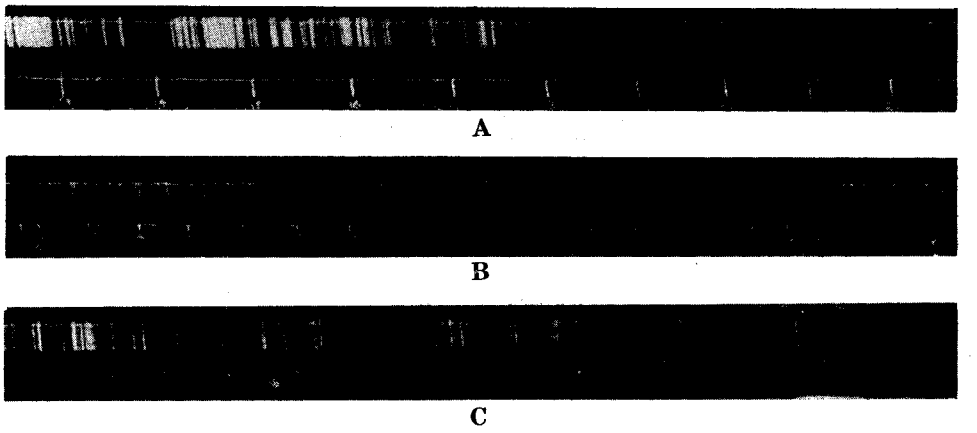

Fig. 2. Examples of kymographic records of feeding activity

A: carp, 28 individuals of 44 mm average body length; size of the tank 120 × 82 × 25 cm; bait, minced crustacean larvae; September 6, 1955. B: goldfish, 37 individuals of 40 mm average body length; size of the tank 140 × 75 × 35 cm; bait, minced crustacean larvae; September 30, 1955. C: rainbow trout, 23 individuals of 48 mm average body length; size of the tank same as the case of (B); bait, aquatic earthworms; August 20, 1955.

also some which are due to touching of a part of the fish body upon the bait box. However, even if fish does not actually peck the bait box, it may be considered that such a touch is not an accidental one, but it is a kind of feeding behaviour in a broad sense, at least, when the experimental tank is large and the fishes used are few in number.

If feeding frequency of some species is desired for a quantitative analysis, calculation may be easily done by counting the marks of its kymographic record. When the counting is difficult as the marks seem to be repeated too close together, the feeding frequency may be calculated by examining the repeated marks under a magnifier or a microscope of low power. Examples of feeding periodicity calculated by such a method are indicated in Table 1 (from the kymographic records of Fig. 2).

Table 1. Examples of the daily periodicity of feeding activity in carp, goldfish and rainbow trout, calculated from the records shown in Fig. 2

Species \ Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Carp	0	0	0	0	0	1	2	19	30	37	56	19	54	45	36	14	1	0	1	1	1	0	0	0	
Goldfish	0	0	0	3	1	6	11	8	3	1	5	1	4	4	5	5	1	0	0	1	0	0	0	0	
Rainbow trout	0	0	0	0	6	11	43	30	27	42	31	46	20	8	18	31	29	34	6	1	1	0	0	0	

The present apparatus is simple and restricted in use to some experimental conditions only, the designing of some revised types of feeding recorder is in progress.

Summary

A simple method for recording the feeding activity in fish was described. The apparatus was designed to make an automatic recording on a kymograph when fish pecked a bait box suspended in a tank of water. A few examples of the records obtained were shown in Fig. 2. The feeding frequency, if desired, can be calculated from the marks of a kymographic record as indicated in Table 1. The designing of some revised types of feeding recorder is in progress.

Literature cited

1) Hoar, W. S. (1942). Diurnal variations in feeding activity of young salmon and trout. *J. Fish. Res. Bd. Canada* **6**, 90–101.

2) Hsiao, S. C. & Tester, A. L. (1955). Reaction of tuna to stimuli, 1952–53. Part II: Response of tuna to visual and visual-chemical stimuli. *U. S. Fish and Wildlife Service, Spec. Sci. Rept., Fisheries* (130), 63–76.