The Loss of Weight in Insects

V. The causes of death in the overwintering larvae of *Dendrolimus spectabilis* BUTLER

MINORU OUCHI, MIKIO SUZUKI, and YOSHITAKA ISAKA*

INTRODUCTION

It was reported in a previous paper that the larvae of *Dendrolimus spectablis* lost weight gradually under room conditions in winter. Most larvae died when the rate of decrease from initial body weight attained to about 55—70%, probably resulted from the unfavourable environmental conditions (Ouchi & Suzuki, in press). On the other hand, it was also observed that the adults of the rice stink bug *Lagynotomus elongatus* (Dallas, 1851) died under different gradients of humidities at 17°C in winter. In this case, the causes of death were supposed to be attributable to both the excessive loss of water as compared with dry materials at extremely low humidities, and to the exhaustion of reserve materials when the loss of water was few under high humidities (Ouchi 1964).

The experiments were performed on the larvae of *Dendrolimus spectabilis* to study the causes of death, when they were kept under diffrent gradients of humidities at a constant temperature in winter.

MATERIALS AND METHODS

Larvae were collected from the field on 18th December, 1963. They were divided into four groups each including 20 larvae. The weighing of larvae was started on 20th December and performed every other week on a batch of 15 and each of 5 larvae for one group until 28th February, 1964 when all larvae had died. Immediately after the initial weighing, larvae of each group were put in each of four desiccators (inner plate diam. 12 cm) containing sulphuric acid solution at a depth of about 2 cm to maintain 29, 45, 70 and 90% relative humidities respectively. The holes of lids were loosely closed with absorbent cotton. These desiccators were placed in a thermostat regulated at 15°C.

During the experiment, those larvae which had been infected with disease were excluded, whenever symptom was observed. Some of the dead larvae at each relative humidity were desiccated in a air drier at 80°C for 24 hours and dry weights of larvae were weighed. And at the middle of February, 1964, those larvae collected from the field were also desiccated and weighed in the same way soon after the collection.

RESULTS AND DISCUSSION

The survival time of larvae at 29, 45, 70 and 90% relative humidities varied as 4—7, 4—8, 6—10 and 5—9 weeks respectively. Many diseased larvae were found especially at higher

* Present address: Federation of Agricultural Cooperation of Gunmma-prefecture, Maebashi-city.

two relative humidities.

The decrease in weight was expressed as percentage decrease from initial weight. The average percentages of weight loss of a batch of larvae at each relative humidity are plotted against time in Figure 1. The slope of curves becomes steeper with the decrease in relative humidity, which results in the increaseng in the average percentage of weight loss at death.

Figure 1. Mean percentages of weight loss at 29, 45, 70 and 90% relative humidities.

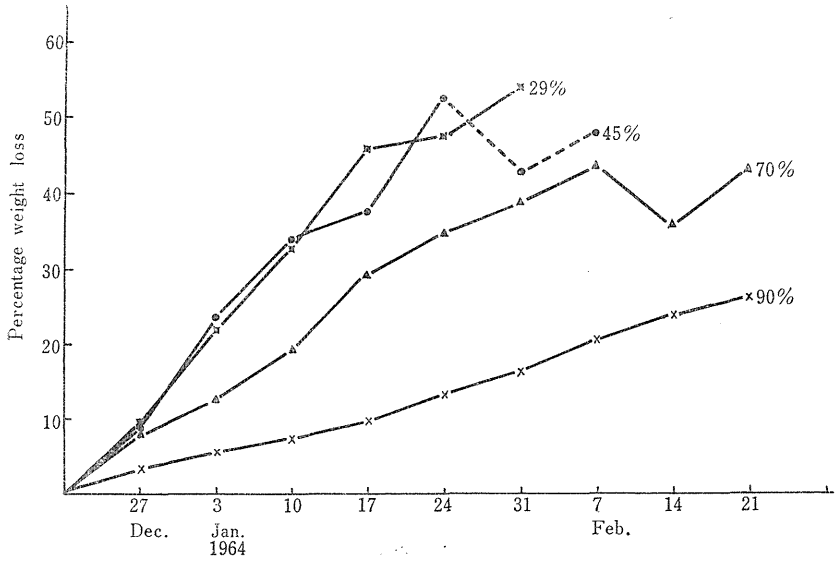

Table 1. Initial body weight and weights of the body, dry materials and water at death (mg)

R.H. (%)	No. of larvae	Initial body wt.	Weight at death		
			Body	Dry materials	Water
29	15	104.5	53.0	18.6	34.4
45	13	102.9	52.4	18.0	34.4
70	10	98.6	58.4	15.7	42.7
90	7	94.9	67.4	14.7	52.6

Table 2. Percentages of the body, dry materials and water at death to initial body weight (mean).

R.H. (%)	Percentages		
	Body	Dry materials	Water
29	50.7	17.7	32.9
45	50.9	17.4	33.4
70	59.2	15.9	43.3
90	71.0	15.4	55.4

The percentages of dry materials to total weights both at initial weighing and at death become smaller as humidity increases. And inverse relations exist between the same percentages of water and humidity (Tables 1, 2, 3).

Therefore, the percentages of dry materials at higher relative humidities and of water at lower relative humidities decreased markedly as compared with that of those collected from the field (Tables 3, 4).

On the other hand, the mean weight ratios of water to dry materials of larvae collected from the field are nearly 2.5, whereas these values at higer two relative humidities exceed 2.5, and at lower two relative humidities are less than 2.5 (Tables 3, 4).

