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 has been postulated that there might be two kinds of dispersal: environmental dispersal and innate dispersal, the latter being due to a genetic combination which produced certain individuals which travelled over great distances across every sort of barrier. Such a situation appears to be present in the deer population in New Zealand. Problems of migration could be studied with the aid of a "test-tube" in the Pacific Ocean. Overseas, such information was related to theories concerning Ice Age influences, whereas in New Zealand there are the beginnings of migration which have little relation with the Ice Age.

J. H. SORENSEN thought it might also be profitable to examine the causes operating in instances of rapid proliferation, followed by decline to normal and fluctuating levels, which apparently had nothing to do with dispersal or natural enemies. He instanced the little owl (*A. noctua*) in Southland, which has declined from a high population peak and is now almost rare. As there was no correlation found with Rabbit Board activity and subsequent loss of food source, was there any other evidence relating to the causes of this natural decline from a high peak?

G. R. WILLIAMS suggested that there was no real difference between the population dynamics of introduced and indigenous species. Some of our avifauna at least is trans-oceanic, and fairly recent in terms of geological time, *e.g.*, the silver-eye.

R. I. KEAN said that the differences between introduced and indigenous populations, if considered on general principles, tend to cancel one another out and work down to an average. For instance, the opossum is limited in distribution by cover, and where this is present, and the opossum fails to establish, there is either a lack of food or a superabundance of cover preventing movement. In the latter case, the population is held down until the animal can condition its environment, when population growth follows the normal curve.

DR. K. A. WODZICKI pointed out the similarity of growth curves for plants, mammals and insects, and stressed the importance of environment. Referring to the published information available, he mentioned a recent article citing 41 references on the dynamics of introduced species.

PROF. L. R. RICHARDSON remarked that environment was multifactorial, and controls an animal in many ways, and parasitological work can provide many relevant examples. The human alimentary canal was a fairly uniform environment beyond the duodenum and the pin worm and others would produce Dr. Cottier's curve. In the bloodstream, one of the most perfect stable environments, blood parasites will show the same curves. Our ideas of multifactorial environments may not be required in considering population build-up and their decline, which appears to be a phase only of young populations.

N. L. ELDER said he thought that dispersal operations were an important factor. Japanese deer seem to have a different pattern from red deer. He did not agree with Healy's curve for *Digitalis*—the plant comes in quickly and dies away; *i.e.*, it does not fluctuate at high levels.

C. B. TREVARTHEN thought there was a close parallel with curves from other fields, especially plant physiology. It appears to be a reaction curve representing the effects of a sudden change within a very complicated dynamic complex.

K. WESTERKOV suggested that the increase and then decline or disappearance of a species was very important. Investigations might provide the answer to the population history of the partridge in the U.S.A. and the pheasant in New Zealand, *i.e.*, high populations for a number of years and then a very rapid and severe drop. The species may use up some essential factor in the environment which cannot be replaced easily.

K. R. ALLEN developed the viewpoint that the fast or slow build-up of populations may only be apparent when considered apart from conventional time scales. If differences and similarities are to be understood these conventional scales may not mean the same time at all.

DR. J. B. HAIR advanced the suggestion that the gene is as important as the environment, and that in newly introduced species there are evolutionary steps taking place, however slowly, and that some of the sharp rises and drops may be due to favourable or unfavourable mutations which in nature, however, are usually slow.

THE CHAIRMAN (Dr. Salmon) in concluding the session mentioned the need for more advanced thinking in biology, and thought there was scope for thinking in terms of new concepts.