

TRANSACTIONS
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I.—MISCELLANEOUS.

ART. I.—*The Displacement of Species in New Zealand.*

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IN the absence of civilisation, the indigenous fauna and flora of any country is liable to little or no change from external causes. Aërial and marine currents may occasionally bring spores or even seeds of exotic plants; more rarely, insects or birds may be introduced by gales of unusual violence; migratory or aquatic birds may introduce the eggs of insects, or even molluscs, as well as seeds and fragments of terrestrial or lacustrine plants, which have become attached to their feathers; and certain terrestrial or fluviatile molluscs may be introduced by drifted logs; but after a certain time any increase in the number of species by agencies of this kind must become extremely rare, and can occur only at distant intervals. It may therefore be concluded that in all probability the constituents of the fauna and flora of this colony, with possibly the exception of the larger Ratite birds, were in much the same condition when they were first seen by Cook and Vancouver as they had been for many previous centuries. But with the advent of civilisation vast and far-reaching changes speedily take place: axe and fire rapidly alter the face of the country; portions of the forest are felled, burnt off, and replaced by grass—a change which of itself involves a multitude of other changes; the unfelled portions of the forest are laid open to violent winds, so that the surface-rooting trees are blown over in large numbers, while the increasing dryness of the atmosphere acts unfavourably

on the undergrowth, which is still further injured by the depredations of cattle; gradually the plants less able to resist changed conditions disappear, and with them many insects, lizards, and birds, which are unable to obtain their usual food in the new environment.

But the space occupied by the displaced plants is not long allowed to remain unoccupied. An army of encroaching weeds speedily takes possession of the vacancy: thistles, star-thistles, docks, groundsels, brambles, briars, and a hundred other unattractive invaders make their appearance, and increase the severity of the struggle for the survivors of the indigenous flora. From sea-level to the highest points reached by the miner or shepherd, from the North Cape to the Antarctic Islands, their hosts press forward, ever seizing some new position, just as on a larger scale they have long since occupied the vicinity of the chief ports on the great lines of ocean travel from Britain to the Cape of Good Hope, from Yokohama to Cape Horn, so that wherever the traveller lands from his floating home he finds himself surrounded by familiar plants which have in a greater or lesser degree amalgamated with the vegetation of the country which they have invaded, and which to a large extent they will ultimately overcome.

And, most unhappily, this invasion is not restricted to phanerogamic plants. Numbers of injurious fungi accompany their hosts. Rust, mildew, and bunt blight the hopes of the wheat-grower at the moment of fruition. The grazier too often sees his pastures rendered useless by the ravages of smut and ergot; while the cultivators of edible fruits and vegetables can point to special enemies of almost every kind of plant grown for its value as an article of food. Nor is this all. Numbers of species, almost equally insidious in their development, are parasitic, not only on members of the indigenous flora, but on the naturalised weeds themselves; so that the circle of infection is constantly widening, while the scientific knowledge and practical skill of the cultivator are taxed to the utmost limit.

Further, the invading army of plants has brought in its train a still more dangerous host of animals; and as in the vegetable kingdom the most injurious forms were found amongst the less highly organized kinds, so in the animal kingdom the invaders whose agency is most dreaded are members of the Invertebrata: the mussel scale, the fluted scale, the black scale, and many others, together with numerous species of plant-lice, will occur to you as belonging to lowly-developed forms of Insecta. Higher in the scale, the Hessian fly, wire-worm, turnip-fly, and others; while numerous species of earth-worms, molluscs, birds,

and even mammals, whether introduced purposely or accidentally, affect alike both fauna and flora.

NATURALISATION, DISPLACEMENT, ETC.

It may be advisable to remind you that a plant or animal is said to be naturalised in a new country when it has become so thoroughly established as to be able to perpetuate itself spontaneously. The term, however, must not be confused with acclimatised, which, as popularly used, conveys the erroneous idea that the organization to which it is applied has been specially adapted to its new environment by having passed through a series of changes. What is called "acclimatisation" is based on the simple fact that many plants and animals are able to flourish under conditions differing from those under which they were originally placed.

Displacement, although usually attended by a diminution in the number of individuals, is sometimes accompanied by increase, as is the case with those insects which now obtain a large supply of food from introduced plants, and consequently exhibit a vast increase in numbers. Replacement can only be said to occur when the naturalised organism occupies the position of that which it has displaced; the displacement being approximately, although perhaps not actually, complete. On the other hand, complete displacement is not always followed by immediate replacement. The tuatara (*Sphenodon punctatum*), for instance, has been all but destroyed on the mainland by the wild pig and the cat, but these cannot be said to have taken the place of the tuatara—their agency has been wholly destructive. On the other hand, the place formerly occupied by the Maori rat in the North Island is now so fully occupied by its old enemy the black rat as to afford a striking instance of complete replacement. It will be useful to bear these distinctions in mind when considering the influence exerted by introduced organisms on the flora and fauna of any country.

It is not proposed to consider in detail the effects produced by naturalised organisms on the flora and fauna of the colony, but merely to draw attention to various cases, more or less of a typical character, and to state the general results so far as they have been ascertained.

INVERTEBRATA.

Although there is some probability that certain species of Infusoria, Rotifera, and possibly Hydrozoa have been introduced into the colony, there is no direct evidence to that effect; while so little is known respecting either native or introduced Entozoa, beyond the fact that several species have made their appearance here as uninvited guests, that atten-

tion may at once be directed to the earth-worms, of which several European species have become naturalised, and succeeded in replacing indigenous forms in various localities in both Islands. When recently travelling in the upper portions of the valleys of the Rangitikei and Turakina I found that in localities where a few years back native worms were plentiful the introduced *Lumbricus terrestris* (L.) had spread over large areas of grass-land to such an extent that it was impossible to find a single square foot of earth free from its castings, while in many places its burrows rendered the soil so spongy that it was dangerous to the passing horseman. As a rule, native worms are most frequent in unploughed land; a single ploughing destroys large numbers, and if the land is frequently ploughed the native kinds speedily disappear—a result invariably accelerated by the advent of introduced species, which quickly effect a complete replacement. It is stated that a large worm which, in the Kaipara, frequently attained a length of over 20in., and was used as food by the Maoris, has not been seen of late years: I believe it has not been described.

Amongst Arachnida the small introduced mite known as the red spider (*Tetranychus telarius*) has increased enormously in some districts, and is found on native and introduced shrubs alike; but my knowledge of the indigenous species of this group is not sufficient to enable me to state whether actual displacement may be observed or not. Many spiders of kinds usually found in or about dwelling-houses in Europe have been accidentally introduced, but it is not clear that they have succeeded in replacing indigenous species.

When the limited area to which many of our indigenous insects are restricted is considered in connection with the wide area over which clearing operations have extended, it will be difficult to evade the conclusion that many species, and possibly entire genera, have become extinct, their places being now occupied by introduced species, although under different conditions; but this can hardly be considered true replacement, and, so far as known to me, no instance has been observed of an introduced insect having extirpated an indigenous species, although not a few of the latter have become rare in districts where they were formerly plentiful, and in all probability the food-supply of others has been reduced by the agency of the honey-bee.

Amongst the indigenous insects which are now to be met with only in diminished numbers is the elephant beetle (*Lasiorhynchus barbicornis*, Fabr.), which was formerly plentiful in the vicinity of Wellington, as in other districts, but is now comparatively rare. Its high degree of specialisation invests it with exceptional interest, so that its diminution can only be witnessed with regret.

