ANALYSIS OF THE ENVIRONMENTAL FACTORS AFFECTING THE LIFE OF THE BRACKISH POLYCHAETE, NEANTHES JAPONIOA (IZUKA) IV. EFFECTS OF ENVIRONMENTAL FACTORS ON PERISTALTIC MOVEMENT IN BURROW

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ANALYSIS OF THE ENVIRONMENTAL FACTORS AFFECTING THE LIFE OF THE BRACKISH POLYCHAETE, *NEANTHES JAPONICA* (IZUKA)

IV. EFFECTS OF ENVIRONMENTAL FACTORS ON PERISTALTIC MOVEMENT IN BURROW

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The behavior of *Neanthes japonica* in U-shaped burrows was always accompanied with peristaltic movements. Observation on the peristaltic movement related to the environmental factors revealed that the frequency increased sharply immediately after feeding and then dropped to a constant value and that it increased with a rise of water temperature and a decrease of dissolved oxygen in the vicinity of burrow.

INTRODUCTION

It is known that the polychaetous annelid, *Neanthes japonica*, inhabits U-shaped burrows in muddy-sand flats, feeding upon deposits, and excreting feces on the surface of the flats, and that the behavior in the burrow is always accompanied with peristaltic movement. Therefore, it will be desirable to clarify the relationship between the frequency of peristaltic movements and the changes of environmental factors. The aim of this paper is to describe the peristaltic movements of *N. japonica* in burrows, with reference to the effects of environmental factors on survival and growth of the worm.

METHODS

As a rearing appearatus, a transparent acrylic resin container (length, 27 cm; width, 14 cm; depth, 18 cm) was used so that the behavior of the worm in the burrow might be observed. The container was filled with sea sand (particle size 0.1 mm in diameter (to a depth of 10 cm to which the sea water diluted with demineralized water was flowed (Fig. 1). The sludge composed of bacteria and protozoa obtained by aerating the artificial sewage was placed on the surface of sand as a food. The dissolved oxygen concentration (DO) of surface water was determined by the sodium azide modification of Winkler method, and was checked

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using dissolved oxygen meter (TOA Electric Wave Co., Ltd.). The oxidation-reduction potential (Eh) was determined using Eh meter (TOA Electric Wave Co., Ltd.). The peristalsis of the worms in U-shaped burrows were observed from the outside of the transparent container and the frequency, the numbers of peristaltic movements per minutes, were counted. The concentration of diluted sea water was shown with chlorinity (Cl).

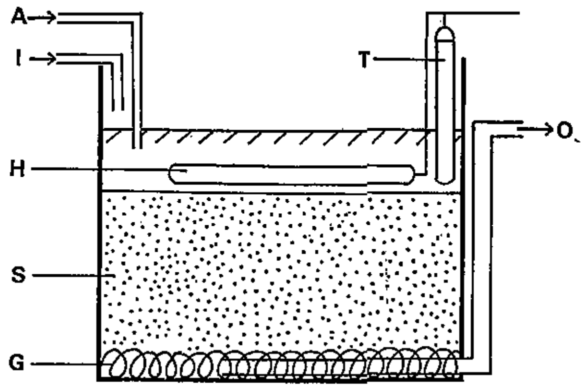

Fig. 1 Experimental apparatus. A: Air; I: Inflow; S: Sand; G: Glass wool; H: Heater; T: Thermostat; O: Outflow

RESULTS AND DISCUSSION

The observation on the worms in U-shaped burrows revealed that the behavior was always accompanied with peristaltic movements (Fig. 2).

In order to study the effects of water temperature and the concentration of sea water on peristalsis, the changes of the frequency in the burrows were determined immediately after feeding and subsequent 24 hours under the following six conditions: Cl 1.0‰ and 20°C, Cl 1.0‰ and 35°C, Cl 6.5‰ and 20°C, Cl 6.5‰ and 28°C, Cl 13.0‰ and 20°C and Cl 13.0‰ and 28°C. The results show that the number of peristalses increased sharply immediately after feeding and then dropped to a constant value in all given conditions (Fig. 3). The number of peristalses during the period from 5 hours to 24 hours, when the values were constant, was examined in relation to water temperature. There existed a close positive correlation between the frequency of peristalsis and water temperature. (Fig. 4).

