per cent. ether, 0.1 per cent. caffeine, ethyl bromide (approximately saturated), 3.2 per cent. formaldehyde, .8 per cent. formaldehyde, .3 per cent. chloroform, .05 per cent. chloroform, 0.1 per cent. acetone, 0.51 per cent. acetone, 17.4 per cent. acetone, 24.2 per cent. ethyl alchohol, 16.1 per cent. ethyl alcohol, 10 per cent. ethyl alcohol, 5 per cent. ethyl alcohol, 2 per cent. ethyl alcohol and 1 per cent. ethyl alcohol.

It was found that whenever the concentration of anesthetic is sufficiently strong to produce any measurable result, the initial effect is always an increase of respiration which may either remain approximately constant over a large number of periods and then gradually decline or the increased rate of respiration may fall very rapidly below the normal when the concentrations of anesthetic are too great.

It is very noteworthy that in no case was the respiration of *Laminaria* observed to fall below the normal when exposed to sea-water containing anesthetic except after prolonged exposure to high concentrations which produced death.

SUMMARY

When *Laminaria* is exposed to the action of anesthetics (in sufficient concentration to produce any result) there is an increase in respiration. This may be followed by a decrease if the reagent is sufficiently toxic. No decrease is observed with low concentrations which are not toxic.

These facts contradict the theory of Verworn that anesthesia is a kind of asphyxia, for his view is based upon the assumption that anesthetics decrease respiration.

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AN OUTLINE OF THE LIFE HISTORY OF THE CLOTHES MOTH, TINEOLA BISELLIELLA

SOME four years ago the writer was asked by Mr. Walter S. Kupper and Mr. J. R. Howlett, of New York City, to undertake an investigation of clothes moths for the purpose of gathering information which would help solve the problem of moth-proofing ordinary woolen fabrics. At that time and at present, the only original information available consisted of disconnected observations, mainly concerned with the case-forming clothes moth, *Tinea*. In connection with the study which followed, hundreds of pounds of fur and old woolen rags were purchased, the moth larvæ painstakingly picked out, and the rags then sold back or thrown away. One lot of eighteen hundred pounds of old rags was purchased at one time. From these several thousand larvæ of *Tineola* was picked out by boys employed for that purpose, and placed on test cloths which had been treated with various chemicals in the hope of finding one which would prevent moth ravages. Two trunksful of fur garments were obtained from the Salvation Army stores. Two hundred pounds of blown fur were purchased from a firm which prepares rabbit fur for the hatter's trade.

The yellow clothes moth, *Tineola biselliella*, was the only moth found in all this material during a period of four years. This seems strange, especially in view of the fact that the rag material had been shipped to New York from all parts of the country, the large bale of cloth above mentioned having come from the south and consisting of dirty cast-off clothing from that region. About three specimens of the spotted clothes moth, *Tinea*, were caught flying about the house in the Bronx, New York City, in which the study was at first carried on, but the circumstances indicated that they were adventitious, and in no way connected with the supply of *Tineola* fur of which only a few cardboard boxes were present at that time. The conclusion would seem inevitable that in the region of New York City, at least, *Tinea* is of comparatively rare occurrence and that the extensive damage which is done in connection with the fur and woolen trades is due almost entirely to the other species. Both the black and the Buffalo carpet beetles were found invariably in each supply of moth material, but in comparatively small numbers. A much larger unidentified beetle occurred in great numbers in the supply of blown hat fur and rabbit skins which had their source in Australia.

Life History.—Mature moths were found

emerging from cocoons in the fur material first studied in June and July, 1913. These were caught and placed in pairs for breeding purposes in jelly tumblers which were easily covered. The females were almost invariably larger than the males and much less active. Breeding began usually immediately after emergence from the cocoons. The males were active in pursuit, fluttering and running about the female and bringing the flexible abdomen forward until it pointed anteriorly. During copulation the moths rested with bodies in opposed directions. The abdomen of the female was always large and distended with eggs even before copulation.

Egg-laying began within twenty-four hours after breeding. Single females were found to lay from thirty to one hundred and sixty eggs, but the latter number was very exceptional and by only one unusually large moth. The usual number was between forty and fifty. The egg-laying might be completed in one day or it might continue two or three weeks. The female died when the eggs were all laid. The males might live and continue active and breeding for two or three weeks. Twenty-three days was the longest period observed. The eggs were carefully placed among the threads of the cloths and fastened by some glutinous material so that they did not readily shake off. If the cloth had a ravelled edge, the female would generally place most of the eggs deep among the loose threads.

To receive the eggs, small pieces of woolen cloth were generally used. When cotton cloth was tried experimentally, the moths did not differentiate, but laid on cotton stocking material and also on silk.

For incubation and brooding, Petri dishes were used and the egg-covered cloths were placed one in each dish. Hatching began in seven days, the larvæ emerging as millimeter-long translucent-white active caterpillars. These began to feed immediately and were then colored according to the color of the cloth used. Experiments were tried with felts of several colors and as a result larvæ could be obtained with a median streak of red, blue, green, *et al.* The dyes passed through the alimentary canal apparently unchanged, and it was always possible to determine by the excreta what material had been fed upon when there were cloths of different colors.