Amongst introduced insects are numerous Coccidæ, of which there are upwards of twenty species, many of them being highly injurious, the three most dangerous perhaps being the fluted scale (*Icerya purchasi*, Mask.), which affects many species of indigenous and cultivated trees and shrubs; the mussel scale (*Mytilaspis pomorum*, Bouché), the great pest of the apple, but also found on numerous shrubs and trees, both introduced and indigenous; and the black scale (*Lecanium oleæ*, Bern.), all of which are widely dispersed, and may be found intermixed with the indigenous *Dactylopius glaucus* (Mask.), and other native forms, which have increased to a large extent owing to the large supply of introduced plants available for food, and possibly to the absence of enemies. In the case of the *Dactylopius*, at least, this increase is occasionally accompanied by a partial abandonment of the native plants on which it formerly subsisted. There does not appear to be any instance of the replacement of a native scale-insect by an introduced species. The number of naturalised aphidian insects is even larger than that of the Coccidæ; but, unlike the members of that group, they do not come into competition with indigenous species, as the family can scarcely be said to be represented in the indigenous fauna, a single undescribed species of doubtful affinity being the only form observed at present; it is small, apparently rare, and seems restricted in its choice of food to a purely herbaceous ground-sel (*Erechtites prenanthoides*, DC.). The introduced kinds, however, have increased to a vast extent, and in many instances infest different kinds of plants to those on which they usually live in Europe. Amongst the most troublesome are *Aphis pruni* (Réaum), on the plum; *A. amygdali* (Fonsc.), on the peach; *A. mali* (Fabr.), chiefly on pome fruits; *Siphonophora fragariae* (Koch), on the strawberry; and *Schizoneura lanigera* (Hans.), on pome fruits: all of which are widely distributed; while *Phylloxera vastatrix* (Planch.) is only found in the north.

Thrips appear to be in course of displacement by introduced species, but my knowledge of this group is insufficient to allow of details being given on this occasion.

Few New Zealand residents of the present day can form any accurate idea of the injury and annoyance inflicted upon the early settlers by the native flesh-fly, which was formerly most abundant in all districts. A spade or other implement used by a man with greasy hands would speedily become fly-blown. Newly-cooked fresh meat could scarcely be transferred from the camp-oven to the table before it was attacked, while blankets or woollen garments were speedily rendered useless when exposed. But this troublesome pest has practically disappeared, having been displaced by the introduced

house-fly (*Musca domestica*, L.). The early settlers recognised the beneficial agency of the intruder, and carried it from the ports to the interior in paper cages.

In many districts the common mosquito, the sand-fly, and the small native flea have disappeared under the beneficial results arising from drainage and other improvements of a similar character.

Amongst indigenous insects which have increased to a large extent owing to the more copious supply of suitable food afforded by introduced plants, whether naturalised or cultivated, three species of Coleoptera deserve special mention. The grass-grub (*Odontria zealandica*, White) in the larval state is terribly destructive to the roots of grass, and has increased to a marvellous extent with the progress of settlement. The grub takes the place occupied by the cockchafer (*Melontha vulgaris*, Steph.) in Europe, but the perfect insect is less destructive, although occasionally injurious to fruit-trees. (In all probability *O. brunneum*, Broun, is equally dangerous.) A small beetle (*Colaspis puncticollis*, Broun), now occurs in vast numbers, the perfect insect feeding upon pome fruits, and doing much damage. The native borer (*Æmona hirta*, Fabr.) is another destructive insect unhappily now occurring in vast numbers. In its larval state it bores galleries in the trunk of *Olearia solandri* (Hook. f.), *Cassinia retorta* (A. Cunn.), and effects a comparatively small amount of injury; but when citrads or other fruit-trees are attacked the galleries are more numerous and more extensive. In some localities it has forsaken the *Cassinia*, &c., and evinces a marked preference for the lemon, orange, and lime.

Amongst introduced Mollusca must be enumerated the common snail (*Helix aspersa*, Müller), which, from its depredations in the garden and field, has become a pest throughout the colony. It is generally agreed that several of the smaller native Helicidæ have become rare since this shell was first observed in Auckland, about 1868; but there is no direct evidence to show that their diminution has been caused by their larger and more robust congener, although in some cases their food-supply must have been diminished by its ravages. The common garden-slug (*Leinax agrestis*, L.) and the large brown slug (*Arion hortensis*, L.) are generally naturalised also, but are not nearly so destructive as the *Helix*. *Limnæa stagnalis* (L.) is abundantly naturalised in the Avon at Christchurch, and may have some connection with the comparative infrequency of the smaller native molluscs in that river.

FISHES.

There is no evidence to show that the few native fresh-water fishes have suffered from the introduction of the Prussian

carp (*Carassias vulgaris*, Nord.), the trout (*Salmo fario*, L.), or from other fluviatile species ; but in some localities eels have increased largely from the increased food-supply afforded by the trout-fry. In other localities, especially in deep water, the trout have suffered severely from the attacks of the fly fungus (*Saprolegnia ferox*, Kütz.), but there is no evidence to show that native fishes have been attacked by the same scourge.

AMPHIBIA AND REPTILIA.

Very few of the Amphibia and Reptilia have been introduced. A green frog from Australia (*Hyla peronii*) has become naturalised in many parts of the North Island, and shows a great liking for the young of the smaller native lizards, which, after considerable effort, are swallowed entire. It may be worth while to mention that some years ago I was shown several specimens of the water-newt (*Triton cristatus*, L.), said to have been found at the Bay of Islands. It would be interesting to learn by what agency it was introduced, and whether it still survives in that locality.

Snakes have been introduced into several localities either by accident or design, but, so far, no species has become naturalised.

The most serious loss amongst the indigenous Reptilia is the tuatara (*Sphenodon punctatum*, Gunth.), which has been all but extirpated on the mainland, chiefly by the agency of the wild pig, the cat, and probably the grey rat. It is still to be found in some quantity on several of the outlying islands. The gecko (*Naultinus pacificus*) has of necessity decreased with the destruction of forests, although it is still to be found in diminished numbers as far south as the South Cape Island, which is, I believe, the extreme southern limit of Reptilia. Several of the smaller species have become comparatively rare from the repeated burnings of the taramea and other surface vegetation, which afforded shelter alike to the lizards and the insects and Mollusca, forming their principal food.

BIRDS.

Birds have suffered more severely than any other section of the fauna from the ravages of introduced mammals, in addition to which the burning of the surface vegetation has deprived many species of food and shelter, while in other cases the food-supply has been reduced by insects. Doubtless a large proportion of the species that have suffered most severely are forms that had lost much of their original vigour and were gradually dying out ; yet it is most unfortunate that birds of such exceptional interest as the kakapo and kiwi should have their extinction accelerated by the introduction

of such pests as the stoat, weasel, and ferret, which are annihilating the surviving portions of one of the most remarkable collections of indigenous birds in the world.

The kakapo (*Stringops habroptilus*, Gray) has suffered so severely from introduced agencies that it is now on the verge of extinction in many districts where it was formerly found in comparatively large numbers. Its eggs, being merely laid in holes at the base of trees, have been attacked by rats, the young birds by wild cats, and the old birds by dogs, stoats, weasels, and by pigs. It still lingers in the centre of the North Island, and is found in larger quantity on some parts of the west coast of the South Island, but its extirpation throughout the colony at a near date seems absolutely certain.

