Daily locomotory activity of *Mesidotea (Saduria) entomon* (L.) (*Isopoda, Crustacea*) from the Gulf of Gdańsk

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Behaviour

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Abstract

The research aimed at examination of a twenty-four hours' rhythm of locomotory activity of *Mesidotea* (*Saduria*) *entomon* (L.) from the Gulf of Gdańsk under conditions close to natural, taking into account the effect of temperature, substrate, and illumination. Determinations of the locomotory activity were accomplished using a thermistor sensor. Duration of the activity under conditions close to natural depends on the length of night. As much as 86% of the total activity takes place at night, while during the day *M. entomon* remains dug in sand. An increase in ambient temperature (from 4° to 12°C) within the limits of environmental temperature results in a decrease of the activity. Replacement of sandy bottom with a glass bottom of the measuring chamber results in an increased daily activity (66% of the total activity) compared to night activity. Continuous illumination causes digging of the animals in sand and reduction of the activity to scarce movements of antennas.

1. Introduction

Mesidotea (*Saduria*) *entomon* (L.) is a constant component of the Baltic bottom fauna. It constitutes 9% of biomass of zoobenthos of the Gulf of Gdańsk (Mulicki, 1957). It is an interesting subject of investigation due to the arctic origin and an important role played by it in nourishment of industrial fish like cod or flounder (Haahtela, 1975). A number of papers have been published on the distribution (Mulicki, 1957; Haahtela, 1975), biology, and ecology of this species (Haahtela 1978, Kopacz and Wiktor, 1968), respiration (Babula *et al*, 1978; Hagerman and Szaniawska, 1988b), ionic adjustment and adaptation to fresh water (Lockwood and Croghan, 1957, Croghan and Lockwood, 1968) or the hemocyanin concentration (Hagerman and Oksama, 1985). However, the problem of locomotory activity has not been dealt with in any of these papers. Animal's motion is one of the processes yielding information on the energy conversions taking place in the individuals. The knowledge of locomotory activity is significant for consideration of energy losses due to animal's mobility.

Our study aimed at a presentation of twenty-four hours' variations in the locomotory activity of *M. entomon* under conditions close to natural and at an investigation of the effect of temperature, substrate, and illumination on the locomotory activity of this species.

2. Materials and methods

M. entomon has been caught at GN station (Gulf of Gdańsk) at a depth of 25–30 m by means of a drag net with 2 mm mesh. The specimens were placed in a water thermostat at a temperature similar to that at which the animals were caught. Determinations of the activity were carried out following a 72 h period of laboratory adaptation. *M. entomon* were nourished every 3–4 days with mussels.

Mature individuals of a 37–57 mm in length were chosen for the determinations and placed individually in a measuring chamber of dimensions 9.5 × 12.5 cm filled with 400 ml of sea water. A 2 cm layer of sand was placed at the bottom of the chamber. A thermistor sensor operating on a balanced bridge principle (Oertzen von, 1984) was applied for the determination of the activity. Movements of the animal were recorded using a TZ 4200 strip-chart recorder. The measuring chamber was naturally illuminated. Each movement of the animal was regarded as an activity. Intensity of the motion corresponded to the height of the recorded peak. The sum of peak lengths during an hour constituted a measure of the activity. The avarage sum of peak lengths *per* hour calculated from all the cycles under specific conditions was taken as the mean activity.

After the experiment, the sex of the individuals was established and their length from cephalic recess between the eyes to the end of thelson was measured with an accuracy of 1 mm. The activity of *M. entomon* during 36 days has been analysed over the period from November 1983 to May 1985. The experiments were performed on 6 females and 11 males.

3. Results

Fourteen twenty-four hours' cycles were analysed under conditions close to natural using 7 individuals (water temperature = 4°C). A distinct division of the twenty-four hours' cycle into day and night has been observed for all the examined *M. entomon* specimens (Fig. 1). The night activity constitutes 86% of the total twenty-four hours' activity (Table 1). During days crustaceans remain dug in sand and start to reveal activity only after dark. Duration of the activity is directly proportional to night's length.

