LARVA REARING

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As a subject specially applicable to both the systematic and economic phases of Entomology, I have chosen "Larva Rearing" to speak about today. Any fresh information as to the life histories of insects, either injurious or otherwise, is so much gain to both departments. I have had considerable experience in the rearing of the larvae of Lepidoptera, particularly of the English species, and perhaps a few remarks on the results of my experience may be of use.

It must be borne in mind that the larvae dealt with are Lepidoptera, but no doubt, hints can be obtained for the treatment of larvae of other orders.

The best way to obtain larvae is from eggs, either found in the natural state, or else from captured females. (Captured females may be encouraged to lay in confinement by feeding with syrup or slices of apple.) Another method is by beating the foliage of trees and shrubs over a beating tray or inverted umbrella. The most profitable times of year for this are in the spring, just after the leaves are out, and in September. The former time will catch hibernated larvae, and those recently hatched from eggs laid the previous autumn. The September beating will secure the larvae which intend to pass the winter in the pupal stage. Instead of beating, I personally prefer to search for the caterpillars by noticing where the leaves have been eaten, and by turning up leaves and branches. Searching low-growing herbage with a lantern after dark is an interesting manner of hunting, and is productive of many species not otherwise observed.

Having first procured your larvae, the next thing to be considered is the best way to feed them in confinement. You all know the kind of cages that dealers sell for this purpose. They are all very well for some kinds of larvae, but they are not suitable for all. Different species require different treatment, and it is here that success or failure comes in. I will mention several kinds of apparatus that I have found most useful myself.

In the first place, it is necessary to have small metal boxes, almost airtight, about 3 in. in diameter, glass topped preferred, to keep newly hatched larvae in. Young larvae can be kept in these, certainly until the second moult (but not too crowded), and in some cases for their whole larval existence. The advantage of closely fitting boxes is that the small larvae cannot escape and that the food does not dry up rapidly. Flower pots (all sizes), partly filled with earth or peat, or sawdust and earth, make excellent breeding cages for many kinds of low-feeding caterpillars. The top must be covered by a piece of muslin or even stronger material, tied round by a piece of string. I generally put a small bottle of water inside the flower pot, sinking it in the soil a little way,

and in this is inserted the food plant, which keeps fresh longer in this way. With larvae that feed on trees or shrubs, sleeving is a very easy way of keeping them. A number of different sized sleeves should be prepared. I have found bags about two feet long by 9 inches wide a useful size. These should be slipped over suitable branches and tied round the open end by a piece of string, care being taken to avoid folds through which larvae enemies could creep. In some cases sleeves open at both ends are more convenient to slip over branches, the outside end being afterwards tied up with a piece of string. The material of which the bags are made should be strong enough to resist the attacks of birds, but transparent enough to see when the food contained inside is getting finished. If necessary to transfer the larvae to fresh pasturage, it is advisable to cut off the old branch and pick off the larvae over a sheet or large newspaper, transferring them to the new sleeve after it is in position on the fresh branch. It is necessary to keep an eye on the sleeves and when the larvae are getting full fed, especially in cases when they pupate in soil or on the ground, to let them finish in flower pots such as I have mentioned. I prefer flower pots for this, because it is desirable to keep only one kind in each pot.

Another variant of the sleeve is to cut off a branch of the food plant required, tie it in the sleeve in the same manner as just described, only leaving about 6 inches of the stem projecting outside and then put the stem in a jar of water, with the sleeve resting on the mouth of the jar. This can be kept in the house or outhouse, and will be found a most convenient and successful method.

Shallow boxes of wood, with moss or cocoanut fibre on the bottom, make excellent cages. The tops must be perfectly level so that a sheet of glass, placed on the top, will not leave any spaces for the larvae to escape. A piece of muslin or butter cloth should be put under the glass over the top of the box. In cases of odd larvae of unknown species picked up, I have found it a convenient practice to use Economy jars or sealers. I first put a little debris, fibre moss or cotton wool, in the bottom of the jar.