It is not in all cases an easy matter to determine whether a given species has suffered more extensively from competition with naturalised forms or from the direct changes in environment effected by man himself. The destruction of the forest over wide areas at once deprives many organisms of both shelter and food, as in the case of the kaka (*Nestor meridionalis*, Gml.), which was formerly abundant where it is now rarely or never seen, a fact all the more to be regretted from its feeding largely upon insects. The kea (*Nestor notabilis*, Gould) has suffered but little from this cause, but numbers have been purposely destroyed on account of the ravages effected by them amongst sheep; still, in the high mountain districts inhabited by this bird it cannot be considered either rare or local. The parakeets (*Platycercus novæ-zealandiæ*, Sparrm, and *P. auriceps*, Kuhl) occurred in large flocks, and were very destructive to the grain-crops of the early settlers; but under the combined attacks of rats, wild cats, and especially of man, they have become comparatively rare and local. One of the most interesting birds in the colony, the huia (*Heteralocha acutirostris*, Gould), restricted to the Ruahine and Tararua Ranges and their offshoots, partly, without doubt, from the ravages of cats, but especially from the more merciless attacks of collectors, has become extremely rare. Formerly a pair or two could usually be found at the back of the Wainuiomata without any great difficulty, but they seem to have disappeared from that locality. The migratory birds, the long-tailed cuckoo (*Eudynamis taitensis*, Sparrm) and the bronze-winged cuckoo (*Chrysococcyx lucidus*, Gml.), are becoming increasingly rare, but without any obvious cause, except possibly the decrease of *Gerygone flaviventris* (Gray), in whose nest both parasites usually deposit their eggs. It is worth while to remark that both the cuckoos may occasionally be seen all through the winter seasons. The silver-eye (*Zosterops lateralis*, Lath.), although still to be seen in large numbers in nearly all parts of the colony, is less plentiful in many districts than formerly;

but the balance of evidence seems to point to its having been introduced from Australia by natural agencies.

The tui (*Prothemadera novæ-zealandiæ*, Gml.), the bell-bird (*Anthornis melanura*, Sparrm), and the stitch-bird (*Pogonornis cincta*, Dubus) appear to have alike suffered from the diminution of their food-supply caused by the introduction of the honey-bee, while they have been incessantly attacked by cats and rats; the tui, however, shows the greatest power of resistance, as it is still to be found throughout the colony, although in greatly diminished numbers. The bell-bird, which formerly existed in large numbers in both the North and South Islands, has become extremely rare and local in the North, although more plentiful in the South; while the stitch-bird appears to have been driven to its last refuge in the Little Barrier Island, where it still forms the prey of the destructive collector. It has been suggested that one cause of the disappearance of the bell-bird from the North Island is the diminution of its food-supply caused by the honey-bee, which is plentiful in nearly all districts; but this would render it difficult to account for its preservation in the South Island, where bees are equally plentiful. It may possibly be found that the increase of bees has been injurious to certain indigenous insects, but at present there is no evidence to that effect.

The little bush-wren (*Xenicus longipes*, Gml.) is almost extirpated in localities where it was once plentiful, and the North Island robin (*Petroica longipes*, Less.) is rarely to be seen even in sparsely-settled districts; while the little fern-bird (*Sphenæacus punctatus*, Quoy and Gaim) has become comparatively rare in numerous swamps and reed-beds where it was once common. The ground-lark (*Anthus novæ-zealandiæ*, Gml.) maintains its ground in country districts, although it has become rare in the vicinity of towns, partly, perhaps, from its being attacked by cats and rats, or by boys still more merciless. So also the familiar forest-bird the fantail (*Rhipidura flabellifera*, Gml.), although its numbers have been greatly reduced in nearly all localities. All, or nearly all, the small native birds suffer alike from the attacks of rats and wild cats. The saddle-back (*Creadion carunculatus*, Gml.) has become very rare throughout the limited portion of the North Island to which it was naturally restricted, and is now in danger of extermination on the Little Barrier Island, where it was formerly plentiful. It is almost superfluous to mention the increasing scarcity of the beautiful native pigeon (*Carpophaga novæ-zealandiæ*, Gml.). Notwithstanding its former abundance throughout the colony, there is scarcely a single district in which it is to be found in large numbers at the present time. Although it has not escaped

the ravages of rats and wild cats, the injury effected by these agencies is but trivial when compared with the destruction wrought by settlers, who have shot it during all seasons, on account of its value for food. The native quail (*Coturnix novæ-zealandiæ*, Quoy and Gaim.), once common over large portions of the colony, is practically extinct; so far as I am aware, not a single specimen has been seen for some years past, although it is believed to survive in the district between Lake Wakatipu and the Cosmos Peaks. Birds of this class suffer perhaps from the progress of settlement more severely than any others; their food is diminished, and numbers are destroyed by the surface-burnings so frequent in the early stages of a pastoral district, while they are attacked by birds of prey, cats, rats, and dogs whenever they venture into the open, and their eggs are destroyed by the weka.

The great diminution in the numbers of the northern and southern wekas (*Ocydromus earli*, Gray, and *O. australis*, Sparrm) affords strong testimony to the intensity of the struggle for existence. Both formerly occurred in great abundance, both are hardy birds, and both are extremely wary; but under the changed conditions produced by the introduction of the sheep and rabbit the wekas have greatly diminished in numbers, and are now but seldom seen near settlements. The southern weka is more plentiful in mountain districts than the northern, but it has become more wary. Although both suffered to some extent from the attacks of rats, wild cats, and dogs, no appreciable diminution was observed until the introduction of stoats and ferrets, against which they are clearly unable to contend. The striped rail (*Rallus philippensis*, L.) does not seem to have diminished so largely as might have been expected, but owing to the excessively shy habits of this bird it is not easy to form an opinion. Hutton's rail (*Cabalus modestus*, Hutt.), of the Chatham Islands, one of the most remarkable, as it is one of the rarest, of ocydromine birds, is on the verge of extinction, if it be not already extinct. It has only been found on the Islet of Mangare, which, according to a valued correspondent, is now under settlement, the first act of the settler having been to capture all the specimens of the *Cabalus* that he could find, in order to realise their market-value. It is a lamentable oversight that this small islet, the value of which could have been but trivial, was not purchased long ago in order to insure the preservation of this singularly interesting bird.

The swamp-hen (*Porphyrio melanotus*, Temm.) seemed for a time to increase with the progress of settlement rather than to diminish, but of late years there has been a marked diminution of its numbers, which may possibly be traced to the destruction of its eggs by the ubiquitous rat.

The small snipe (*Gallinago pusilla*, Buller) has become extremely rare in the few habitats where it has been observed, in all probability from its eggs having been destroyed by rats. Mr. James Baker informed me that in the early days of Auckland he had observed from twelve to twenty together on the shores of the Hauraki Gulf, but I believe it has not been observed in that locality since 1868.

The white heron (*Ardea alba*, L.) has long been known to be extremely rare in the colony, but of late years it has almost disappeared, chiefly, it may be, from the rapacity of collectors, although it has doubtless suffered from the attacks of the large hawk, and from rats, &c. The blue heron (*Ardea sacra*, Gml.) appears to have suffered but little in comparison with its white relative, as there are but few suitable places on our coasts where one or two pairs may not be seen by a patient watcher. Of late years extensive inroads have been made amongst the Anatidæ, all of which are greatly diminished in numbers. About fifteen years ago the paradise-duck (*Casarca variegata*, Gml.) was very common on the east coast of the Wellington District, between Cape Palliser and Castlepoint, but at the present time the traveller may ride the entire distance without seeing a specimen. The eggs and young birds have suffered from the attacks of rats and wild cats, while stoats and weasels are said to have disposed of the adults, and numbers have been shot for mere sport. The same diminution of numbers has been observed in the South Island, where it was always more plentiful than in the North. The brown duck (*Anas chlorotis*, Gray), the grey duck (*A. superciliosa*, Gml.) the little teal (*Querquedula gibberifrons*, Müller), and the black teal (*Fuligula novæ-zealandiæ*, Gml.), have been specially sought by the sportsman, with the result that where large numbers were formerly seen only a comparatively few individuals can be found to-day. They have also suffered severely from the depredations of rats.