In December *M. entomon* revealed a 14 h activity. In April the active period is shorter and lasts for 5–6 hours. Time in which the animals reveal motion is variable. In May the activity period was shortened to 7 h, but at the same time the motions became much more intense. The animals more often swam and changed place, while in winter the motions of abdomen or antennas prevailed, due to which the intensity was 3–4 times lower than in May. It can be noticed that crustaceans fall into scarcely active animals. Under conditions close to natural in December it spent 67% of a twenty-four hours' period dug in sand or moving antennas, in April 76%, while in May 79%.

In order to determine the effect of temperature, the specimens caught at 4°C have been adapted to a temperature of 12°C for 4 days and their activity was subsequently determined. The remaining conditions remained unchanged. A de-

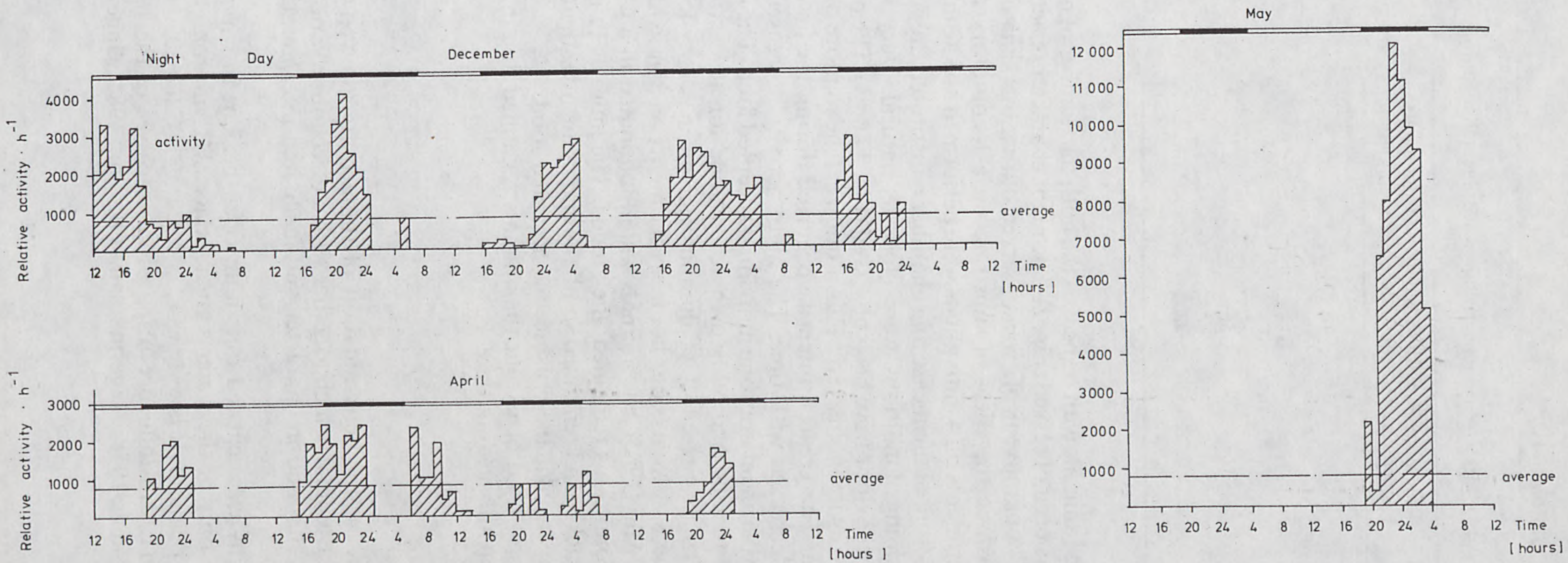

Fig. 1. Pattern of twenty-four hours' activity of *M. entomon* under the conditions close to natural (December, April, May)

Table 1. Locomotory activity of *Mesidotea entomon* under experimental conditions

	Natural conditions	Elevated temperature	Without sandy substrate	Continuous illumination
Number of days	14	6	10	6
Mean activity	769	131	1278	0
% daily activity	14	31	56	0
% night activity	86	69	44	0

crease in activity of the animals with respect to the both the number of movements and their intensity has been observed (Fig. 2). The night character of active animal life still prevailed (67% of movements was observed during this time of the day).