Then I take a small bottle about 3 inches high, and tie a piece of string around its neck; after filling the little bottle with water, I put in a sprig of the food plant and lower the whole into the jar by the string. The string will be found necessary, for if not used the inside bottle will slip away from the food.

The string is also needed to lift out the bottle when renewing the food plant. The mouth of the jar must be covered by a piece of cheese cloth, secured by a string or elastic band. The advantage of this method is that a description of the caterpillar can be attached to the jar and the connection of larva and perfect insect be safely established. Moreover the larvae may be allowed to pupate in the jar—the jar can be stored in

a suitable situation and an eye can be kept upon it for indication of the emergence of the perfect insect, without removing the cover. In practice, however, I have found that the perfect insect often rests on the cover where it is not easily seen, so that it is advisable to take off the cover occasionally and look inside.

When breeding large numbers of the same species for varieties, I have found large tubs, or a barrel cut in two, most effective. Of course the tubs must have a cloth cover tied round by a piece of string. There are some interesting notes on the subject of breeding Lepidoptera in B.C.E.S. Bulletins No. 6 and 7 by Mr. J. W. Cockle of Kaslo. For other directions, observations, hints and recommendations, I shall quote extensively from an article on "The Rearing of Larvae" by Mr. C. Rippon, M.A., F.E.S., in "The Entomologist" during the past year, because the experiences there recorded so generally correspond with my own that I am glad to avail myself of the diction and of the writer's individual observations. I consider the article a most interesting contribution to the subject.

Newly hatched larvae have a tendency to scatter, therefore they should be confined to a somewhat small space, with the receptacle comfortably filled with the food plant, taking care that some of the food is in contact with the lid of the box, where, as a rule, the young larvae congregate. In some cases where the food plant is not known, I always put in single leaves of as many plants as are available, choosing such kinds as I think the species would be likely to feed upon in a state of nature and being guided by what I know already to be the general kind of food of the different families. For instance, a great many geometer larvae will eat **Polygonum aviculare** although that plant may not be their usual food. Likewise most noctuid larvae will eat dock, plantain or chickweed. But, in passing, I may say that any too succulent food, like chickweed or lettuce, is bad for larvae, and should be used very sparingly. Arctiid larvae prefer fairly succulent food, such as low-growing herbs. They are dirty feeders and need frequent change of food. Notodonts generally require leaves of trees. Whatever food is put in with young larvae should not be too wet and should be disturbed as little as possible. It will soon be seen if the larvae are taking to any of the leaves provided, indicated by their resting elsewhere than on the glass lid. If they congregate there or seem restless, it is best to put in fresh kinds of food. When it is seen that the larvae have eaten, they should be left alone until the food is withered, by which time the larvae have generally passed through their first instar. The food can then be examined to see which of the leaves have been preferred and the subsequent supply determined thereby. When larvae are larger, so much care need not be taken to see that the foliage is dry, except in boxes where there is very little ventilation, but such cages should be avoided, as plenty of fresh air is necessary for successful rearing. Overcrowding

is another thing to be avoided, and it is best not to have more than one kind of larva in each receptacle. "The choice and condition of pupating material most suitable to the species being bred is a matter of considerable importance. Some larvae require quite a special type of material, while the majority do best in a light, fibrous, sandy soil, more analogous to pure leaf-mould and very different to the ordinary soil in a garden. Then again, for convenience in manipulation, the material should have nothing in it which could be mistaken for a cocoon, i.e., no lumps, stones, etc.; it should also be easily capable of being moistened to any degree required, and, most important of all, should be free of any insect pests.

I quote the foregoing information about the moistening the pupating material, for the use of anyone it may appeal to. My own experience is that, as a rule, if pupa are kept in the open air, under cover and shade, they do not require artificial moistening. I think, however, that if pupae are found in a damp situation, it is important that the moist condition should be continued, as it is fatal to allow the same pupae to be sometimes damp and sometimes dry.