Speaking generally, the oceanic birds that breed on the coasts of New Zealand appear to have suffered but little from introduced enemies, their breeding-places being usually out of reach of rats or wild cats. Captain Fairchild, of the Government steamer "Hinemoa," is of opinion that the albatros and its allies are less numerous on the Auckland and Campbell Islands than formerly, but the diminution can only have been caused by the ravages of the collector. The feet of the larger kinds are in demand for tobacco-pouches, and the head is mounted for ornamental purposes. Some years ago the late Mr. Charles Traill informed me that large numbers had been killed on the Antarctic Islands for the sake of the wing-bones, which were in demand for pipe-

stems. But nearly all the Procellariidæ, the Laridæ, and the Pelicanidæ are still to be found in vast numbers. In 1891 I visited the Snares, and was filled with amazement at the number of petrels that made their appearance on the approach of evening. From the surface of the sea to the greatest height at which it was possible to distinguish them they were to be seen in myriads, and gave me such an idea of their vast numbers as I had never before been able to realise; while their rapid but graceful evolutions were a never-ending source of pleasure. The scene reminded one of the countless vistas of stars opened to the eye of the observer through a good telescope, or, perhaps better still, of the ever advancing and receding hosts of bacteria to be seen in infusions under a high power of the microscope. The vast assemblage of penguins to be seen on the Bounty Islands did not impress me with nearly such overwhelming ideas of the numbers of marine birds as that memorable aerial scene at the Snares.

The common shag (*Phalacrocorax varius*, Gml.), which was formerly frequent on the banks of fresh-water, and more rarely of tidal, rivers, has certainly diminished of late years, although there is no danger of its immediate extinction; but, on the whole, there seems very little, if any, diminution in the numbers of the marine cormorants.

Passing from the sea-birds to the Apterygidæ, a widely different state of affairs is found to prevail. *Apteryx mantelli* (Bartl.) of the North Island is in much the same position as *A. australis* (Shaw) and *A. oweni* (Gould) of the South Island (but also found sparingly in the North). All alike are extinct, or nearly extinct, over large districts in which they were formerly so plentiful that explorers and surveyors calculated on their furnishing a considerable portion of the food-supply; but this is now entirely out of the question, and every year brings the date of their complete extinction appreciably closer. Their supply of food is indirectly reduced by the rabbits, which in some cases have invaded their haunts; their eggs are destroyed by wekas and rats; and the adult birds are killed wholesale by stoats, weasels, wild cats, and occasionally by dogs which have escaped from domestication. The complete extinction of these interesting birds by agencies now in operation will not extend over a lengthened period.

It is not easy to determine the effects produced by introduced birds upon the indigenous birds of the colony, nor in all cases to trace the lines along which their influence has been exerted; but it is advisable to make brief mention of the kinds that have become most extensively naturalised. The Chinese pheasant (*Phasianus torquatus*, Gml.) is abundant in many districts, and by its superior vigour has almost completely

absorbed the common pheasant (*P. colchicus*, L.), which was introduced at an earlier date, and has added considerably to the food-supply of the colony, but, except possibly by diminishing the food of certain indigenous species, does not appear to have exercised any injurious influence. The partridge (*Perdix cinerea*, Briss.), the Tasmanian quail (*Coturnix australis*, Lath.), and the Australian quail (*C. pectoralis*, Gould), although liberated in large numbers, have not become generally naturalised, chiefly owing to the ravages of rats and wild cats. The beautiful Californian quail (*Ortyx californica*, Steph.) has become plentiful, especially in thinly-wooded districts. The white swan (*Cygnus olor*, Gml.) has been liberated in several localities, and increased rapidly until the rats and Maoris discovered that its eggs and young birds were good for food, when a speedy diminution took place, so that at present its numbers are but small. The black swan (*C. atratus*, Lath.) is abundantly naturalised in many localities from the North Cape to Canterbury, and sometimes occurs in thousands, as in the great lagoon at the entrance to the Opawa River, where it seems to have displaced *Porphyrio melanotus*. Its simultaneous appearance in so many localities between 1865 and 1868 proves that it must have been a spontaneous immigrant, and that its naturalisation is not due in any large degree to its having been introduced by man.

The self-assertive sparrow (*Passer domesticus*, L.) is perhaps more abundantly naturalised from the North Cape to Stewart Island than any other bird, and, although it steals the grain of the farmer and the fruit of the orchardist without scruple, makes some return by the destruction of hosts of the cultivator's enemies, especially during the breeding season; but, occurring in such vast numbers, it must have trenched upon the food-supply of the smaller indigenous birds, in which it has been assisted by the yellowhammer (*Emberiza citrinella*, L.), the skylark (*Alauda arvensis*, L.), the hedge-sparrow (*Accentor modularius*, L.), the grey linnet (*Fringilla cannatena*, L.), the green linnet (*F. chloris*, L.), the chaffinch (*F. cælebs*, L.), the goldfinch (*F. carduelis*, L.), and especially by the starling (*Sternus vulgaris*, L.), which occurs in immense flocks in nearly all districts. The Australian mainah (*Myzantha garrula*, Vig. et Hors.), with the thrush (*Turdus musicus*, L.) and the blackbird (*T. merula*, L.), in all probability have been less injurious. I am not aware of any other birds that have become so generally naturalised as to require mention here.

MAMMALIA.

The indigenous terrestrial mammals are restricted to two species of bats—the long-eared bat (*Mystacina tuberculata*,

Gray) and the short-eared bat (*Chalinolobus morio*, Gray), which, although often local, are occasionally seen in considerable numbers. Both are less frequent than formerly, owing to the destruction of large areas of forest, and possibly to their food having been diminished by naturalised birds. The so-called Maori rat (*Mus maorium*, Hutton), and the Maori dog, long since extinct, were introduced by the Maoris, and used for food. For a long time the Maori rat was supposed to have been extirpated by the black rat (*Mus rattus*, L.), which is especially plentiful in certain parts of the North Island, and the grey rat (*Mus decumanus*, L.), which is established throughout the colony. The Maori rat is, however, still to be found on several islets in the North, and appears to be not uncommon in the northern parts of the South Island. The ravages of the grey rat upon native birds have been repeatedly mentioned, but its partiality for the freshwater bivalve *Unio aucklandicus* is not so well known. In tributaries of the Waikato, where this mollusc is abundant, small heaps of its shells may be seen on the banks with the front margins bitten through by the rodent, which, after extracting the animal, has left the empty shell as a mute witness to his voracity. The mouse (*Mus musculus*, L.) is to be found everywhere, and, when occurring in great abundance, often causes the grey rat to abandon the field. In country districts it feeds upon the seeds of sheep-sorrel, wireweed, and other prostrate plants during the winter season. The injuries effected by the wild cat are too well known to need further mention, and the same may be said of the dog escaped from domestication.