In order to determine the effect of substrate on a locomotory activity of *M. entomon*, ten experiments on 4 individuals were performed at 5°C in April and May 1985. A glass bottom of the measuring chamber constituted the substrate in this case. The remaining conditions were close to natural. Very significant changes in animal's behaviour have been observed (Fig. 3 and 4). The majority of *M. entomon* started to swim intensively. This motion extended more or less over the entire experiment. The greatest intensity occurred during the first hours of experiments and it decreased with time. The night activity decreased to 34%. After the end of the experiment only one individual accepted food. The remaining ones dug themselves in sand and refused to accept food for at least two days.

In order to determine the effect of illumination on a twenty-four hours' activity of *M. entomon*, six twenty-four hours' experiments on 3 individuals were performed at 5°C in May 1985. The animals were illuminated in a continuous manner. The other conditions remained unchanged. The animals buried themselves in sand very quickly and remained so till the end of the investigation. After completion of the experiment the crustaceans accepted food.

Under conditions of total black-out the animals remained dug in sand and scrambled out only at the feeding time.

4. Discussion

The method used for the determination of the activity allowed recording every movement of the animal, which together with a direct observation enabled the determination of the motion character and facilitated interpretation of the results.

The determinations were carried out in an open beaker, in which the gas exchange took place only at the water–air interface. *M. entomon* is a species having small oxygen demand. It is only $PO_2 = 2\ \mathrm{mg \cdot l^{-1} \cdot C}$ (*ca* 20% of oxygen saturation) or less that can influence respiration processes of the individuals (Kangas and Lappalainen, 1978; Hagerman and Oksama, 1985; Hagerman and Szaniawska, 1988).

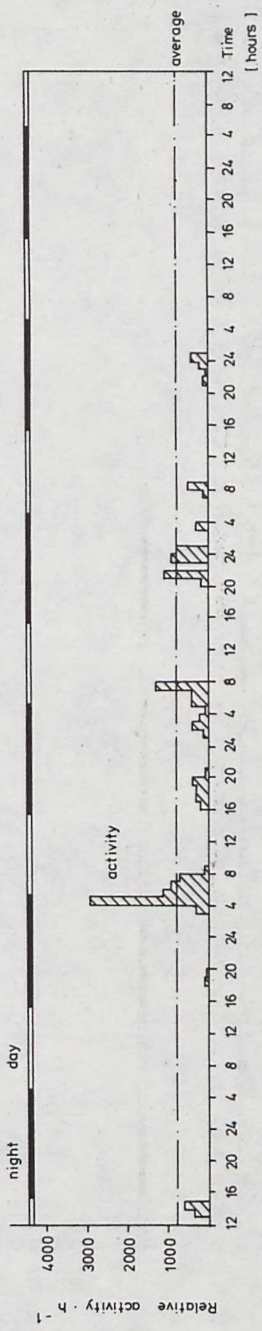

Fig. 2. Twenty-four hours' activity of *M. entomon* under conditions of elevated temperature (from 4°C to 12°C)

