New Zealand has a similar history of logging, followed by the plough or fire, or similar disturbances. In addition, since all the ungulates have been introduced in a short time, biologically speaking, the native plants are generally ill-adapted to maintain themselves under heavy browsing pressure. An inevitable imbalance between animal numbers and the amount of available food has resulted.

The eventual status of deer in New Zealand may be much the same as in Michigan: (1) browsing pressure by ungulates will continue strong for some time, resulting in changes in species composition of various plant communities; (2) continued control measures will reduce deer numbers and inevitably an altered flora and fauna will evolve (some native species probably becoming rare or extinct); (3) eventually a balance between plant and animal numbers (probably artificially depressed by shooting) will occur; (4) political and social problems will continue to play an important role in natural resource management.

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DISPERSAL AND DESTRUCTION OF SEED IN CENTRAL NORTH ISLAND PODOCARP FORESTS

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Introduction

Over the past six years studies have been carried out, mainly in dense podocarp stands of Pureora and Pouakani Forests, to gather information about the periodicity, abundance, and soundness of seed crops, the animals that disperse or destroy seed, and how they do so. The ultimate objective is to find out what part each bird, rodent or insect plays in assisting or limiting regeneration of timber species.

Methods

Seed crops were assessed subjectively until 1961, when pairs of seed traps were placed beneath crowns of permanent seed trees of rimu *(Dacrydium cupressinum)*, totara *(Podocarpus totara)*, kahikatea *(Podocarpus dacrydioides)*, miro *(Podocarpus ferrugineus)* and matai *(Podocarpus spicatus)*. Since 1961, the number of sound and defective seeds collected in the traps has been counted annually.

Seed dispersal and destruction have been studied by observing the feeding habits of birds and by examining seed and droppings on the ground, on collection sheets, and in seed traps, some of the latter being rodent and bird proof. Seed has also been fed to captive rats and insects. Recently the populations of rodents in different forest types have been studied by systematic trapping with break-back traps baited with peanut butter.

In January 1962, at Pureora, P. C. Bull of the Animal Ecology Division, D.S.I.R., demonstrated that mist nets can be used in native forest to capture birds so that their role as seed dispersers can be studied.

Results

SEED CROPS AS A FOOD SUPPLY

Podocarps

There is a marked periodicity in fruiting amongst some podocarp species but no regular interval between good seed crops has been

observed (Hinds and Reid 1957). In any year, one or several species may fruit well in a particular locality, or there may be few sound seed of any species in the forest interior. In Pureora Forest, seed-crop ratings have been recorded as follows for the past 10 years:

rimu: good crops in 1954 and 1958; fair crop in 1962;

kahikatea: good crops in 1955, 1960 and 1963; fair crop in 1958;

totara: light crops annually;

miro and tawa *(Beilschmiedia tawa)*: annual crops fluctuating in quantity;

matai: no good seed crops, only a few seed on occasional trees from 1953 to 1962; fair crop in 1963;

hinau *(Elaeocarpus dentatus)* and rewarewa *(Knightia excelsa)*: good crops annually.

Total yields of seed have been estimated for mature trees with deep, vigorous crowns considered to have a heavy crop. Estimates for individual trees in Pureora Forest, based on seed collections, are: rimu, 40 lb. ripe seed and receptacles yielding 4 lb. of clean, sound seed (200,000); miro, 100 lb. ripe berries (32,000); kahikatea, 1,800 lb. ripe seed and receptacles yielding 300 lb. of clean, sound seed (4,500,000). In calm weather, comparatively few seeds of rimu, kahikatea or totara fall with the ripe receptacles still attached as many seeds and receptacles are eaten in the crowns of the trees.

Production and ripening of seed of the podocarp species may vary considerably in the same forest, even within areas of similar forest type, aspect, and altitude. The quantity and quality of seed borne by individual trees in any locality also varies greatly so that very intensive sampling would be required to reliably estimate seed fall per acre.

Shrub-hardwood species

These appear to produce seed annually but the quantity varies according to forest type. Species such as mahoe *(Melicytus ramiflorus)*, pate *(Schefflera digitata)* and fivefinger *(Neopanax arboreum)* are present in dense podocarp forest but bear little seed except in large canopy gaps; in these forests, podocarp seed is the main food source for seed-eating birds, rodents, and insects. When such forest is clear felled, the regrowth consists mainly of berry-producing shrubs such as fuchsia *(Fuchsia excorticata)* and wineberry *(Aristotelia serrata)*.

