

SEASONAL VARIATION IN THE GROWTH OF, AND SILK PRODUCTION BY, THE SILKWORM *BOMBYX MORI, L.*

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SUMMARY

The results of 7 experiments spread throughout the various seasons of the year to study the influence of saturation with water vapour of the rearing atmosphere of the silkworm have been presented. It has been revealed that increase in the humidity conditions results in a marked improvement in larval development, curtailment of the larval phase of life as well as in an increase in the production of silk. Better humidity conditions also appeared to be conducive to their survival in larger numbers.

The humidity of the rearing atmosphere was controlled at different levels by use of saturated solutions of certain salts and it was observed that increased humidity was conducive to the larval growth and better silk yield.

INTRODUCTION

That temperature and humidity of the surroundings have a pronounced influence in the study of the bionomics of insects has come to be recognised as early as 1921. Howard (1921), for instance, observed that the wilt disease of indigo plants flourish during the rainy season owing to the high soil temperature and increased humidity obtaining at the time and explained the disappearance of the symptoms soon after the season on the basis of the disappearance of the causative insects which found the climatic conditions that follow rains unfavourable.

Likewise, a report from the Calcutta School of Tropical Medicine (1954) reveals that the population as well as the sex ratio of sand flies (associated with spread of human diseases) depend upon the weather conditions. A study of the bionomics of adult *S. damnosum* in Northern Nigeria has also indicated that the rotation of seasons has a pronounced effect on their biting habits inasmuch as they prefer slightly humid and overcast days to hot days during which the sun shines unobscured. The natural population of *Drosophila* in Eastern Queensland has likewise been shown to be influenced by the seasonal changes (Mather, 1956). Inasmuch as there exist considerable variations in the temperature and humidity conditions in the environments under which silkworms are reared for industrial purposes, it was considered worthwhile to establish the temperature-humidity relationships which prove to be most conducive to the rearing of the locally exploited species

of the silkworm. In this paper are presented the results recorded in a study designed to determine the influence of humidity alone on silkworm reared under the temperature ranges obtaining in Bangalore.

MATERIALS AND METHODS

Disease-free *Mysore* × *C. Nichi* 1 cross-breed layings were obtained from Channapatna Silk Farm. When the hatched worms just completed their II moult, three batches of 20 worms each were taken for rearing under a water-saturated atmosphere and three similar batches were kept as controls for rearing under atmospheric conditions of the laboratory.

The experimental rearing chambers consisted of two large-sized vacuum desiccators, connected in series, through which air, saturated with water vapour, was allowed to pass continuously by means of a water-pump. The temperature inside the chambers as well as that outside was recorded daily. The two temperatures, however, differed only insignificantly. When the larvæ completed their III, IV and V instars, they were removed from the desiccators and allowed to spin cocoons outside like the control batches of worms. On the 5th day of mounting the cocoons from both the series were separately harvested and their shell weights taken before and after drying in an oven. To ascertain the percentage survival only worms which underwent simultaneous moulting and which were of equal sizes were retained during the rearing period and the total cocoons spun by them were counted. Silk yields were calculated in two ways:

(a) If the weight of the dry shells of the control series was x and that of the experimental series y , the percentage yield of silk of the latter series was calculated as $y/x \times 100$, and (b) the weights of shells obtained from 100 g. of raw cocoons was recorded for both experimental and control series.

Temperature at intervals of 2 hours was noted down every day and the first and the last readings were taken at 9 a.m. and 5 p.m. respectively. The average of these daily 5 readings was recorded as the mean daytime temperature. A wet and dry bulb thermometer furnished readings of relative humidities at these intervals and their average provided the mean relative humidity of the day.