The domesticated ox and the horse can scarcely be said to have exercised any directly deleterious effects on the native fauna, except, perhaps, upon the earthworm; but the sheep, by devouring the food of other animals, has been only less injurious than the rabbit, and, like that unwelcome intruder, ranges from sea-level to the limits of perpetual snow. At present no serious damage has been sustained from the hare. The wild pig, however, has been a terrible enemy to young birds, and, in a few localities, the goat has assisted, by destroying the shrubs which formed their shelter.

In addition to the widespread destruction caused by bringing fern- and forest-land under cultivation, the indigenous fauna has suffered severely from naturalised worms, insects, birds, and mammals—partly through the diminution of the food-supply caused by the invaders; from their superior vigour; often from their predaceous habits; and from their rapid increase, which in many cases has enabled them to crowd the native species off the field. With the exception of the sheep, rabbit, cat, and especially of the stoat, ferret, and

weasel, the greater portion of the injury has been effected by animals which have been introduced through inadvertence or accident.

NATURAL REPLACEMENT AMONGST PLANTS.

Before considering the injuries sustained by the flora from the numerous naturalised plants, it seems desirable to describe a kind of natural replacement which may be observed to a greater or less extent in nearly all forest districts. On forest or scrub being felled and burnt off, unless grass-seed is sown immediately, certain species of fungi or of mosses make their appearance, *Funaria connivens* (Hampe), being perhaps the most frequent; next, the bracken; more rarely, *Gleichenia circinata* (Sw.). The latter, however, is soon overpowered by the former, and the entire area is quickly covered with a luxuriant growth of "aruhe," thus affording a suggestion as to the way in which the wide fern-clad "pakihi" were originally formed and the timber replaced by fern. But a more striking form of replacement is often to be witnessed: a dense growth of the makomako (*Aristotelia racemosa*, Hook. f.) takes the place of the pines and broad-leaved trees which have fallen under the axe. Not infrequently the makomako forms a kind of coppice, the dense growth killing off most of the branches, so that the plants form long, straight rods; the stronger individuals, outgrowing the others, develop branches, and, being thus enabled to assimilate a larger amount of nutritive matter, become more robust, and, gaining complete mastery, prevent the weaker from obtaining their fair portion of air and light, so that at length they die out, leaving the more vigorous specimens to form a makomako grove; these repeat the process amongst themselves, the weakest continually going to the wall, until the undergrowth becomes more or less open, when various shrubs and trees make their appearance, and a new piece of mixed forest replaces the makomako, which has become comparatively rare. In many parts of the Kaipara the first tree to make its appearance after a clearing has been formed is the fuchsia (*F. excorticata*, L. f.), which often occurs in vast abundance, to the exclusion of almost all other plants; it grows less rapidly, however, than the makomako, and is more speedily interspersed with other shrubs and trees. Another plant which often makes its appearance in large quantities after clearing is the poroporo (*Solanum aviculare*, Forst.), which is less permanent than either of the preceding. In 1864, owing to the Maoris having fired upon our troops along the line of the Great South Road, between Drury and the Waikato, the heavy forest on each side of the road was felled for a width of about 2 chains and burnt off, when a

remarkably strong growth of poroporo sprang up, and for many miles both sides of the road were bordered with this plant, which in its turn afforded temporary shelter for many shrubs and young trees, amongst which the totara was remarkably frequent. On the west coast of the South Island, much of the lowland forest when burnt off is temporarily replaced by a robust growth of a large native groundsel (*Erechtites prenanthoides*, DC.), which often attains the height of 5ft., most of it, however, disappearing before the close of the third year, when its place is taken by fern or, more rarely, by shrubs and trees. When the road from Nelson to the Buller was formed through the Hope Valley, about 1870, the burnt area on each side of the road-line was thickly dotted with the rare pine, *Podocarpus acutifolius* (T. Kirk), although very few specimens of the plant were to be seen in the immediate vicinity. It is, however, already overgrown by larger trees to a considerable extent, and affords an instance of a phenomenon often observed by foresters in Europe, where certain plants, as *Pyrola minor* (L.) and *P. rotundifolia* (L.), make their appearance in forests which have recently been thinned, and, after increasing for three or four years, gradually die out, to reappear after the next periodical thinning. Much, however, has yet to be learned with regard to phenomena of this kind in New Zealand.

DESTRUCTION OF KAURI FORESTS.

It is now proposed to trace the principal lines along which injury has been done to the flora, and at the outset to glance at the agency of man. So far as the necessary results of clearing land for cultivation are concerned, they are sufficiently obvious, and have already been mentioned. But they are greatly aggravated and intensified when attention is attracted to the economic value of certain timbers, and the forest is felled at the demand of commerce: the giant kauris, whose branches were waving high in the air long before the civilisation of the West was called into existence, are thrown down, and these grand trees, the growth of many centuries, are in a brief space made available for the thousand requirements of every-day life. But before this has been done rolling-roads have been formed, or tramways laid, involving the destruction of a vast amount of arboreal growth, of elegant flowering shrubs, of fragrant orchids, of delicate herbaceous plants, and of charming ferns, which never again can beautify that scene; for directly the last log has been removed the intelligent bushman, with a recklessness which would be reprobated by a savage, applies a match to the dead branches, for the mere pleasure of seeing the blaze, and not only destroys thousands of promising young trees, but effectually prevents all possibility

of renewal, since the surface-soil, being charged with resin, becomes so intensely heated that all fallen seeds are destroyed, and the site of the forest becomes a desolation, which, after a short interval, is partially covered with an unattractive weedy growth, the seeds of which have been introduced in the wool or hair of animals, or the wings of birds, or blown by aerial currents, after a time to be slightly relieved by patches of bush-lawyer (*Rubus australis*, Forst.) or other uninviting plants. There is probably no greater scene of desolation in the colony than the sites of the large kauri forests in the Kaipara district and on the Cape Colville peninsula. In cases like this the direct and intentional agency of man compresses into a brief space a far greater amount of destruction than would be effected by natural agencies during many centuries.

INJURY CAUSED BY CATTLE.

Whenever cattle gain access to the forest they browse upon the young shoots, while they consolidate the soil, thus preventing the germination of seeds and consequent renewal; this renders the atmosphere dry, and eventually leads to the destruction of the older trees, although no actual clearing may have been made by man.

Next to man, however, the chief agents in this destructive work are the sheep and the rabbits. Some districts are eaten almost bare by these close feeders, little being left except the tough bases of the silver-tussock (*Poa cæspitosa*, Forst.) and the wiry, ligneous stems of *Muhlenbeckia* and similar plants; even the woolly leaves of some species of *Celmisia* are often closely cropped, the result being that the more delicate plants are all but extirpated over large areas. In a few localities goats have been equally destructive. I have been informed that the tainui (*Pomaderris apetala*, Vahl.) has been completely destroyed at Kawhia, where it was formerly abundant, and is now restricted to the south head of the Mokau River and the Chatham Islands.

INJURY CAUSED BY RATS.

Some plants formerly plentiful have been to a large extent destroyed by the pig and the rat (*Mus rattus*, L., and *M. decumanus*, L.), as the curious orchid (*Gastrodia cunninghamii*, Hook. f.), the tubers of which are highly nutritious. This plant has become very rare in districts where the black rat is plentiful. On one occasion, in 1874, I found three remarkably fine specimens, quite 2ft. in height, with tubers 6in. or 7in. in length, and placed them in what seemed a safe place in a hut at Omaha, but during the night they were carried off by the rodents. Both the pig and the grey rat feed upon the fleshy roots of the larger Umbelliferæ.

INJURY CAUSED BY INSECTS.

