

THE AGENCY OF MAN IN THE DISTRIBUTION OF SPECIES.¹

AMONG the many influences which, during the last century or two, have been affecting that unstable condition of life which is expressed in the words "the geographical distribution of animals and plants," none has approached in potency the agency of man, exerted both purposely and unwittingly or accidentally.

Natural spread was for centuries the rule. Species dispersed under natural conditions along the line of least resistance. Winged animals and seed were spread by flight and by the agency of winds, and at their stopping-places thrived or did not thrive, according as conditions were suitable or not suitable. Aquatic animals and plants and small land animals and plants were distributed by the action of rivers and streams and by the ocean itself. Wonderful migrations have occurred, commonly with birds, more rarely with other animals; ice-floes and drift-wood have carried animals and plants far from their original habitats, and even volcanic action has taken part in the dispersal of species. Smaller animals, especially molluscs and insects, and the seeds of plants have been carried many hundreds of miles by birds, and lesser distances by mammals.

With the improvement of commercial intercourse between nations by land and by sea another factor became more and more prominent, until in the present period of the world's history the agency of man in the spread of species, taking all plant and animal life into consideration, has become the predominating one. Potentially cosmopolitan forms, possibly even insular indigenes, have by this important agency become dispersed over nearly all of the civilised parts of the globe, while thousands of other species have been carried thousands of miles from their native homes, and have established themselves and flourished, often with a new vigour, in a new soil and with a novel environment.

It is obvious that this agency is readily separable into two divisions—intentional and accidental.

INTENTIONAL IMPORTATIONS.

Since early times strange plants and animals have been carried home by travellers. Conquering armies have brought back with the spoils of conquest new and interesting creatures and useful and strange plants. With the discovery of America and with the era of circumnavigation of the globe such introductions into Europe of curious and useful species, plants in particular, increased many-fold, while with the colonisation of America and other new regions by Europeans there were many intentional return introductions of Old World species conducive to the welfare or pleasure of the colonists. Activity in this direction has been increasing and increasing. Public botanical gardens and many wealthy individuals in all quarters of the globe have hardly left a stone unturned in their efforts to introduce and acclimatise new plants, particularly those of economic importance and æsthetic quality, not failing occasionally, it must parenthetically be said, to establish some noxious weed, or some especially injurious insect; while it is safe to say that probably the majority of the desirable plants of Europe which will grow in the United States have already been introduced, and that there has been an almost corresponding degree of activity in the introduction of desirable plants from the United States into Europe. In all this host of valuable introductions there have been comparatively few which have turned out badly, aside from failures of establishment. The wild garlic (*Allium vineale*), that ubiquitous plant which gives its taste to milk, butter, and even to beef during the spring and summer months in many States, is said to have been intentionally introduced by the early residents of Germantown, Pennsylvania. The water hyacinth (*Piaropus crassipes*), originally grown for ornament in a pond near Palatka, Florida, escaped into the Saint John's River about 1890, and has multiplied to such an extent as to seriously retard navigation and to necessitate Government investigation. The distribution of the orange hawk-weed (*Hieracium aurantiacum*), a dangerous species which has ruined hundreds of acres of pasture land in New York of recent years, was originally aided by a florist as a hardy ornamental plant. The European woad-waxen (*Genista tinctorium*) was early introduced at Salem, Mass., in

fact about thirty years after the settlement of the colony. It has apparently not been used as a dye plant, but for garden and ornamental purposes only. During the last few years it has become a noxious weed throughout Essex and the adjoining counties. Standing recently on a rock at Swampscott, the writer was able to see that the country for miles around was coloured a bright yellow with enormous masses of this plant. Similar instances are fortunately rare, and the majority of our noxious weeds have been accidental introductions.

Intentional introductions of animals, however, have by no means resulted as advantageously as intentional introductions of plants, with the exception of the truly domesticated species, such as the horse, ass, cow, sheep, pig, dog, cat, poultry, honey-bee, and silk-worm of commerce. Even with such species, the grazing ranges of Australia have been overrun by wild horses to such an extent that paid hunters shoot them at a small sum per head, and the European rabbit has become a much worse plague on the same island continent.

Intentional introductions of wild species, however, have almost without exception resulted disastrously.

At various intervals between 1850 and 1867 a few pairs of English sparrows were introduced into the north-eastern States to destroy canker-worms, and to-day this species is an ubiquitous and unmitigated pest throughout all the austral and transition regions of North America, finding its limit only at the borders of the boreal zone, while the place of the injurious insect it was imported to destroy has been taken by another and worse insect pest which it will not touch.