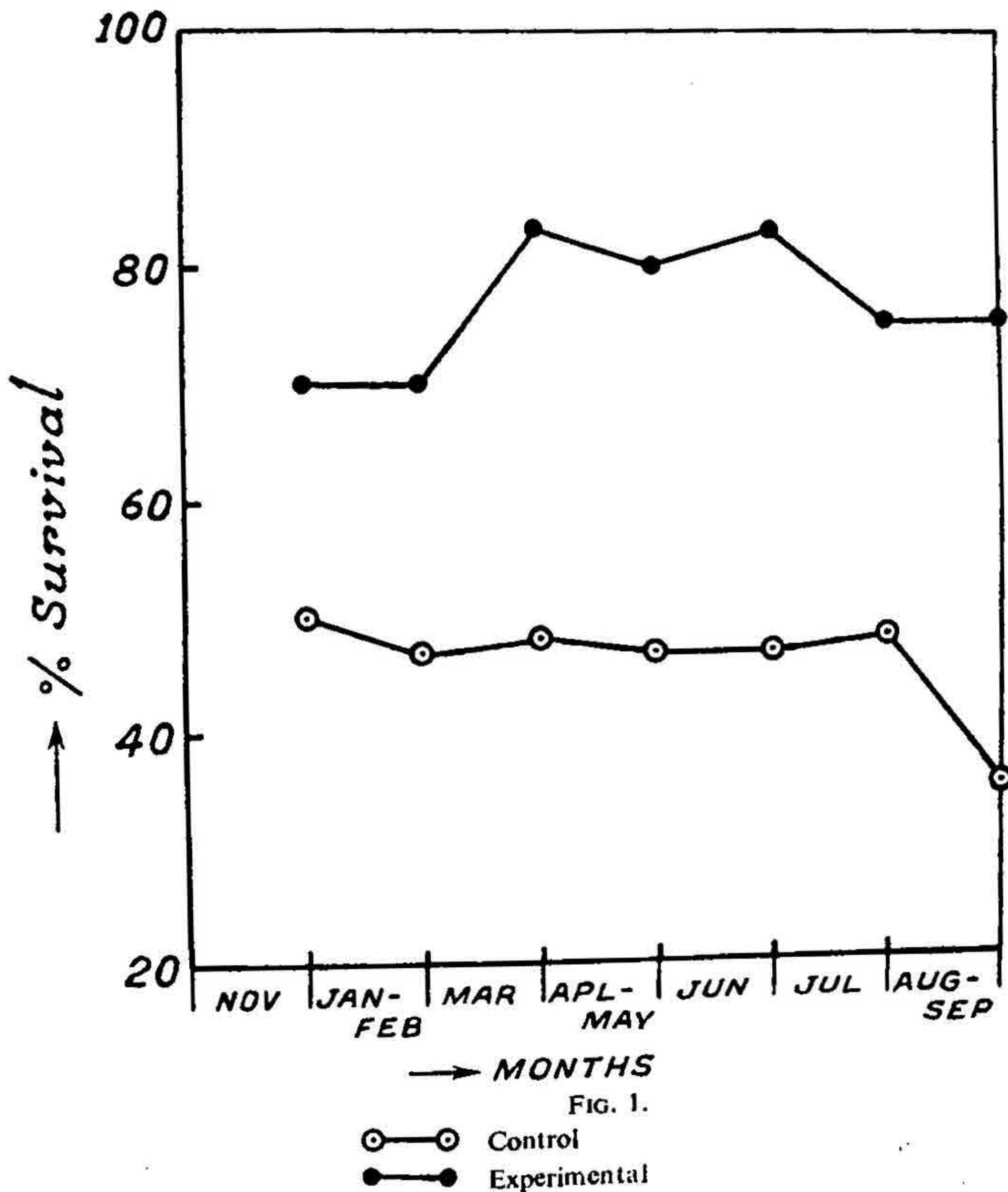
The mean relative humidity reading for whole of the experimental period (15–16 days) was calculated from the average values derived for each day. The humidity of the rearing atmosphere inside the desiccator was taken as 100% as the air therein was saturated with water vapour. The mean excess of humidity within the chamber was obtained by subtracting the mean humidity values derived for the surrounding atmosphere from 100.

For regulating the humidity conditions in the rearing chambers, vacuum desiccators were used with a capillary tube on the top for air circulation. The saturated solutions of the salts along with the solid were kept at the bottom of the desiccators and the silkworms were reared in trays above these solutions. As long as there was excess of solid salt in equilibrium with its saturated solution, the humidity

of the atmosphere above it remained constant and this could be measured by means of a paper-coil hygrometer (Edney). Concentrated sulphuric acid was used to obtain a dry atmosphere and its humidity was assumed to be zero since the hygrometer recorded a very low value for it. Other salts used to regulate humidity conditions at 30%, 52%, 68%, 76%, 82% and 92% were those listed in the *Handbook* (1947). In every experiment, the silkworms were taken after the II moult, and only on completion of their V instar they were allowed to spin cocoons under the normal atmospheric conditions. The feed at all times and in every experiment consisted of fresh mulberry leaves without any supplementation.

