DISTRIBUTION AND ABUNDANCE OF THE ROOK (*Corvus frugilegus L.*) IN NEW ZEALAND

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1. INTRODUCTION

A preliminary survey of the distribution of rookeries in Canterbury and in Hawke's Bay was undertaken during the 1955 and 1956 breeding seasons, and the primary purpose of this paper is to report the results of this survey. As a secondary objective, an attempt has been made to bring together some of the information which exists on the distribution of rooks in earlier times. By combining these two sets of data, it is possible to get a picture of the distribution of rookeries in time as well as in space, and from this to identify some of the factors which have controlled the size and distribution of the rook population in New Zealand.

The rook, with its large size and gregarious habits, is a convenient species for field studies, and Lockie's (1955) work on this bird in Britain has demonstrated that such studies can contribute much towards obtaining a better understanding of the factors which control the size of bird populations. New Zealand provides unusual opportunities for studying the population dynamics of rooks because, unlike the situation in Europe, the species has a very restricted distribution and is non-migratory. Apart from its value as a contribution to scientific knowledge, a better understanding of the ecology of rooks in New Zealand is urgently required as a basis on which to plan more efficient control measures. The birds cause damage to crops growing in the vicinity of the rookeries, and, from 1915 onwards, reports of such damage have been received with increasing frequency. As a result, efforts are constantly being made to reduce the rook population, and most of the rookeries are disturbed every year by control operations, especially shooting. It is regrettable that, despite the natural suitability of rooks as a subject for ecological study and the desirability of such studies on economic grounds, the disturbance of rookeries, caused by the existing methods of control, make it very difficult to carry out a major research project on the population dynamics of this interesting but troublesome bird.

Despite these difficulties, it is still possible to collect useful information on several aspects of the ecology of rooks in New Zealand, and the present study, though incomplete in some respects, is published at this stage in the hope of interesting amateur ornithologists in the study of rooks and of stimulating local historians to bring forward additional information on the liberation and spread of the species.

2. MATERIAL AND METHODS

The present paper is based on two very different sets of data, the first being a compilation of various historical records relating to the past distribution of rooks, and the second the results of field surveys carried out by the writer since 1955. The methods used in collecting these two sets of data are presented separately below, together with information bearing on the reliability of the data.

(A) HISTORICAL DATA

Information on the past distribution and abundance of rooks was obtained from the various publications cited in the list of references, from newspaper clippings, and from the following five unpublished sources:

(i) Replies to questionnaires sent by Dr Wodzicki in 1952 and 1954 to farmers and other people interested in rooks.

(ii) Files of the Department of Internal Affairs (indicated in the text by the letters I.A.).

(iii) Notes provided by Drs R. A. Falla, D. Macmillan and K. Wodzicki

and by Messrs D. H. Brathwaite, M. B. Crequer and W. J. MacGibbon.

(iv) Letters or verbal information supplied by people living near the rookeries visited during the survey, or having an interest in the history of local areas. (Information supplied in writing is denoted in the text by the abbreviation *'in litt.'* and verbal information by 'pers. comm.').

(v) 'East Coast Naturalist', a manuscript in Alexander Turnbull Library.

In a few instances, information concerning the history of a given rookery was obtained from more than one source, and this provided an opportunity for testing the reliability of some of the historical data. The few comparisons that can be made between data obtained from different sources suggest that the information is fairly reliable with regard to general trends. For example, all accounts agree that, for many years, the only Christchurch rookery was located at Fendalton, and that the eventual decline of this rookery was accompanied by the development of several new rookeries and by an increase in the rook population. On the other hand, there are considerable discrepancies in such details as dates and numbers of birds. To quote some extreme examples, three correspondents give the date of abandonment of the Fendalton rookery as 'early twenties', 1936 and 1938 respectively; similarly, the year of establishment of a rookery near Paparua Prison was stated to be 1935 by one person and 1947 by another; finally, estimates of the total rook population of the Christchurch area in recent years have varied from two thousand to ten thousand. Discrepancies of this kind are often less serious than they might at first appear, because further investigation often reveals good reasons for placing more reliance on one observation than another. Of more importance is the probability that errors, similar to those reported above, also occur in some of the historical material that cannot be checked by reference to an independent source of information.

(B) RECENT SURVEYS

Replies to Dr Wodzicki's questionnaire provided a useful start for locating the rookeries, and valuable help was also given by Mr G. S. Barwell, Farm Manager at Paparua Prison, by members of Federated Farmers, and by officers of the Department of Agriculture. Rookeries reported in this way were visited, and interviews with farmers nearby often led to the discovery of yet other rookeries. A high proportion of the rookeries was ultimately located by a continuation of this process, and by observing the flight lines of the birds themselves. Once a rookery was discovered, its position was marked on a mile to the inch map published by the Lands and Survey Department. Sheet numbers and grid references, mentioned in the text below, refer to these maps. The sites of many of the Canterbury rookeries were photographed to assist in recognising any subsequent changes in the area occupied by the birds. The size of the rookery was assessed by counting the number of nests, and an attempt was made to learn something of its history from local residents.

The use of nest counts as an index of the abundance of rooks requires some explanation. Observers vary both in their ability to see partly-obscured nests and in their judgements as to the number present in a compact group of nests. If allowance can be made for errors of the above kind (observer error), nest counts, taken at the height of the nesting season, should provide a useful indication of the number of breeding pairs, but they take no account of non-breeding birds.

A preliminary estimate of observer error was obtained in Hawke's Bay when 11 rookeries, each of more than 30 nests, were counted by two or more observers simultaneously. From the figures obtained (Table 4), the standard deviation (s) of the proportional deviations was calculated to be 0.0648. This means that counts of a hundred nests might be expected

to vary between 81 and 119 (three times the standard deviation multiplied by 100 = ± 19). The value s = 0.0648 was obtained from data collected by people who had been working together, and a larger value would be expected for counts by observers having no opportunity to standardise their methods of counting. Conversely, successive counts by one person might have a smaller standard deviation.

