OPHELIA, 12: 117-127 (December 1973)

SEASONAL AND DIEL VARIATION IN THE RHYTHMICITY OF *IDOTEA BALTICA* (PALLAS) AND *IDOTEA GRANULOSA* RATHKE.

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ABSTRACT

The swimming activity of *Idotea baltica* and *Idotea granulosa* was investigated by means of photocells. The activity patterns of both species showed great seasonal variations.

Both species showed no swimming activity in winter (*Idotea baltica* from November-March, and *Idotea granulosa* from September-March). The rest of the year both species had one activity peak between midnight and sunrise.

Idotea baltica was nocturnal in early spring, in summer the activity was high all 24 hours, besides the nocturnal maximum an increased activity was evident in the afternoon till two hours after SS.

At the end of September and the beginning of October *I. baltica* was nocturnal.

The same variation in the activity pattern was found for *I. granulosa*.

Under artificial light/dark conditions both species were nocturnal. When the light/dark change was right-angled this was the dominating Zeitgeber.

INTRODUCTION

The ecology of *Idotea baltica* (Pallas) and *Idotea granulosa* Rathke has been investigated by a.o. Sywula (1964), Naylor (1955), Muus (1967), and Jansson (1971). According to these authors *I. baltica* is in Denmark found in localities with continuous renewal of water and *I. granulosa* in more exposed localities with strong currents or waves.

I. baltica and *I. granulosa* are the most common species of the genus *Idotea* along the coast north of Helsingør.

They can here be found living together at the same locality and it could thus be interesting to see if *I. baltica* and *I. granulosa* had different patterns of activity with special reference to seasonal variations, thus avoiding competition with each other regarding food and space.