Ripening of seed crops

At Pureora Forest, the earliest ripe fruit is found in December on second-growth species such as fivefinger and fuchsia. Wineberry and the first tawa berries ripen in February. Ripe rimu seed with fleshy receptacles is available from mid March to May when the bulk of the kahikatea, miro and totara crop ripens. Most of the shrub-hardwood species fruit from March to June but berries of some species such as supplejack *(Rhipogonum scandens)*, *Coprosma robusta*, broadleaf *(Griselinia littoralis)* and horopito *(Pseudowintera* spp.) may be available throughout the winter.

The hard-coated seeds of miro have taken at least three years to germinate in the F.R.I. nursery and some matai seeds have taken two years (D. S. Preest pers. comm.). In forest, seed of these species may remain dormant on the ground for two or more years. Kahikatea seed and most of the rimu and totara seed germinates in the late spring and summer after seed fall.

SEED DISPERSAL BY BIRDS

At Pureora there is a marked concentration of fruit-eating birds during a good podocarp fruiting season. The most active dispersers of podocarp seed are New Zealand pigeons *(Hemiphaga novaeseelandiae)*, tuis *(Prosthemadera novaeseelandiae)* and bellbirds *(Anthornis melanura)*. These birds swallow both fleshy receptacles and seed of podocarps but digest only the pulp, the seeds passing intact through the digestive tract. All three species eat the succulent fruits of a wide range of shrub hardwoods. White-eyes *(Zosterops lateralis)* are the most common birds in the regrowth of logged forest at Pureora where they feed extensively on succulent fruits such as those of wineberry; they also swallow whole less succulent berries such as those of lancewood *(Pseudopanax crassifolium)* and fivefinger.

During the fruiting season, pigeon droppings may consist entirely of podocarp seed plus fibrous parts of the fruit. Large droppings attributed to pigeons have contained up to 100 kahikatea seeds or 12 matai seeds. Miro and tawa seeds cleaned of pulp are dropped continually by pigeons feeding in fruiting trees; thus miro seedlings are commonly found beneath tawa trees. After feeding, pigeons may perch in nearby emergent trees of any species, and large droppings found beneath these trees are probably from perching birds.

Large kamahi *(Weinmannia racemosa)* in patches of low shrub hardwoods are frequently associated with groups of podocarp seedlings. Seeds found in pigeon droppings are always sound.

In 1960, an exceptionally heavy crop of kahikatea seed at Pureora afforded the opportunity to observe mass dispersal of seed from virgin forest into adjacent cutover forest. Tuis gathered in hundreds where kahikatea was dominant over 10 acres of a large block of dense podocarp forest. There were also smaller numbers of bellbirds and pigeons. Residual trees in adjacent cutover forest were constantly visited by tuis in particular, and logs and stumps in the open to a distance of several chains from the forest edge were sprinkled with sound kahikatea seed deposited by flying birds. These seeds were scattered or in droppings containing up to five seeds plus receptacle skins and the small bracts characteristic of kahikatea fruit. All seeds were detached from their receptacles but most retained the strand of fibrous tissue that denotes dispersal by birds. On 16 May most of the birds suddenly moved away, leaving smaller numbers well dispersed throughout the forest.

The presence of some large, deep-crowned kahikatea at the natural forest edge near Pureora village enabled closer observation to be made of the feeding habits of both native and introduced birds. Birds clearly seen to be feeding on ripe kahikatea fruit were tuis, pigeons, white-eyes, Indian mynas *(Acridotheres tristis)*, starlings *(Sturnus vulgaris)* and sparrows *(Passer domesticus)*. Only the tuis and pigeons were seen to swallow both seed and receptacles and were therefore the only birds obviously acting as seed dispersers. (Elswhere, bellbirds have been seen to feed on kahikatea; they probably disperse seed in the same way as tuis.) White-eyes pecked at the receptacles and often dropped seeds with remnants of pulp attached. Starlings and mynas swallowed the whole receptacle and often appeared to drop the seed from their bills immediately after detaching it. However, a starling shot in this locality had whole kahikatea seed in the gizzard. Starlings may disperse some seed in flight, as they feed in an excitable manner, moving constantly from tree to tree, whether it is fruiting or not. Sparrows merely extracted the juice by crushing the receptacles, which fell still attached to the seed. The gut of a thrush *(Turdus ericetorum)* shot at the forest edge in May contained sound kahikatea seed.

