The periodicity in the consumption of oxygen in Asellus aquaticus

Preliminary report.

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The consumption of oxygen in Asellus aquaticus was measured to find if there existed a periodicity in the consumption of oxygen and how this showed itself during the course of the day, year and in various experimental conditions.

The measurements were carried out with a Drastich micro-respirometer during four months of the year - May, June, October and December - so that the changes in the consumption in the different seasons could be seen and allowed for. From the figures obtained comparative values were calculated and from these curves were plotted of the changes in the consumption of oxygen during the day and year.

First males and then females were measured separately to find the difference in the consumption in the two sexes.

May: Av. temp. 15-16°C Males:- Minimum .04 mm^3 O_2 11am - 2pm

Maximum .08 mm^3 O_2 5pm - 6pm

Consumption of O_2 for 1gm body weight in 1 min. .93 mm^3 O_2

Females:- Minimum .03 mm^3 O_2 11am - 2pm

Maximum .06 mm^3 O_2 5pm - 6pm

Consumption of O_2 / 1 gm. body weight in 1 min. 1.386 mm^3

As the differences in consumption of O_2 showed themselves only in size of values obtained, the later measurements were carried out without attention to sex.

First we interested ourselves in the consumption of oxygen in normal individuals. The experimental animals were kept for a long time in the aquarium, as far as possible under the same living conditions as in nature and at average room temperature.

In the first experiments we picked out ten males as far as possible of the same size, and then ten females in the same conditions.

In later experiments ten specimens were taken of about the same size without reference to sex. These animals were first weighed so that the oxygen consumption could be calculated per 1 gm body weight. After weighing they were placed in the receiver of the Drastich respirometer - both recivers contained the same amount of water. As little water as possible was given so that the animals were in closest contact with air in the reciever of the microrespirometer. The same amount of cotton wool was placed in each receiver and after leveling the temperature measurements were started.

The first values obtained were not taken into account (from 8 - 9 a.m.) Measurements were carried out from 9 a.m. - 6 p.m. i.e. in nine day time hours. For completeness some measurements were made during the night when it was found that the amount of oxygen consumed agrees with the amount consumed during the day in values and in time spacing. As only a few of these measurements were taken we do not mention them in the tables.

Exact values of the night periodicity in the consumption of oxygen and the results of measurements under experimental conditions (while starved, and in various solutions) will be published later. For the moment we mention only some resluts of our experiments.

Apart from measurements carried out with normal individuals in normal conditions, the consumption of oxygen was measured in starving animals and those kept in a weak solution of $CuCl_2$ and $ZnCl_2/10^{-5}$. Animals chosen for starvation were kept alone in dishes on sterilized filter paper, which was changed each day, until the alimentary canal was completely clean and empty. They were then transferred to clean dishes of clean water and again separated from each other and then only was this day ~~w~~ called the first day of starvation.

For measurement in weak solutions of $CuCl_2$ and $ZnCl_2$ the experimental animals were kept for a longish (literal transl. of word used. E.L.) time before the measurements in solutions of these salts so that a fast change in their surroundings would not have an effect on their oxygen consumption - this may be a temporary effect which could affect the experiment. The setting of the Drastich micro-respirometer was the same as used in working with the normal animals.

See table I. page 91.

The values measured in May, June, October and December are set out in ~~the~~ Table I. Graphs of the periodicity of the consumption of oxygen during these months are shown in Fig. 1 (P.92) Curves mark the average daily course of ~~c~~unsumption of oxygen in the different months and there is a strongly marked daily periodicity in the consumption from average values for different months. To simplify the matter we give (at bottom of page 90) figures for the maximum and minimum consumption of oxygen in different months as well as the average consumption of oxygen per 1 gm. body weight and the average temperature during the experiments.

Average values obtained from starved individuals and from individuals kept in solutions of $CuCl_2$ and $ZnCl_2$ are set out in table II Graphs showing the periodicity in consumption of oxygen under these changed conditions are shown opposite (on page 95) On the whole it is possible to say that the amount of oxygen consumed by starving individuals is less than normal, in solutions of $CuCl_2$ the same as normal but in $ZnCl_2$ the amount consumed is about 100 times higher than normal. We give again (at top of page 94) the minimum and maximum and average consumption per 1 gm body weight per minute, and average temperature during the experiment and the number of experimental animals.