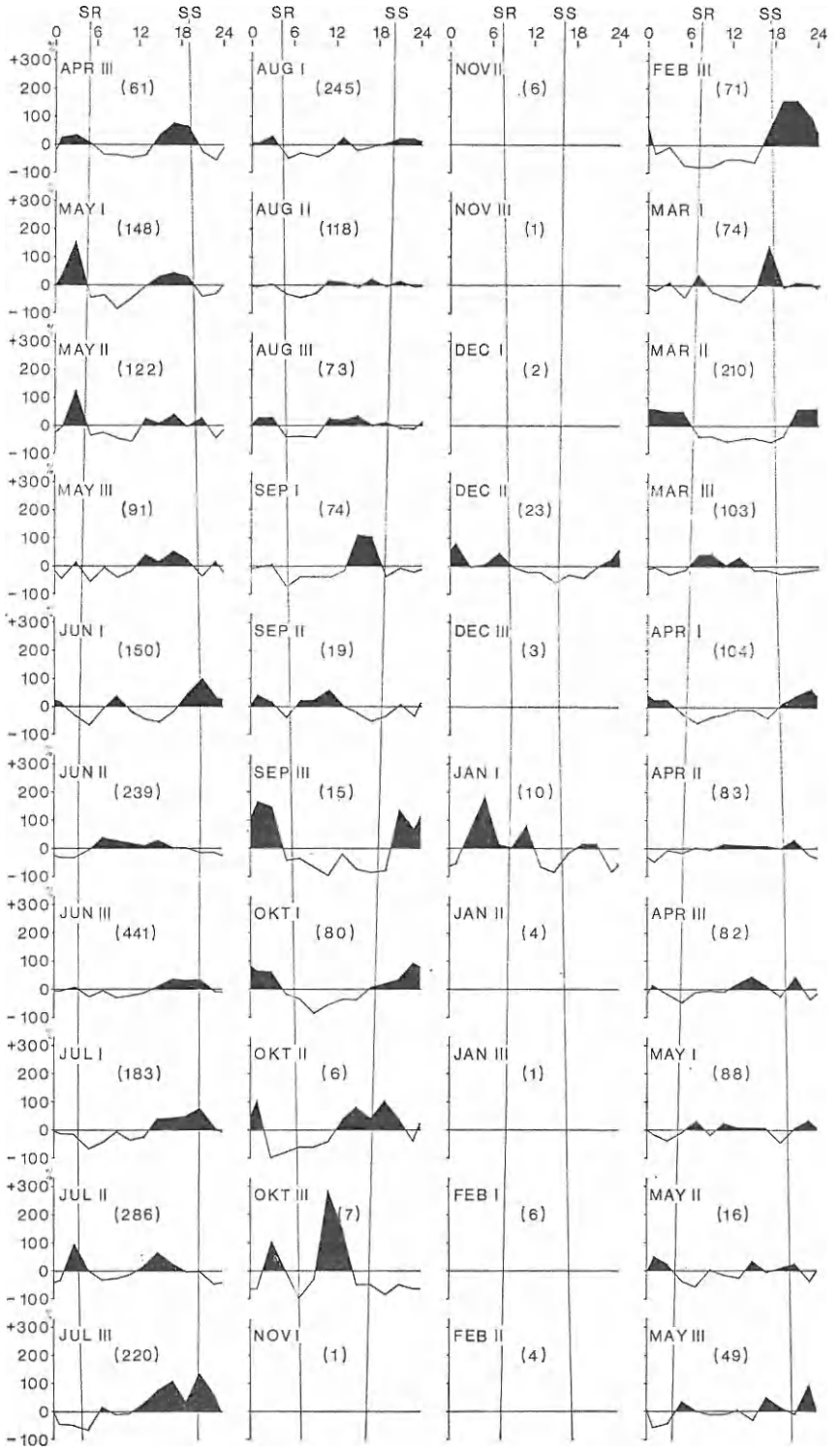

FIG. 1. Diel activity pattern of *Idotea baltica* in natural light conditions, given as percentage deviation from the mean value of the registration period. Each group averages 10 days. Numbers within brackets show the mean number of counts/24 hours.