Observers probably count fewer nests than actually exist in a given rookery, particularly when the nests are grouped close together, or are partly obscured by foliage and branches. This conclusion is suggested by a few figures which are available on the number of birds killed during control operations in certain Canterbury rookeries. Allowing three young per nest, a figure suggested by Lockie's (1955) work in Britain, four of these rookeries should have produced 105, 135, 417 and 789 young respectively. However, according to local farmers, the actual numbers of birds shot in the previous year were 170, 200, 580 and 2000 respectively, and nearly all of these were young birds. Even allowing for some optimism on the part of the shooters, it would appear that an appreciable number of nests were missed during the counting; farmers were emphatic that there had been no decline in the number of birds breeding in these rookeries. Similarly, the thousand rooks picked up after poisoning operations at Paparua in October 1956 (*Evening Post*, 12.1.57) is higher than would be expected from nest counts (321 and 472) made during the same month. The thousand birds picked up do not represent the entire population, because at least 30 survivors were seen, and many birds probably died on their nests or in other inaccessible places.

The relationship between the breeding population and the total population is unknown, although it is obvious that the latter will be considerably higher than the former immediately after the breeding season. By means of ringing, Giban (1947) was able to show that in France at least some rooks breed when they are only twelve months old, but he regarded this as a somewhat exceptional occurrence. If rooks usually take more than twelve months to reach sexual maturity one would expect to find a substantial non-breeding juvenile population. In this connection it is interesting that in 1946 the late E. F. Stead counted only 1700 nests in the Christchurch rookeries, yet spoke of a total population of 7000 birds (E. B. Davison in File I.A. 47/82). Similarly, M. B. Crequer wrote that about 2000 rooks were present at Islington Freezing Works in 1945, but that the nests numbered only 250 - 275 (1952 questionnaire). However, this latter example could be explained if birds breeding at Paparua visited Islington for food. The existence of a substantial non-breeding population would explain why, in 1956, more rooks were poisoned at Paparua than would be expected from the number of nests counted.

To summarise, nest counts tend to give a low value for the size of a rookery, and they are also subject to considerable observer error which can be measured. The counting is relatively simple to carry out, and it can be done at any time of the day during the height of the breeding season. The counts appear adequate for detecting gross changes in the size of a rookery, and this is sufficient for most purposes. Nest counts merely provide an indication of the number of breeding adults; the total rook population may also include substantial numbers of non-breeding juvenile birds.

3. RESULTS

Although the present work is concerned mainly with rookeries in the Hawke's Bay and North Canterbury districts, it may be useful to preface these more detailed studies with a review of what is known of the liberations and present distribution of rooks in New Zealand as a whole.

(A) GENERAL ACCOUNT

According to Thomson (1922) rooks were liberated in Nelson, Auckland and Christchurch between 1862 and 1873 (Table 1).

TABLE 1: LIBERATIONS OF ROOKS

Year	Place	No. of birds	Result
1862	Nelson	3	Stayed a few years, then disappeared
1862?*	Canterbury	?	Killed by cats
1869	Auckland	2	?
1870	Auckland	64	Last mentioned 1874; not doing well
1871	Christchurch	5	?
1873	Christchurch	35	Well naturalised, 1890; fairly common, 1916

*Rooks liberated by Mr Watts Russell about this time, poorly documented.

At the present time there are five isolated rook populations in New Zealand. These are referred to below as the Hawke's Bay, Pirinoa, Christchurch, Banks Peninsula and Peel Forest populations respectively. (Peel Forest is near Geraldine in Fig. 1.) Only one of these, Christchurch, can be traced directly to one of the liberations recorded by Thomson. However, there are reasons for believing that at least some of the remaining populations resulted from liberations rather than natural spread. For instance, Guthrie-Smith (1921), referring to Hawke's Bay, stated 'the few pair liberated near Hastings have, after many years, increased to a considerable rookery'. Likewise, Stead (1927) wrote of a rookery at Mt Peel, 'where there are a few pairs of birds which were taken there by Mr Dennistoun'. It seems likely that the rooks which now exist in the Peel Forest district are derived from this earlier rookery at Mt Peel Station. The origins of the Pirinoa and Banks Peninsula rookeries are unknown.

The Hawke's Bay and Christchurch populations have prospered, and these localities remain the main headquarters of the species in New Zealand (see Sections B and C below). The main Pirinoa rookery is in some tall eucalypts (Sheet N 165, grid 737096); a small offshoot of this rookery (grid 726211), established in 1956, was abandoned after shooting (J. M. Cunningham, *in litt.* 9.4.57). There may be other small ones on the west side of Lake Wairarapa and near Hinakura (Stidolph, 1943). Three birds appeared at Pirinoa in 1930, and their numbers gradually increased to reach 40 or 50 by 1943, even though a fair number were poisoned or shot (Stidolph, 1943). According to Mr H. Warren, the largest number of rooks seen in the district was 210 'a few years ago', but only about 120 were seen in 1956 (J. M. Cunningham, *in litt.* 9.4.57). In October 1956 the rookery contained 36 nests (J. M. Cunningham, pers. comm., 1956).

Three rookeries have been reported from Banks Peninsula, but their present status is unknown. A rookery on the south headland of Le Bons Bay was known to the late E. F. Stead (Davison, File I.A. 47/82), and two others were reported in replies to Dr Wodzicki's 1954 questionnaire, one at Long Lookout Point (Mr T. S. Craw) and the other at Okains Bay (Mr J. E. Thacker). Mr Thacker stated that rooks were first seen in the Okains Bay district in 1925, and that a rookery, containing several hundred birds in 1954, had existed there for about 25 years.

There are three rookeries in the Peel Forest district, but only one, the smallest, has been visited by the writer. It was situated in a dense plantation of *Pinus radiata* (Sheet S 91, grid 799055), some three miles south of Peel Forest Post Office, and contained about 50 nests. Two other rookeries, one of them large, are situated a mile or so to the west, and the total population of rooks in the district is said to be of the order of 2000 birds (J. Thatcher, pers. comm., 1956).

