THE FLOWERING OF BEECH

By A. L. POOLE

In the course of investigating the floral morphology of New Zealand *Nothofagus* it was found that in the summer of 1948 certain trees which were being kept under observation were carrying flower primordia in an abnormal number of the axillary buds. The development of these buds is such that they have a period of twelve months during which internal development proceeds. Flower primordia formed in the dormant buds in one summer appear in the following spring. The summer prior to their appearance is the critical period of their development.

Further investigation disclosed the presence of the same large number of flower primordia on trees from beech forests in the vicinity of Wellington and the Wairarapa. This phenomenon has since proved to be the forerunner of a prolific flowering season in the spring of 1948 throughout the greater part of the range of *Nothofagus*. In forests in the Wellington and Wairarapa districts, which have been under special observation, the flowering has been particularly heavy. It was not unusual to see trees on which over ninety per cent of the spring shoots over the whole crown bore flowers.

The occurrence of this flowering suggested checking records to see when these heavy flowering years occurred and if they were related in any way to climatic fluctuations. Such prolific flowering years are sometimes spoken of by New Zealand foresters who have had experience in beech forests. Moreover, that they must normally be followed by heavy seeding or "mast" is evident from the different aged regeneration groups, some of great density, seen in beech forests. The pages of this journal contain a number of articles describing such regeneration. The same habit of having heavy flowering seasons, followed normally by masts which produce dense regeneration, has enabled European foresters to domesticate, in a highly successful manner, the closely related *Fagus sylvatica*. European beech forests worked on the "shelterwood" system are amongst some of the best examples of successful silviculture.

A note on these habits of *F. sylvatica* may not be out of place as an introduction to New Zealand records. Busgen (1929) summarising German work on the periodicity of seed years, stated that flowering in European beech did not necessarily coincide with fruiting. He quoted work of Hartig (1885) on the storage of starch in the stem and the correlation of accumulated starch reserves and seed years. "Before a mast year the outer rings, actually in older trees, the outer 20 rings, are so full of starch that all the parenchyma cells are packed with it." Heavy seeding exhausted the starch reserves which had to be built up again before another heavy seeding. Klebs (1904) considered that summer drought increased the C/N ratio which in turn was

responsible for initiating flower primordia. This belief in the correlation between hot dry seasons followed by heavy flowering and seeding seems to be commonly held by European foresters. Bourne (1942-1945) working in English beech forests, where this species is on the edge of its natural range, and has full mast years so infrequently as to be almost useless for natural regeneration of the forests, attempted to correlate seed years with the eleven year sun spot cycle. Full masts occurred in 1913 and 1922. One was expected in the period 1933-35, but three fine summers gave three partial masts. A very heavy mast occurred in 1944. This had been predicted by Bourne but it did not follow a hot dry summer. It was, however, preceded by two dry springs. It should be noted, however, that climatologists are by no means agreed that there is a general cycle of weather corresponding to sun spot cycles. The most regular occurrence of European beech masts, every three to four years, occurs in the continental climate of Europe where the summers are hot and dry. Busgen quotes German work which correlates exceptional beech mast years with preceding hot dry summers.

In perusing New Zealand records it was found that the summer of 1947-48 was hotter than average throughout the country. Similar hot years occur periodically at irregular intervals. From the scanty records available it would appear that there is a marked correlation between these hot summers and beech flowering and seeding. Prior to 1947-48 a hot summer was experienced in 1937-38. This was followed by a heavy flowering, in some parts of New Zealand at least, and by a mast year in the autumn of 1939. Cranwell (1939) recorded some precocious flowering preceding the main flowering, for she wrote : "but in spring of '38 there was a heavy production of pollen throughout the range of the species. Previous to this, in parts of Auckland district at least, a weak and abnormal flowering took place. This was observed in the field in May, while on 7th June, 5-pored *N. truncata* pollen was found on one of the atmospheric slides exposed on the Museum (Auckland) roof. Almost at the same time Mr. A. C. Caldwell found the same species in flower at Thames, on the Coromandel Peninsula." In November of 1938 a remarkable photograph was taken by C. Skottsberg and reproduced by Cranwell, of a *Nothofagus* pollen cloud near Lake Te Anau. This was stated by H. H. Allan (verbal) to be *N. cliffortioides* pollen.

