Circadian Rhythm of Oxygen Consumption in Winkles, *Littorina (Littoraria) undulata* (Gray) & *Nodilittorina pyramidalis pyramidalis* (Quoy & Gaimard)

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Increased respiration was observed during the scotophase. The respiratory rhythm persisted when both the species were subjected to different photoperiodic conditions of constant light, constant darkness and an inverted photoperiod for 24 hr.

Rhythm of oxygen consumption has been reported in a wide variety of intertidal animals. There are, however, species and habitat differences in the rhythmicity. In the present investigation, rhythmicity in the nature of oxygen consumption in intertidal littorines, *Littorina (Littoraria) undulata* and *Nodilittorina pyramidalis pyramidalis* has been determined and compared with other forms.

Animals, approximately of the same size were collected in November, from the rocks of Lawson's Bay of Visakhapatnam (long. 83°18'30" to 83°21'30" E, lat. 17°42'30" to 17°43'30" N) from the high tide level. Salinity, pH, temperature and dissolved oxygen of the habitat varied from 31.6 to 33.2, 7.95 to 8.05, 23.9°C to 26.0°C, and 5.2 to 5.3 ml O₂/1 respectively.

Animals (20) were acclimatised to the laboratory conditions in glass aquarium containing 10 l of aerated running seawater (sal. 32%, pH 7.5 ± 0.5) at 25°C ± 0.5°C for 24 hr before use. Animals were not fed during acclimatisation and experimentation.

In all experiments oxygen consumption was measured on a single animal at 2 hr intervals for 24 hr using respiratory chambers maintained at 25°C ± 0.5°C. Filtered (Whatman 42) seawater of sal. 32% and pH 7.5 ± 0.5 was used for experiments. The dissolved oxygen was estimated by Winkler's method.

To observe circadian rhythm, oxygen consumption was determined every day on 6 animals under normal photoperiod and the same experiment was repeated every day on different animals for 7 days. Respiratory measurements were made subjecting the animals to 4 different photoperiod conditions. Four series of experiments were made. In the 1st series animals were maintained on a normal photoperiodic schedule (12:12; light from 0600 to 1800 hrs) while in the 2nd they were placed on an inverted photoperiodic schedule (12:12; lights on from 1800 to 0600 hrs). In the 3rd series, animals were kept in constant darkness (DD) and in the 4th they were placed in constant light (LL) throughout the period of study. The light source was provided by daylight fluorescent tubes (25 cd/m²) at the surface of respiratory chambers. In each series, experiments were made on 7 individuals of about the same size.

After completion of the experiments, soft parts of the animals were dried to a constant weight at 60°C for 24 hr. Average hourly oxygen consumption of all individual animals was considered for the presentation of data (Fig.1).

In *L. undulata* and *N. pyramidalis pyramidalis*, a persistent circadian rhythm of oxygen consumption was clearly evident, with an increase in the rate of oxygen uptake during night time. Respiratory rhythm in these is different from the rhythm observed in other

![Fig. 1—Daily rhythmicity in rate of oxygen consumption of *Littorina undulata* (0—0) and *Nodilittorina pyramidalis pyramidalis* (0—0) under different photoperiodic conditions](image-url)
littorines, *Littorina irrorata* and *Urosalpinx cinerensis*.

High oxygen consumption was observed at 0600 and 2400 hrs in *L. undulata* and at 0400 and 2400 hrs in *N. pyramidalis pyramidalis* with lowest being at 1600 hrs in both species. The increased respiration during night may be due to its decreased predation at night.

The diurnal pattern of respiratory rhythm in *L. undulata* and *N. pyramidalis pyramidalis* shows similarity with the rhythm observed in *Cellena radiata*, *Melampus bidentatus* and *L. irrorata*.

The results indicate that *L. undulata* and *N. pyramidalis pyramidalis* do not exhibit tidal rhythm. Non-occurrence of tidal rhythm has been reported in *L. irrorata*. It is also clear from the earlier observations that the circadian rhythm is independent of tide. Further Shirley *et al.* showed that there is no circatidal rhythm in *L. irrorata*. However, both tidal and diurnal rhythm have been reported in *Cellena radiata*.

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**References**