Rooks used to occur in a few districts where they are now absent. Apart from the early rookeries at Auckland and Nelson (Table 1), there was a rookery at Mt Biggs, in the Feilding district, but this was destroyed about 1925 (Dear, 1951). Between 1939 and 1950 a small number of rooks were seen regularly near Porirua, Wellington (K. R. Allen, pers.

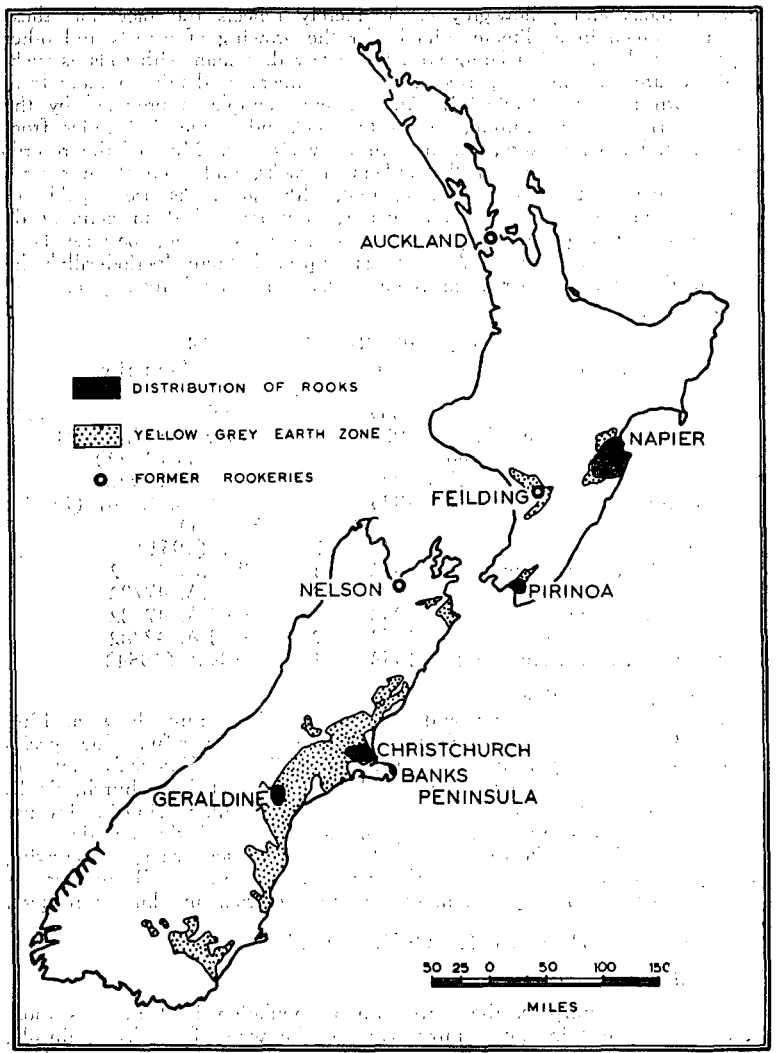

Fig. 1: Location of breeding populations of Rooks in New Zealand.

comm., 1956). During this period numbers increased from two to about five, but none were seen after 1950. Similarly, three rooks were frequently seen at Stoke, Nelson, about this time, but they disappeared in 1953 (J. Bullivant, *in litt.* 26.8.56). An article in the *Nelson Evening Mail* of 9.12.53 presumably refers to the same birds.

Fig. 1 shows the location of rook populations in relation to the distribution of a certain group of soils, the yellow-grey earths (Soil Map of New Zealand, 1948). It is interesting to note that, except for those on Banks Peninsula, all the known rookeries are located in or near the zone of yellow-grey earths, and even the rookery which used to exist near Feilding was on soils of this kind. It is probable that this apparent correlation

between rooks and yellow-grey earths merely reflects the fact that these soils are formed in a climate suitable for the growing of cereals and other crops, the real correlation being with land-use rather than with soils as such.

Rooks are sometimes reported in small numbers in districts remote from any known rookery (Table 2). An extreme example is provided by the specimen from Maungaturoto, in North Auckland, some 300 miles from the nearest known rookery, which is in Hawke's Bay. Most of the records in Table 2 refer to very small numbers of rooks, and even these records are infrequent. It seems, therefore, that, although rooks are capable of dispersing far from their breeding places, very few of them actually do this. The Feilding district provides a possible exception, because Dear (1951) stated that 'numbers' of rooks appeared there 'periodically'; he thought they came either from some undiscovered local rookery or from Hawke's Bay.

TABLE 2: DISPERSAL OF ROOKS

Locality	Year	No. of birds	Authority
Leeston, Canterbury	1869	1	*Lyttelton Times* (5.11.69)
Tutira, Northern Hawke's Bay	1907	6	Guthrie-Smith (1921)
Hicks Bay	before 1922	?	Thomson (1922)
Lake Taupo	before 1922	?	Thomson (1922)
Upokongaro, Wanganui	1935	1	M. J. S. Smart (*in litt.* 5.12.56)
Feilding	1949	?	Dear (1951)
Hunter Valley, Lake Hawea	1952	1	File I.A. 47/82
Wairoa district	1953	2	File I.A. 47/82
Ngongotaha, Rotorua	1953	1	File I.A. 47/82
Tauranga-Taupo River	1953	2	File I.A. 47/82
Maungaturoto, North Auckland	1953	1	Turbott (1954)

Summary of Distribution

Rooks were liberated in Auckland, Nelson and Christchurch between 1862 and 1873, but only the Christchurch liberation was successful. The species is now well established in two North Island districts (Hawke's Bay and Southern Wairarapa) and in three South Island ones (Christchurch, Banks Peninsula and Peel Forest), the main centres of population being in Hawke's Bay and near Christchurch; a rookery in the Feilding district was destroyed about 1925. Most of the rookeries are located in districts where the growing of crops is an important aspect of farm management. Small numbers of rooks are occasionally reported in districts remote from any known rookery.