The larvæ behaved differently in the matter of case making. Some began immediately to spin a webbing case or sometimes a passage several times the length of the body in which they would live for a longer or shorter length of time. Woven into this "silk" tunnel were usually fibers from the material from which they were feeding. In the case of fur, the resulting case would often have the appearance of a bur with the hairs woven crossways and forming a case sometimes much thicker than long. On cloth, the case was made of shorter fibers closely attached to the cloth, thus distinguishing it from the cases formed by *Tinea* which are carried about. When a *Tineola* larva wished to change its feeding place it would either continue its gallery, sometimes for several inches, or would leave it entirely and build another when a satisfactory place was reached. As the larvæ grew to mature size, the feeding case was enlarged and changed to form the cocoon.

Other larvæ seemed to spend their time "grazing" about without ever forming more than small patches of silk if any. No conclusion was drawn as to the probable explanation of the difference. It might be that the quieter kind were eventually to form the female moths, and necessarily had less energy to spend in roaming. If this is true, it establishes another instance of the application of Kipling's law, for the larvæ which remained in cases do much more damage than the roaming kind. Moth holes usually appear as round holes, or as dumbbell-shaped slits. The latter are made by the feeding of a stationary larva, the straight slit part being cut out underneath the case, the enlarged ends being at either opening of the case. The single holes are merely the feeding places at the ends of a case without the connecting split. These stationary larvæ also use much more cloth in order to make their cases. Of course both types enter cases at the end before passing into the pupa stage.

The larval stage may be completed in about ten weeks. It was found difficult to carry definite specific larvæ under observation in Petri dishes through the entire period, but the time was established by noting the appearance of new groups of moths in the larger stock of fur. Just what there was in the Petri-dish method of culture to hinder the larval development could not be determined. Some larvæ grew to large size, approximating maturity, others died in a few weeks, but none were certainly carried from the egg to the cocoon. Ten weeks appeared to be the shortest period in which larval growth was completed, but this is necessarily partly an estimate.

The cocoon stage lasted at the shortest two weeks. This was definitely established by observing the time at which larvæ ceased feeding, and closed their cases, and then putting such cases away for observation.

It is probable that all stages of the life history may under some circumstances be more or less indefinitely lengthened. Certainly the larval stage may. Its conclusion probably depends entirely on the obtaining of a sufficient amount of food, and may probably last several months, as over winter for example. Winter stops the activities of this moth only when the temperature of the surroundings is too much lowered. In the present investigation moths were observed emerging from cocoons and larvæ were seen feeding during all months of the year. Breeding experiments were not attempted during the winter but there seems no reason to suppose they would not have been successful and that egg-laying would also have occurred.

Remedies for Moths.—A summary of results along this line may be interesting.

Remedies intended for the flying-moth stage are worse than useless. So-called repellants such as tobacco, cedar, did not repel or harm the moth in any stage. The imago stage is the most delicate of all, but it could be placed in a small closed tumbler with burning tobacco with no apparent injury. Cloth soaked in odoriferous substances for the purpose of repelling them was made the recipient of eggs as readily as untreated cloth. As already noted, the moth laid eggs as readily on cotton and silk as on wool although neither of these was used as food by the larvæ.

Any method of attack must be directed toward the larval stage to be effective. Camphor and napthalene in closed places kill all stages. The egg and larvæ turn from whitish to a yellowish brown in color; the larvæ cease activity almost immediately. No gaseous poisons were tried but undoubtedly the common ones would be effective. Kerosene and gasoline fumes were not effective.

The main method of attack in this case was directed toward poisoning the larvæ through their food. The problem was to find some poison which could be placed on cloth and serve to kill larvæ feeding on it before they could do material damage. At the same time it must not be harmful to human beings, or if harmful in posse, must be insoluble. If baby wants to chew mother's dress or its woolen blanket, it must be able to do so with impunity. After about four years of nearly continuous investigation, during which several chemists were cooperating, the problem was finally dropped. Numerous compounds were used in tests but the larvæ proved singularly immune. Larvæ placed in Petri dishes with a piece of cloth soaked in corrosive sublimate as well as other common poisons, ate of the cloth as shown by the color of their alimentary canal and the fæces, but lived on for weeks apparently uninjured. Some few substances were found which did appear to have some result but not enough to justify adopting them as the basis of a moth-proofing process.

The problem still seems to be possible, but the solution is not apparent. After the substance is found, there still remains the overcoming of the objections of the tailors and clothing manufacturers, some of whom consider clothes moths among their best friends.

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A CHROMOSOME DIFFERENCE CORRELATED WITH SEX DIFFERENCES IN SPHÆROCARPOS

THE chromosome group found in the cells of the female gametophyte of *Sphærocarpos Donnellii* contains one large element which