Table 3. Mean percentages of dry materials and water to total weight and the mean wet/dry weight ratio at death

R.H. (%)	Percentage		Water / Dry materials
	Dry materials	Water	
29	35.1	64.9	1.84
45	34.3	65.7	1.91
70	26.8	73.2	2.71
90	21.8	78.2	3.57

From these results, the causes of death may be attributed to the smaller ratio of water to dry materials at low relative humidities and to the exhaustion of reserve materials at high relative humidities.

Figure 2. Percertage weight loss in individual larvae at 29 and 45% relative humidities.

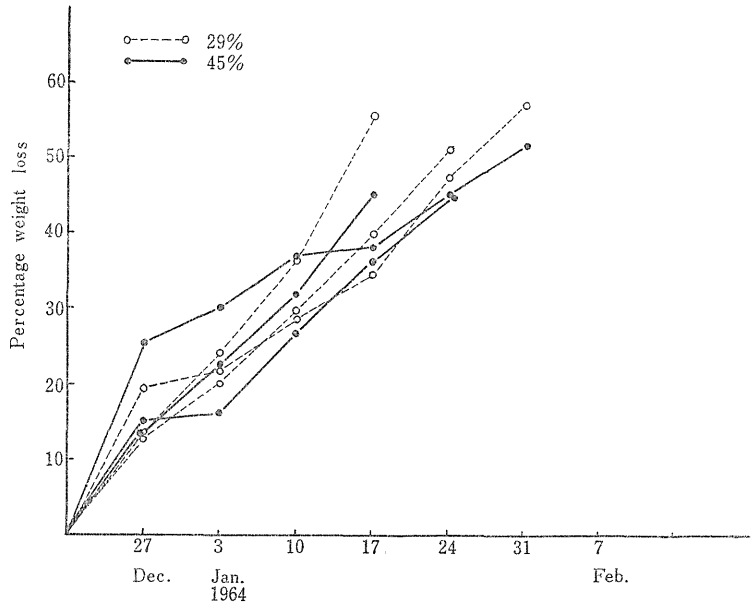

Table 4. Weights (mg) of the body, dry materials and water, percentages of the latter two and the wet/dry weight ratio in the larvae collected at the middle of Feb. '64

Group	No. of larvae	Wt. of the body	Wt. of dry materials and %	Wt. of water and %	Water / Dry materials
1	15	80.8	20.9 (25.8)	59.9 (74.2)	2.86
2	22	80.1	23.3 (29.8)	56.8 (70.2)	2.58
3	39	117.6	33.0 (28.0)	84.6 (72.0)	2.56
4	28	120.9	33.7 (27.8)	87.1 (72.2)	2.58

Between lower two relative humidities, no remarkable differences in the average percentages of weight loss were found (Fig. 1). But such different tendencies were observed that the percentage weight loss at 45% r. h. increased rapidly at first two or three weeks and then gradually, but at 29% r. h., steadily throughout the experiment (Fig. 2). The same tendencies were also observed in the adults of *Lagynotomus elongatus* (Ouchi, unpnblished). And it is supposed probable that at 29% r. h., as insects are able to feel rapid evaporation sooner than at 45% r. h., the spiracles start their regulatory function earlier.

SUMMARY

During winter in 1963—64, loss of weight in larvae of *Dendrolimus spectabilis* was measured every other week under 29, 45, 70 and 90% relative humidities at 15°C.

All larvae died in 5–10 weeks and the lower the r. h. was, the earlier the larvae died. The slope of curves for average percentage decrease from initial weight at each r. h. became steeper with the decrease of r. h. And the percentage weight loss of dry materials became smaller with the increase in r. h. On the contrary, that of water showed inverse relations to r. h. The mean weight ratios of water to dry weights of larvae in the field are nearly 2.5, whereas these values of tested larvae at higher two relative humidities exceed 2.5, and at lower two relative humidites are less than 2.5.

From these results, the causes of death was supposed to be attributable to the smaller ratio of water to dry weights of larvae at low humidities and to the exhaustion of reserve materials at high humidities.

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摘　　要

昆虫の体重減少について

第5報　マツカレハ越冬幼虫の死因について

大内　実・鈴木　幹男・伊坂　義孝*

本研究は，マツカレハの幼虫が冬季に生理的原因で死亡する際の体重減少の経過，死体の重量，体水分，乾燥重を知るために行なった。

1963～64年の冬季に．幼虫を採集し 29, 45, 70, 90% の湿度，15°C の温度下に置き集団と個体に分けて1週間ごとに体重を測定した。各湿度区における死亡直後のある個体と2月中旬に採集したある個体を乾燥して乾燥重を測定した。

供試幼虫は5～10週間内に総べて死亡したが，湿度が低いほど早く死亡した。初体重に対する体重減少率(%)一時間（週）曲線を描くと，その勾配は大体湿度が低くなるに従って急になった。死体の風乾重の初体重および死体重に対する比率（%）は，湿度が高くなるに従って小さくなった。しかし死体水分量はこれと逆の関係を示した。よって，高湿区における初体重に対する風乾重の比率および低湿区における水分の同比率は，後期に採集した個体に比較して著しい減少を示した。一方後期に採集した幼虫の水分量/風乾重の比率は約2.5を示し，死虫のそれは高湿区では2.5以上，低湿区では2.5以下であった。以上の諸点から，本実験における幼虫の死因は低湿区では風乾重に対する水分量の比率の低下，高湿区では貯蔵物質の消耗によるものと考える。

* 群馬県前橋市農業協同組合連合会