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Article VI.

A Study of the Catalase Content
of Codling Moth Larvae

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ARTICLE VI.—*A Study of the Catalase Content of Codling Moth Larvae.* By C. S. SPOONER.

At the suggestion of Professor Shelford, a series of experiments was undertaken to test the hypothesis that the enzyme catalase might be a determining factor in the dormant period of codling-moth larvae. The method devised by Professor Burge ('16) was used with a few minor modifications in determining the catalase content of the larvae. This method consists in collecting and measuring the oxygen gas liberated from neutral hydrogen-peroxide by the catalase present in the crushed larvae.

The most surprising fact discovered in these experiments was the comparatively enormous quantities of oxygen obtained from the catalase in a single larva—over 650 cc. being obtained in some cases. The reaction was extremely violent, and the gas bubbled off at a surprising rate. The large quantity of gas necessitated an enlargement of the apparatus, with a consequent loss in accuracy.

All tests were run for a period of twenty minutes. The quantity of gas was read every minute for the first ten minutes, then at the end of 15 minutes, and finally at the end of 20 minutes. Although the reaction had not entirely ceased at the end of twenty minutes, it had become so slow as to make the continuation of readings useless. The experimental error, though large, is thought to be practically constant and always in the same direction; that is, the recorded results are proportionally low for all larvae. Table I gives four typical records obtained during the course of these experiments.

TABLE I. *Typical Records of the Volume of Oxygen (in cc) Obtained from Codling-Moth Larvae.*

Time in Minutes	1	2	3	4
1	20	35	63	17
2	32	62	106	25
3	42	85	150	35
4	50	110	196	41
5	60	135	245	50
6	68	155	300	57
7	77	180	340	65
8	85	202	375	72
9	92	223	405	80
10	100	244	430	85
15	132	312	500	113
20	155	338	530	135
Weight of larva in gms.	.036	.047	.034	.022
Gas in cc. per gm. of larval wt.	4305.5	7191.4	15588.2	6136.3

It will be noticed that approximately two-thirds of the gas is given off in the first ten minutes. At the end of twenty minutes the reaction has slowed down so that very little gas is given off after that time.

TABLE II. *Summary of Data on Catalase Content of Codling-Moth Larvae.*

Date. 1920	Wt. of larva in gms.	Gas obtained in cc.	Gas in cc. per gm. of larval weight.
July 14	.030	228	7105.2
July 14	.035	276	7953.8
July 14	.032	298	9463.1
July 14	.040	378	9460.3
July 14	.039	348	8945.7
July 15	.066	451	6833.3
July 15	.038	355	9078.7
July 15	.034	396	1164.7
July 16	.020	773	3650.0
July 16	.055	494	8981.8
July 16	.033	193	5848.5
July 16	.064	438	6843.7
July 20	.046	508	1104.3
July 20	.040	245	6125.0
July 20	.042	400	9523.8
July 22	.034	260	7764.7
July 22	.053	378	7132.0
July 22	.039	276	7076.9
July 22	.062	509	8209.7
July 22	.052	425	8173.0
July 22	.048	457	9956.5
Aug. 5	.050	368	7360.0
Aug. 5	.044	295	6704.5
Aug. 5	.055	508	9236.0
Aug. 5	.034	242	7117.0
Aug. 5	.042	414	9857.1
Aug. 13	.061	348	5704.9
Aug. 13	.053	226	4264.1
Aug. 13	.052	169	3250.0
Aug. 13	.061	335	5498.8
Aug. 13	.076	520	6842.1
Aug. 13	.067	655	9786.1
Aug. 13	.072	602	8361.1
Aug. 13	.053	508	9236.3
Aug. 16	.054	286	5296.3
Aug. 16	.043	160	3720.9
Aug. 16	.075	446	5946.6
Aug. 16	.064	333	5203.1
Aug. 20	.062	405	6532.2
Aug. 20	.054	355	6574.0
Aug. 20	.054	595	11018.5

An examination of Table II shows that there is a very great variation in the catalase content per unit of larval weight. One cause of this variation was undoubtedly the difference in the age of the larvae. Food, conditions of the environment after leaving the apple, and individual variation are other possible causes. It seems reasonable to suppose that there is a gradual increase in catalase content up to the time of pupation. This is not proved by these experiments, but the general results seem to indicate that it is a point well worth further investigation. Experiments are planned for this purpose.

While it is always a question what any given larva used in the experiment would have done if left alone, experience with several thousands of larvae leads to the belief that the general appearance of an individual when the pupation time arrives, indicates whether it will pupate or not. The plump, healthy-looking individuals nearly all pupate, while those which appear thin and shrivelled remain dormant and eventually die without pupating. The plump, well-conditioned larvae always gave a high catalase content, 5,000 cc per gram or more, while those which appeared dried and shrivelled gave a low catalase content, usually about 3,000 cc per gram. In the absence of better criteria by which to tell those larvae which would pupate from those which would remain dormant, it is justifiable to suppose that, if the catalase content increases as the larva advances toward the time for pupation, then the catalase content may be a determining factor or at least a correlated factor in the dormancy.

Table III shows the results obtained from nine larvae which had been kept over winter in a cool place and subjected to a flow of dry air. Five of these appeared plump and healthy and gave a high catalase content (Nos. 1, 4, 5, 8, 9). The other four were shrivelled and gave a low catalase content. A control set, which was kept and allowed to pupate, showed that about one-half of the lot would probably have pupated.

TABLE III. *Catalase Content of Larvae Kept Over Winter in Cool Dry Air.*

No.	Weight of larva in gms.	Gas obtained in cc.	Gas per gm. of larval weight.
1	.036	325	9027.7
2	.036	155	4305.5
3	.035	106	3028.5
4	.047	338	7191.4
5	.030	253	8433.3
6	.037	187	5054.0
7	.030	102	3400.0
8	.034	530	15588.2
9	.022	135	6136.3

Conclusions.

1. Codling-moth larvae contain large quantities of the enzyme catalase.

2. The quantity of catalase per unit of larval weight varies considerably in different individuals.

3. Catalase content is directly correlated with the health and continued life of larvae.

4. Catalase content may be directly correlated with pupation and dormancy. In order to test this conclusion a large series of tests should be made covering each day of larval life from the time the larvae leave the apple until time of pupation.

Bibliographical Reference.

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1916. Relation between the amount of catalase in the different muscles of the body and the amount of work done by these muscles. *Am. Jour. Physiol.* 41: 153-161.