of the North Island. In 1951 it was recorded in Nelson and Blenheim, only reaching serious numbers in the latter district in this present (1954) season. Establishment in Nelson probably took the sigmoid curve.

In the summer of 1948-49 *Microphanurus basalis* Woll., an egg parasite, was introduced and liberated in several areas infested with the bug. Surveys have been carried out to determine whether the parasite has established, and at Paihia, Bay of Islands, in 1953 95 per cent. of egg rafts located in this area were parasitised. It would appear that the parasite has considerably reduced bug populations in Northland. However, the evidence is not completely satisfactory because the bug appears to be very sensitive to weather conditions, since attempts to discover egg masses in Auckland have been unrewarding during relatively poor summer seasons, and there is no evidence to show parasites are the cause of low population levels. The green vegetable bug is an example of an insect whose population growth is greatly influenced by temperature. Whereas it has been suggested that the wasp may do better in climates with a colder winter, it is suggested that the opposite may occur with this bug.

The aim of the author's sphere of activity is the control of insect pests, including the above three, and consequently population dynamics are incidental to the development of control measures. However, an attempt has been made, with, it is believed, some degree of success, to fit population growth to the sigmoid curve shown to represent growth in such laboratory systems as *Tribolium* in flour, *Drosophila* and yeast cells in laboratory culture.

Among insects, some of the salient features of population growth in newly introduced species that find the environment suitable are:—

1. The short period of adjustment to and establishment in the environment.
2. The rapidity with which the population increases under favourable conditions of food and climate.
3. The truly catastrophic destructive influence of effective natural enemies.
4. The sensitivity of population fluctuations to factors in the environment, *e.g.* climate.

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Do Newly Introduced Species Present A Separate Problem?

D. F. Hobbs

It is intended to suggest that there are grounds for the separate consideration of the dynamics of newly introduced species, and further, that there is a need for closer research interest in the dynamics of new populations. These aspects are dealt with in general terms.

There is little evidence in the literature to suggest that newly introduced species possess any special problems in population dynamics. In Allee's "Principles of Animal Ecology" and in recent studies by both Solomon (1949) and Haldane (1953) on natural regulation of animal populations, little distinction is made between indigenous and introduced populations, between human and other populations, or between, except in the case of Solomon, the test-tube populations of Gause and other workers and populations in a natural state. While it is not suggested that any serious student of populations could afford to limit his reading and thinking to populations of either type, it appears that there could be dangers in failing to appreciate certain differences which seem to warrant separate consideration of the dynamics of newly introduced populations. Some of the more important aspects are indicated in the table.

The following points arise from an examination of these differences.

1. Extinction of a native species within a short period is a rare thing, even where great changes of environment follow settlement of a new country by people of European races. The North American continent provides two or three instances of the extinction of birds under such circumstances and at least one of the near extinction of a mammal. Contraction of range

INDIGENOUS	INTRODUCED
1. Extinction of species rare.	Extinction of species common.
2. Relatively high population minimum.	Usually very small initial population nucleus.
3. Period of population increase always relatively short.	Period of increase often very protracted.
4. Increase of population temporary.	Increase often permanent involving extension of range and merger of populations.
5. Environment conditioned by use.	Environment yet to be conditioned.
6. Natural enemies already present.	Natural enemies often arrive later.
Best data on populations indirectly obtained from cropping natural populations.	Best data from direct observations on test-tube populations.

and even extinction of local populations is more usual, although the processes are often protracted. On the other hand extinction of introduced species very shortly following arrival has been a fairly common happening. Unfortunately relatively too much attention has been given to the biologically spectacular successes of a few introductions of new species, *i.e.* mongoose, grey squirrel, muskrat, deer, rabbit, sparrow and trout. The literature accords relatively scant notice to the great number of failures, immediate or deferred, or to the faltering successes. These equally merit study.

2. Almost invariably an exotic population is initially much smaller numerically than ever could be found in its original environment. In other words the curve of population growth will start at a very much lower point.

3. Indigenous populations usually confine their upsurges to relatively short periods. The increase represents only the "rising" side of an oscillatory movement which rarely exceeds 11 years in total duration. The increase of an introduced population may continue over a very protracted period. In this country natural increases of vertebrates as dissimilar as the red deer, the opossum and the quinnat salmon probably continued for a period of roughly 50 years, and in places may still be continuing. Increases of comparable duration would rarely occur with indigenous species except following a significant change of environment, or cessation of man's excessive depredations—a possibility suggested by the history of some seal herds.

4. The fluctuations of a native population involve numerical increases of a temporary nature, followed by reduction. The numerical increase in exotic populations and the expansion of range which usually accompanies it is a much more complex process, commonly involving merger of what were originally a series of independent populations. Such merger is not necessarily a feature of growth of introduced populations because much depends on the number and distribution of population nucleii.

