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Detection of Locomotive Behavior in Aquatic Animals by the Use of Infra–red Light

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Abstract

To promote catching efficiency of shrimp pots, infra–red light was applied to the detection of animal movements. A sensing unit was composed of a LED (light emitting diode) and a photo–transister. At two sections in the entrance funnel of the pot, one each unit was fixed as a check point. By reading the time lag between transit signals from each gate, the direction of animal locomotion was recognized, furthermore, the number of individuals both entering and escaping animal was counted.

Introduction

It has been believed that the fishing techniques must be established on the basis of fish behavioral studies. Among the various techniques, the trap fishing is especially connected with animal behavior. The typical shrimp pot has one or two conical entrance. In a preliminary test using the typical one, it was found that about half the number of shrimps escaped through the entrance. In order to prevent such an easy escapement, size effect of the funnel is considered most important. To get an optimum design of the funnel by trial–and–error method, a device to record the animal locomotion became necessary. In the observation of underwater animals, the image sensing techniques (e. g. camera or TV work) is ordinarily used, however, these needs lighting and it disturbs animal behavior. Sound or supersonic wave were also excluded because of their excessive instrumental size, then, infra–red light was choozen for this study.

Recently, the use of infra–red light became popular in our life, and by such a small device it can reach about 5 meters or more. Pointing out the only disadvantage, the light is heavily declined by a propagation through water. Due to the weak point, it has never been applied to the underwater technique of long distance. The only attempt was done by DALLEY (1981) to record behavior in prawns and shrimps. He installed all equipments

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in the atmosphere on both side of a small glazed tank, and the light penetrated water from outside of the tank.

Apparatus and Method

A pot demensioned 30 × 30 × 30 cm was made of stainless steel wire net. A conical funnel 7 – 4 cm dia., 12 cm length was fixed to a side as an entrance. Two sections in the funnel were determined as check gates, and the distance between the gates was 8 cm. On the circumference of each gate, a LED and a photo–transister was alligned to face each other. As the gate was curtained with infra–red light, an existence on the section intercepted the ray of the light. The signal occured by an animal locomotor was amplified and then indicated with a pen recorder. As shown in Fig. 2, the circuit for amplification was designed simply and a 2–pen recorder (YOKOGAWA 3057–22) was used for a duplex channel indication. Both LED and photo transister were wide range type and the peak wave length of LED was 940 n. m.. An adapter for pocket computer or 1.5 V × 4 dry batteries supplied electric power to the sensor unit. As the experimental animals, small shrimp *Palaemon paucidens,* prawn *Penaeus japonicus,* crab *Eriocheir japonicus,* pond snail *Cipangopaludina chinensis nalleata* and guppy *Poecilia reticulata* were used.

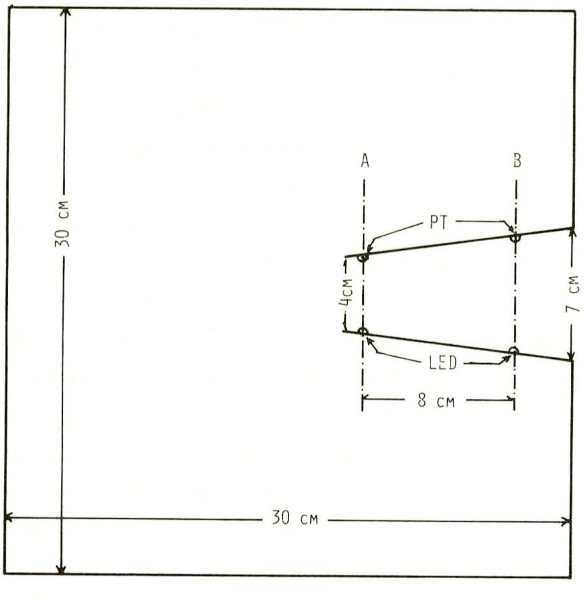
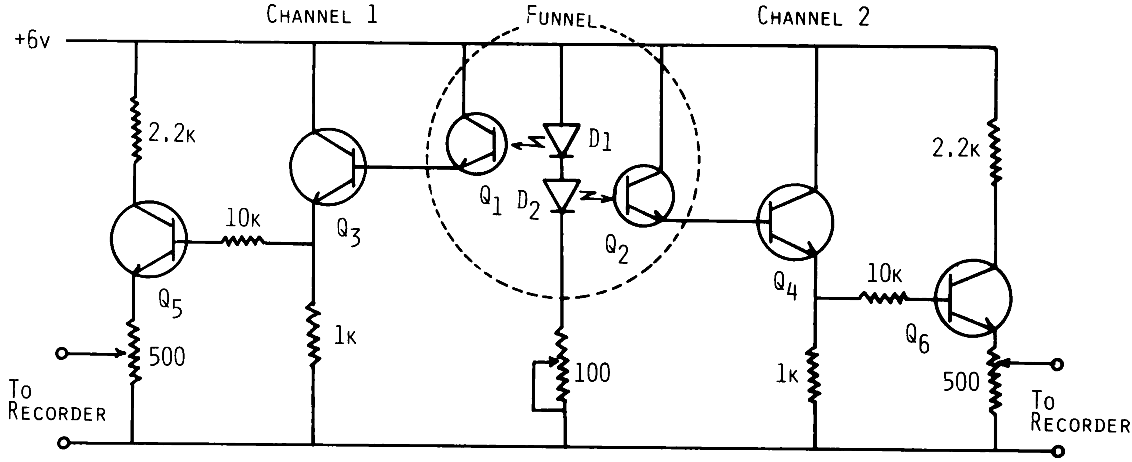