In a preliminary trial with mist nets set up at the margin of Pouakani Forest, 22 birds were caught, including five white-eyes, five blackbirds *(Turdus merula)* and two thrushes. Some of the fruit-eating birds had been feeding on tutu *(Coriaria arborea)*, fuchsia, and *Muehlenbeckia australis*, and seedlings of all these species were grown from seed contained in droppings of birds caged for a short period before release. That 178 fuchsia seedlings were grown from the contents of a single dropping shows the importance of the blackbird as a seed distributor.

Evidence of effective seed dispersal by birds over the past 50 years was obtained by a 2½% sampling of 160 acres of fire-induced second growth surrounded by virgin forest. Nearly 80% of the ¼-chain-square quadrats were stocked with seedlings and saplings of podocarp species, mainly rimu; some quadrats contained as many as 40 stems over 6 in. high, dense groups often growing round old kamahi stumps.

DESTRUCTION OF SEED

Rimu. A large part of the rimu seed crop is destroyed during seed fall. At Pureora Forest in 1958, 100 lb. of rimu seed and receptacles, collected from hessian sheets laid on the ground, yielded 10 lb. of clean, sound seed. Some 40% of the seed was collected after a gale on 10 May had stripped trees of most of their ripe seed; most seeds fell with the fleshy receptacles attached. At Minginui Forest during the same period, 100 lb. rimu seed and receptacles yielded only 3 lb. of sound seed; many seeds were split and empty.

Some rimu seed is destroyed on the crowns of the trees. Empty, split, crushed and fragmented seed coats have been found in rodent- and bird-proof seed traps. From 20 May to 1 August 1958, at Pureora, collections were made every fortnight from pairs of square-yard seed traps placed beneath crowns of fruiting trees. One of each pair was covered with ½ in. wire mesh and the other was left open. Counts showed that during seed fall, proportions of seed, receptacles, and fragmented seed coats were similar in open and in covered seed traps. Table 1 shows that some 80% of the rimu seed collected in a covered trap from 20 June to 3 July 1958 had been destroyed in the crowns.

TABLE 1. *Condition of rimu fruit collected in a trap.*

	Number of seeds	Percentage of total
Seeds with fleshy receptacles	44	1.5
Seeds with undeveloped receptacles	284	9.6
Seeds without receptacles	289	9.8
Fleshy receptacles detached from seeds	2,335	79.1
Fragmented seed coats	many hundreds	

The only excreta found in either open or closed traps were a few weta *(Hemideina* sp.) droppings. Rimu seeds do not normally become detached from ripe receptacles unless separated by animals.

Miro. The proportion of miro seed and fruit from a single tree eaten between March and September 1957 has been assessed. Counts were made of seeds falling into a pair of square-yard seed traps placed beneath a fruiting tree in Pureora Forest. One trap was covered with $\frac{1}{2}$ in. wire mesh. Seed was placed in three categories according to its condition, as shown in Table 2.

TABLE 2. *Condition of miro seed and fruit from one tree.*

	OPEN TRAP	COVERED TRAP
Total number of seeds	581	802
Condition of Seed	*Percentage of total*	*Percentage of total*
Gnawed or broken (contents eaten by rats or kaka *(Nestor meridionalis)*)	22	26
Whole seed cleaned of pulp (dropped by pigeon)	34	30
Whole berries	44	44

DESTRUCTION OF SEED BY BIRDS

At Pureora the only birds seen feeding on *rimu* seed (as distinct from receptacles) have been Californian quail *(Lophortyx californica)* and chaffinches *(Fringilla coelebs);* both species were feeding on the ground in clearings. Quail shot in May have had some whole rimu seed in their crops.

Many birds eat the fleshy receptacles of kahikatea and totara but *kahikatea* seed falls undamaged from the crowns, whether dropped by birds or not. The only bird observed destroying *totara* seed has been the yellow-crowned parakeet *(Cyanoramphus auriceps),* which cracks the seed crosswise and extracts the contents, dropping the crushed seed coat. In June 1958, up to 40% of the totara seed falling from a tree with a light seed crop was destroyed by parakeets. These birds have also been seen eating seed of *mountain toatoa (Phyllocladus alpinus)* in January, the unripe receptacles being discarded.