In regard to "receptacles for pupating, it may be mentioned that, though metal may be used, those constructed of rough wood are infinitely preferable, except for wood-eating larvae and one or two species which seem to like stone or earthenware to pupate on.

"The size and depth of the receptacles are again dependent largely on the species to be treated. About three or four inches deep are sufficient for the majority of burying larvae, but for some of the larger hawk moths and certain fastidious things, the compost should be much deeper. As to size of receptacle, it is much better to have a number fairly small and let only a few larvae do down in each, than one large one, and expect a lot of larvae to go down in it.

"One reason is that generally the majority of a batch of larvae unaccountably prefer one end or corner of a pupating box; consequently if a large number are allowed to pupate in the same box, however large it may be, those which descend last will disturb those already down, with bad results as to the number of pupae obtained.

"For larvae which spin up on the surface of the ground there is nothing equal to natural moss (sterilized), pressed down gently on to the surface of a layer of the peaty compost already described.

"For those which spin up in dead leaves, it is obvious what should be supplied, while larvae which spin above ground usually do not require anything special, but will make their cocoons on the food plant or cage. Ornamental cork is not a bad substitute for such larvae as require the bark of trees in which to make their cocoons, while wood-feeders and a few others demand special treatment, such as hollow sticks, rotten wood, and the like."

"All breeders of Lepidoptera naturally aim not only at obtaining a high proportion of imagines to the number of larvae, but also at obtaining fine, richly coloured specimens. No doubt a large variety of factors conduce to the production of such imagines, but one of the greatest is, I believe, quickness of development in the larval stage. Of course the average life of larvae of different species varies enormously, some taking years to come to maturity and others weeks only; so that in speaking of quickness of development I only mean it to refer to the usual length of life of the larva under consideration. Suppose for example, we have a larva whose average life is 3 months; it will usually produce a far finer imago if it comes to maturity in ten weeks, than if it drags on for three and a half months. Other things being equal, the quicker, within certain limits, larvae can be fed up without interferring materially with their cycles, the larger will be the proportion to pupate and the finer the resulting imagines. This I have found to be particularly the case with larvae that feed up in the spring or early summer.

"Now if there is one thing that has more influence than another on quickness of development, it is temperature. I do not mean that the greater the heat the better will be the results. The temperature wants to be consistent with that prevailing under the best conditions at the time of year when the larvae naturally feed, and, above all, it should be regular. I have frequently obtained quite remarkable results by feeding up certain spring larvae in a temperature of 55 to 60 degrees kept up regularly day and night in April and May.

"This sort of treatment has one disadvantage, and that is, that the imagines may appear two or three weeks before their proper time; but against this may be set very many advantages. The larvae seem very much less liable to ailments; they feed heartily and steadily, there is practically no loss in changing skins or pupation, and the imagines are large and handsome. I have found this use of a steady, fairly warm temperature of the greatest help in rearing larvae hatched in the spring from ova which were laid the previous summer or autumn, and have by its means bred without any difficulty several species which pass the winter as ova and are considered difficult, if not impossible, to get through successfully in confinement.

"Perhaps this effect of a regular temperature is one of the chief reasons why some species vary so enormously in their abundance in different years. If the temperature during the months the larvae are feeding is unusually warm and steady for that period of the year, then the next emergence of the species will be unusually abundant. It will be noticed that I refer to the temperature being warm, not hot. Great heat and drought have quite a contrary effect; the larvae may feed up very quickly, but the imagines are frequently small and stunted. This may very likely be due to the fact that great heat dries up foliage and makes it much less succulent, besides making it more difficult for the

larvae to eat, so that the latter cannot consume enough to keep pace with their rate of development; and what they do consume has very little moisture in it—a commodity most essential to a larva's well-being.

"The successful hibernation of larvae is, in my opinion, the most difficult part of larvae rearing.