A small native beetle, which I have not been able to identify, has greatly reduced many species of *Celmisia* and other Compositæ by depositing its eggs on the disc florets, where they quickly enter the larval state, and destroy the carpel before it reaches maturity. The great increase of this insect during recent years is doubtless caused by the frequent burning of the surface vegetation, and consequent destruction of the lizards and predatory insects which kept the beetle in check. Several species of Diptera which are equally destructive doubtless owe their rapid increase of late years to the same cause.

DISPLACEMENT BY INTRODUCED PLANTS.

In many instances a comparatively few species of naturalised plants have taken possession of sea-beaches, completely displacing the original vegetation by their more vigorous growth and their vast numbers—simply crowding it out by depriving it of air and light, and to a large extent absorbing its nourishment: This may be seen, for instance, south of the Township of Kaikoura, where a broad stretch of land at the water-margin is wholly given up to such weedy plants as the common brome-grass (*Bromus sterilis*, L.), docks (*Rumex obtusifolius*, L., *R. crispus*, L., &c.), fleabane (*Erigeron canadensis*, L.), catch-fly (*Silene anglica*, L.), Yorkshire-fog (*Holcus lanatus*, L.), and others, perchance intermixed with one or two native plants of similar habit. Here the displacement is almost complete, the original littoral vegetation having been driven to a few peculiarly favoured spots, where it maintains a somewhat precarious existence.

The displacement of the New Zealand flax (*Phormium tenax*, Forst.), the coarse sedge known as toe-toe-whatu-manu (*Cyperus ustulatus*, A. Rich.), and the common fern (*Pteris esculenta*, Forst.), by European grasses and clovers is so striking that it has arrested the attention of the natives; and, indeed, it is calculated to attract the notice of even a casual observer, for the indigenous species mentioned are so robust that the mere idea of their being overcome in the struggle for existence by such plants as clovers and grasses seems almost absurd: but the fact remains. Seeds of rye-grass, meadow-grass, white or red clover, &c., germinate by the side of the coarse-growing toitoi, and gradually abstract the moisture which it has been enjoying undisturbed; the growth of the sedge becomes less vigorous, while that of the interlopers is more robust. The result would not be in doubt were the plants now left undisturbed, but an overpowering force comes to the help of the invaders—the rich grass attracts

cattle and horses to graze upon it; this increases the vigour of the grass, while the native plants have to contend against the consolidation of the soil caused by the trampling of heavy stock; this further invigorates the interlopers, and enables them to continually extend their area by giving off new shoots from the base, and occasionally by producing seed. As their growth increases the vigour of the toitoi perceptibly diminishes, and its ultimate extinction is certain, although the process may occupy several years. The occasional replacement of manuka (*Leptospermum scoparium*, Forst.) and other shrubs by grasses is still more striking. Sir George Grey drew my attention to this fact on my first visit to the Kawau, in 1864, where the naturalised *Sporobolus indicus* (R. Br.) was spreading amongst manuka from 5ft. to 8ft. in height, forming a sward which, notwithstanding the coarse character of the herbage, was closely cropped by stock, to the benefit of the grass and injury of the shrub. But even this is less surprising than an instance of a similar kind at the Bay of Islands, where a delicate and slender naturalised love-grass (*Eragrostis brownii*, Nees) is exerting the same influence on a large scale. Introduced grasses exhibit similar action upon many native grasses in all parts of the colony and at all elevations. In the Upper Waimakariri, *Triodia exigua* (T. Kirk) often forms a compact and extensive sward, which is usually able to resist aggression on the part of its indigenous allies, but if a single grain of rye-grass (*Lolium perenne*, L.) or meadow-grass (*Poa pratensis*, L.) falls amongst it and germinates, the continuity of the sward is speedily interrupted and a process of disintegration sets in which ultimately destroys the whole, or reduces it to small tufts or patches. The same result is often exhibited at the expense of more robust plants. The gradual replacement of the spaniard (*Aciphylla colensoi*, Hook. f.) by self-sown pasturage-plants is most remarkable. It seems next to impossible that the large rigid bayonet-like leaf-segments which surround the base of the flower-stem in this strange plant should be injured by a growth of soft herbs, however compact: yet, so it is: dense masses of the spaniard actually impenetrable to stock of any kind are destroyed by this simple agency. When once its vigour is reduced the ultimate destruction of the spaniard is simply a matter of time. The common spear-grass (*A. squarrosa*, Forst.) is often displaced in the same way.

AMALGAMATION OF NATIVE AND INTRODUCED PLANTS.

But there is another aspect to the case; for, however remarkable it may seem after the statements that have just been made, certain slender native grasses, of great value on account of their nutritive qualities, are able to resist the

invaders, and ultimately become amalgamated with them, to the great benefit of the stock-grower. *Microlena stipoides* (R. Br.) and *Danthonia pilosa* (R. Br.) are fair examples of this group.

REPLACEMENT BY EPACRIDS.

One of the most interesting instances of replacement that has been observed up to this time is now in progress on the Te Karaka flats, between Papatoitoi and Drury, in the Auckland District. These flats for many miles are clothed with a dense, but not always luxuriant, growth of manuka, manukaraunui (*Leptospermum ericoides*, A. Rich., *Dracophyllum urvilleanum*, A. Rich.), mirgimingi (*Cyathodes acerosa*, R. Br.), &c., the manuka being the prevailing plant. Rather more than forty years ago the late Dr. Sinclair and General Bolton discovered the beautiful *Epacris purpurascens* (R. Br.), a native of New South Wales, in this locality, when it was rightly considered by Sir Joseph Hooker to have been introduced.* Fifteen years elapsed before it was seen by other botanists, when it was found in several places on the flats, presenting the aspect of a truly indigenous plant, and attaining the height of from 2ft. to 6ft. or more. From the great quantity in which it was found I was erroneously led to consider it indigenous, and this conclusion has been generally accepted. † More recently it has been observed in localities fully twenty miles distant. In 1875 three plants of another species (*E. microphylla*, R. Br.) were discovered by A. T. Urquhart, Esq., in the same district. This species is also a native of New South Wales, but has a wider range, extending to Queensland, Victoria, and Tasmania. In three years the plant increased to such an extent that it formed "a dense mass 60 yards in circumference, the intermediate vegetation—*Leptospermum*, *Pomaderris*, and *Pteris*—being almost completely destroyed."‡ In 1887 I had the pleasure of visiting the habitat under the guidance of Mr. Urquhart, and found that not only had the area occupied by the plant been greatly extended, but that colonies had been formed at a greater or less distance from the original centre, and would in their turn form new centres of distribution. Mr. Urquhart also pointed out a very old specimen of another species, *E. pulchella* (Cav.), also a native of New South Wales: this was surrounded by numbers of young plants, which were producing perfect seed, and increasing at a rapid rate. My friend informed me that he had discovered a colony of this species at some distance from the parent plant, but, unfortu-

* Fl. N.Z., vol. ii., pp. 321 and 334.

† Trans. N.Z. Inst., vol. ii. (1869), p. 107.

‡ Trans. N.Z. Inst., vol. xviii. (1881), p. 364.

nately, I had not time to visit it. These three species were alike extending their area mainly in the direction of the prevailing winds, and would, I am convinced, be able practically to replace the indigenous vegetation over the entire area if not interfered with by man. This instance of replacement is replete with interest, as it is almost the only case in which there is clear evidence of the seeds of phanerogamic plants having been carried by aerial currents over a distance of from 1,200 to 1,400 miles and becoming established in a new country.