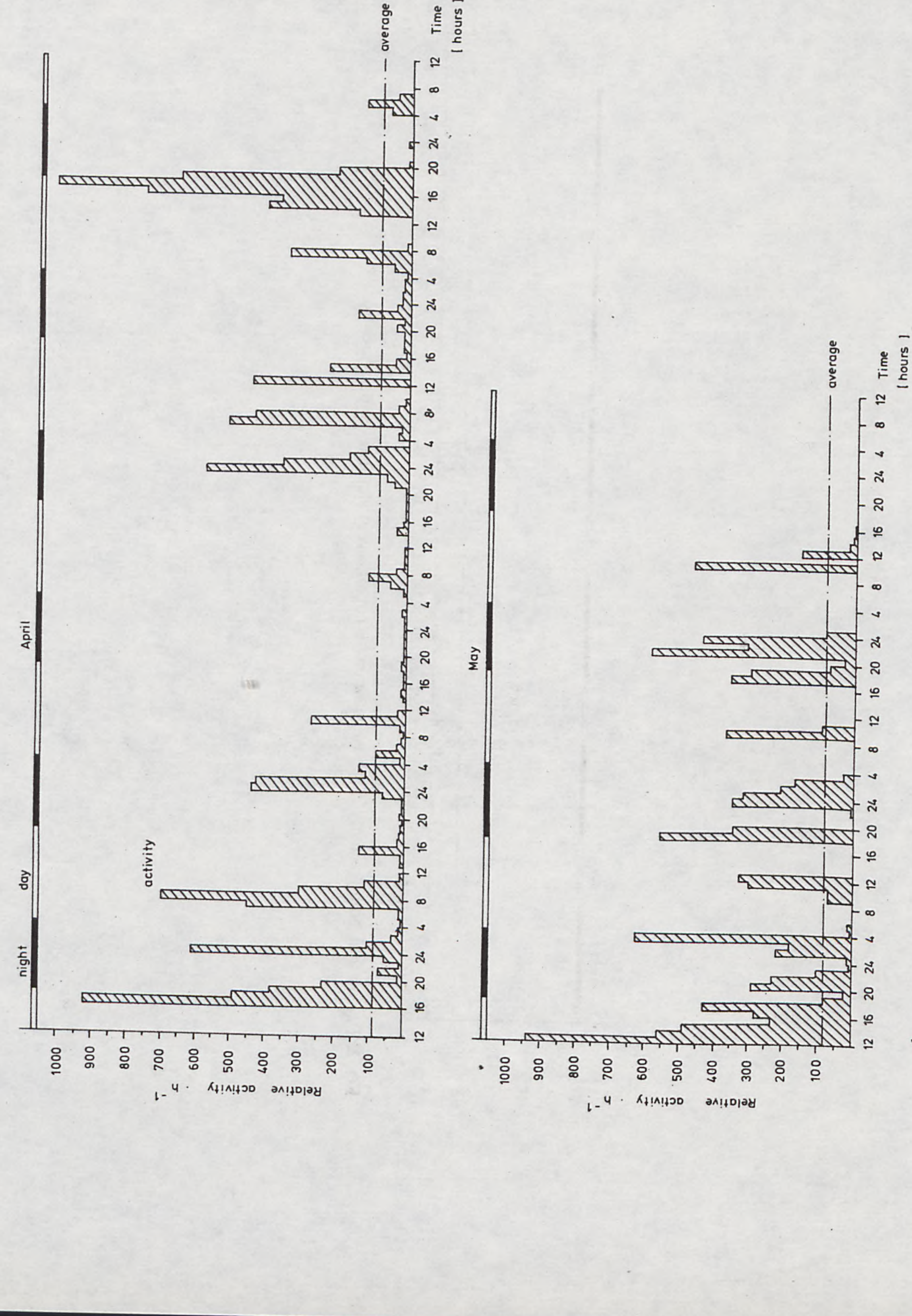

Fig. 3. Twenty-four hours' of *M. entomon* under conditions of lack of sandy substrate (glass bottom)

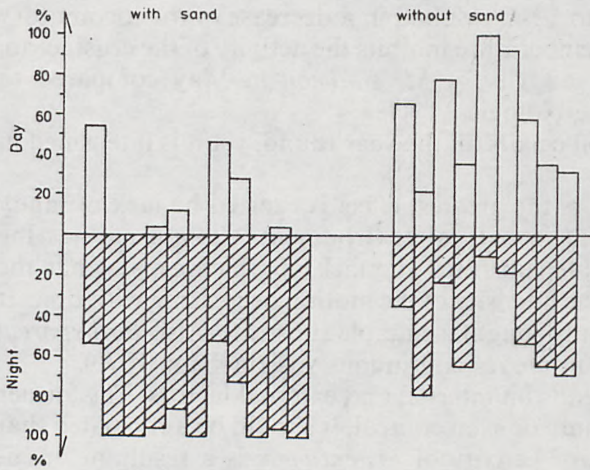

Fig. 4. Percentage of locomotory activity of *M. entomon* under conditions close to natural and without sandy substrate

M. entomon is the animal of low locomotory activity. In some cases during several weeks' observations (December 1984, January 1985) it remained buried in sand and performed only single antennas movements.