RESULTS AND DISCUSSION

The results of 7 experiments spread throughout the course of one year are presented in the accompanying table and Figs. 1, 2 and 3. Fig. 1 represents the



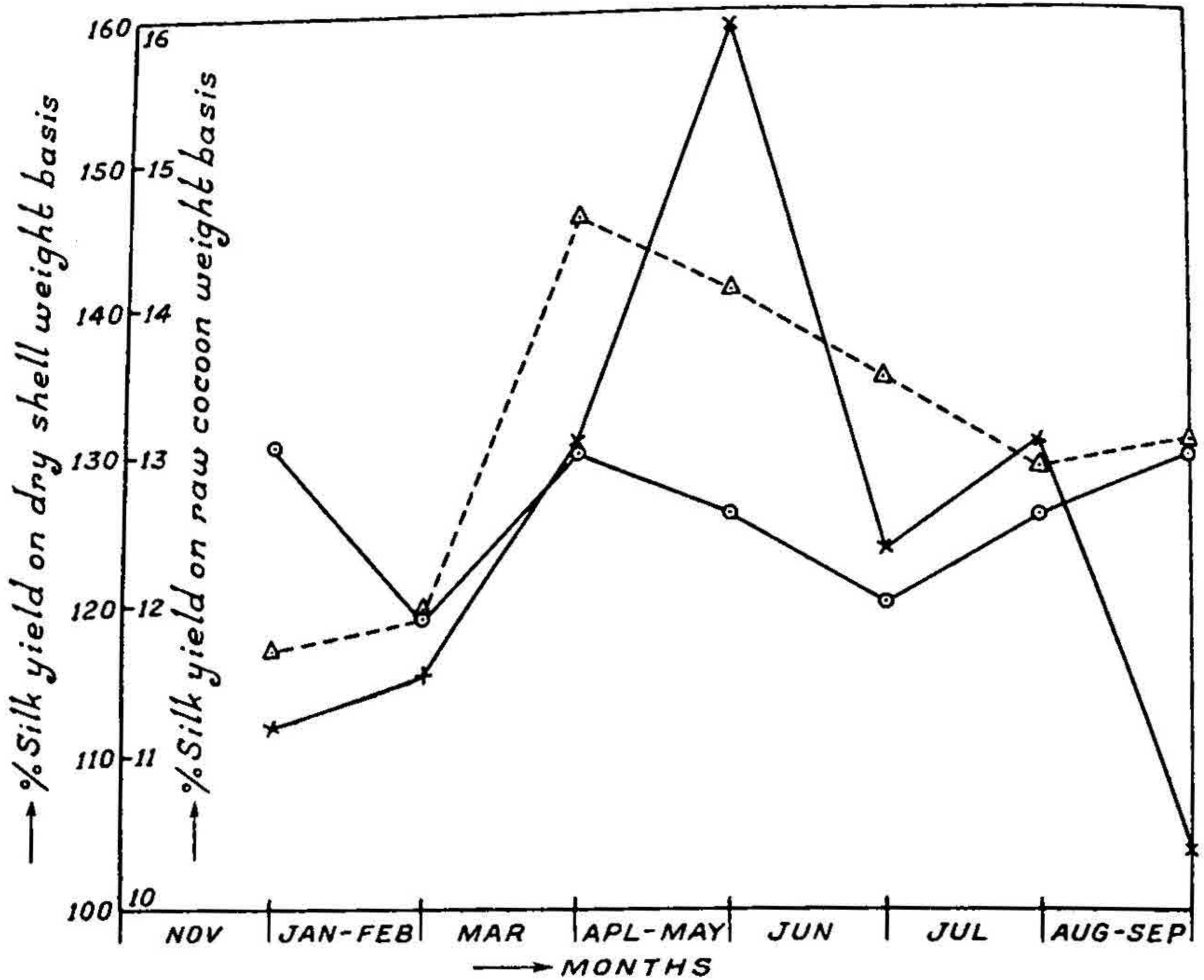


FIG. 2.

