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MAN AS A DISPERSAL AGENT[1]

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ABSTRACT. Evolution of means of crossing barriers and discontinuities between suitable habitats has been a characteristic of plants, resulting in various and highly ingenious dispersal mechanisms. Most of these are adaptations to take advantage of different dispersal agents. Prominent among these agents are animals, of which man has, at least in recent time, been the most effective. Certain plants have evolved so far in this direction as to become entirely dependent on man for their dispersal. Most of these are cultivated plants, deliberately carried around by man. Some are even reproductively sterile. That this is a highly successful adaptation is shown by the wide distribution and enormous numbers of individuals of certain man-carried species.

The effects of man's activities as a dispersal agent are various. Species have disappeared and other new ones have come into existence as a result. Floras have been confused and the natural distribution patterns obscured. Additional variable factors have been added to an already complex situation. Perhaps an additional result of this is the well-known aversion of so many botanists to the study of cultivated plants and other taxonomic and vegetational situations dominated by man.

The dispersal of plants and animals is a subject that has been written on by many able students and about which an enormous literature has grown up. To review even the part of this related to man would be manifestly impossible in the time allotted. Therefore it seems best to attempt only to present some of my own knowledge, experience, and ideas to stimulate discussion, and furthermore, to limit myself to plant dispersal, on which obviously I speak with more authority. Certain of the observations would apply also to animals, but their possession of means of voluntary motility alters the problem very considerably.

There is a direct relationship, long apparent to naturalists, but made more and more clear by modern biosystematic studies, between the diversity of plants, variously estimated at between 200,000 and 500,000 species and countless lesser forms, and the mosaic of different habitats and environmental niches found in the world. Plant taxa have evolved adapted to almost every conceivable habitat or niche.

Since these habitats are seldom continuous, plant species have survived changes by developing means of getting across the intervening spaces or barriers. Their often ingenious apparatus for accomplishing

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this are referred to as dispersal mechanisms. Since the motility of plants or their diaspores under their own power is, at best, extremely limited, most dispersal mechanisms are adaptations to take advantage of external means of transport, termed dispersal agents. The effectiveness of these means of dispersal may be measured, in part, by the degree to which species are actually found in the situations where they are able to establish themselves and grow. That natural means of dispersal are not all 100% effective is suggested by the cases in which exotic plants have naturalized themselves after introduction into new habitats by man. Consideration of this naturalization is complicated, however, by the great disturbance of habitats brought about by man's activities. This includes the creation of new habitats and the modification, expansion and contraction of old ones. One of the difficulties in evaluating man's role and effectiveness as a dispersal agent is to separate the effects of his direct activity in dispersal from his indirect function in plant distribution through his influence on habitat. The latter effects are major in extent and importance and have been dealt with in other parts of the symposium. Here we should try to confine ourselves to the relation of man to the actual transportation of plants or their diaspores from one place to another.

Some very fancy terminology has been devised to express classifications of plants based on their means of dispersal. A current system of dispersal types (Molinier and Müller, 1938, as modified by Dansereau and Lems, 1957) divides plants into six self-explanatory categories:

I. Barochores (dispersed by gravity)
II. Hydrochores (dispersed by water)
III. Anemochores (dispersed by wind)
IV. Zoochores (dispersed by animals)
V. Anthropochores (dispersed by man)
VI. Autochores (dispersed by their own mechanisms).

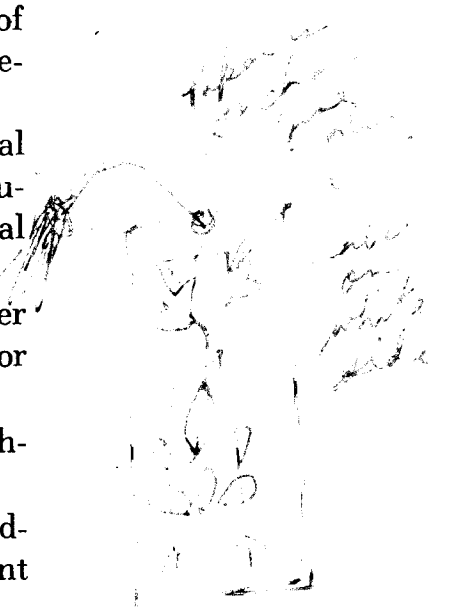
These are clearly not mutually exclusive. We are obviously concerned here with category V.

Anthropochory is, of course, only a special class of zoochory. In spite of the recent demonstration of the possibilities of extremely rapid evolution, it is clear that a vast number of plants that are dispersed by man evolved their dispersal mechanisms long before man became a factor of importance in carrying plants around. Man is merely functioning as another animal when he eats a fleshy fruit and rejects its indigestible seed, or when a burr or other adherent fruit clings to his hair, clothing or implements and is thereby moved from one place to another. There is no doubt, however, that he is in some instances many

times more effective than most animals in accomplishing long distance transport.

True anthropochory, as distinct from these cases of ordinary zoochory with man as the animal agent, are principally found among cultivated plants: those which were either originally especially useful to man, or have become so by deliberate selection or breeding. Species and even genera have apparently been brought into being this way, so distinct that we are not even sure what their wild ancestors were. Others, not usually called distinct species, are so different that, were not the facts of their origins known, they would doubtless be placed in separate species, or even genera. These man-made taxa are usually entirely dependent on man for their dispersal. Judging by the extent of their ranges and the numbers of individuals in existence, many of them must be regarded as eminently successful organisms, with dependence on man as a very effective means of dispersal.