Night is a period when not only *M. entomon* lives more intensely. A number of *Isopoda* (*Idothea baltica*, *I. chelipes*) also reveal an increased activity when the light intensity changes (Jansson and Kallander, 1968). In the case of *C. crangon* the greatest locomotory activity was found to occur at night (Hagerman, 1970; Dalley and Bailey, 1981; Szaniawska and Wołowicz, 1988), while in the case of *Palaemon adspersus* – at dusk and dawn (Dalley and Bailey, 1981; Hagerman, 1970). Similarly to the crustaceans mentioned above, a crab *Chasmagnathus convexus* leads an active life at night (Nakasone *et al*, 1983).

It has been observed that under conditions close to natural food does not influence the pattern of locomotory activity of the animals. The same dependence has been established during investigations on the activity rhythm of *P. adspersus* (Hagerman and Ostrup, 1980).

M. entomòn spend a larger part of the year in deeper regions of the sea (Żmudziński, 1966). The depth scale ranges from 25 to 123 m (Mulicki, 1957), where the illumination is quite restricted. Probably due to this under conditions of stress-inducing, intensive illumination the animals dug themselves in sand and are capable of surviving in this way even long-term unfavourable conditions. Also *I. baltica* and *I. chelipses* did not reveal the activity when permanently illuminated (Jansson and Kallander, 1968). Avoidance of excessive illumination by a series of marine species can be important for survival, taking into account a large number of predators (Jansson and Kallander, 1968).

M. entomon is a typical cryophilic species. The greatest biomass has been established in the Baltic at a water temperature equal to 2°C (Mulicki, 1957). The temperature change from 4°C to 12°C resulted in a decrease of the locomotory activity. Within this range the temperature inhibits the activity of the crustacean. On the other hand, a greater activity of *M. entomon* in May compared to December can be related to the biological cycle.

Reproduction of *M. entomon* occurs all the year round, yet it is intensified in late spring and in summer.

Among the disturbing factors the greatest effect is exerted by lack of sandy bottom. It is quite obvious that in natural environment *M. entomon* has the possibility of choosing a suitable substrate, the lack of which causes that the animals move constantly, and the intensity of the motion decreasing with time. It seems as if the animals continually sought a suitable substrate. Also *Bathyporeia pelagica* devoid of sandy bottom moves continuously (Frincham, 1970).

Activity of the animals depends on internal and external factors. The former are much more difficult to measure or even control. It should be anticipated that the pattern of twenty-four hours' activity of *M. entomon* is a resultant of endogenous mechanisms, what is testified by longer, several days' periods of almost complete immobility under conditions close to natural, and exogenous mechanisms, what is evidenced by a distinct dissynchronous effect of constant illumination and the lack of sandy bottom. Supposedly, in natural environment the external mechanisms exert a greater effect on the behaviour and mode of *M. entomon* life. This statement is confirmed by investigations on the ventilation, heart beat, and oxygen consumption of this species (Hagerman and Szaniawska, 1988a).

Endo- and exogenous character of twenty-four hours' cycles is observed for a number of species. In the case of *Eurydice pulchra* (*Isopoda*), an endogenous control has been established of frequency and swimming rhythm of individuals during day and night, synchronized with waving and changes in hydrostatic pressure (Jones and Naylor, 1970; Hastings, 1981).

Endogenous character of the activity rhythm is revealed by *Bathyporeia pelagica* (Frincham, 1970), *Penaeus semisulcatus* and *P. monodon* (Moller and Jones, 1975), while the exogenous one – by *Crangon crangon* (Szaniawska and Wołowicz, 1988).

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