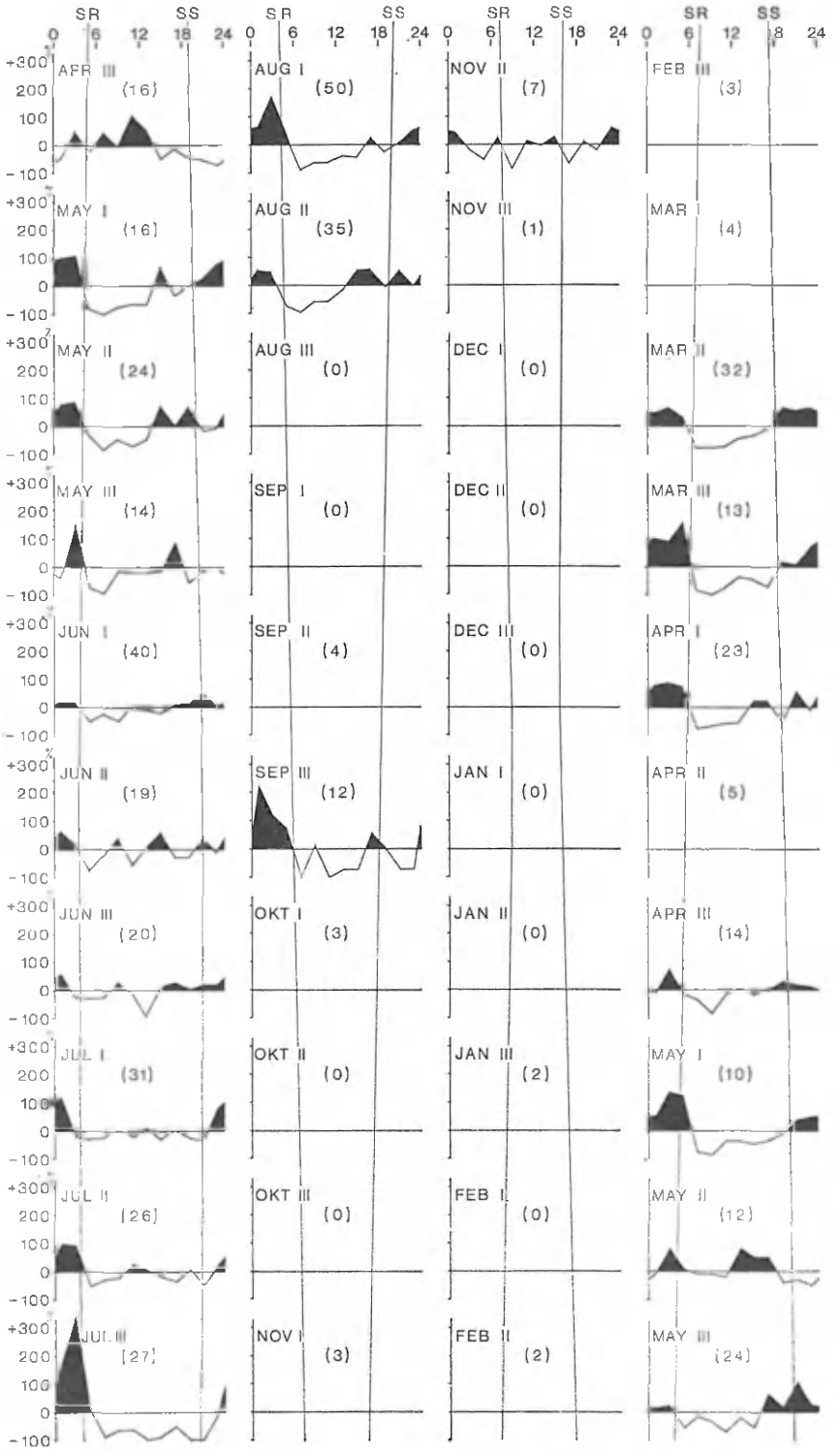

FIG. 2. Diel activity pattern of *Idotea granulosa* in natural light conditions, given as percentage deviation from the mean value of the registration period. Each group averages 10 days. Numbers in brackets show the mean number of counts/24 hours.