The precocious flowering noted by Cranwell occurred to a marked extent last summer, autumn and early winter on some garden grown trees and on trees in beech forests around Wellington and the Wairarapa. It was also seen at Karioi and in Auckland where two garden grown trees bore a large number of flowers in the summer. Most of the precocious flowering was abnormal and consisted of stainate flowers only. Precocious flowers were produced by all species except *N. menziesii* which did not appear to do so anywhere, although special watch was kept in forests around Wellington and in Southland.

An interesting record of the seeding which followed the 1938 flowering was found on the files of the Department of Internal Affairs and brought to my attention by C. M. Smith. It reads :—"Regeneration, Rangitikei, Ngaruroro. In 1938 after a drought, young beech seedlings sprang up all through this bush. The deer were out on the tops and in the open valleys. In the early winter deer could be seen going along eating these seedlings, as they would grass, and, during winter cleaned out the lot . . . . . E. Macgregor, District Field Officer, Taupo. 2/9/47."

The important observation is the quantity of regeneration. The statement that deer "cleaned out the lot" is probably erroneous as most of it would die from summer drought and other natural causes. The record is also written more than ten years after the event and an error of one year in recording the date is likely, for the seeding would occur in the autumn of 1939 and germination in the spring of 1939.

The 1934-35 summer was stated by Kidson (1936) to be the hottest and dryest ever recorded. A note of seeding in the Reefton area following this year was made by Field (1939) who wrote as follows :—"Seed trenches were therefore prepared over a trial area, (P.S.F. 132, Reefton District), of several acres by grubbing away surface litter and duff and exposing the mineral soil in preparation for an indicated good seed year in 1936." A photograph taken two years later of regeneration in these trenches is evidence that the seed year did occur.*

In the herbarium of the Dominion Museum, Wellington, specimens of *N. menziesii*, *N. fusca*, *N. cliffortioides* and hybrid beeches, mainly collected by H. J. Matthews around Lake Manapouri in 1907, are in heavy flower. This heavy flowering may possibly have been general in beech forests, for meteorological records show that the 1906-07 spring-autumn season was hotter than average throughout New Zealand.

It appears therefore from the records available that a possible flowering in 1906 and known flowerings in 1935, 1938 and 1948 have all been preceded by spring-autumn seasons hotter than the average. The meteorological records show that throughout New Zealand these hot seasons have average mean daily temperatures above the normal temperatures for at least the summer months. Evidently during these months the stored food reserves are marshalled in some way for flower production. The accompanying table shows for four stations the deviation of the mean temperatures from the normal for the months of October to April for the seasons preceding known or suspected heavy flowering. The stations have been chosen for their

* In the 1936 issue of this Journal G. H. Hocking recorded an abundant flowering and seeding of indigenous species, including beech, in the 1935-36 season and suggested its connection with the previous hot dry summer. He noted that in North Auckland, where rainfall had been slightly above average in the 1934-35 summer, seed production was not good, probably less than usual according to local observers.—Ed.

TABLE SHOWING DEVIATION OF MEAN DAILY TEMPERATURES $\left(\frac{\text{min.} + \text{max.}}{2}\right)$ FROM NORMAL IN SPRING—AUTUMN SEASONS PRECEDING KNOWN OR SUSPECTED BEECH FLOWERING YEARS.

(Temperature in Degrees Farenheit)

	ONEPOTO (L.Waikaremoana)				WELLINGTON				NELSON				WEST COAST			
													Hokitika		Westport	
	1906–7	1934–5	1937–8	1947–8	1906–7	1934–5	1937–8	1947–8	1906–7	1934–5	1937–8	1947–8	1906–7	1934–5	1937–8	1947–8
October	No Records Available	No Records Available	+7.0	+1.7	+0.3	—0.4	—1.9	+0.4	—1.8	—0.1	—2.0	—0.1	—0.4	+1.8	—.04	0.0
November			+1.4	+0.4	+3.0	+3.6	+1.3	+0.8	+1.5	+2.2	+1.4	+0.4	+2.9	+4.5	—0.6	+2.4
December			+2.9	+0.1	+5.1	+7.2	+2.3	+1.5	+3.1	+5.2	+2.7	+1.5	+3.8	+7.6	+3.4	+3.1
January			+3.7	+2.5	+2.3	+5.4	+1.2	+2.9	+3.4	+4.4	+2.6	+0.2	+2.1	+4.7	+3.5	+2.6
February			+4.2	—0.2	+2.1	+4.5	+3.6	+1.0	0.0	+0.6	+4.6	+0.6	+2.3	+6.9	+6.3	+1.6
March			+5.1	+3.0	+1.9	+2.4	+4.1	+2.0	+1.4	+0.8	+4.2	+1.9	+3.8	+3.5	+5.0	—0.1
April			+5.1	—1.1	+1.7	+2.7	+3.7	+0.5	+0.4	—6.2	+6.1	+0.8	+1.3	+2.9	+8.5	+0.9