Kaka destroy *miro* seed, often when berries are still green, by cracking them open and extracting the seed contents; the two halves of the empty seed are dropped with the pulp still attached.

DESTRUCTION OF SEED BY RODENTS

Caged specimens of the ship rat *(Rattus rattus)* have eaten quantities of podocarp seed, providing authentic samples of the type of damage they do. Seed baits placed in the forest at Pureora showed that wild rats had the same preferences for different podocarp species as caged rats. The order of preference was rimu, matai, miro, and kahikatea. Totara and tawa seed remained untouched. Fleshy receptacles of rimu and totara were quickly eaten, and some kahikatea receptacles were taken. Captive rats discarded the ripe pulp of miro berries before gnawing through the hard seed coat to extract the kernel. In forest trials, a few miro and matai berries were removed altogether from baits, presumably for eating at a more favoured site; piles of gnawed miro and hinau seed have been found under logs and in other sheltered positions in the forest. On Pureora mountain, small heaps of Hall's totara *(Podocarpus hallii)* seed have been found with rat droppings; the receptacles had been removed.

In no case has the ship rat eaten the coats of podocarp seeds. These are split or gnawed, according to their size and hardness and the presence or absence of an easily opened suture line, and the contents consumed. Thus rat damage to miro and hinau seed is easily recognised by the hole gnawed in the end or side of the hard seed coat. Matai seed is split into halves or gnawed after the pulp has been eaten. Rimu and kahikatea seed are usually split lengthwise but a few rimu seed coats may be fragmented, the damage being difficult to distinguish from that presumably caused by finches.

There may be many rat droppings on hessian sheets placed on the ground beneath rimu crowns but there are few in accessible seed traps during the main seed fall. Rats turn to the seed in open traps from late winter. By December, open traps with quantities of rimu