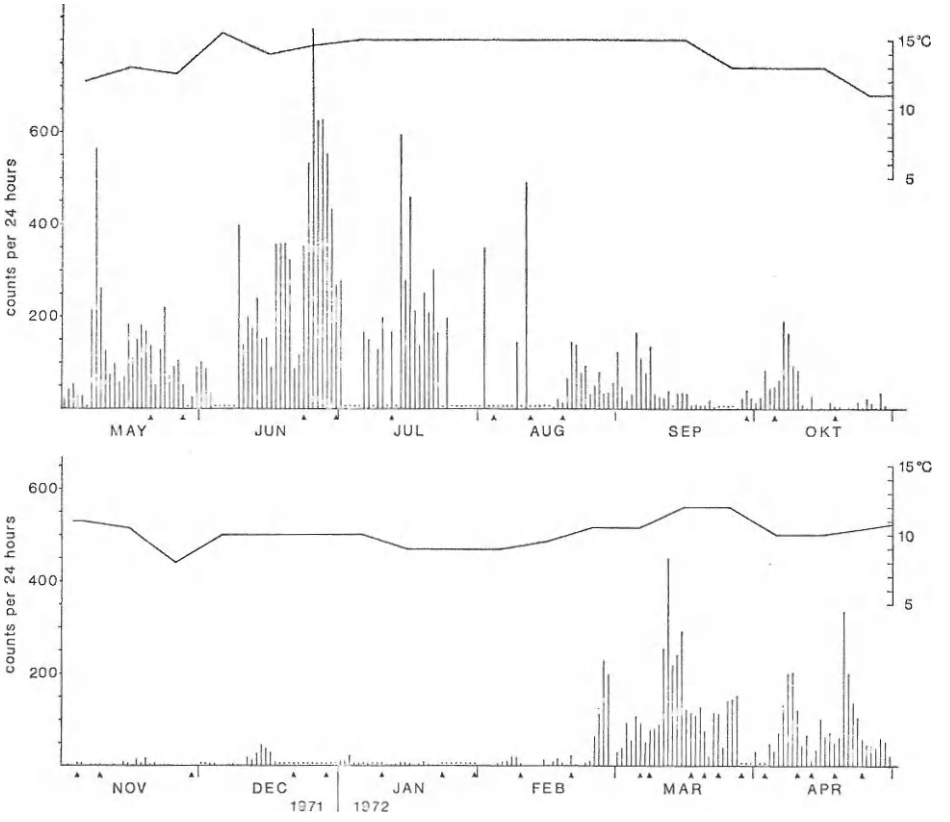

FIG. 3. The number of registrations per 24 hours for *Idotea baltica* in natural light conditions. Triangels below horizontal line indicate days of feeding with *Mytilus* flesh. Dots above horizontal line indicate interruptions in the registration, i.e. no total value for all 24 hours.

ACTIVITY PATTERNS IN ARTIFICIAL LIGHT

To test the light/dark change as an external factor controlling the diel rhythm, and the influence of varying daylengths, the animals were kept in a dark-chamber and lighted by a fluorescent tube (500 Lux).

The artificial day was gradually prolonged two hours every week untill LL and then shortened two hours weekly untill DD. The results are shown in Figs 5 & 6.

Idotea baltica was caught and put under these experimental conditions in May 1971 (nLD was 16:8).

In artificial LD *I. baltica* was nocturnal except when the L-period or the D-period was extremely long. (Fig. 5).

When *I. baltica* had a light period longer than 16 hours it showed some activity during daytime and the total amount of activity fell. When the L-period

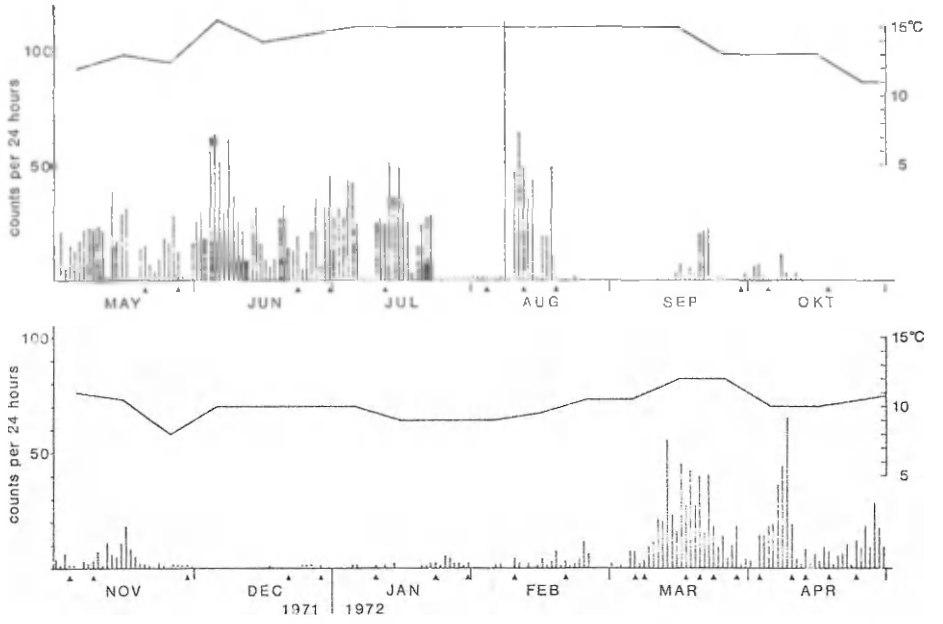

FIG. 4. The number of registrations per 24 hours for *Idotea granulosa* in natural light conditions. Triangels below horizontal line indicate days of feeding with *Mytilus* flesh. Dots above horizontal line indicate interruptions in the regisstration, i.e. no total value for all 24 hours.

was shorter than 16 hours (the activity of *I. baltica* began at the artificial SS. When the D-period was longer than 8 hours more than one activity peak appeared, i.e. a typical bigeminus rhythm.

