Chapter I

Whole animal oxygen consumption
Results

Total metabolism:

The data on the total metabolism of the toad, *Bufo melanostictus* at 4 hour interval of the 24 hours day are shown in table 1.1. The mean values and standard deviations of total oxygen consumption are presented in figure 1.1 and the per cent change is shown in the form of histograms in figure 1.2. Higher energy expenditure is observed in the toads at 00.00 hours of the day when compared to the rest of the time intervals.

The statistical comparison of the data (Table 1.2) revealed that there is a significant decrease in the total metabolism at 12.00 hours of the day. The highest peak observed in the total metabolism of the toads is at 00.00 hours which significantly differs from the values reported at 08.00, 12.00 and 16.00 hours of the day. Hence, it can be concluded that the toad being a nocturnal animal exhibited high energy expenditure during the night time and lesser energy expenditure during the day time.
Table 1.1: Whole animal oxygen consumption of the toad, *Bufo melanostictus* in relation to dial variations.

<table>
<thead>
<tr>
<th>O₂ consumption</th>
<th>08.00</th>
<th>12.00</th>
<th>16.00</th>
<th>20.00</th>
<th>00.00</th>
<th>04.00</th>
<th>08.00</th>
<th>F ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total metabolism</td>
<td>4.30</td>
<td>4.16</td>
<td>4.45</td>
<td>7.58</td>
<td>8.26</td>
<td>5.62</td>
<td>4.23</td>
<td></td>
</tr>
<tr>
<td>(ml O₂/hour)</td>
<td>±0.35</td>
<td>±0.41</td>
<td>±0.21</td>
<td>±0.41</td>
<td>±0.44</td>
<td>±0.40</td>
<td>±0.18</td>
<td>140.43**</td>
</tr>
<tr>
<td>% change</td>
<td>(-3.25)</td>
<td>(3.49)</td>
<td>(76.28)</td>
<td>(92.09)</td>
<td>(30.70)</td>
<td>(-1.63)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit metabolism</td>
<td>0.110</td>
<td>0.108</td>
<td>0.113</td>
<td>0.184</td>
<td>0.196</td>
<td>0.140</td>
<td>0.108</td>
<td></td>
</tr>
<tr>
<td>(per gm wt)</td>
<td>±0.01</td>
<td>±0.01</td>
<td>±0.005</td>
<td>±0.01</td>
<td>±0.009</td>
<td>±0.01</td>
<td>±0.004</td>
<td>103.99**</td>
</tr>
<tr>
<td>% change</td>
<td>(-1.82)</td>
<td>(2.73)</td>
<td>(67.27)</td>
<td>(78.18)</td>
<td>(27.27)</td>
<td>(-1.82)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are mean ± SD of six individual observations.

** Level of significance $P < 0.01$
Table 1.2: Statistical comparison of the data given in table 1.1

<table>
<thead>
<tr>
<th>O₂ consumption</th>
<th>Mean values arranged in the ascending order along with corresponding time of the day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.00</td>
</tr>
<tr>
<td>Total Metabolism</td>
<td>4.16</td>
</tr>
<tr>
<td>Unit metabolism</td>
<td>0.108</td>
</tr>
</tbody>
</table>

Values grouped together by a common underline do not differ significantly among themselves.
LEGEND FOR FIGURES

Fig. 1.1: Histograms representing the mean values in the total oxygen consumption of toad, *Bufo melanostictus* in relation to dial variations.

Fig. 1.2: Per cent change in the total oxygen consumption of the toad, *Bufo melanostictus* in relation to dial variations.
LEGEND FOR FIGURES

Fig. 1.3: Histograms representing the mean values in the unit oxygen consumption of toad, *Bufo melanostictus* in relation to dial variations.

Fig. 1.4: Per cent change in the unit oxygen consumption of toad, *Bufo melanostictus* in relation to dial variations.
Unit metabolism

Unit metabolism was calculated from the data on the total metabolism of the toads at different times of the day (Table 1.1). The mean values and standard deviations of unit oxygen consumption are presented in figure 1.3 and the per cent change is shown in figure 1.4.