"The majority of hibernating larvae require to be on or near their food plant to live through the winter, and there is little doubt that many larvae feed far more during hibernation than many persons suppose. Low-feeding larvae may be successfully treated in a cage in which is placed a flower pot planted with what they feed on. I would, however, suggest that whatever the plants may be that the larvae fancy, a little grass should also be put in the pot, for I have found that quite a number of species which never touch grass at other times will frequently nibble it during the winter months.

"Quite a number of species which hibernate as larvae in nature can be made in confinement to feed straight up, pupate and emerge about Christmas or early in the new year. The two necessary factors are warmth and suitable food. . . . . A suitable temperature is, of course, all-important, and it should on no account be allowed to drop very low even for a short period. One really cold night will start some larvae hibernating, and nothing will then induce them to resume feeding. This forcing through of hibernating larvae is only possible with certain species; others, whether kept warm or not, utterly refuse to go on feeding after a certain period in the autumn. With many hibernating larvae it is not particularly difficult to bring them through the winter; but the problem is how to prevent them dying off when hibernation is over, which they often persist in doing, despite being supplied with the most tempting portions of their food plant. When the latter is available sufficiently early, I have found that the best plan is to bring the larvae into a warm, steady temperature about a month or more before they thoroughly wake up under natural conditions. I often begin to bring in hibernating larvae in February, with most excellent results."

"I have seen it stated in quite a number of works on the British Lepidoptera that the pupae of burying larvae should not be dug up, and that cocoons should not be interfered with. In the great majority of cases I would unhesitatingly advise the very opposite.

"In confinement many of the spinning larvae will make their cocoons one on top of the other in such a way that if left in position the imagines could never get out of those at the bottom, while with those that bury I have already pointed out how one end or corner of the pupating box will be patronized by the majority of the larvae. Then, again, despite the greatest care, insect pests may get established in the pupating material; and if the pupae are left in it for months they may all be destroyed long before the perfect insects are ready to emerge. Another

point about taking out the pupae is that they are then much easier to handle and look after and to place, so that they get the full benefit of the damp atmosphere which is so necessary to most species just before emergence. When, in addition to this, it is realized that the removal of the pupae, if carefully done, does them no harm, and adds to the percentage of emergences, there seems no tangible reason for leaving pupae in situ.

"I do not by all this mean that every cocoon should be opened and the pupae removed. As long as the cocoons are fairly substantial there is no object to be gained by doing more than separating the cocoons one from the other, and removing the loose outer web if there is one. Indeed, from the difficulty of doing so without injury, it is unwise to attempt to remove pupae from tough cocoons."

"When dealing with larvae whose period of rest is unknown, the receptacle in which they have gone down should be left untouched for a fortnight, then the compost in one corner should be gently removed till one of the insects is found; if it is a thoroughly hard pupa, the lot may be turned out with safety; if, on the other hand it is still a larva, leave it, slightly exposed if possible, so that it can be inspected every few days. In this way the period of rest can be found out, and, at any rate, the breeder does not endanger the whole brood. The chief thing in keeping bare pupae over any length of time is to prevent them coming into contact with anything that will block up their spiracles. They should never be allowed to lie on, or in any dusty material, such as dry earth. Bare pupae and cocoons can quite easily be kept during the winter piled into and shut up in chip or glass-topped boxes exposed to outdoor temperature."

"About a month or more before the time arrives for the emergence of the perfect insect, the pupae and cocoons should be spread out in shallow pans or boxes, the bare pupae between two layers of sterilized moss, and placed in a cage or large, well ventilated box with rough sides and top. The atmosphere in this box should be kept decidedly damp, or many cripples will be bred, especially amongst the Geometers. The pupae of many species do not all emerge the first year, a provision of Nature that has no doubt saved many an insect from extinction; but this class of pupae does not seem to call for any special treatment, unless it be extra care in making sure a pupa is really dead before throwing it away."

That is all I have to say about larvae-rearing today. I am conscious that all the members present may not feel greatly interested in the subject, and may think that I might have chosen a less commonplace one, but my excuse must be that I wish to encourage the practice of larva-rearing; for it is a sad fact that in the case of a great number of our insects, little or nothing is known of their earlier stages.