Fig. 1. Schematic diagram of the experimental pot.



D_1 , D_2 : GL 513 (LED)
Q_1 , Q_2 : PT 500 (PHOTO-TRANSISTER)
Q_3 , Q_4 , Q_5 , Q_6 : 2SC 945

Fig. 2. Circuit diagram of the whole electrical equipment.

Result and Discussion

It was known from an underwater test that the unit reduced its sensitivity to 1 / 20 of an atmospheric test, however, it had enough ability to cover such a short distance across the funnel. For driving the diode, 50 mA current was enough to cover 5 cm distance through the water. In addition, two LED for both gates were connected together in series, consequently the batteries stood continuous use more than 2 days. In a continuous recording through the night, no disturbance due to visual lights was indicated. It is shown in Fig. 3 that a small and transparent body like *P. paucidence* gave a faint rise, while large and opaque one like a fish registered a clear impulse. A fast swimming fish indicated a brief response and a slowgoing snail showed a wide indication. Shrimps were often observed stopping upon the diode projected from the funnel. Judging from this observation, animals did not avoid the ray of infra–red light, consequently their behavior was not disturbed with it. If a signal from gate B precede gate A, the direction of animal locomotion is decided "entry". So, the number of individuals entered or escaped are countable. The diurnal periodicity in animal behavior is known from the continuous record, and a time scheduled fishing operation can be also carried out. As an extended study, the mean locomotive speed and the body length are relatively computable. According to the following merits, infra–red light technique is considered suitable for a deep sea local sensing. (1) The technique needs no lighting, while it is essential for the image sensing technique. (2) Parts to be underwater (LED and photo-transisters) are compact molding and have perfect waterproofness.

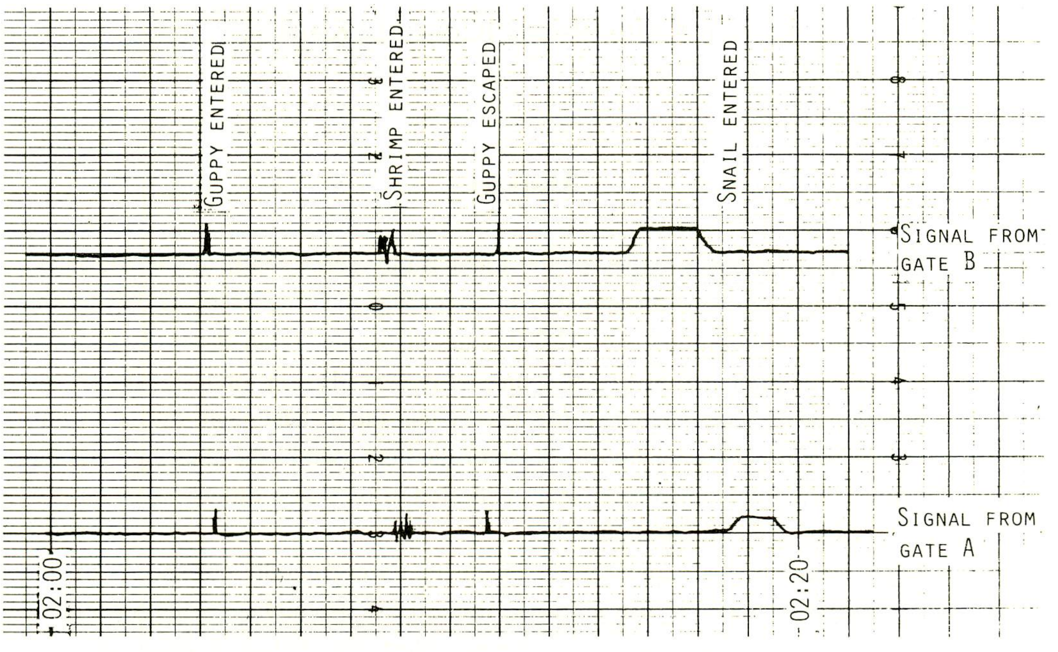


Fig. 3. An example of the recording paper showing animal locomotion.

Referencees

1) DALLEY R. and BAILEY H. (1981) : A new apparatus used to record the locomotor rhythms of laboratory reared prawn and shrimps. Mar. Ecol., **4**, 229–234