In 1872 Mr. W. Bancroft Espeut imported four pairs of the Indian mongoose from Calcutta into Jamaica for the purpose of destroying the "cane-piece rat." Ten years later it was estimated that the saving to the colony through the work of this animal amounted to 100,000*l.* annually. Then came a sudden change in the aspect of affairs. It was found that the mongoose destroyed all ground-nesting birds, and that the poultry as well as the insectivorous reptiles and batrachians of the island were being exterminated by it. Injurious insects increased in consequence a thousand-fold; the temporary benefits of the introduction were speedily wiped away, and the mongoose became a pest. Domestic animals, including young pigs, kids, lambs, newly-dropped calves, puppies and kittens, were destroyed by it, while it also ate ripe bananas, pine-apples, young corn, avocado pears, sweet potatoes, cocoas, yams, peas, sugar-cane, meat, and salt provisions and fish. Now, we are told, nature has made another effort to restore the balance. With the increase of insects, due to the destruction by the mongooses of their destroyers, has come an increase of ticks, which are destroying the mongoose, and all Jamaicans rejoice.

The flying-foxes of Australia (*Pteropus* sp.) are animals which are very destructive to fruit in their native home. Frequently some well-meaning but misguided person will arrive on a steamer at San Francisco with one or more of those creatures as pets. While it is not probable that any of the flying-foxes will thrive in northern California or, in fact, in austral regions, the experience is too dangerous a one to try, and the quarantine officer of the California State Board of Horticulture has always destroyed such assisted immigrants without mercy.

Less than thirty years ago (in 1868 or 1869) Prof. Trouvelot imported the eggs of the gypsy moth (*Porthetria dispar*) into Massachusetts. The insect escaped from confinement, increased in numbers, slowly at first, more rapidly afterwards, until in 1889 it attracted more than local attention, with the result that in 1890 the State began remedial work. This work has steadily progressed since that time, and the State has already expended something over a half-million of dollars in the effort to exterminate the insect, and it is estimated that one million five hundred and seventy-five thousand dollars more must be used before extermination can be effected.

Contrast with this a single intentional importation which has had beneficial results. The Australian ladybird (*Vedalia cardinalis*) was introduced into California in 1889 with the result of saving the whole citrus-growing industry of the State from approaching extinction through the ravages of the cottony-cushion scale (*Icerya purchasi*). Later importations of the same insect into South Africa and Egypt also resulted beneficially.

We have thus had sufficient experience with intentional importations to enable us to conclude that while they may often be beneficial in a high degree, they form a very dangerous class of experiments, and should never be undertaken without the fullest

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understanding of the life-history and habits of the species. Even then there may be danger, as with a new environment habits frequently change in a marked degree.

ACCIDENTAL INTRODUCTIONS.

The agency of man, however, has been more potent in extending the range of species and in changing the character of the faunas and floras of the regions which he inhabits by means of accidental importations.

The era of accidental importations began with the beginning of commerce, and has grown with the growth of commerce. The vast extensions of international trade of recent years, every improvement in rapidity of travel and in safety of carriage of goods of all kinds, have increased the opportunities of accidental introductions, until at the present time there is hardly a civilised country which has not, firmly established and flourishing within its territory, hundreds of species of animals and plants of foreign origin, the time and means of introduction of many of which cannot be exactly traced, while of others even the original home cannot be ascertained, so widespread has their distribution become.

These accidental importations would at first glance seem to have been more abundant with plants than with animals, since the opportunities for the carriage of seed, especially flying or burr-like seed, and especially when we consider the vitality of this form of the plant organism, are plainly manifold, but possibly even this obvious generalisation must be modified in view of the multitudinous chances for free travel, which the smaller insects have under our modern systems of transportation.

The agencies which have mainly been instrumental in the accidental distribution of plants are :

(1) Wind storms. It is obvious that light-flying seeds may be carried many hundreds of miles by hurricanes, and may fall in new regions.

(2) Water. This is a very important agency in the distribution of plants upon the same continent, but less important as affecting intra-continental distribution. Still, they may be carried by this means from one island to another adjoining island, and when lodged in the crevices of the driftwood they undoubtedly travel greater distances.

(3) Birds. Seeds are frequently carried great distances by birds. Many of the larger seeds will germinate after passing through the alimentary canal of a bird, and may thus be eaten at one point and voided with the excrement at a widely distant point. It has been shown, for example, that the local distribution of *Rhus toxicodendron* is greatly affected by the carriage and distribution of the seed in this way by the common crow. Smaller seeds are carried in earth on the feet of birds. Darwin's example of a wounded red-legged partridge which had adhering to its leg a ball of earth weighing $6\frac{1}{2}$ ounces, from which he raised thirty-two plants of about five distinct species, is an evidence of the possibilities of this agency, while his experiment with $6\frac{3}{4}$ ounces of mud from the edge of a pond which produced 537 distinct plants, an average of a seed for every six grains of mud, is still more conclusive.