NOTE :—An average increase in temperature of +2°F. for a month causes widespread comment.

proximity to beech forests. It will be seen that the 1906-07, 1934-35 and 1937-38 seasons are much hotter than the average. The 1947-48 season is not very much hotter but there is a lapse of ten years from the previous heavy beech flowering. From the few records investigated it appears that drought is not necessarily connected with the hot years or with beech flowering.

With the help of State Forest Service officers and other observers it has been possible to obtain records of the heavy flowering which occurred last spring and early summer. This flowering seems to have been general throughout the range of the beech forests with the possible exception of *N. menziesii* and some *N. cliffortioides* forests. From records available for forests near Auckland, in Hawke's Bay, the Wairarapa, Wellington, Nelson, the West Coast and the Fiordland, it seems that *N. truncata* flowered heavily throughout its range; so did *N. fusca*, *N. solandri* and in some localities *N. cliffortioides*. Records for *N. menziesii*, particularly from the south, are variable, though judging from buds examined early in the season, there must have been some heavy flowering there. On the western Tararuas it appears from a few observations made that there might have been only negligible flowering in the *N. menziesii* sub-alpine forest which occurs there. There is a record of heavy seeding of this species from a tributary of the Wairau River in the late summer of 1948. Investigation may reveal that *N. menziesii* has a different behaviour from the other species. It is, however, unlikely that the other species flower heavily and produce a mast only in the hot seasons which occur throughout New Zealand. From verbal statements it seems that flowering occurs more frequently in the Sounds—Nelson region where beech forests have developed to a greater extent than elsewhere in New Zealand.

Of particular interest was the flowering last spring of the two South American beeches, *N. procera* and *N. obliqua*, introduced into this country and distributed as seedlings in 1936. Specimens of these flowered at Auckland, Wellington, Otaki Forks and Kiwitea (Manawatu). Specimens of the South American *N. dombeyi* and the Australian *N. moorei* introduced a little later did not flower. The tree of *N. obliqua* which flowered in Auckland in the spring also flowered the previous spring but the nuts contained no seed. This year seed is developing. Trees of *Fagus sylvatica* in Christchurch, and a large specimen of the "copper beech" variety of this species in Wellington, also flowered profusely last spring and are setting seed.

Careful and continous observations should be made of these flowering and seeding seasons because of their direct relationship with the regeneration and life history of the beech forests. If these forests are to be brought under management, the best use must be made of the periodic regeneration. Flowering and nut development

does occur between the mast years, but examination of the nuts of all species collected from widely dispersed areas during one of these intermediate seasons (1947-48) has shown that nuts are nearly always empty. One exception was for *N. menziesii* noted previously. The forester is directly concerned with these mast years, with the ages at which trees commence to produce mast and with the quantity of mast produced.

Acknowledgments.

Grateful acknowledgment is made to the many observers and collectors, especially State Forest Service Officers, who have contributed material upon which part of this study has been based.

Summary.

A record, based upon the observations and collecting of a number of people, is made of the heavy southern beech flowering which occurred in the spring of 1948. A preliminary attempt has been made to correlate this and previous flowerings with preceding hot summers. Comparisons are made with the flowering and seeding behaviour of *Fagus sylvatica*.

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NOTE.—Since writing this article there has appeared in the State Forest Service Annual Report for 1947-48 (p. 30) a note on "Lammas Flowering of Beech Species," referring to the same precocious flowering as has been recorded here.