The activity pattern under DD with a peak around 20.00 hrs and 02.00 hrs were found only during the first 3 days. After this no rhythmic activity occurred.

The experiment with *I. granulosa* was started in October 1971 (nLD 12:12).

I. granulosa showed the same diel activity pattern (Fig. 6) as *I. baltica* except that the activity of *I. granulosa* never started right after the artificial SS, as there was always a delay before onset of swimming.

To test the possibility of controlling the diel rhythm of both *I. baltica* and *I. granulosa* the following experiment was performed in the dark-chamber. The artificial day/night was set to be opposite to the real day/night (LD 12:12).- Under these conditions both *I. baltica* and *I. granulosa* followed the artificial day/night rhythm, i.e. the active period occurred during the artificial night, also when the light intensity at artificial daytime was very low (ca. 30 Lux) Figs. 7 and 8.

Both species followed the artificial night, indicating that the Zeitgeber which started working at the light/dark change was very sensitive, i.e. exerted a strong influence on the activity of the animals.

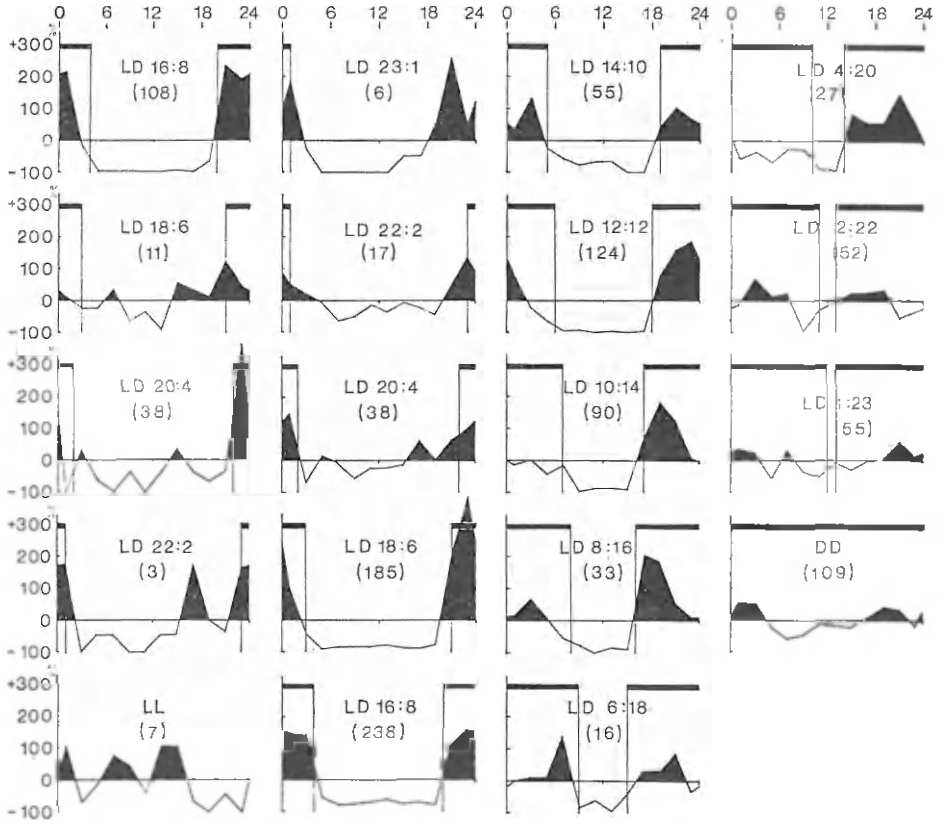

FIG. 5. Diel activity pattern of *Idotea baltica* in artificial light/dark, given as percentage deviation from the mean value of the registration period; each group averages one week. Numbers in brackets show the mean number of counts/24 hours.