The types of adaptation (including the more obvious dispersal mechanisms) effective in bringing about dispersal by man are numerous. Most of them may be arranged in relatively few general categories as follows:



1. Seeds or fruits viscous or equipped with hooks, barbs, or other means to secure accidental transport on man's body, clothing, or implements.
2. Vegetative parts of plant, capable of taking root and establishment, carried accidentally by man or his implements.
3. Seeds so small that, even without special mechanisms, they adhere to man or his implements or to mud or other substances adherent to him or his implements.
4. Edible fleshy fruits and other parts with or without inedible seeds.
5. Edible seeds, nuts or grains.
6. Edible stems, leaves, roots and other vegetative parts. (Edibility in 5 and 6 either to man or to animals of interest to him.)
7. Edible or otherwise useful oils and essences.
8. Useful fibers and sources of cellulose.
9. Useful woods.
10. Drugs and other useful chemical components or products.
11. Capacity to ferment or otherwise modify other substances.
12. Showy or aesthetically pleasing flowers, fruits, bracts, leaves, or growth habit.
13. Curious or bizarre forms.
14. Ability to stabilize or modify certain environmental factors—

e.g. to produce shade, to bind sand, to inhibit erosion, to fix nitrogen, etc.

15. Habit of growing in cultivated ground, so that accidental transport with cultivated plants and nursery stock is frequent, or at least may happen.

16. Parasitism on plants otherwise transported by man.

Other categories could likely be thought of, or some of those listed here might logically be combined. Some cases are not easily classified; for example, plants brought into botanical gardens merely to have representatives of particular groups, though they are neither useful nor ornamental. Then there are the multitudes of plants deliberately carried around for no apparent reason whatever.

There are, in the older centers of human activity, some wild species or varieties of wild species, that have, over a long period, become adapted to life in the company of man, either in his cultivated fields and gardens, or in his nitrogen-rich waste places and rubbish heaps. These should be mainly considered in other papers, but they do seem to possess effective means of following man around, either carried by him or by other means. They would logically fit into category 15, above.

There remain to be considered the effects of the activities of man as a dispersal agent. These are largely very obvious. Almost anywhere may be seen plants that originated in all parts of the earth. The majority of exotics in any one place are from regions of similar climate, but even climatic lines are transgressed. Witness the multitudes of tropical species raised in temperate or even cold climates as house plants or in greenhouses.

In the total flora of almost any locality inhabited or influenced by man a substantial proportion of the species are exotic. Many of them are effectively naturalized, many dependent on man for their continued presence, some merely temporary waifs. Of the latter continued reintroduction may take place until a biotype is brought in that is adapted to an available local habitat and the species then may become naturalized. Or this may never happen.

Man has, as is well known, brought about the disappearance of many species. This extinction, local or general, is not, of course, entirely or even principally the result of man's dispersal activities, but much of it is. Competition with introduced species is undoubtedly a major factor in the increasing rarity or disappearance of many pioneer species, and possibly even of some members of more mature communities. A somewhat more strained example would be plants which disappear be-

cause their habitats are taken over by cultivation of introduced crop plants. The introduction of exotic plant disease organisms or insects that damage plants is at least a factor in the extinction or reduction of some plant species. I do not know of an example of a plant completely wiped out by such an occurrence, but the American chestnut and the Bermuda juniper are no longer important components of vegetation types in which they were formerly dominant, following introduction of a disease and an insect, respectively. The proportions, if not the exact composition, of vegetation is highly modified in such cases. In the case of the several extinct Hawaiian drepanid birds, introduced disease organisms are credited by some authorities with responsibility for their disappearance. Perhaps the most certain instances that belong here are the plants and animals that have disappeared as a result of man's propensities in dispersal of goats to isolated islands. Though such results are in a sense indirect, man cannot escape the responsibility for the losses that are consequences of the activity of the goats.

Over long periods this dispersal of plants by man has gone on until original patterns of distribution have sometimes become obscured. The actual original homes of some species are not known or are matters of some dispute or uncertainty. Plants may continue to exist in places where they were taken by man after they have disappeared from their original homes—e.g. *Franklinia.*

Finally, as a direct result of dispersal of certain species by man, new species may come into existence. A few documented cases among wild plants exist, such as the well-known *Spartina townsendii,* result of hybridization between an introduced American species and a native European species, followed by amphidiploidy. Many others doubtless exist which have not been proven yet. Similar phenomena are well known among cultivated plants. The cultivated American cottons, for example, are thought to have originated in this way. The whole art of plant breeding depends on the bringing together of suitable related plants, usually from different places. The extreme form of this process may be the transport of pollen, as in orchid culture, from a plant growing in one locality, to pollinate a plant growing in another.

Most of these dispersal processes in plants correspond to similar ones among animals. Even the transport of pollen is matched by transport of sperm in animal breeding.

In conclusion, the evidence seems to indicate that man is by far the most effective dispersal agent that ever has existed. His influence on the floras of the world during only the last 500 years has been greater than that of any other single agent in many times that length of time.

His influence on the vegetation of the world has been greater than that of all other agents combined. A detailed consideration of his actual activities as a dispersal agent or of their consequences would be a major project, rather than a subject for a fifteen minute talk.

LITERATURE CITED

DANSEREAU, PIERRE, and KORNELIUS LEMS. 1957. The grading of dispersal types in plant communities and their ecological significance. Contrib. Inst. Bot. Univ. Montréal No. 71. 52 pp.