- ×—× % Silk yield of the experimental batch taking the dry shell weight of the control as 100 g.
- Control; % yield of silk for 100 g. of raw cocoons.
- Δ--Δ Experimental; % yield of silk for 100 g. of raw cocoons.

percentage survival of the larvæ reared under the two states of humidity whereas the other two figures depict the gain recorded for the body weight and output of silk from the two series of experiments.

From the results presented it is clear that saturation of the rearing atmosphere with water vapour has its beneficial influence well reflected not only in the enhancement of the body weight of and the silk yield from the larvæ but also in the form of a significant increase in the number of the worms that survive until the time of spinning. Generally speaking, it would appear from the tabulated results that a mean excess of humidity of the order of 30% and above over that of the atmospheric humidity has its beneficial effect manifest to a remarkable degree in the body weight of the insect even as it would seem from Fig. 3 that body weight and silk yield begin to show a steep rise when the humidity level touches 70% and reach their maximum at the saturation point. It is important to note (see Fig. 1)

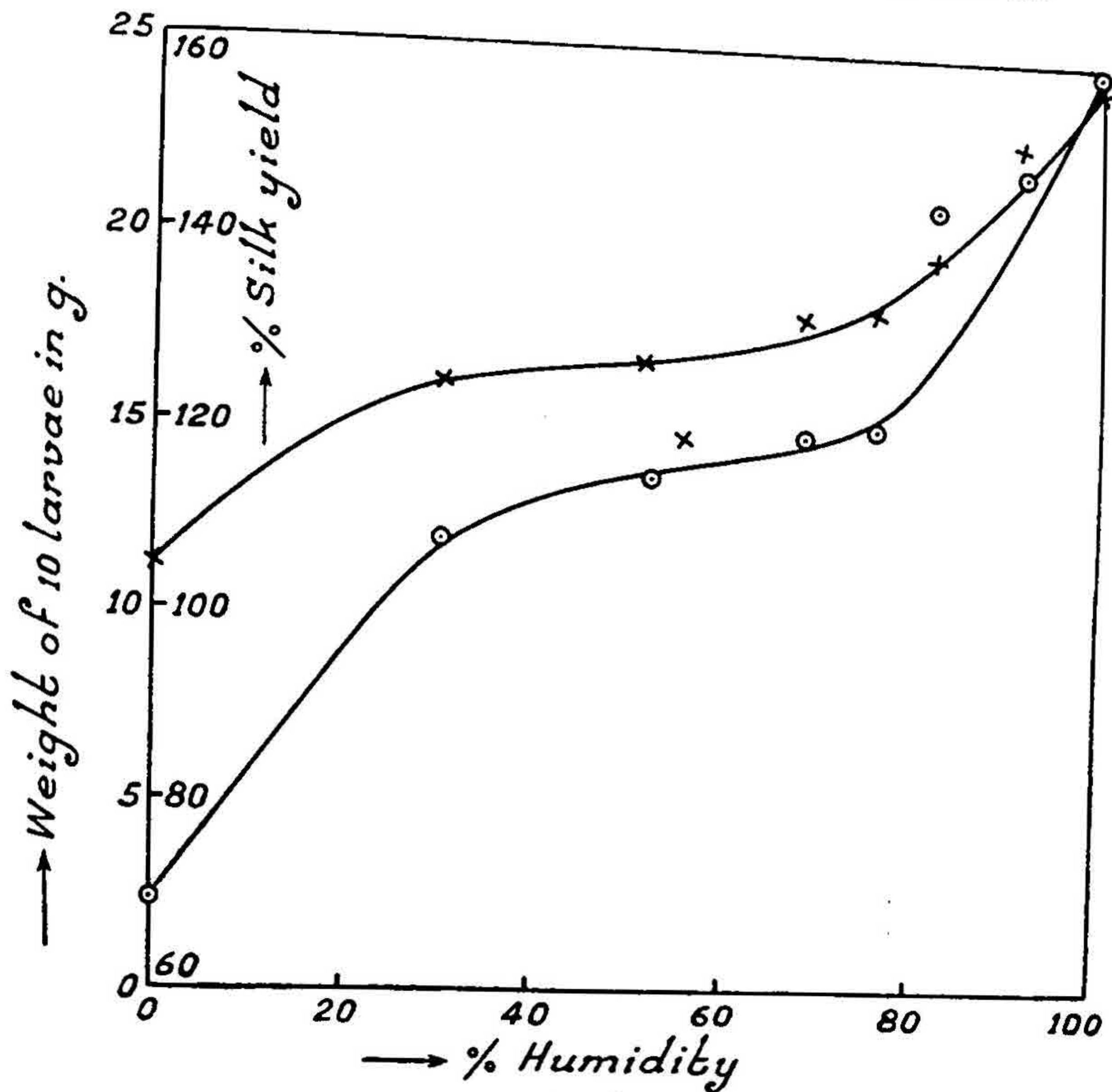


FIG. 3.

x—x Body weight at different humidities.
 o—o Silk yield at different humidities.

that whereas only about 50% or less of the larvæ survive when reared under prevailing atmospheric humidity at any time during the year, more than 70% live to spin cocoons successfully when the rearing atmosphere is saturated with water vapour. What is even more significant to observe from the results (see Fig. 2) is the fact that humidity promotes better production of silk irrespective of whether the yield for the same is calculated on the dry weight basis of shells or on the basis of raw cocoon obtained from the experimental and the control series of worms. The wet preference thus exhibited by this insect confirms the previous observation that an increased intake of water by the larvæ with their mulberry feed (1956) results in their better growth as well as higher yield of silk and tends to support the view that humidity indeed has an important part in insect metabolism (1931).

Maximum Body Weights Attained by the Silk Worms and Duration of Their Larval Period under 100% Humidity and Atmospheric Humidity during Various Seasons (1955-56)