Since DO in burrows was difficult to measure, the relationship between DO in the surface water and the number of peristalses was studied. As is shown in Fig. 5, the number of peristalses correlated negatively with the concentrations of DO in the surface water, indicating that peristalses might increase at deficient DO in burrows. It was observed that the sludge supplied as a food was readily dispersed in particles of 50–100 μ which flowed in through one end of U-shaped burrows and flowed out through the other end by peristaltic movements (Fig. 2). An inflow of

sludge particles may be an indicator of perfusion of water from the vicinity of the burrow. From the fact that the frequency of peristaltic movements increased when DO in burrow was reduced, it is considered that the worms afford the supply of oxygen required for respiration by peristalsis. This suggests that the worms are also possible to inhabit blackened substrata of reduced Eh due to the inflow of water caused by their peristalses in the burrows. In other words, when Eh in the vicinity of burrow is reduced, and surface water contains sufficient DO, the worms can obtain oxygen required for living by perfusion. It was usually observed that the inner part of burrows became yellowish brown due to the perfusion of sea water containing oxygen, even if Eh of the substratum of mudflat indicated −130 mV.

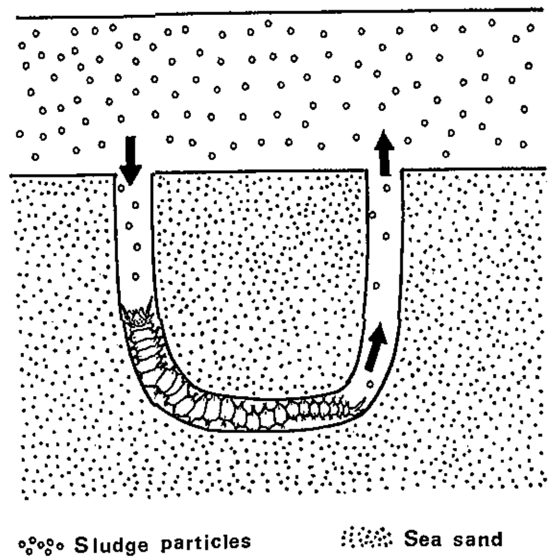

Fig. 2 Longitudinal section of burrow. The arrow shows stream of the sludge particles and the sea water.

We have already reported on the changes of the food intake and weight gain depending on the water temperature (Inamori and Kurihara 1979). At a low temperature of below 4°C, a negative growth was observed because they did not feed, while at a high temperature of 30°C the growth was inhibited to a great extent though the food intake remained approximately the same as that at the optimum water temperature (20°C). This phenomena may be ascribable to a high frequency of peristalses at high temperatures. The growth of the worms will be inhibited at such water temperatures as 30°C or more due to the increase of energy loss caused by violent peristalses. In addition, peristaltic movements are considered to increase when the DO of surface water is less than 3.0 mg/l and consequently the growth will be inhibited.

