Biological Investigations of the Silk Worm

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It must be pointed out that the biological investigations which will be discussed, are not entirely complete. Nevertheless, valuable information has been obtained, which may be helpful in solving this particular problem.

The investigation to be described, has for its purpose an increase of output and improvement in the quality of the individual silk worm. To obtain this result, the plan is to raise perfectly healthy silk worms. The condition necessary for raising healthy stock from European origin is not entirely satisfactory. During centuries of domestication, the silk worm has been so weakened that it has very little resistance. The proof of this statement is the number of diseases which the silk worm has at different stages in its life. For many years, continuous effort was made to counteract the diseases, which at times became epidemic, with disastrous results. It is recalled that in the sixties and seventies of the last century, insomnia destroyed practically the whole sericulture in Italy, which had to be stocked with a new and hardier breed. It is not enough that the older diseases have not been combated successfully as yet, but that a new pest, the jaundice, has appeared which threatens to become an epidemic.

Methods of combating diseases at present, consist in detecting the disease and then destroying it. If it is impossible to detect the cause, careful breeding of the silk worm is the only means of guarding against losses. The method to be suggested is based on different principles. It is planned to immunize the silk worm against diseases by improving its health and sanitary conditions. This method can be designated as a preventive one. A hardened body is less susceptible to infections or disease, and is able to resist an infection better than a weakened one. It has been observed that by improving the sanitary condition of the silk worm, a marked improvement in the quality of the silk is secured also.

Only such remedies for strengthening will be mentioned, as have given satisfactory results in practice. For this reason, the value of the direct induction current will be discussed. Such treatment of the larvae has been very gratifying. The period for treatment must be chosen according to the age of the larvae. In experimenting along the line suggested, a number of weak silk worms were subjected to the electric influence, and it was observed that those which were treated, developed into producing silk worms while the others perished. In a second investigation, a number of normally healthy silk worms were divided into two lots. One lot was subjected to the treatment, and none perished, but in the second lot, which was not subjected to the electric current, 3% to 4% of the larvae perished.

Another very interesting phenomenon was observed, namely, that the silk worms, which were treated, began to spin much sooner than those not subjected to the electric current. The cause was perhaps the increased appetite of the silk worm. Therefore, it appears probable that the various stages of the development can be shortened considerably. There is this drawback, namely, that this treatment cannot be given on a large scale. It is possible that this could be carried out commercially, by means of suitable apparatus, but at present such are not available. A counterpart to this treatment is the electric method of treating the egg. It is known that an embryonic development of an egg which requires three months for its maturity, can be shortened to fourteen days, so that in time the small worms are developed. It is necessary that the treatment be applied before the eggs begin to change color. By using this method, it is possible to obtain two crops in one year. This actually occurs in China and Japan with certain races of silk worms. The quality and quantity of such silk from a second crop is not comparable with that of the first crop. The beneficial effect of the electric current is observed also at the time of incubation, that is, the time after the rest period, and before the awakening of the embryo, until the time of development of the small silk worm. Such worms are sturdier and are more immune to diseases. The quantity of silk obtained from them is greater and the quality better. Exact figures are not available as yet, because the experimentation has not been completed.

Another idea has been to strengthen the silk worms by breeding and developing in the open. It was anticipated that a great loss of silk worms would occur, and also a temporary lowering of the quality of the silk spun by these silk worms. Therefore, hardened worms were not only used for interbreeding, but also for cross-breeding, to strengthen certain races of good quality, but which had been weakened by domestication. These worms were exposed to all physical weather conditions, except rain. For comparison, with each open air breeding, a room breeding was conducted. In the first case, the breeding was divided into two periods. The worms were kept in the room until the second shedding of the skin, and then exposed to the open. This was a very unfavorable experience, for the temperature in the room had been more or less constant, but in spite of having been exposed to cold, wind and rainy weather, not one of them died. In the other set, which were raised exclusively in the room, there was a loss of 2 to 3%. The influence of free life was noticed in the coloration of the silk obtained. The first third of the length of the silk was white and became more and more yellow in the second third, while the cocoons obtained from the room rearing, were opposite, that is, two thirds of the length was white, and one third yellow.

The difference in size of the cocoons in the two sets was noticeable, particularly. Those reared in the room were considerably larger than those reared outdoors. However, this advantage was an imaginary one only, since the cocoons spun outdoors had a denser and thicker filament, so that in length it was equal to that of the room cocoons, and sometimes even longer. The quality of the filament was very good, it was fine and very evenly spun. Any coarsening which might have been expected from the change, could not be detected. However, no definite conclusion could be drawn from this particular breeding.

It was noticeable particularly that in spite of the diminished size of the outdoor cocoons, the pupa so obtained, was larger and heavier than

the larger cocoons of the room rearing. They filled out completely the inner cocoon. The moths that emerged were healthy and well developed, and were quite active. For the complete development, up to the time of spinning, the outdoor breed required on the average one to two days more which is remarkable when the unfavorable weather conditions are considered. The appetite of the worms during the whole period was very good.

The second crop in which the eggs had been brought to emergence outdoors showed similar results. The loss, in spite of the unfavorable weather conditions, was considerably lower than for the indoor bred ones. As has been mentioned previously, the results as yet cannot be accepted as final. However, the results so far obtained, are much better than expected.

Experiments were made also for securing information concerning the silk worm at various stages of its life, when subjected to ultra-violet light. The application of this method is very simple in practice, and can be carried out by a mercury lamp. Attention has been concentrated for the present, upon the egg and the larvae states, but this does not indicate that the action of the violet light cannot be applied to the pupa and the moth states without benefit.

Noticeable improvement is obtained by subjecting the freshly laid and fertilized eggs to the influence of this light. In a manner similar to that when the electric current is used, the development of the embryo seems to be hastened. The best method for obtaining these results must be studied still further, but the author is convinced that this method is superior to any other method for the reduction of the period of development. First, it is an easy method to apply; and secondly, there is certainty as to the general emergence which will take place. Whether the violet light can be made use of for a second breeding in the year, the same as for the electrically treated silk worms, or whether the prematurely emerged worms will show weaklings, will have to be determined by further experimentation.

The larvae also showed a distinct improvement in health by subjecting them to ultra-violet light. In one set of the breed, there were no losses observed, due to disease, while in another lot not subjected to the violet rays, a loss of 2 to 3% was noted. The appetite, in the first lot, during the whole stage of development, was exceedingly good, and the silk obtained from the cocoons so treated, was of a finer quality. The difference between the quality of the silk of the same race, one set subjected to violet rays and one not so treated, was marked. Considered as a whole, the experiments made so far, have given satisfactory results, particularly concerning the use of the ultra-violet rays on larvae.