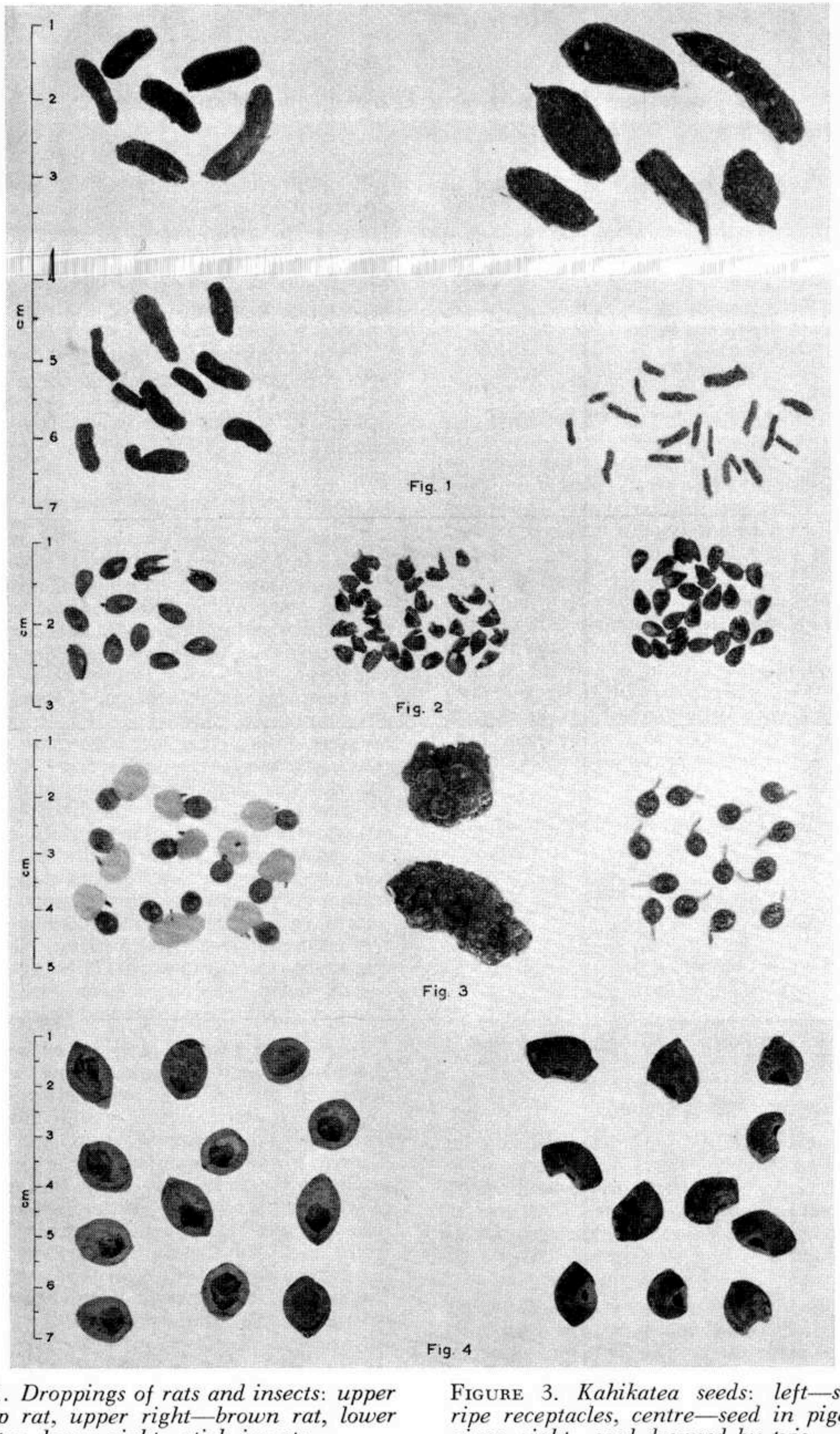

FIGURE 1. *Droppings of rats and insects: upper left—ship rat, upper right—brown rat, lower left—wetas, lower right—stick insects.*

FIGURE 2. *Rimu seeds: left—after germination, centre—opened by wetas, right—opened by ship rat.*

FIGURE 3. *Kahikatea seeds: left—seed with ripe receptacles, centre—seed in pigeon droppings, right—seed dropped by tuis.*

FIGURE 4. *Miro seeds: left—after germination, right—opened by ship rats.*

Photos by T. Ransfield, N.Z. Forest Service.

and kahikatea seed contain little but split, empty seed coats and rat droppings. Sound miro or matai seed can rarely be found beneath seed trees from September to March but there are usually many gnawed seeds. Gnawed miro seed and supplejack *(Rhipogonum scandens)* fruit found in rodent-proof traps show that ship rats, which nest in trees and are good climbers, do feed in the crowns of trees.

There is no evidence of totara seed having been eaten by ship rats, either on the ground or in open seed traps. Fallen kahikatea seed usually remains undamaged until September but after that much is destroyed by rats beneath parent trees.

On Mokoia Island, in Lake Rotorua, there is abundant evidence that seed and fruit of shrubs and trees constitute an important part of the food of brown rats *(Rattus norvegicus)*. The island is covered with second-growth forest; there are no podocarps except a few totara. Captive specimens of the brown rat from this locality ate no podocarp seed when alternative food was available.

NUMBERS OF RODENTS IN FOREST LOCALITIES

The ship rat has been caught in many different vegetation types near Pureora, indicating that there is a fairly high population in virgin forest.

A variety of baits and types of traps were used at first but these have since been standardised. In each of two types of virgin forest, rats are being trapped along a permanent line consisting of 20 traps spaced at one-chain intervals. The types being sampled are dense podocarp forest (Type L1, McKelvey and Nicholls 1957), in which kahikatea is locally dominant, and mixed podocarp/tawa forest (Type M2).

Recently it has been found that there is a dense population of brown rats on Mokoia Island. Traps have been placed at half-chain intervals along lines leading inland from the water's edge.

Results to date for both species are shown in Table 3.

TABLE 3. *Trapping results for ship rats in Pouakani Forest and brown rats on Mokoia Island.*

Date of Trapping	*Forest type*	*No. of trap nights*	*No. of rats caught*	*No. of rats per trap night*
SHIP RATS				
May 1960	L1	140	15	0.11
	M2	140	17	0.12
January 1962	L1	99	4	0.04
	M2	77	2	0.03
May 1962	L1	40	9	0.22
	M2	16	2	0.12
February 1963	L1	92	8	0.07
	M2	210	2	0.01
BROWN RATS				
March-April 1963	—	83	43	0.52

Mice are present in virgin high forest at Pureora but only five were caught in 814 rat-trap nights. There appear to be more in the shrub ecotone at the forest edge and in monoao *(Dracophyllum subulatum)* heath; in these places, and in a store building, mice were trapped and rimu seed baits eaten. Both receptacles and contents of rimu seed were taken, only fragmented seed coats remaining; seed and fruit of other podocarp species were not eaten.