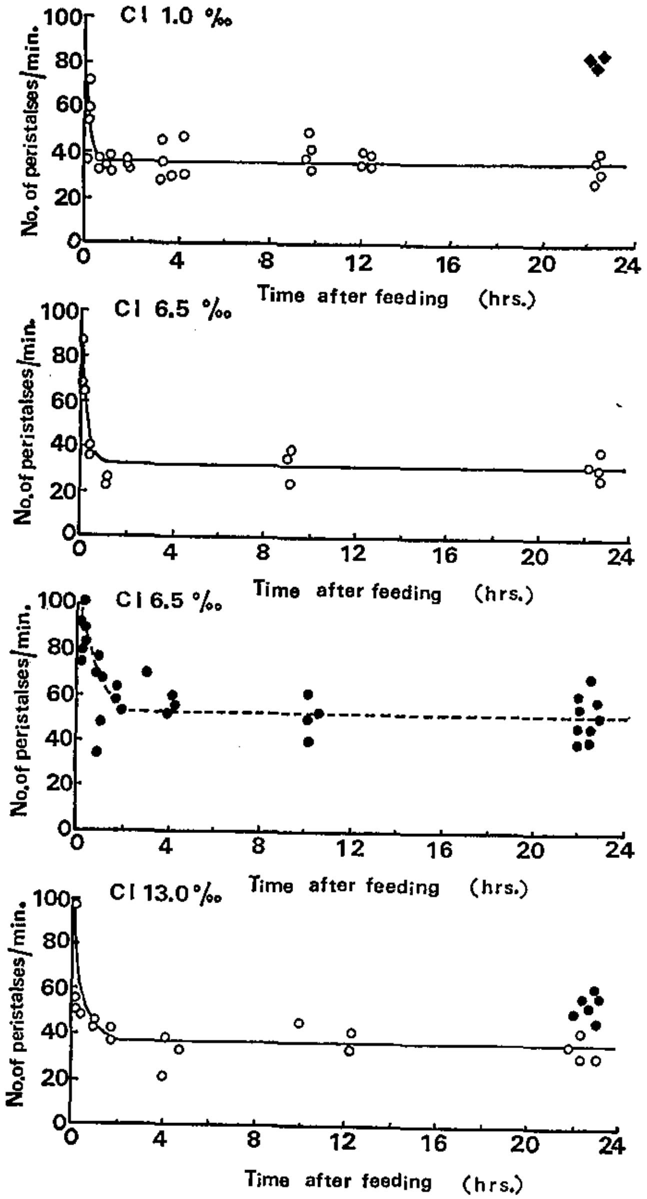

Fig. 3. Peristalsis under various temperature and chlorinity. The symbols ○, ● and ◆ show respectively the number of peristalsis/min. at 20, 28 and 35°C.

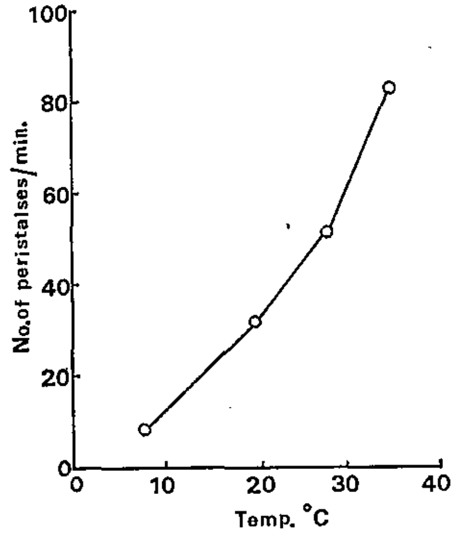

Fig. 4

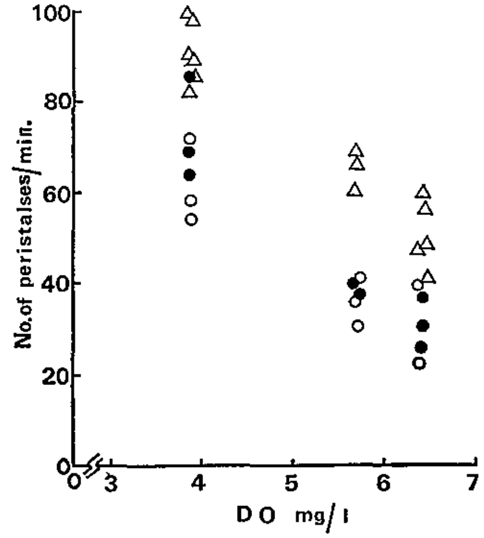

Fig. 5

Fig. 4 Correlation of peristaltic frequency and temperature.

Fig. 5 Peristaltic frequency related to DO in surface water. The symbols ○, ● and △ show the number of peristalses/min. at chlorinity of 1.0‰ and temperature of 20°C, at chlorinity of 6.5‰ and temperature of 20°C and at chlorinity of 6.5‰ and temperature of 28°C respectively.

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