Mass Production of Insect Parasites and Predators

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Mass-production of parasites and predators is often necessary or desirable in connexion with many biological control projects, particularly where attempts are made to increase parasitism or predation by mass releases of entomophages over a wide area at a time in the season when these natural enemies are few or absent. However, the term "mass-production" is vague and individuals differ in their concepts of large numbers. Moreover, the actual numbers needed in connexion with different biological control problems vary considerably. Some successful parasite introductions have been made with only a dozen or so individuals; others have required very large numbers before establishment has been obtained.

There are two main types of biological control, each of which has different requirements with regard to mass-production. As mentioned above, there is that in which large numbers of entomophages are released at critical times in the season in order to increase the destruction by natural enemies. In such cases it is obvious that mass-production methods are essential, the scale depending on the size and duration of the operation. The main difficulties here are to produce the required enormous numbers of entomophages at exactly the correct critical period of the season, particularly when this period is dependent on weather and may vary considerably and somewhat unpredictably from year to year. A thorough survey of the results obtained from this method of control in the number of instances in which it has been used would be very interesting.

The second, and far more desirable, procedure is to establish a suitable exotic entomophage against a pest which will thrive in the new environment and give perennial reduction in the pest population. This has, of course, been accomplished successfully many times, but where failure has occurred the exact reasons for it are often obscure and it is sometimes attributed to the introduction of too few individuals. In such cases it is claimed that mass-production and release might yield better results.

Mass-production—whether of parasites or predators, fungi, protozoa, bacteria, viruses, sterile males, or genetically incompatible individuals—has become an integral part of biological control programmes.

Large-scale field collection is often the simplest and most economical method of obtaining large numbers of a given species. Often this entails feeding the host or immature predators in the laboratory, where considerable care may be necessary to eliminate hyperparasites and diseases.

Mass-production methods usually produce large numbers of entomophages, free from contaminants, which can be released immediately in the field. However, there are virtually no general rules that can be laid down as to optimum conditions of cage-size, environment, feeding and illumination for breeding these. Each problem demands different treatment, depending on the requirements of individual species and numbers to be produced, and each scheme is usually based on a technique developed in the laboratory and then modified for cheap, large-scale production.

However, there are a number of general aspects of mass-production of entomophages that should be considered.

In many cases it is necessary to provide large numbers of a host species. These may possibly be collected in the field and, if necessary, stored for future use. Such collections may, however, be impossible or impracticable and it may be necessary to propagate hosts in large numbers, often throughout the year, in heated insectaries. Great care is then necessary to produce normal, healthy adults, rather than small individuals susceptible to disease. In some cases, too, precautions have to be taken to avoid cannibalism.

When normal plants are unavailable or unsuitable for mass-production methods, it may be possible to find a more suitable alternate host-plant, or even

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to provide an artificial, not necessarily synthetic, diet in place of the host. Although the mass-production of host-plants does not actually concern insect vectors of medical importance, it is mentioned here on general grounds.

Perhaps the normal host cannot be mass-produced. It is then often possible to find an alternative, but unnatural, host on which the entomophage can develop, and which can be produced in large numbers. Sometimes it may be necessary to "condition" such alternative hosts with extracts of normal hosts before oviposition by entomophages can be induced.

The logical development from this is research into producing artificial, and even purely synthetic, diets on which entomophages may be mass-produced.

The use of unnatural or artificial hosts may possibly produce abnormalities in the progeny, and this must be guarded against. The diet of both the preceding larval generation and also of the adult entomophages themselves may have considerable influence on their longevity, reproductive rate, fertility of eggs, and possibly on the proportion of progeny entering diapause—all of which are of major importance in mass-production schemes. There is the possibility also that the use of unnatural hosts may affect the host preferences of the progeny, a point which should be investigated where necessary.

The genetical aspect of breeding and mass-propagation of entomophages is important. In most instances laboratory stocks, or those for mass-production schemes, are derived from a small amount of field material and they are often further inbred during the course of many generations. Genetic variability of the stock will almost certainly be reduced and with it, possibly, the adaptability of the entomophage to different environmental conditions. Hence every effort should be made to maintain or increase genetic variability in mass-propagation programmes.

The determination of optimum mating conditions to provide maximum numbers of progeny with an adequate sex ratio is also essential.

In mass-production schemes it is usually easy to eliminate hyperparasites in the case of parasites, or parasites in the case of predators. Diseases and mites, however, may often cause losses in crowded mass-production conditions, and if this occurs rearing methods must obviously be suitably altered. Diseases transmitted through the eggs are particularly difficult to eradicate.

In conclusion it should be stressed that not only does each problem in mass-production of an entomophage present its own difficulties, but also the actual need for, or size of, a mass-production programme should be carefully considered, since once such a programme is initiated there is sometimes a tendency to increase production out of proportion to real needs.