On the Significance of Dispersal Power for Populations of Carabid-Beetles (Coleoptera, Carabidae)

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Summary. By various observations on carabid populations the author attempts to give an impression of the quantitative occurrence of dispersal and of the relation between dispersal and the chance of founding populations (dispersal power). Pitfall-catches in the recently reclaimed "Zuiderzee"-polder E-Flevoland demonstrate that within seven years individuals of a number of monomorphic macropterous and dimorphic species had founded populations there. From the very high frequency of full-winged individuals within the latter populations it follows that full-winged carabid individuals generally must have a much greater power of dispersal than flightless ones. Therefore, winged individuals of dimorphic species were about equally able to reach E-Flevoland as were those of monomorphic macropterous ones, whereas individuals of monomorphic brachypterous species obviously are seriously hampered. The early appearance of individuals of riparian species on the shores of an artificial lake in the dune area "Meijendel" suggests that particularly populations living in unstable environments extensively "invest" in dispersal. It appears, however, that an important "investment" in dispersal apparently is not restricted to species from unstable environments; at least some sparse populations living in more stable environments also "sacrifice" relatively great numbers of individuals for dispersal (Pterostichus strenuus). The hypothesis is proposed, that populations facing a high risk of extinction generally will have a sufficient chance of founding populations (high "turnover") when "investing" extensively in dispersal. Not only macropterous but — at least in some populations — also brachypterous individuals participate in migration, although in the populations studied the dispersal power of flightless individuals is found to be very small (Carabus problematicus). Under certain conditions the dispersal of full-winged individuals from wing-dimorphic populations may ultimately lead to a decrease or even a loss of dispersal power by a decrease of the frequency of macropterous individuals. It is assumed, however, that under certain natural conditions also brachypterous individuals may contribute to the spreading of risk within and between populations. The dispersal power of monomorphic macropterous, dimorphic and monomorphic brachypterous populations in a cultivated countryside like Drenthe is discussed. The connection between the dispersal power of different kinds of carabid populations and the resulting chance of survival under different conditions is discussed. Some suggestions for nature preservation management are given.

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1. Introduction

From the unequal distribution of macropterous and brachypterous specimens within the geographic range of a wing-dimorphic carabid species Lindroth (1949, 1953) concludes that long- and short-winged individuals must have different powers of dispersal. At the periphery of a species range macropterous individuals — “the parachutists” — will outnumber the brachypterous ones, and this would indicate recent range extensions. On the other hand a preponderance of brachypterous specimens would characterize areas colonized long ago. Mainly directed by this hypothesis Lindroth (1949) was able to reconstruct the late Quaternary colonization history of 25 dimorphic carabid species in Fennoscandia.

The high percentage of brachypterous specimens in obviously old populations might indicate that under these conditions flightless individuals must have some selective advantage. Darlington (1936, 1943) supposed that brachypterous individuals might have an overall “higher viability”. Some preliminary experiments by Lindroth (1949, 1953) do not confirm this supposition. Hence, by lack of information the influence of possible differences between brachypterous and macropterous individuals on the chances to survive and to reproduce must be kept out of the present discussion. On the other hand Lindroth (1949) offers the very reasonable suggestion that for populations, which live in small areas surrounded by uninhabitable land or water, flying itself constitutes selection against macropterous individuals\(^2\). This may be true more general, because the chances to return to the population will be smaller for individuals flying away than for those only running away. Only in large and overall densely populated areas individuals flying in from somewhere in the area may on the average counterbalance the local losses.

Leaving these things as they are, we may wonder whether it can be demonstrated that under natural conditions the dispersal power of the individuals of a wing-dimorphic population is indeed much greater in the macropterous than in the brachypterous individuals. Or, stated alternatively, is it justifiable to consider the macropterous specimens of a dimorphic species to represent the “dispersal morph” (diaspores)? In a more general sense we may wonder, to what extent the chance of founding a population and that of exchanging individuals between

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1 Under dispersal power is understood the ability of a group of individuals to bridge relatively great distances. We are especially interested here in the extent to which dispersal power does increase the chance of founding populations.

2 The available information indicates that the wing-dimorphism in carabids is genetically determined, cf. Lindroth (1946, 1949), Palmén (1944). Compare also: Jackson (1928). In the carabid Pterostichus anthropicus, Illig. brachypterous wing is a dominant and the macropterous individuals, consequently, are homozygotes (Lindroth, 1946).