DISPLACEMENT AND INCREASE.

The blue-gum (*Eucalyptus globulus*,* Lab.) in some localities shows itself able to compete with the indigenous vegetation under special circumstances. Seedlings germinating amongst manuka 4ft. or 5ft. in height will speedily overtop it. In several localities self-sown plants are found by thousands, and, as a second generation of naturalised plants is already to be found, there can be no doubt that if not interfered with it would entirely alter the aspect of large portions of the colony. *E. piperita* (Sm.) and *E. rostrate* (Schl.) appear to have the same power of adapting themselves to new situations, although perhaps not to an equal extent.

The brush-wattle (*Albizzia lophantha*, Benth.), a native of Western Australia, is able to destroy the strongest vegetation in open manuka country, as may be seen in numerous localities; while the tan-wattle (*Acacia decurrens*, Willd.) and the silver-wattle (*A. dealbata*, Link.), although much slower, are equally effective in the northern districts. Another Australian plant, *Hakea acicularis*† (Sm.), according to Mr. Cheeseman, "has established itself over several miles of open manuka country at the foot of the Waitakerei Ranges, and is increasing fast." Cobbet's locust-tree (*Robinia pseudacacia*, L.) forms large groves in the Waikato and other localities; its lofty stature and numerous suckers effectually prevent the growth of other vegetation. The well-known furze (*Ulex europæus*, L.), by its dense habit, has killed tauhinu (*Pomaderris phyllifolia*, Lodd.), manuka, &c., over large areas, and is continually extending, while its near relative, the broom (*Cytisus scoparius*, Link.), is no less troublesome. The injury to pasturage caused by the sweetbriar (*Rosa rubiginosa*, L.) is unhappily too well known to need special mention; but few are equally familiar with its power of overcoming manuka and other shrubs of similar habit. The dog-rose (*R. canina*, L.) exerts the same influence to a less extent in several districts of the South Island; while various forms of the European

* Trans. N.Z. Inst., vol. xvi. (1883), p. 383.

† Trans. N.Z. Inst., vol. xv. (1882), p. 291.

blackberry (*Rubus fruticosus*, L.), &c., by overgrowing their unfortunate competitors, deprive them of light and air while absorbing their nourishment.

The tutsan (*Hypericum androsaenum*, L.), although little more than a strong-growing herb, less robust than any of the plants previously mentioned, has become abundant in certain districts, and is able to compete successfully with manuka, karamu, hange-hange, and other shrubs of stronger growth. Its seeds appear to be disseminated by birds.

Two trees may be mentioned here, although they do not perhaps displace the indigenous vegetation to any great extent. They never perfect seeds or give off suckers, yet they have become self-diffused along the margins of rivers and in similar situations to such an extent as to impart a distinct character to the landscape in certain districts. They are the weeping-willow (*Salix babylonica*), a native of Northern China, and the crack-willow (*S. fragilis*, L.), of Northern Europe. Twigs of these trees are easily detached, and are floated by the river to new situations, where they quickly take root and develop with rapidity, so that in certain situations navigation is impeded.

INTRODUCED PLANTS ON BROKEN SOIL.

Introduced plants compete with indigenous species for the possession of any newly-loosened surface, and especially for waste land. The margins of newly-formed roads are speedily clothed with a dense growth of sheep's-cress, docks, thistles, Yorkshire-fog, and many others, mixed with the native pipiriri (*Acæna sanguisorbæ*, Vahl.), toad-grass (*Juncus bufonius*, L.), *Danthonia semi-annularis* (R. Br.), and when neglected form splendid nurseries for injurious insects and fungi. Crumbling places on hillsides in many localities are quickly covered with a strong and permanent growth of the blessed-thistle (*Silybum marianum*, Goertn.), which distributes vast quantities of seeds, and overcomes indigenous and introduced plants alike, forming continuous masses of variegated foliage in the early spring, but presenting a ragged and untidy appearance during the autumn and winter months. The common spear-thistle (*Cnicus lanceolatus*, L.) furnishes a striking example of the ability of a plant to seize upon situations suitable for its growth; in many districts immediately after the bush is burnt off the entire area is overrun by this rapacious invader, which exhibits a dense luxuriant growth often 4ft. to 5ft. high, preventing the growth of grass, and forming an almost impenetrable mass. The growth becomes less luxuriant during the second season, so that the grass is able to make headway, and by the end of the fourth season only a few old thistles have retained sufficient vigour to reassert themselves. The so-called Californian thistle (*C. arvensis*, Curtis) is the

only naturalised species capable of injuring pasturage to any serious extent, and, unhappily, it is often the cause of serious loss to the pastoralist and agriculturist. The Gundagai thistle, as it is called in New Zealand (*Carduus pycnocephalus*, Jacq.), flourishes on newly-disturbed soil in many localities, but is comparatively rare on grass-land.

Whenever the finely-comminuted basaltic scoria of the Auckland isthmus is disturbed, a luxuriant crop, chiefly of naturalised plants, speedily makes its appearance, but amongst them one of the most abundant is the indigenous *Chenopodium carinatum* (R. Br.), although not a specimen may have been seen in the vicinity until the surface was disturbed. After the second year the number of plants is greatly diminished, and during the fourth year only solitary specimens are to be found. A similar instance has been observed at Cape Whanbrow, near Oamaru. Whenever the fine silt which covers the surface is disturbed, *Lepidium tenuicaule* (T. Kirk) and the indigenous form of *Atriplex patula* (L.) make their appearance in abundance, although usually both plants are only to be found in small quantity.

NATURALISED AQUATIC PLANTS.

The increase of the watercress (*Nasturtium amphibium*, R. Br.) in streams and watery places is phenomenal, and attracts the attention of new arrivals on account of the excessive luxuriance and robust growth of the herb, which is not infrequently from 3ft. to 5ft. in height above the water-level, and often impedes the passage of boats. This luxuriance is chiefly due to the mildness of the climate, and has a singular parallel in one locality in England. At the Wyken Colliery the water pumped up from a great depth is of a high temperature, and flows into a stream which expands into a large, shallow pond. As the pond is never frozen, even in the severest weather, the watercress is almost as luxuriant as in New Zealand.

The Canadian water-weed (*Anacharis alsinastrum*, Bab.) simply chokes the River Avon at Christchurch, and has been carried by aquatic birds to other streams in Canterbury and Otago, but is rare in the North Island, being restricted, so far as known to me, to a river near Mongonui, and another in the Bay of Plenty. It is of considerable interest, owing to its being the only submerged aquatic plant that has become naturalised in the colony.

NATURALISED FUNGI.

Several naturalised fungi are highly injurious to the indigenous vegetation, as the ergot (*Claviceps purpurea*, Tul.), which infests numerous native grasses; the clematis cluster-

cup (*Ecidium clematidis*, DC.), frequently infests *Clematis colensoi* and other species almost to the point of destruction, the stem, petiole, and even parts of the flower becoming thickened and distorted under its attacks: but the limits of this address will not permit me to enter into detail.

RATE OF INCREASE.

As the number of species more or less completely naturalised in the colony is upwards of five hundred, it becomes a question of some interest whether additions will be made to the catalogue at the same rate during the next half-century as in the past; if so, the number of species of naturalised and indigenous Phanerogams would be about equal, and many of the latter would be crowded out of the field. A satisfactory answer may, I think, be given.