(B) THE CHRISTCHURCH POPULATION

(a) Introductory Remarks

For the present purpose, the Christchurch population is defined as those rooks which breed in the country lying to the west of Banks Peninsula, and between the Waimakariri and Rakaia Rivers. No rookeries have been reported from the districts immediately north of the Waimakariri River, and the Banks Peninsula and Peel Forest rookeries, described in Section A above, appear to be discrete populations separate from the several rookeries, with overlapping feeding ranges nearer to Christchurch.

A preliminary investigation of the area was made on 21 and 22 August 1955, on which dates some of the outlying rookeries were still unoccupied. Further visits were made later in the breeding season (1 to 3 November and 16 November) to count the nests in the rookeries. Only limited information was collected during 1956, because the birds were disturbed by control operations – first the issue of a bounty on rooks, then an organised shooting drive, and finally a successful poisoning campaign. Mr K. H. Miers, of the Department of Internal Affairs, did some nest counts in early

October, just before the shooting, and the writer spent two days inspecting some of the rookeries at the end of October.

Information, of varying completeness and accuracy, was collected on forty-one rookeries which have existed in the Christchurch area at various times between 1872 and 1956 (Table 3), but only twenty of these rookeries were in use during the 1955 or 1956 seasons. The exact location of many of the abandoned rookeries is unknown, and there may be some duplication. For instance, 'Halswell', 'Lincoln-Prebbleton' and 'Prebbleton' may be three descriptions of the same rookery, or, alternatively, of the location of a single rookery at different periods. The columns in Table 3, listing the years in which rookeries were established or abandoned, represent approximations made by the author from the information available. Much of this information was supplied verbally and some of it was contradictory. The sources of information are too numerous for inclusion in the table, but most of them are mentioned elsewhere in the text. Mr Overton's rookery (No. 19 in Table 3) may be quoted as an example of the kind of approximations that have been made. In 1955 Mr Overton stated that his rookery had been in existence for many years, and he had known it personally for eight years, i.e. since about 1948. The rookery was apparently not known to Stead in 1947, but was in existence by 1951 (Davison, File I.A. 47/82). Its date of establishment has therefore been assessed as c. 1948, but of course it may have originated much earlier than this.

(b) Liberation and Early Spread (1871 - 1925)

According to Thomson (1922), five rooks were liberated 'in the gardens' in Christchurch in 1871, and a further 35 in 1873. By 1885 at least four rookeries were known, three of them near Cathedral Square and one at Fendalton; all are now deserted. The best known was the Daresby rookery, which dates from the 1870's, and was located in some tall bluegums (*Eucalyptus globulus*) on the property of the late Mr George Humphreys at Fendalton (D. Macmillan, *in litt.* 29.11.55). The Daresby rookery was much valued by its owner, who is reputed to have forbidden his employees to go near it during the nesting season (G. S. Barwell, pers. comm., 1956), and to have mentioned in his will his desire for its future preservation (*Christchurch Press,* 17.3.34).

The other three early Christchurch rookeries were located as follows:

(i) On the north side of Cathedral Square. These rooks were mentioned as early as 1872, a date which precedes the main liberation of 1873, and a few pairs still nested in the vicinity as late as 1899 (D. Macmillan, *in litt.* 29.11.55).

(ii) On Dr Prin's property, which is now the site of the City Council offices in Manchester Street. About 1884, rooks used to fly between this rookery and the one at Fendalton (*Christchurch Press,* 17.3.34).

(iii) On the property of J. P. Jameson, now occupied by St Mary's Catholic Presbytery in Colombo Street. This rookery was first established in 1880 (*Christchurch Press,* 17.3.34).

It is clear that, from the 1870's until the turn of the century, rooks were present both in the centre of the city and at Fendalton. The city rookeries seem to have been abandoned about the end of this period, and for the next twenty-five years or so the only occupied rookery near Christchurch appears to have been the Fendalton one. In the middle 1920's the bluegums began to die, and it was not long before some of the rooks were forced to use new nesting sites.

(c) Changes in Distribution (1925 - 1956)

As early as 1926, a few rooks had moved from the bluegums at Fendalton to some pines at Middleton, but no other rookeries were known at this time (Stead, 1927). The Fendalton rookery continued to decline during the following decade, and was finally abandoned between 1936 (D. Macmillan, *in litt.* 29.11.55) and 1938 (R. A. Falla, *in litt.* 1955). During this

