Resumen por el autor, Joseph Hall Bodine.

Algunos factores que influyen sobre el contenido de catalasa en los organismos.

Los resultados expuestos en el presente trabajo demuestran que el contenido de catalasa en los animales (saltamontes, gusano de luz, escarabajo de la patata (*Leptinotarsa*)) disminuye á medida que la edad aumenta. La cantidad de anhídrido carbónico producido y el contenido de catalasa parecen variar en la misma dirección, pero en los animales hibernantes (saltamontes) no existe dicha relación. El contenido de catalasa disminuye durante la inanición. El autor hace notar que es necesario poseer más datos cuantitativos para demostrar la existencia de una relación definida entre el contenido de catalasa y la cantidad de anhídrido carbónico producido por los organismos.

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SOME FACTORS INFLUENCING THE CATALASE CONTENT OF ORGANISMS

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THREE FIGURES

In recent years attention has been directed to the presence of the enzyme catalase in organisms and various interpretations of its functions advanced. Most striking are the properties attributed to it by Burge and Burge.¹ These authors assume that the presence of catalase determines the rate of oxidations occurring at different stages in the life-cycle of an organism, e.g., "*the increase in the respiratory metabolism or oxidation in youth and decrease in old age are attributed to the increase in catalase in the young and its decrease in the aged.*"

Various experiments have been carried out by the author on the catalase content and the rates of carbon-dioxide output of grasshoppers and other insects to see in how far such a theory applies in the case of these organisms. The results herein presented show, 1) the catalase content of animals of different ages; 2) the relation between the rates of carbon-dioxide output and catalase content; 3) the effect of hibernation on catalase content, and, 4) the effect of starvation on catalase content. These will be discussed in the order given.

METHODS

Catalase determinations were made by the method essentially similar to that described by Burge.² Diluted commercial hydrogen peroxide was used—the same sample for experimental and normal animals in each case. Readings were made at five- and ten-minute intervals, and the rates of oxygen per gram per minute calculated from the averages thus obtained. Carbon-

dioxide determinations were made by the barium-hydrate-titration method of Lund.³

The grasshoppers used (*Chortophaga viridifasciata*) were caught in the vicinity of Philadelphia and kept under the usual laboratory conditions and fed grass. The other organisms used fireflies and potato-beetles—were brought into the laboratory and determinations made at once.

Temperature and other laboratory conditions were kept as nearly constant as possible throughout any series of observations.

CATALASE CONTENT OF ANIMALS OF DIFFERENT AGES

It has been found by the author⁴ that for grasshoppers an increase in body weight accompanies increasing age up to the last instar, hence, heaviest animals are the oldest. Figures 2 and 3 show graphically the relative amounts of catalase contained in grasshoppers of different body weights and ages. Youngest animals tend to have the highest catalase content with a gradual decrease in amount to a minimum for the oldest individuals. Figure 1 shows a similar condition in fireflies taken at various intervals during the season. Experiments carried out on potato-beetle larvae and adults gave similar results, thus agreeing with those reported for these forms by Burge and Burge.¹

From the results of these experiments one can reasonably conclude that the amount of catalase an animal contains decreases progressively during its life-cycle up to a minimum in old age.

RELATION BETWEEN RATES OF CO₂ OUTPUT AND CATALASE CONTENT

Evidence has been presented by the author⁴ which shows that the rates of CO₂ output for grasshoppers are highest for younger and lowest for older individuals. It has been pointed out in the preceding paragraph that the catalase content of these animals also apparently varies in the same direction.

Figure 1 shows that the rate of CO₂ output and catalase content for fireflies seems to bear a similar relation.

From these results, however, it does not necessarily follow that a parallelism between CO_2 output and catalase content exists, since by varying the rates of CO_2 output by external factors, such as temperature, no appreciable changes in the catalase content are brought about. A possible objection, however, to such an experimental procedure can easily be eliminated by taking advantage of the natural 'hibernating' habit of this grasshopper, which lives normally as a nymph throughout the

Fig. 1 Curves show the rates of CO_2 output per gram body weight per hour and also the cc. of O_2 evolved per gram body weight per minute for fireflies. A, catalase; B, CO_2 . Abscissas represent body weights in milligrams. Ordinates at the right, grams CO_2 per gram body weight per hour. Ordinates at the left, the number of cubic centimeters of oxygen obtained per gram body weight per minute. Based on some fifty separate determinations. For further explanation see text.

winter. During 'hibernation' the animal becomes extremely sluggish, and metabolic activity must also take place at a greatly reduced rate. Determinations of CO_2 output at room temperature ($20^\circ\text{C}.$) show that the rate of output for hibernating forms (0.0005 to 0.0008 gram CO_2 per gram per hour) is decidedly lower than that for individuals of the same body weights which are not hibernating (0.0018 to 0.0025 gram CO_2 per gram per hour).

If the theory is correct, that catalase content and CO_2 output are definitely related, these hibernating individuals ought to show greatly reduced amounts of catalase. Figure 2, however, shows that the catalase contents of hibernating and growing individuals of the same body weights are practically identical. Results somewhat similar to the above have been reported by Stehle and McCarty⁵ for cats and rabbits.

Fig. 2 Curves show the relative amounts of catalase in normal and hibernating grasshoppers of different weights. Solid line, normal animals. Broken line, hibernating animals. Abscissas represent body weights in milligrams. Ordinates represent number of cubic centimeters of oxygen obtained per gram body weight per minute. Based on 315 separate determinations.

EFFECT OF STARVATION ON CATALASE CONTENT

Inasmuch as Burge and Neill⁶ have shown that starvation in higher forms results in a decrease in catalase content, it is of some interest to see in how far such results can be produced in insects.

Groups of grasshoppers were starved for varying periods of time up to 144 hours and catalase determinations made at twenty-four-hour intervals. Determinations on normal animals (those fed) and experimental ones were carried out at the same time, using the same sample of peroxide.

Figure 3 shows graphically the results of such experiments. In general it is found that catalase content falls during successive periods of starvation. Such a result is quite in agreement with that of the above-mentioned authors.

It has also been pointed out⁴ that during starvation in grasshoppers the rate of CO_2 output decreases during successive periods of starvation. Here again as in the preceding paragraphs

Fig. 3 Curves and points show the relative amounts of catalase in normal grasshoppers and in those starved for varying periods of time. Abscissas represent body weights in milligrams. Ordinates represent number of cubic centimeters of oxygen obtained per gram body weight per minute. Based on some 150 separate determinations. For further explanation see text.

one cannot necessarily conclude that this apparent parallelism between the CO_2 output and catalase content shows the two to be definitely related. Much further quantitative data seem to be necessary before such a theory can be definitely established.

SUMMARY

1. Catalase content of insects (grasshopper, firefly, potato-beetle) decreases with increasing age and body weight.

2. The rate of CO_2 output and catalase content in normal animals seems to vary in the same direction, but in 'hibernating' forms a marked decrease in CO_2 output takes place with no corresponding change in catalase content.

3. Starvation results in decreased amounts of catalase.

4. Further quantitative data regarding catalase content and CO_2 output are required before any definite relationship between the two can be established.

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