No. of experiment	Season	Range of daytime temperature °F.	Range of relative humidity %	Mean excess or relative humidity %	Maximum body weight attained by experimental larvæ (weight of 10 in g.)	Maximum body weight attained by control larvæ (weight of 10 in g.)	Excess of body weight attained by experimental larvæ	Larval period under saturated atmosphere (days)	Larval period of control (days)
1	November	.. 72-76	58-86	27.10	24.2341	19.1053	5.1288	13	16
2	January-February	73-78	53-77	35.17	26.8916	22.1058	4.7858	16	19
3	March	.. 81-85	34-64	50.80	24.2240	17.2220	7.0020	12	15
4	April-May	.. 78-89	45-64	44.70	24.1380	15.0526	9.0854	12	16
5	June	.. 79-83	60-75	31.48	24.4180	15.3675	9.0505	12	15
6	July	.. 73-79	68-87	22.15	25.9990	21.3590	4.6400	12	15
7	August-September	76-80	63-76	31.55	27.8351	18.0020	9.8331	12	16

1952). Furthermore, in the present case, the effect of high humidity appears to be independent of both temperature and seasonal variations.

Another significant feature in the insect life pertains to the influence humidity has on the duration of their larval cycle, and it may be seen from the results recorded in the table that saturation of the rearing atmosphere with water vapour has the remarkable effect of reducing the larval phase of its life by as many as three days. The economic value of this observation would be obvious when it is considered that this would mean a saving of at least 10% in the feeding cost, not to mention of the quick returns of the investment made. That humidity has its effect in insect metabolism has also been demonstrated in the case of *Aphis pomi* (1923) and sand flies (1953).

The rearing of silkworm larvæ under water-saturated atmosphere seems to afford still another advantage in that the mulberry feed under this state of humidity retains its freshness and perhaps its palatability for 12 hours or more in contrast to the feed which under ordinary atmospheric conditions dries up soon rendering it perhaps unsuitable. This becomes apparent when it is observed that larvæ reared under the saturated atmosphere, feed well throughout whereas those reared under ordinary conditions feed with gusto only when fresh feed is made available. This perhaps accounts for both the lesser wastage in the feed materials and the shorter larval period observed under the experimental conditions.

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