A TEMPERATURE GRADIENT APPARATUS AND TEMPERATURE PREFERENCE OF THE THERMALLY ACCLIMATED PLANARIAN, DUGESIA JAPONICA

HIROKO TSUKUDA and KUMIKO OGOSHI*
Department of Biology, Faculty of Science, Osaka City University Sugimoto-3, Sumiyoshi-ku, Osaka 558, Japan
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Abstract—1. A thermal gradient apparatus was designed for determination of temperature preference of the planarian acclimated to 13, 18 and 23°C.
2. The temperature at which the planarian become immobile altered subsequent to the acclimation temperature.
3. Temperature preference of the active planarian altered in parallel to the change in the acclimation temperature.

INTRODUCTION

Temperature preference has been regarded as an important response regulating body temperature in poikilotherms and it has been found that the temperature preferred by the poikilothermic vertebrates depended on their thermal history (Pitt et al., 1956; Norris, 1963; Lucas and Reynolds, 1967; Roy and Johansen, 1970; Hutchison and Hill, 1978). On the other hand, it has been found that the animals usually selected similar temperatures regardless of acclimation temperature (Crawshaw et al., 1980).

Temperature preference in poikilotherms has been reviewed by some investigators (Fischer, 1958; Fry and Hochachka, 1970; Proser, 1973; Elliott, 1981). Fischer (1958) noted for fish that temperature preference was affected by variation of the light intensity as well as the temperature in environment. Engbroten and Hutchison (1976) elucidated the effect of photoperiod on the thermal selection of the lizard.

Concerning the temperature preference of invertebrates, there is little information except for insects, although Rising and Armitage (1969) found that the temperature preference of the gastropods was altered subsequent to temperature acclimation. Crawshaw (1983) showed that the temperature selection of the crayfish was independent of thermal acclimation.

We found previously that temperature tolerance and gliding rate of the planarian depended on the acclimation temperature (Takamatsu and Tsukuda, 1977; Tsukuda and Ogoshi, 1978). In the present study, we examined temperature preference of the planarian in relation to temperature acclimation using a thermal gradient apparatus which was newly designed for this experiment.

MATERIALS AND METHODS

An asexual strain of the planarian Dugesia japonica was obtained from the stock culture which had been maintained under constant conditions in our laboratory for several years. The planarians were divided into three groups and reared at 13, 18 or 23°C respectively, for more than six months before the determination. During this acclimation they were fed on beef liver once a week.

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*Present address: Department of Public Health, Nara Medical University, Kashihara, Nara 634, Japan.
RESULTS

Figure 2 shows intervals of the aluminium plates and mean temperature within the glass tube of each segment. The polystyrene foam (adiabatic material) between the aluminium plate and the glass tube was necessary to keep a linear gradient of temperature within the glass tube.

The planarians, which tended to aggregate at both ends in the case of a straight glass tube showed random distribution in the oval-ring glass tube without thermal gradient for 3 hr, but they moved towards a certain zone after a thermal gradient was set up. Figure 3 shows temperature preference of the planarians acclimated to 13, 18 or 23 °C in percentage of total distribution for four observations every hour.

The distribution of the 18°C- and the 23°C-planarians was bimodal, while that of the 13°C-planarians showed the third peak in the higher temperature zone. The hatched areas in Fig. 3 represent the temperature zone in which the planarians became inactive or immobile. The 23, 18 and 13°C-planarians became immobile in the zones below 13, 12 and 11°C respectively, although no coma symptom appeared. The 13°C-planarians were immobile in the zone above 24°C, but the 18 and 23°C-planarians were active. Consequently, the practical distribution under immobile conditions is given by the empty area in Fig. 3 and it indicates that the temperature preference of the planarian depends on acclimation temperature.

DISCUSSION

The apparatus which sustained a thermal gradient have been presented by some investigators (Lucas and Reynolds, 1967; Roth and Ralph, 1976; Jaring et al., 1984), but this apparatus was inadequate for the planarian, which is small and relatively inactive. Therefore, a new apparatus had to be designed for the present experiment. Simple cooling and heating of the ends of the water bath was insufficient to sustain an adequate thermal gradient, but it was satisfied by separation of the water bath with aluminium plates and by insertion of the adiabatic material between the aluminium plates and the glass tube. This apparatus is able to attain the gradient of air temperature also and it is possible to use it for experiments on temperature preference of small terrestrial animals.

It found that the planarian, as well as many poikilotherms, shows temperature preference affected by temperature acclimation, unless the planarian became immobile at the temperature extremes. The planarian fails to escape from the temperature extremes, because the gliding rate of the planarian decreases at higher or lower temperature (Takamatsu and Tsukuda, 1977). Therefore, thermal preference of the planarian might possibly have resulted to escape from cold or heat stress rather than selection of...
favorable temperature. It is reasonable to consider the temperature preference in the exclusion of the immobile planarians represented by hatched areas in Fig. 3.

The cold temperature at which the planarian became immobile changed in parallel with acclimation temperature, and only the 13°C-acclimated planarian was immobile at high temperature. These facts indicate that thermal tolerance of the planarian depends on the acclimation temperature, as in previous findings (Tsukuda and Ogoshi, 1978).

According to Engbretson and Hutchison (1976) the thermal selection of the lizard was affected by photoperiod. In the present study, the planarian was reared under constant illumination and determination of temperature preference was always initiated at the same time. Consequently, the effect of photoperiod may be negligible.

Müller (1977) found that temperature selection of the goldfish and the brook trout depended on the temperature of the head after heterogeneous temperature acclimation. The planarian is alive after cutting into halves, and separate examination of the both halves is possible. Which half, the anterior or the posterior, has more dependent thermal preference on the acclimation temperature? This is an interesting problem.

REFERENCES