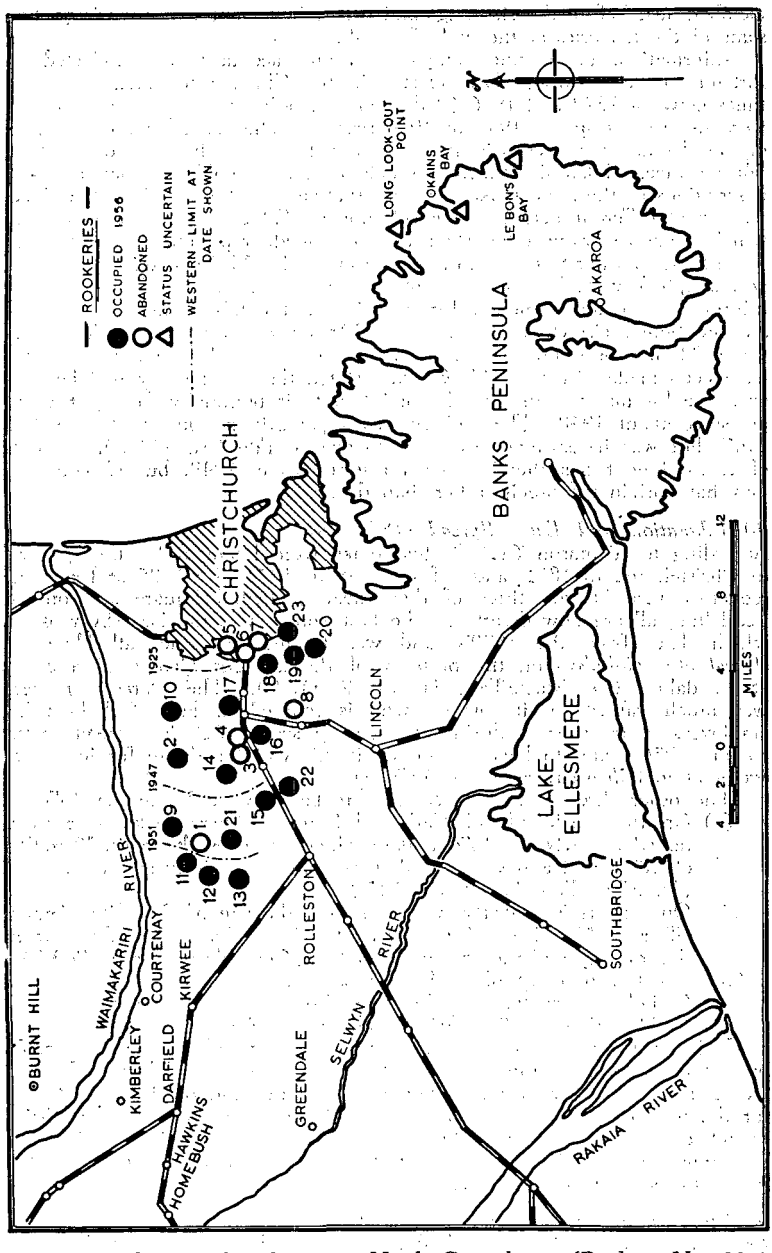

Fig. 2: Distribution of rookeries in North Canterbury. (Rookery No. 20 is incorrectly marked; it was occupied in 1955 but *not* in 1956.)

period several new rookeries were established in pines (probably *Pinus radiata*) at St Andrew's College and Templeton (D. Macmillan, *in litt.* 29.11.55), Sunnyside Mental Hospital (R. A. Falla, *in litt.* 1955), Paparua Prison (G. S. Barwell, pers. comm., 1955) and at Islington (M. B. Crequer, 1952 questionnaire).

The distribution of rookeries near Christchurch about 1946 - 47 is indicated by some notes made by Dr Wodzicki and Mr E. B. Davison following independent visits to the late E. F. Stead, who was a well-known authority on birds in Canterbury. At least 13 rookeries, scattered over an area of some 60 square miles, were occupied in or near Christchurch at this time (Table 3), and their western limit is bounded by a line running through Yaldhurst, Paparua, Islington and Halswell. This represents a considerable extension of the breeding range from the single rookery at Fendalton in 1925 (Fig. 2).

In July 1951 Davison collected further information on the distribution of rookeries by interviewing local farmers in the Christchurch area. Two new rookeries had been established since 1947, one on Mr Overton's farm opposite Mt Magdala on the Lincoln Road, and the other on Mr Watson's property near West Melton (File I.A. 47/82). The second of these represents a further western extension of the breeding range of the species. Four rookeries were abandoned between 1947 and 1951 (Table 3).

Finally, the distribution of rookeries in 1956 is supplied by the author's recent survey. A total of 19 rookeries were occupied in 1956 (Table 3), and these all lie to the west of the city and to the south of the Waimakariri River; the western limit of distribution is bounded by the West Coast railway, and the southern one by an east-west line running through Rolleston (Fig. 2). Three of the new rookeries are located to the west of any known in 1951, and the breeding range of the species now occupies an area of the order of 100 square miles. It is possible that some additional rookeries still remain to be discovered in outlying districts. For instance, there are unconfirmed reports of rookeries at Burwood (east of Christchurch city) and at Kimberley (G. S. Barwell, pers. comm., 1956), but the writer was unable to discover anything about these rookeries during brief visits to the districts concerned in October, 1956.

In Fig. 2, lines have been drawn to indicate the probable western limit of rookeries in 1925, 1947 and 1951 respectively, the 1925 line being based on Stead (1927), the 1947 one on Stead's unpublished material, as reported by Davison and Wodzicki, and the 1951 line on data collected from local farmers by Davison in that year. These lines must be regarded as approximate, because some rookeries probably existed for several years before they were reported. However, most of the older rookeries tended to be concentrated near Christchurch, while many of the newer ones are further to the west (Table 3 and Fig. 2). The three rookeries to the west of the 1951 line were not reported by Davison, and local residents state that two of them (Nos. 11 and 12 in Fig. 2) were certainly not established until 1952 (Messrs Fairburn and Wilson, pers. comm., 1955). It seems clear, therefore, that, since about 1925, the breeding range of the rooks near Christchurch has been steadily extending westwards. The dotted lines in Fig. 2 provide a rough indication of the rate of spread, which, over the whole period, is something of the order of a mile every two years, but probably faster after 1947 than before it. There has been no corresponding spread to the north or south (Fig. 2); indeed, with the disappearance of rookeries in the Halswell - Prebbleton area (Table 3) there has been a slight contraction in the southern boundary of the breeding range.