DESTRUCTION OF SEED BY PIGS AND OPOSSUM

Examination of the stomach contents of a pig killed in Pouakani Forest in May revealed a large quantity of crushed hinau and matai and a little miro seed, together with a few whole berries.

In June, gnawed cotyledons of tawa seed were found with fresh opossum droppings at Minginui Forest. Berries had fallen two or three months previously and the pulp had therefore rotted.

DESTRUCTION OF SEED BY INSECTS

At Pureora, destruction of immature matai seed by unidentified insects appears to be a major cause of the constant failure of seed crops. Flowering is often profuse but little seed reaches maturity. Immature fruit may be attacked by gall-forming insects in October, whilst in December the ground may be littered with green berries, most having insect exit holes.

Tree wetas must feed in the crowns of podocarps for droppings are generally found in raised seed traps. Weta droppings resemble smaller droppings of the ship rat and have sometimes been confused with them. Captive wetas *(Hemideina thoracica)* will eat both fleshy receptacles and contents of rimu seed,

leaving fragmented seed coats with jagged edges. Four captive wetas destroyed 109 rimu seed in a fortnight as well as some seed and foliage of *Griselinia littoralis* supplied as alternative food.

The abundant droppings of stick insects in seed traps placed beneath rimu trees indicate that these insects are present in rimu crowns in considerable numbers when fleshy receptacles have developed on the rimu seed, but it is not known whether they eat receptacles or seed.

J. S. Dugdale of the Forest Research Institute has reared ten species of insects from tawa fruit but the larvae of only one species, the moth *Cryptaspasma querula*, were found to be eating the fleshy cotyledons that constitute the bulk of the seed.

DISCUSSION AND CONCLUSIONS

In central North Island forests there are usually some species fruiting at all times of the year although fruit is scarce in spring; the greatest quantity is available from March to June. The volume of sound podocarp seed produced fluctuates markedly from year to year but some species have seed that can remain sound for one or more years, thus providing a long-term food source for rodents.

Seed of most podocarp species cannot be distributed more than one or two chains from the crowns without the aid of birds, except possibly by water. Many of the native birds that are probably seed dispersers have become rare, e.g. the kokako *(Callaeas* spp.), saddleback *(Philesturnus carunculatus)*, and New Zealand thrushes (*Turnagra* spp.). However, species such as pigeons, tuis, and bellbirds are still dispersing large quantities of seed in Pureora and Pouakani Forests. There is a marked movement of fruit-eating birds to areas where crops are heavy.

White-eyes are the most numerous distributors of small-fruited species but some small birds such as robins *(Miro australis)* and tits *(Petroica* spp.), generally considered to be mainly insectivorous (as in Oliver 1955), may distribute seed. Thus Watson and Bull (unpub.) have suggested that the South Island robin may do this in Westland, where they observed it feeding on fleshy receptacles of rimu. The writer has seen a pied tit carrying a berry of *Coprosma parviflora*. The Lake Monk expedition to Southern Fiordland (Riney *et al.* 1959) recorded that the yellow-breasted tit was seen feeding on ripe, small-leaved coprosma fruits.

The blackbird is an important seed disperser that has become adapted to a forest habitat. It eats small-seeded berries, and has been seen swallowing miro fruits (D. S. Preest, pers. comm.). St. Paul (1960) recorded that 60 blackbirds were feeding on matai fruit at Minginui on 14 March.

Some birds that usually drop podocarp seed whilst feeding on the ripe receptacles may occasionally disperse seed by swallowing it, or detaching it in flight. Starlings appear to act in this way. St. Paul (1952, 1956) has noted that thousands of starlings gathered to feed on heavy crops of kahikatea fruit in 1951 and 1955 at Minginui.

The presence of certain shrub species in subalpine scrub may depend on bird dispersal of seed from fruiting specimens at lower altitudes. On Pureora mountain (3,800 ft.) *Dacrydium bidwillii* and *Phyllocladus alpinus* in the subalpine scrub have shown no sign of fruiting in recent years, and spread mainly by vegetative means, while specimens on the plateau at 1,800 ft. have often fruited well. The frequency of rimu seedlings well above the limit of mature trees shows that extensive dispersal occurs up the mountain. At 2,500 ft. rimu has borne green seed, but ripe seed has not been observed.