DISCUSSION

The activity measured in these experiments was the swimming activity. This means that an observation of no activity does not exclude other activities such as feeding and preening. As the light-beam is very narrow it is, furthermore, only a part of the swimming activity that is registered.

As *I. granulosa* is smaller than *I. baltica* the probability that it passes though the narrow light-beam is smaller, and this may be one of the reasons why the counts/24 hours generally is lower than for *I. blticaa.*

I. granulosa also has a longer period than *I. baltica* with no swimming activity during the winter. There is a probability that this is due to the same reason as mentioned above. In nLD both *I. baltica* and *I. granulosa* showed a rather varying annual activity pattern. This was not found when the animals were kept under

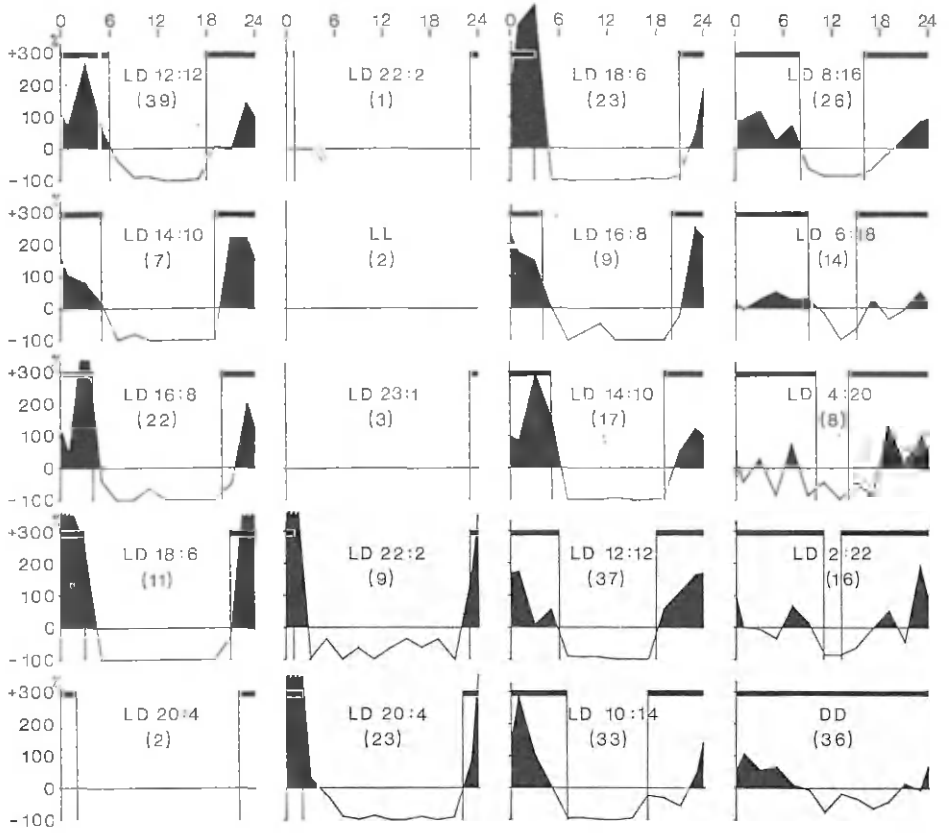

FIG. 6. Diel activity pattern of *Idotea granulosa* in artificial light/dark, given as percentage deviation from the mean value of the registration period. Each group averages one week. Numbers in brackets show the mean number of counts/24 hours.

artificial light/dark conditions. In artificial light/dark both *I. baltica* and *I. granulosa* were nocturnal and the decreasing activity, when the light period was less than 8 hours (*I. baltica*) or 12 hours (*I. granulosa*), was missing. Moreover the LD-experiment with *I. granulosa* was performed during the winter period. If the lower temperature in winter was an impulse for no activity one should expect no activity. On the contrary the activity level was quite high.