(d) Changes in Numbers

The earliest estimate of the Christchurch rook population is provided by Mr W. J. MacGibbon, who stated (*in litt.* 24.5.55) that 'forty years ago', i.e. about 1915, 'the main rookery was on the Humphrey's property on

TABLE 3: LOCATION AND HISTORY OF CHRISTCHURCH ROOKERIES

NAME OF ROOKERY	Reference No. (Fig. 2)	MILE TO INCH MAP Sheet No.	MILE TO INCH MAP Grid Ref.	Year Established	Year Abandoned	Stead (1946)	NEST COUNTS Bull (Nov., 1955)	NEST COUNTS Miers (Early Oct. 1956)	NEST COUNTS Bull (Late Oct. 1956)
Cathedral Square	–	S 84	003563	1872	c.1900	N.O.	N.O.	N.O.	N.O
Fendalton	5	S 84	965575	c.1873	1938	N.O.	N.O.	N.O.	N.O.
Colombo Street	–	S 84	003564	1880	?	N.O.	N.O.	N.O.	N.O.
Manchester Street	–	S 84	004564	c.1880	?	N.O.	N.O.	N.O.	N.O.
Sunnyside A	7	S 84	968538	c.1929	1930	N.O.	N.O.	N.O.	N.O.
Sunnyside B	18	S 84	962537	c.1930	S.O.	}	165	214	N.I.
Sunnyside C	18	S 84	959539	c.1930	S.O.	} 500	155	136	N.I.
Sunnyside D	18	S 84	958536	c.1930	S.O.	}	185	215	N.I.
Islington 'Works', A	4	S 83	884553	c.1930	c.1953	200	N.O.	N.O.	N.O.
Islington 'Works', B	4	S 83	884553	c.1930	c.1953	100	N.O.	N.O.	N.O.
St Albans	–	S 84	*	1934	?	N.I.	N.I.A.	N.I.A.	N.I.A.
Paparua A	14	S 83	853568	c.1935	S.O.	N.I.	206	314	237
Paparua B	14	S 83	844570	c.1935	S.O.	N.I.	57	158	64
'Bell's'	8	S 84	905510	1938	1939	N.O.	N.O.	N.I.	N.I.
'Mrs King's'	2	S 75	872612	c.1945	1953†	150	N.O.	20	N.I.
'Mould's'	15	S 83	834527	c.1945	S.O.	N.O.	139	114	90-111
Yaldhurst	–	S 83	*	1927–46	1947-50	150	N.O.	N.O.	N.O.
Sunnyside Orphanage	–	S 84	*	1927–46	?	N.I.	N.I.A.	N.I.A.	N.I.A.
Mt Magdala	–	S 84	*	1927–46	1947-50	150	N.O.	N.O.	N.O.
Halswell	–	S 84	*	1927–46	1947-50	25	N.O.	N.I.	N.I.
Sockburn	–	S 84	925553	1927–46	?	40	N.I.A.	N.I.A.	N.I.A.
Lincoln-Prebbleton	–	S 83	*	1927–46	1947-50	N.I.	N.O.	N.O.	N.O.
Hornby	–	S 84	*	c.1945	?	50	N.O.	N.O.	N.O.
Hornby Pipe Co.	17	S 84	909552	c.1946	S.O.	150	26	N.I.	N.I.
Lawford Farm	21	S 83	789551	c.1948	c.1950†	N.O.	N.I.	94	N.I.
'Mackays'	1	S 83	793595	c.1948	c.1951	N.O.	N.O.	N.O.	N.O.
Islington C	16	S 83	886544	c.1948	S.O.	N.O.	18	N.I.	N.I.
St Joseph's Home	6	S 84	962548	c.1948	c.1954	N.O.	N.O.	N.I.A.	N.I.A.
'Overton's'	19	S 84	954521	c.1948	S.O.	N.O.	65	48	49
'Robinson's'	13	S 83	748556	c.1950	S.O.	N.O.	206	172	136-184
Prebbleton	–	S 83	*	1951	1954	N.O.	N.O.	N.O.	N.O.
'Watson's'	–	S 83	*	1951	?	N.O.	N.O.	N.O.	N.O.
Templeton	3	S 83	875552	c.1951	c.1954	N.O.	N.O.	N.I.A.	N.I.A.
'Fairburn's'	11	S 75	774606	1952	S.O.	N.O.	45	57	48
'Wilson's'	12	S 83	748586	1952	S.O.	N.O.	35	71	N.I.
'Northcott's'	9	S 75	799619	1953	S.O.	N.O.	30	70	N.I.
Harewood	10	S 76	907624	1953	S.O.	N.O.	30	45	N.I.
Henderson's Road	20	S 84	965510	1955	1956	N.O.	9	N.O.	N.O.
'Cheeseman's'	22	S 83	841519	1955–56	S.O.	N.O.	N.I.	78	N.I.
Cashmere	23	S 84	985511	1955–56	S.O.	N.O.	N.I.	N.I.	10
Paparua C	14	S 83	865575	1956	S.O.	N.O.	N.O.	N.I.	20
TOTAL	–	–	–	–	–	1515	1371	1806	–

* Exact location in doubt
† Reoccupied in 1956 (Miers)
N.O. Not occupied
N.I. Not inspected
N.I.A. Not inspected, believed abandoned
S.O. Still occupied

Fendalton Road, where my observations would indicate there would be approximately 400 birds'. This may be a conservative figure, because Mr MacGibbon's estimate of the Canterbury rook population in 1955, 'between 1500 and 2000' (*in litt.* 24.5.55), is well below those of other observers. The number of rooks at Fendalton about 1926 is given by Stead (1927) as 'perhaps a thousand birds'. According to Dr D. Macmillan, who was closely associated with Stead, an estimate made by Stead about 1944 was 'perhaps as many as 4000 or as few as 2000' (D. Macmillan, *in litt.* 29.11.55). On the other hand, Davison's notes (File I.A. 47/82) state that in 1947 'there are a total of 1700 nests counted, and Mr Stead considers this a very accurate count', and again, 'E. F. Stead gave the number of rooks around Christchurch in 1947 as 7000' (File I.A. 47/82). An even larger population is suggested by Dr R. A. Falla, who wrote (1947) 'during an organised campaign of destruction of Canterbury rooks, about 5000 birds, representing half the breeding population, were killed by shooting and poisoning in the 12-month period up to 31.8.46'. The 1955 and 1956 surveys were limited to nest counts, and no estimates were made of the sizes of flocks. However, allowing for nests which were overlooked, the nest counts shown in Table 3 would suggest a breeding population of the order of 5000 birds, but the total population, including non-breeding birds, might be considerably higher than this, perhaps as many as 7000 birds. Mr G. S. Barwell (pers. comm., 1955) stated that some 6000 rooks roosted at Paparua in the winter of 1955. On the basis of the rough estimates quoted above, it would appear that from 1926 to 1947 the rook population increased from about 1000 to a figure somewhere between 7000 and 10,000 birds. This fairly rapid increase in the population does not appear to have been maintained, for the 1956 estimate falls within the range of those made in 1947.