The observations in respect of the unit oxygen consumption were found to be similar to those of the total oxygen consumption. The statistical comparison of the data revealed that the lower energy expenditure was observed at 12.00 hours of the day.

Discussion

Respiration is defined as the gaseous exchange between the organism and its environment. It includes two processes viz., inspiration a process in which oxygen is taken in and expiration in which carbon dioxide is given off. Even a minor change in the rhythm of any one of these two processes, may affect the oxygen uptake of the animal and in turn its metabolism. A similar condition in the whole animal oxygen consumption of crab, *Oziotelphusa senex senex* was reported (Sailaja, 1989).

Abiotic factors like temperature and dissolved oxygen exert greater effect on the metabolism of diverse organisms. The length of the day could provide the environmental cue, which would time or phase these metabolic changes (Rice and Armitage, 1974). As such, the animal has to regulate against these changes also rather than changes in temperature alone.

In two species of amphipods, respiration is highest during night time active period (Arudpragasam, 1964). In penaeid prawn, the rate of oxygen uptake showed a gradual increase from 05.00 hours towards 17.00 hours and declined afterwards. Maximum uptake was observed during dark hours (upto 23.00 hrs) Penaeid prawns (*P. indicus, Metapenaeus*
monoceros) were reported to be nocturnal with reference to motor activities (Menon and Raman, 1961 Narayanakutty and Murugaboopathy, 1968). In accordance with the activity of the animals oxygen uptake also exhibited corresponding phase of activity during 24 hour day.

Studies on the respiration of poikilotherms have shown that their oxygen consumption is related to body size, respiratory surfaces and its evolution (Zeuthen, 1953; Hemingsen, 1960). The snails showed a marked diurnal rhythm in oxygen consumption and they consumed minimum oxygen at noon and maximum at mid night(Saty Reddy and Balaparameswara Rao, 1968).Sailaja (1989) reported that based on the oxygen consumption, the crab, O. senex senex has been shown to be nocturnal.

An animal’s activity is perhaps the most obvious physiological parameter influenced by circadian rhythms. Nocturnal animals move about and do their foraging during darkness. This higher level of activity is also synchronised with a higher basal metabolic rate as well as body temperature (Aschoff and Pohl, 1970).

It has been shown in anurans that a high percentage of carbon dioxide is eliminated through the skin (Foxon, 1964) and this function should not be seriously impaired by submersion. The oxygen uptake through the lungs was more than twice as large as the uptake through the skin when the animals had access to air (Emilio and Shelton, 1980).

In the present investigation, the oxygen consumption was decreased in the toad, Bufo melanostictus with decreased dissolved oxygen content of the medium in the day light. So, the level of metabolism can not be constant throughout the 24 hours of a day. The period of higher metabolic rate seen to alternate with a period of lowest metabolic rate (Gopalakrishna Reddy, 1967). The increase in oxygen consumption in the crabs at 00.00 hours has been correlated with the increment of glucose and decreased glycogen in the O. senex senex
(Chandrasekhar Reddy et al., 1981). A similar trend was observed in *Bufo melanostictus*. Hence, in the present study it can be concluded that the animal could step up its oxygen consumption to carry out the speed locomotor activity in the dark hours i.e. 00.00 hours of the 24 hours day. Due to high temperature, the toads remain in the burrows throughout the day time, especially at 12.00 hours to minimize the water loss. During this time, the animal exhibits low activity. So, the metabolism of the toad has been decreased at 12.00 hours of the day (Fig. 1.1). Chugunov and Kispoev (1968) measured the oxygen consumption of *R. temporaria* in the field and found that the average O$_2$ consumption at night was significantly higher than during the day. In the present investigation, the increase in the magnesium content in the blood of the toads at 12.00 hours and 16.00 hours of the day has a depressing effect on metabolic activity of the animal. Similar observations were recorded in the marine crustaceans (Robertson, 1957).

Thus, with the nocturnal activity of the *Bufo melanostictus*, oxygen uptake as well as the metabolism exhibited corresponding phase of activity during the 24 hours day. Accordingly, the oxygen consumption of these animals is gradually increased from evening and reached maximal at midnight i.e. 00.00 hours of the 24 hours day.