The first catalogue of naturalised plants was published in the original "Flora of New Zealand," vol. ii., p. 321 (1855). It comprises sixty-one species, seventeen of which must be excluded as erroneous, leaving forty-four naturalised species. The second list, published in the "Handbook of the New Zealand Flora," p. 757 (1867), contains 171, from which twenty-one species must be deducted as included on insufficient grounds, leaving 150 species naturalised. A list prepared by the present writer was published in "Transactions of the New Zealand Institute," vol. ii., p. 131 (1869); it embodied all that was then known on the subject, and enumerated 292 species, a summary of which, given at page 146, showed forty-one species erroneously included, or of uncertain position, and 251 species truly naturalised. During the three following years I added fifty-three species to the list, making a total of 304 species known to me at the date of my ceasing to reside in Auckland. In 1882 Mr. Cheeseman published a list of the naturalised plants of the Auckland District, in which he raised the total to 382; but this does not include a few species seen by myself, and still unpublished. At the present time the number of species is certainly over five hundred, as already stated. Making all fair allowance for the imperfection of the records for 1855 and 1869, it will be seen that naturalised species have increased with great rapidity during the last fifty years. But it is not probable that this rate can be maintained; the number of encroaching species suitable for a given habitat, after all, must be limited, and it may well be that the limit for New Zealand, so far as introductions from European countries are concerned, is very nearly reached. As bearing upon this point, it may be remarked that, as many of the naturalised plants of different countries are migrants from a common centre, a large proportion must necessarily be identical; for instance, out of 243 species enumerated by Mr. C.

Moore, F.L.S., as naturalised in New South Wales, fully three-fourths are naturalised in New Zealand also; the remainder, consisting chiefly of plants from warmer countries, are not capable of becoming naturalised here. Again, out of 103 species of plants recently introduced with ballast from Buenos Ayres, eighty-six were already naturalised here.

The distribution of naturalised plants in the colony follows to a very great extent the same lines as those of the indigenous flora: the number of species decreases rapidly southward. Upwards of four hundred and twenty species are found in the Auckland District, but no other district in the colony contains so large a number; less than three hundred species would be found in the Wellington District. It must, however, be remembered that the climate of Auckland is much more favourable to the naturalisation of plants from warm temperate climates than that of any other part of the colony. A singular illustration of this has been recently given. A large quantity of ballast taken on board at Buenos Ayres was discharged at Wellington from a vessel loading for Europe. Over a hundred species of plants made their appearance on the ballast before the close of the second summer, the great majority being plants already naturalised in the Auckland District; twenty-seven species, however, had not previously been observed in Wellington, and of these seventeen species had not previously been seen in any part of the colony. In all probability not more than two of these will become naturalised—most likely only one. But had the ballast been deposited on the light scoria soil of the Auckland isthmus instead of on the stiff Wellington clay it is absolutely certain that in the absence of interference fully one-third would have become established—probably more. I will only add, as an additional reason for not expecting so large an increase in the number of introductions as formerly, that during the last fifteen years great improvements have been made in cleaning garden-seeds, agricultural seeds, and cereals, which will not only tend to reduce the number of species likely to be introduced in the future, but to prevent the yearly importation of certain species which at present are but partially naturalised. Chiefly from this cause certain species, such as *Fumaria officinalis* (L.), *Lepidium campestre* (R. Br.), *Papaver rhæas* (L.), *Githago segetum* (Desf.), *Scandix pecten-veneris* (L.), are less plentiful in many districts than they were twenty years ago.

POSSIBLE EXTINCTION OF INDIGENOUS SPECIES.

It is scarcely to be feared that any large number of indigenous species will become exterminated unless under special conditions not yet realised. It has been shown that the aspect of vegetation over large areas may be changed by

displacement, but it does not follow that this would involve the absolute extinction of many, or even of any, indigenous species. Displacement rarely passes into absolute replacement; after it has reached a certain stage the invaders lose a portion of their vigour, and become less encroaching; a portion of the indigenous vegetation becomes gradually inured to light and air, the severity of the struggle becomes less intense, and a gradual amalgamation takes place between the invaders and the invaded, which of itself facilitates the preservation of many of the more delicate kinds, while those less fitted to hold their place in the contest become restricted to those habitats which are of a peculiarly favourable character. The danger of extinction is greatest for those endemic species which are so remarkably local; for instance, *Epilobium brevipes* (Hook. f.), restricted to a solitary habitat on Mount Torlesse, and another in the Awatere, may at any time be destroyed by an unusually hungry rabbit or sheep, and one of the most interesting plants in the colony blotted out of existence. *Clianthus puniceus* (Banks and Sol.) is already restricted to one or two islets where sheep are unknown, and owes its preservation in a wild state to their absence. *Logania depressa* (Hook. f.), *Myrsine montana* (Hook. f.), and *Abrotanella pusilla* (Hook. f.) are in exactly the same position as *Epilobium brevipes*. The list might be increased, but it is needless to mention others.

PROTECTIVE MEASURES.

In 1868 Professor Hutton and myself pointed out the desirability of having the Little Barrier Island proclaimed a reserve for the protection of the native birds, with which at that time it abounded. After the lapse of a quarter of a century this has been partially effected. The Little Barrier Island in the north, and Resolution Island in the south, have been proclaimed reserves for the protection of native birds and plants; but the work of destruction is still being carried on. No serious attempt has been made to place on either island the birds or plants whose existence is most imperilled, although any of the endemic birds or plants of the North Island would find a suitable place of refuge on the Little Barrier, and those of the South on Resolution Island, which is specially adapted to the growth of alpine plants and the endemic species of the Antarctic islands. Owing to the variations from the typical form exhibited by the birds of the Snares, the Auckland Islands, Campbell Island, Antipodes Island, &c., they have attained a high commercial value, and are therefore, at this time, peculiarly exposed to the rapacity of collectors. It is possible to prevent their extinction by the immediate removal of representa-

tives of each species to Resolution Island if the work is taken in hand at once, and the island placed under the care of a skilful curator. If it be postponed for any length of time, who can say what may occur? It would require a very short time indeed to destroy every land-bird on Antipodes Island, or on the Snares; and, now that attention has been drawn to their interest, their value, and to their limited power of flight, the danger has become urgent.

If this address should be instrumental in drawing attention to the danger and accelerating the adoption of protective measures it will not have been given in vain; but I venture to hope that it may be productive of still greater benefit in leading some of those present to investigate the phenomena of change and replacement which are now in progress, and in the results of which we are so deeply interested, before the opportunity has passed away for ever.

ART. II.—*True Instincts of Animals.*

By CHARLES W. PURNELL.

[*Read before the Philosophical Institute of Canterbury, 1st May, 1895.*]

THE definition of the term "instinct" has been greatly narrowed of late years by scientific thinkers. Formerly, every action of an animal betokening intelligence was attributed to instinct, but latterly the term has been restricted to actions like that of cell-making in the bee, the construction of dams and canals by the beaver, and so forth—actions which are performed in an apparently mechanical manner by one generation after another, and seem to be prompted by some other faculty than intelligence. It is now admitted that many acts done by the higher animals must owe their origin to a faculty akin to, if not identical with, human reason; but the apparently unchanging and invariable nature of such actions as those just mentioned—as the construction of webs by spiders and nests by birds, and the migration of birds—seem to mark off these actions from the variable acts which are done upon the spur of the moment at the bidding of the animal's intelligence.

I think we can restrict the definition still further. Writers upon this subject have not taken sufficiently into account how much the young animal may be taught by the old, and how much it can learn through imitation and from its own observation. The migratory habits of certain birds, for example, are always set down to "instinct"; but birds usually migrate in