Nest counts probably provide a better indication of changes in the size of the rook population than do estimates of the numbers of birds. However, nest counts are available only for the years 1946, 1955 and 1956 (Table 3), and even these counts are difficult to interpret. Stead's 1946 counts have been variously reported as totalling 1700 (Davison, File I.A. 47/82) and 1515 (Wodzicki, File A.E.S. 4/2/3); Wodzicki supplies totals for each rookery (Table 3), but Davison only a grand total, which appears to include rookeries at Paparua and Le Bons Bay, which are not mentioned by Wodzicki. In view of these facts, 1600 nests would appear a reasonable total figure for the Christchurch area in 1946. The writer's total of 1371 nests in 1955 (Table 3) should perhaps be increased to 1500, since he did not visit two rookeries where Miers counted 172 nests the following year. Similarly, Miers' total of 1806 nests might be increased to 1880 to include nests in four small rookeries which he did not visit, but which were counted by the writer in either 1955 or 1956 (Table 3). The available nest counts, adjusted as above, are therefore 1600 in 1947, 1500 in 1955 and 1880 in 1956. The 1947 figure of 1600 nests falls within the range of the two recent counts, and, allowing for observer error (about $\pm$ 300 nests), no great significance can be attached even to the difference between the 1955 and 1956 counts. On the basis of nest counts, therefore, it would appear that the breeding population has not increased significantly during the last decade. This result is in agreement with the conclusion drawn from an examination of the available estimates of the total population.

These conclusions conflict with the opinion of many local farmers, who consider that the rook population has greatly increased during recent years. For example, Mr Overton stated (pers. comm., 1955) that during the last eight years the population at his rookery had been increasing by about one-third each year. It must be admitted that the available nest counts and estimates of the rook population are so few, and subject to such large errors, that they might fail to reveal anything but a large change in the

size of the rook population. The possibility of some increase in the rook population in recent years cannot be ruled out on the basis of the data described above, but the substantial increase reported by many farmers may be deceptive. Individual rookeries may increase in size, due to the arrival of adult birds from other rookeries which have been disturbed by control measures. Similarly, new rookeries may become established without any increase in the total population (Table 3), and this matter is discussed further in the next section.

(e) Some Effects of Control Operations

Towards the end of 1956, large numbers of rooks were killed at Paparua by officers of the Department of Agriculture who were testing the effectiveness of a new poison, sodium fluoracetate (1080). However, during the period covered by the present paper, the main methods of control have been shooting the birds at their rookeries and cutting down the trees used for nesting; poisoning, trapping and various scaring devices have been tried occasionally, but with limited success. Control measures were applied sporadically until about 1945 and with considerable vigour and co-ordination thereafter. These measures have had two main effects: they have resulted in the death of a considerable number of rooks, and they have caused the birds to extend their breeding range.

Large numbers of rooks have been shot in the Christchurch area each year since 1945, but it is mostly the young birds that are killed. Falla's (1947) figure of 5000 birds destroyed during the year ending 31 August 1946 is probably above the average for the post-war years, but, according to information supplied by local farmers, the annual kill frequently amounts to some two to three thousand young birds. The effect of this mortality on the rook population as a whole is uncertain, and the matter is considered further in the discussion (Section 4 below).

The cutting down of trees in which rookeries are located has an obvious effect in dispersing the birds, because they are frequently forced to move considerable distances to find other trees which are suitable for nesting. Rookeries were abandoned at 'Mrs King's', Lawford Farm and 'Mackay's' (Table 3) after trees had been cut down or topped at these places. The birds from 'Mrs King's' moved to Harewood about 1953 (Mr MacArthur, pers. comm., 1955), a distance of about two miles, but by 1956 at least twenty pairs of rooks were again nesting at 'Mrs King's', and the Harewood rookery also remained occupied (K. H. Miers, pers. comm., 1956). Similarly, the Lawford Farm rooks moved to 'Robinson's' about 1950 (T. Fairburn, pers. comm., 1955), again a distance of about two miles, but in 1956 rooks nested at both Lawford Farm and 'Robinson's' (Table 3). The trees at 'Mackay's' were cut down about 1951 and the birds established two new rookeries at 'Fairburn's' and 'Wilson's' (T. Fairburn, pers. comm., 1955), which properties are respectively one and two miles from 'Mackay's'. In each of the three examples mentioned above, the cutting down of nesting trees has resulted in the eventual establishment of two rookeries instead of one, and also in an increase of about two miles in the breeding range of the species. The subsequent re-occupation of two of the abandoned sites may be explained by the conservative nesting habits of rooks and by subsequent growth of unfelled trees near the site of the old rookery. The fact that the protected rookery at Fendalton persisted for some fifty years without giving rise to any daughter-rookeries suggests that those at 'Mrs King's', Lawford Farm and 'Mackay's' would have done likewise if they had been left undisturbed.

The shooting of birds at the rookeries sometimes causes the rooks to find new nesting sites elsewhere. According to Mr Bell (pers. comm. 1955) a rookery which became established near his homestead about 1938 was vacated within a year as a result of shooting. Mr M. B. Crequer, in replying to Dr Wodzicki's 1952 questionnaire, supplied a detailed account of a similar experience at Islington. About 1930 a rookery became estab-

lished at the Freezing Works, and flourished until about 1945. Shooting was then started because the rooks were thought to have driven away the gulls which formerly were very numerous and served a useful purpose in removing pieces of offal from the drainage ponds. About 2000 rooks were present in 1945, and the nests (250 - 275) were confined to one end of a clump of trees. During 1945, 434 rooks were shot; the old rookery declined in size, but two new ones appeared nearby. In the third year of shooting there were 97 nests in the old rookery and 45 in the new ones. Continued shooting broke up the rookery still further into four small rookeries with a total of about 60 nests, but many other birds moved further afield to establish new rookeries at Hornby Mental Hospital, Islington Main Road, Sockburn By-products Company, St Joseph's Boys' Home, Templeton Golf Links and Lawford Farm. By 1953 the Freezing Works rookeries had all been abandoned; the fates of the daughter-rookeries are summarised in Table 3. The shooting at Islington (1656 birds killed 1945-50) apparently caused the birds to establish a considerable number of new rookeries, but later there was a redistribution between the rookeries, the less-favourable ones being abandoned and the more favourable rapidly increasing in size.