(4) Ballast. This is the first of the distribution methods which may be combined under the head of "agency of man." The discharge of earth ballast by vessels coming from abroad has been a notable means of distribution of plants by seed. We have just seen how many seeds may germinate from a very small lump of earth, and the possibilities in this direction of the many thousands of pounds of discharged ballast are very great. In fact, the ballast grounds in the neighbourhood of great cities are invariably favourite botanical collecting spots; they have usually a distinctive flora of their own, and from these centres many introduced plants spread into the surrounding country.

(5) Impure seed. The great industry in the sale of seed which has grown up of late years is responsible for the spread of many plant species, principally, it must be said, undesirable species. Mr. L. H. Dewey says: "It may be safely asserted that more of our foreign weeds have come to us through impure field and garden seeds than by all other means combined."

(6) The packing material of merchandise. The hay or straw used in packing crockery, glassware, or other fragile merchandise, is a frequent carrier of foreign seeds. Such goods frequently reach the retailer without repacking, and the hay or straw is thrown out upon the fields, or used as bedding for domestic animals and carried out with the manure.

(7) Nursery stock. Plants are often accidentally introduced by

means of seeds, bulbs and root stocks attached to nursery stock, or among the pellets of earth about the roots of nursery stock. The extraordinary development, of late years, of commerce in nursery stock has undoubtedly been responsible for the intra-continental carriage of many species of plants in this way.

Instances of the accidental spread of larger animals by man's agency are necessarily wanting. Of the smaller mammals the house rat and the house mouse have been accidentally carried in vessels to all parts of the world, and have escaped and established themselves, the former practically everywhere except in boreal regions, or only in its southern borders, and the latter even as far north as the Pribiloff Islands, as I am informed by Dr. Merriam. Small reptiles and batrachians are often accidentally carried by commerce from one country to another; but although there are probably instances of establishment of such species, none are known to me at the time of writing.

Land shells are often transported accidentally across the ocean in any one of the many ways in which the accidental transportation of plants and insects may be brought about, and by virtue of their remarkable power of lying dormant for many months are able to survive the longest journeys. The conditions which govern the establishment of species in this group, however, seem somewhat restricted, whence it follows that comparatively few forms have become widespread through man's agency, although Binney mentions a number of European species which have been brought by commerce into the United States and have established themselves there, mainly in the vicinity of the seaport towns of the Atlantic coast.

With the earthworms a striking situation exists. It has been shown that, "without a single exception, the Lumbricidæ from extra-European regions are identical with those of Europe; there is not a variety known which is characteristic of a foreign country." Careful consideration of the evidence seems to show that this is due to accidental transportation by the agency of man.

Comparatively little has been done in the study of the geographical distribution of insects.

The insects which are accidentally imported are carried in three main ways. Either (1) they are unnoticed or ignored passengers on or in their natural food, which is itself a subject of importation, such as nursery stock, plants, fresh or dried fruit, dried food-stuffs, cloths, lumber, or domestic animals; or (2) their food being the packing substances used to surround merchandise or the wood from which cases are made, they are thus brought over; or (3) they may be still more accidental passengers, having entered a vessel being loaded during the summer season, and hidden themselves away in some crevice. The coleopterists (Hamilton and Fauvel) make a distinction by name among these classes, calling the first group "insects of commerce," and the latter "accidental importations."

The practical point to which we must come, after summarising all that has been shown, is that since so many species have been imported by pure accident, and have succeeded perfectly in becoming acclimatised, may not much be accomplished by wisely-planned and carefully-guarded introductions? The work of Mr. Albert Koebele, first for the United States Government, afterwards for the State of California, and now for the Hawaiian Government, is certainly an indication, taken in connection with what we have shown, that thorough experimental work with predaceous and parasitic insects promises, in especial cases results of possibly very great value.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The announcements of professors, readers, University teachers, and lecturers for Michaelmas term include the following:—A course of lectures on elementary pathology by the Regius Professor of Medicine, Dr. J. Burdon-Sanderson. A practical course of instruction in general pathology by the University lecturer, Dr. Ritchie. The Lichfield Lecturer in Clinical Surgery, Mr. W. L. Morgan, will lecture on elementary surgery. The Professor of Human Anatomy, Prof. A. Thomson, will lecture on human osteology. The Lecturer in Materia Medica, Mr. J. E. Marsh, will give at the University Museum a practical course of organic chemistry. The Savilian Professor of Geometry, Prof. W. Esson, will lecture at Merton College on (1) the theory of plane curves; (2) synthetic geometry. The Savilian Professor of Astronomy, Prof. H. H. Turner, will