Dial variations in the levels of blood glucose and hepatopancreatic glycogen in the slug, *Laevicaulis alte* (Ferussac 1821)

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Summary. In *Laevicaulis alte* maximal blood glucose level at 00.00 h alternates with minimal level at 12.00 h of the day, while hepatopancreatic glycogen showed an opposite trend. Variations in blood glucose levels are inversely proportional to the corresponding variations in hepatopancreatic glycogen content, while blood glucose level shoots up to a maximum, hepatopancreatic glycogen declines to a minimum and vice versa.

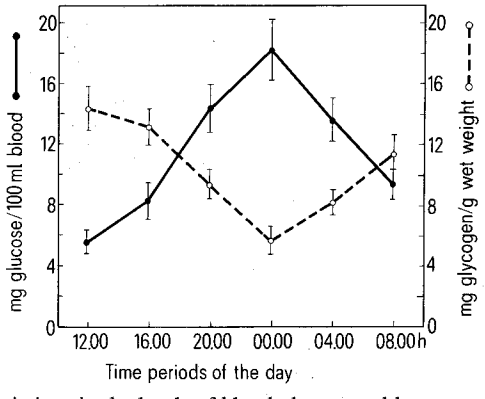
A survey of the literature has shown the presence of different types of rhythms in molluscs[2-4]. The slugs (vaginulus) are reported to be more active during night than during the day time[5], and hence there could be corresponding variations in the various physiological processes in these animals. Dial variations have been noticed in the heart rate, locomotion[6] and phosphatases' activity[7] of the slug. Rhythms have been noted in many animals for numerous biological parameters[8]. Among the metabolites that vary rhythmically are blood glucose, liver glycogen[9] and plasma free fatty acids[10]. But no attempt was made previously to analyse the rhythmicity of these metabolites in the slug. In view of this, the present study was undertaken to see whether blood glucose and hepatopancreatic glycogen vary rhythmically during a 24 h period of alternate 12 h periods of light and darkness.

Material and methods. Slugs, collected locally, were maintained in the laboratory in large wooden boxes filled with mud. They were kept under moist conditions by sprinkling water once in 2 days and the animals were fed ad libitum on croton leaves. The laboratory provided a cycle of 12 h cool (23 °C) dark and 12 h warm (28-29 °C) light cycle for the animals during experimentation. The animals were starved for 24 h prior to the experiments. Blood was collected from individual specimens by making an incision along the middorsal line of the body. The hepatopancreas was isolated in cold (5 °C) at different time intervals of the day. Material from 3 specimens was pooled to represent a single sample. The experiments were conducted at regular interval of 4 h (2 samples at each time) to cover the 24 h period. The levels of blood glucose and hepatopancreatic glycogen were estimated by the methods of Mendel, Kemp and Myers[11] and Kemp and Heijninger[12] respectively. The experiments were repeated for 3 consecutive days to see whether the pattern remained the same.

Results and discussion. Results represented in the figure indicate that the blood glucose and hepatopancreatic glycogen vary significantly during different periods of the day. The amount of blood ranged from 5.7 mg/100 ml at 12.00 h to 18.2 mg/100 ml at 00.00 h and the hepatopancreatic glycogen, from 5.6 mg/g wet wt at 00.00 h to 14.4 mg/g wet wt at 12.00 h of the day. Glycogen reserves declined gradually from 12.00 h and reached a minimum at 00.00 h whereas the blood glucose showed an opposite trend. As glycogen reserves increased progressively from 00.00 h to 08.00 h, the blood glucose level gradually dropped (figure). This trend was observed on all the 3 days exhibiting the presence of a typical diel rhythm in the levels of blood glucose hepatopancreatic glycogen. Similar type of rhythms were reported in the rate of heart beat, locomotion[6] and enzymatic activities[7] of the slug.

Rhythmic variations observed in blood glucose level and hepatopancreatic glycogen content in the slug indicate variation in the utilization of carbohydrate energy sources. This in its turn reflects changes in the overall metabolic rate of the animal during different periods of the day. The maximum rate of heart beat and increased locomotor activity[6] of the slug require high amounts of energy. The necessary energy is, perhaps, made available through the increased metabolic degradation of blood glucose which is maintained at a higher level at 00.00 h (figure).

Hepatopancreatic glycogen is a labile store of energy and most of the blood glucose is derived from hepatopancreatic glycogenolysis. It is evidenced by the low levels of hepatopancreatic glycogen and high levels of blood glucose at 00.00 h of the day. It was also found that the hepatopancreatic phosphorylase activity was very high at 00.00 h[13] suggesting that the hepatopancreatic glycogenolysis is the predominant source of blood glucose. As the slugs were starved for 24 h, the dietary carbohydrates could not have been the source of blood glucose. Based on these observations, it may be suggested that the existence of a dial rhythm in the blood glucose level reflects its varying levels of utilization to meet the energetic requirements of various physiological processes like rate of heart beat and locomotion[6].



Dial variations in the levels of blood glucose and hepatopancreatic glycogen in the slug, *Laevicaulis alte*. Values expressed at each time interval are mean ± SD of 6 observations.

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