The relative importance of rodents, birds, and insects in the destruction of a large portion of the rimu seed crop has not yet been determined. It is suspected that finches eat rimu seed in the tree crowns, particularly chaffinches, lesser redpolls *(Carduelis flammea)* and greenfinches *(Chloris chloris)*, but confirmation is required from examination of crop and stomach contents. At Pureora chaffinches enter deep into the forest and flocks are present through the winter and greenfinches have been observed at the forest margin. Redpolls were overlooked until P. C. Bull pointed out that they were present at the forest edge in January. Small quantities of rimu seed could be destroyed in tree crowns by ship rats, wetas and parakeets. The role of insects in the destruction of rimu seed has not been adequately studied.

The only native birds observed destroying seed have been kaka and yellow-crowned parakeets. Although both these species may be seen or heard daily at Pureora they are not present in sufficient numbers to cause a serious amount of damage to seed, at least in a good seed year. Characteristic damage is caused to miro and totara seed.

Rats eat a large part of the seed falling beneath parent trees of all the main podocarp species except totara; for species other than rimu most of this destruction takes place after the main seed-fall period. To judge from rat droppings and broken rimu seed found on hessian sheets, much rimu seed must be eaten by rats during seed fall. Moreover, comparison of seed in open and in rodent-proof seed traps, and the small number of rat droppings in the former, shows that little podocarp seed is eaten in accessible traps during the main seed fall. Possibly rats are reluctant to enter seed traps while there is still plenty of seed on the ground. Bird-dispersed seed is less likely to be destroyed, since rats would naturally concentrate on feeding beneath seed trees.

Trapping hitherto indicates a fairly steady population of rats at Pureora but the data are too meagre to allow conclusions to be drawn about seasonal fluctuation in numbers. No trapping has yet been done in spring, when an increase in numbers could occur after a good seed fall.

There are few records of trapping of rodents in other areas of indigenous forest. Watson and Bull (unpub.) working in Westland during poor weather, trapped only one rat in 192 rat-trap nights and four mice in 105 mouse-trap nights. No rats were trapped during the Lake Monk expedition.

More figures are needed before the importance of rats as destroyers of forest-tree seed can be assessed. Seed of various indigenous species is being fed to captive specimens of both the ship rat and the brown rat to find out how much they can eat.

It appears that tawa seed is not eaten by rats under natural conditions, at least where there is alternative food. A major destroyer of fallen tawa seed at Pureora is the moth *Cryptaspasma querula*. It is also suspected that wild pigs eat freshly fallen tawa fruit. The destruction of tawa seed on the ground by opossums has not previously been recorded and this may occur only when a high deer population has destroyed most of the understorey species, as at Minginui.

Despite the many seed-destroying agents in central North Island forests, there appears to be no lack of germinating seed after a good seed year. Young seedling regeneration of kahikatea is usually prolific. Many small seedlings of podocarp species, however, are ephemeral and seedlings do not become established beneath parent trees. Dispersal of sound seed by birds is vital for the regeneration of scrub areas situated more than a chain or so from fruiting trees.

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SUMMARY

Seed-crop studies carried out over the past six years show that there is a marked periodicity in fruiting amongst some podocarp species but that shrub hardwoods fruit annually. Some berries and dormant seeds are available throughout the year as a food source for birds, rodents, and insects. During a good fruiting season podocarp seed is effectively dispersed in Pureora Forest by pigeons, tuis, and bellbirds, sometimes in local concentrations. Blackbirds, thrushes, and starlings can also disperse podocarp seed.

Part of the rimu seed crop is destroyed on the tree crowns, probably by finches, and a large part on the ground by ship rats, which are numerous and widespread in forest near Pureora. Kahikatea seed is not damaged on the tree crowns, but fallen seed is eaten by ship rats. Miro, matai, and hinau seed is eaten by ship rats and wild pigs, and miro seed is eaten by kakas. Totara seed is not eaten except by parakeets. Podocarp seed that falls beneath crowns of parent trees when birds eat the fleshy receptacles does not contribute to regeneration of the forest. Much fallen tawa seed is destroyed by larvae of the moth *Cryptaspasma querula*, and it is also eaten by opossums.

Despite the many seed-destroying animals, there has been prolific germination of rimu and kahikatea seed in the summer following a heavy seed fall.

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