See table II. p.94.

From the results of our experiments with normal individuals of Asellus aquaticus it is obvious that regular oscillations of the rate of consumption of oxygen are maintained throughout the year. There are only differences in the total amount of oxygen consumed in summer (May, June) and winter (October, December). The same differences are recorded in the different sexes of the measured animals (May, June) Males have slightly higher consumption rates than females. These differences have no effect on the changes in the rate of consumption throughout the day - i.e. the times of maximum and minimum remain the same.

So we see that neither altering the living conditions (by starvation) nor by changing the medium (solutions of $CuCl_2$ and $ZnCl_2$) upsets the periodic oscillation of the maximum and minimum rates of consumption of oxygen.

SCHULTZ, BRUNOW (1911), KESTNER & PLAUT (1924) quote gas exchange in some Crustaceans on the basis of chance observations and

they do not come to a definite conclusion. They noticed that the consumption depends on the size of the animals and that the results appear to be influenced by the calcium of the skeleton and possibly by temporary concentrations of CO_2 and $CaCO_3$ in the blood and body fluids. COHNHEIM (1911) writes about the effect of feeding on the gas exchange in Palaemon serratus. According to HENSE (1910) gas exchange in Carcinus maenas and Scyllaris latus does not depend on the partial pressure of oxygen.

PUTTER (1924) examined the relationship between the consumption of oxygen, body size and the amount of food in Copepods in summer and in winter. He found, for example, that Oithona in summer consumes in 1 hour 6.51 oxygen value (no units given K.E.M.) when it contains much food material. In winter the consumption of oxygen had dropped to 2.26 when the food content is smaller.

Consumption depends on the temperature and therefore also on the season of the year. It depends also on the amount of algae and on the amount of light. The results observed and obtained by A. Pütter in Copepods confirm also our results with Asellus aquaticus in connection with the values of the consumption of oxygen and the season of the year, the temperature and the amount of light. When the temperature is raised the amount of oxygen consumed is greater. The effect of light on the oxygen consumption was observed during the experiments we carried out in summer and in winter on the time variation of maximum and minimum in the periodic oscillation of the values of expired oxygen.

MICHAL (1931) observed oscillation in the consumption of oxygen during the day and during the development of the larvae of Tenebrio molitor. The consumption of oxygen corresponds with the

way of living of these animals. The maximum consumption of oxygen appears here at about 2 a.m. when they are most active and consume most food. Consumption of oxygen then drops until it reaches a minimum around 3 p.m. when the larvae are normally inactive. When they become active again at about 4 p.m. the consumption rises to reach a maximum at about 2 a.m. Maxima at 2 a.m. and minima at 3 p.m. we found regularly. On top of these daily oscillations MICHAL presumed also yearly and monthly oscillations.

LANG (1934) ascertained in Lumbricus variegatus L. and Rhynchelmis limosella periodic variations in the consumption of oxygen with two maxima and two minima. Periodic consumption and the position in time of the maxima and minima was preserved during starvation to death. Values are smaller so that the oscillations in the last stages of starvation are almost imperceptible.

LANG & WENIG (1935) carried out measurements in some limicolous and terricolous oligochaetes and found patterns of in limicolous oligochaetes because they have a much higher consumption of oxygen than terricolous oligochaetes. The highest value for terricolous oligochaetes is not higher than the lowest values of the limicolous oligochaetes.

From the results of our measurements and from the contents of the literature mentioned it is obvious that changes in the consumption of oxygen depend on the changes in external living conditions. The amount of oxygen consumed during the day shows a periodic changing of maximum and minimum values in connection with life phases and life metabolism.

The seasons of the year - mainly the amount of light and heat als

change the course of the curve for the consumption of oxygen and prolong the duration of maximum and minimum values during the daytime.

It is also interesting to compare the periodicity in the consumption of oxygen in limicolous oligochaetes and Asellus aquaticus and to ascertain a regular change of maximum and minimum.

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Notice

Please note that these translations were produced to assist the scientific staff of the FBA (Freshwater Biological Association) in their research. These translations were done by scientific staff with relevant language skills and not by professional translators.