5. Impact of environment differs for the two types of population. Despite, in some cases, eruptive forays beyond its environment, an indigenous population exists in an environment suited to it and for better or worse to some extent conditioned by it. On the other hand, an introduced population invariably finds itself turned adrift in an environment not conditioned to its impact. Where a beast's world is a small pond such conditioning may become effective fairly soon after introduction. However, in the case of browsing animals such as deer, the conditioning processes may be extremely protracted, as, for instance, where the regeneration of slowly growing trees is affected.

6. Commonly in practice most introduced species of all classes arrive well ahead of many of those things which preyed on them in their country of origin, *e.g.* cabbages arrived with Captain Cook, the white butterfly yesterday.

Another aspect which may be recorded is the source of data to which we look for information about these two groups. Except for statistics of the human race, the great sources of data relating to the abundance of vertebrates over long periods (and in some cases to qualitative changes in populations) have been marine and freshwater fisheries statistics, whaling statistics, and, in the case of land mammals, the records of skin sales and of bounty payments. In such cases it is the crop which we measure, and from it we infer, with varying degrees of accuracy, the fluctuations in size of population or, more commonly, in numbers of adult components of populations. Cropping statistics may seem rather inadequate alongside intimate population studies on such test-tube populations as yeasts, flour beetle and fruit-fly—truly "newly introduced" populations.

In considering "*newly*" introduced species in New Zealand it seems reasonable to ignore at least the present and very recent status of such long-established animals as rats and mice, also game birds and fish. Regarding the various deer species, opossums and rabbits, just where and when any could cease to be regarded as newly introduced depends on whether or not dispersion and increase were still continuing. Once relative

stability is reached, whether through natural causes or through man's control measures, interest diminishes except from comparative angles.

New opportunities of studying population dynamics occur whenever, for instance, fire sweeps through a forest, a swamp is drained, or an impoundment of water is created, or when successive species of animals reach and populate conveniently isolated environments, such as newly created ponds, where the successive invaders might include mosquitoes, corixids, frogs and eels. Apart from test-tube populations there seems to be an opportunity to deliberately introduce animals, particularly larger problem animals, to small islands set aside as ecological laboratories in which subsequent developments can be studied over many years without interference from any pressure group.

The essential environmental conditions for newly introduced species may be summed up as all that makes for a receptive niche which provides the essentials of the environment of origin. It must be either a biotic vacancy or a place weakly held by displaceable species. On the physical and, particularly with aquatic animals, chemical aspects it must fall within the range of tolerance possessed by the animal, which may not be identical with the optimum in the native environments . It is quite conceivable that an introduced species could live, and indeed flourish, near or a little beyond the borderline of its normal climatic range, if the biotic compensations were adequate. The history of the moose in New Zealand suggests this. Conversely, a beast transferred to an environment, no matter how ideal as regard physical factors, is not assured of survival if the biotic factors are strongly adverse. In passing it must be added that the climograph is a very imperfect tool to deal with multifactor situations.

More attention has usually been given to the question of minimum size to which a population may fall before extinction threatens than to that of minimum effective nucleus for introduction to a favourable environment. Superficially, this appears to be simply the number required to ensure survival, encounter and mating of a single reproducing pair, *e.g.* the recorded cases with rats and beaver. However, usually survival hazards necessitate a greater number of parent pairs. While these remarks are restricted to introductions to favourable environments, Allee wrote: "Many plants and animals are able to modify an unfavourable environment to such an extent that though some or all of the pioneers may be killed, others following . . . can survive and often thrive, where they could not do so in a raw environment". Thus it must be recognised that a satisfactory nucleus may in the case of some species include a sufficient excess to be used up simply in the process of conditioning the new environment.

In colonial-nesting birds, it has been shown that reproductive efficiency diminishes sharply once a population drops below a certain threshold. Thus development of a healthy population in newly introduced species will probably not result from a population nucleus so small as to curtail its reproductive efficiency. Where a species is subject to considerable population fluctuations from causes independent of density, it seems that the minimum population nucleus could vary according to the time of introduction. If an animal is introduced at a time when conditions are such as to make for decline of population, then a larger nucleus would possibly be required compared with the state when conditions were favourable for population expansion.

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Discussion

P. B. HANNKEN asked if there was evidence that the fluctuation in the wasp population was not, in fact, an indication of very strong fluctuations which might bring the population back to full strength.

DR. W. COTTIER said he was not certain of the situation, his statement had only been postulation.

T. RINEY emphasised the bountiful opportunities in New Zealand for studying introduced animals, where there was a unique situation offering rare opportunities to investigate biological principles. In New Zealand there might be opportunity for testing a recent hypothesis, largely theoretical, developed in the U.S.A. as a result of studies on the dispersal of the white-footed deermouse. It