The difference between the LD and the nLD experiments is that the light/dark change is right-angled and the light intensity was constant during the light period. In the nLD-experiment there is twilight between night and day and the mean light intensity is lower in winter than in summer. As the experiment was performed indoor this slow change between light and dark was prolonged. This show that when the light/dark change is right-angled this sudden change is the dominating Zeitgeber.

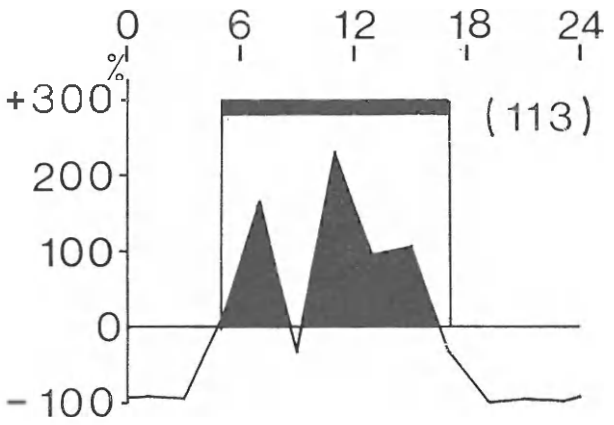

FIG. 7. Diel activity pattern of *Idotea baltica* given as percentage deviation from the mean value of the whole registration period in artifical light/dark (LD 12:12). Light intensitity during the artificial day was 30 Lux.

According to Jansson and Källander (1968) *I. baltica* starts the activity period when the light intensity falls below one Lux, and the period of inactivity begins at 400-800 Lux. This was not found in this experiment. Even when the aquaria were lighted by extra light during daytime. the animals showed the same activity pattern as in nLD, i.e. they showed activity during daytime. The experiments performed with low light intensity (Figs. 7 and 8) also show that the animals are able to react upon very low changes in light intensities.

The phase setting of the rhythm seems more to depend upon changes in light intensity than on absolute values. The way of light change (abrupt or slow) also seems to be of great importance. A similar phenomenon has been discussed for various species by Harker (1964).

When the activity period lasts more than 6 hours, the activity patterns for both *I. baltica* and *I. granulosa* are of bigeminus or trigeminus type dependent upon the length of the activity period. At shorter activity periods only one maximum appears. This type of activity pattern is also shown by the brackish-water shrimp *Crangon vulgaris* (Hagerman, 1970) and by the freshwater amphipod *Gammarus pulex* (Müller, 1966).

As a supplement to the laboratory studies the species have been observed by diving in daytime. They never swam up into the free waters but were only seen swimming from plant to plant, and this was also the situation in the aquaria in the laboratory.

Generally the two species *I. baltica* and *I. granulosa* show no significant differences in their diel rhythms. As to the variations during the year, *I. granulosa* shows a longer period of no activity in wintertime than *I. baltica*. There seems to be no difference in the activity patterns of the adult animals of these species which may hinder competition for food and space.

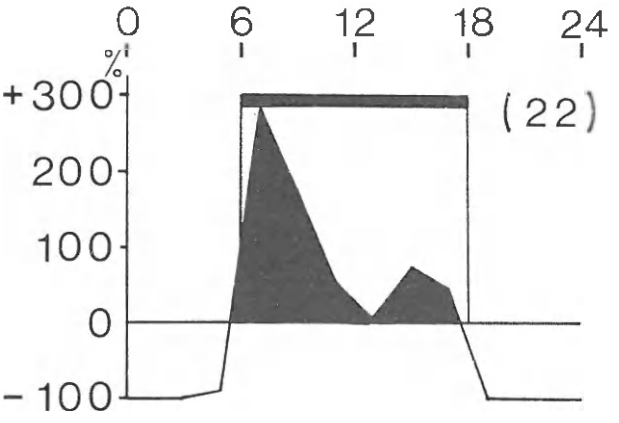

FIG. 8. Diel activity pattern of *Idotea granulosa* given as percentage deviation from the mean value of the whole registration period in artificial light/dark (LD 12:12). Light intensity during the artificial day was 30 Lux.

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