In other instances rookeries have persisted despite frequent shooting, for example the rookeries at Sunnyside, Paparua, 'Wilson's' and 'Fairburn's' (Table 3). The important factors in deciding whether or not shooting will cause a rookery to be abandoned are probably the suitability of the trees for nesting purposes and the length of time the rookery has been established. The Islington rookery was located in some rather stunted trees, and at Prebbleton shooting was started within a few months of the birds' arrival.

(f) Miscellaneous Observations

There has been a change in the kind of trees preferred by rooks for nesting purposes in the Christchurch area. This was first noted by Stead, who stated (1927), 'Rooks have hitherto nested almost exclusively in bluegums (*Eucalyptus globulus*) in Christchurch. At first they nested in the extreme tops of the trees, but the heavy winds so often dislodged the nests or their contents that the rooks took to building on more solid branches. Owing to diseases, the bluegums are rapidly dying out, and the rooks are now being forced to take to other trees, and are already occupying some pines at Middleton. I have never known them to nest here in either oaks or elms, their favourite trees in England.' Information collected during the recent survey confirms Stead's observations. Of 28 rookeries in which the kind of tree was known, five were in eucalypts (mostly *E. globulus*), twenty in pines (mostly *Pinus radiata*) and three in mixed plantations, two (Sunnyside B and 'Mould's' in Table 3) of conifers (*Pinus* and *Cupressus*), and one of pines and eucalypts ('Robinson's'). Three of the five rookeries in eucalypts (Cathedral Square, Manchester Street and Fendalton) were established before 1900, one (Sunnyside A) was established about 1929, but soon abandoned (A. R. Andrews, pers. comm., 1955), and one ('Cheeseman's') was established in 1955 or 1956 in some unusually tall and healthy-looking trees. All of the 23 rookeries in pines or mixed plantations were established after 1926. Most rookeries are situated in fairly tall trees which provide a good view over the surrounding country and have few branches at lower levels; such trees are usually in isolated groups ('Fairburn's' and 'Mould's'), sometimes in long shelter belts (Paparua and Sunnyside D) and occasionally in small plantations ('Robinson's' and 'Wilson's'). It is probable that the situation and form of trees are of more importance than the actual species as such. Losses of nests and contents through the effects of strong winds, as mentioned by Stead (1927), are not confined to eucalypts; considerable losses sometimes occur when the birds nest in 'the taller whippy tops of younger pines', and in one instance 500 young rooks were found on the ground under a rookery after a strong

wind (Davison in File I.A. 47/82).

Nothing has been recorded concerning the breeding season of rooks in New Zealand. In England the species is normally single-brooded and begins breeding in late March or early April; incubation takes 16 to 18 days and fledging 29 to 30 days (Witherby *et al.*, 1943). On 21 August 1955 birds were carrying nesting material at Paparua and Sunnyside, but some of the outlying rookeries were still unoccupied. On 1 November most of the rookeries contained well-feathered young, many of them out of the nest and a few already flying. Using Witherby's fledging period of 29 to 30 days, this would suggest that hatching had occurred about 1 October. In 1956 birds were building at Paparua and at 'Mould's' on 7 September, but apparently not yet laying. On 1 October Mr Miers found that at 'Robinson's' rookery, several of the nests contained newly-hatched young, but many others still had eggs. On 30 October a few young had just begun to leave the rookery at Paparua (G. S. Barwell, pers. comm., 1956). The above observations suggest that laying begins about the middle of September and that the eggs hatch early in October; some birds nest later, possibly as a result of the destruction of earlier nests. In both 1955 and 1956, hatching began about 1 October in the Christchurch area, and this is nearly three weeks ahead of the Pirinoa rookery in the Wairarapa, where, according to Mr H. Warren, hatching occurred about 20 October 1956 (J. M. Cunningham, *in litt.* 9.4.57).

The only detailed information available on clutch size and hatching success of rooks in New Zealand was obtained by Mr M. B. Crequer, who examined forty nests at Islington before and after hatching. Clutch size varied from two eggs to five eggs, the relative frequency being eight clutches of two eggs, ten of three, twenty-one of four, and one of five (M. B. Crequer, *in litt.* 21.7.56). The mean clutch size is 3.4, which is lower than the figures reported by Lockie (1955) in Britain, 4.3 in early clutches and 3.5 in late ones; it is likely that some of the clutches counted by Crequer were incomplete, so his figures must be regarded as minimum ones. Crequer found that, after hatching, eight nests had two young, thirty had three, and two had four, but there were still some unhatched eggs in some of the nests. On the basis of Crequer's two counts, 84½% of the eggs hatched, and this is very similar to Lockie's figures, which varied from 82% to 88%, depending on the size of clutch.

More information is required on the seasonal movements of rooks. In spring the birds are distributed among the various occupied rookeries listed in Table 3, but many of these rookeries are deserted after the breeding season. According to Mr G. S. Barwell (pers. comm., 1955), a large part of the Christchurch rook population congregates at Paparua about the end of March (up to 6000 birds have been seen) to roost in a plantation of pines behind the prison; this roosting plantation is quite separate from the shelter belts in which the birds nest. The rooks leave the roost soon after daybreak and return to Paparua again in the evening. The winter flock breaks up into the various breeding flocks during August. Mr Barwell's observations are supported by Mr Mould, who stated that, although birds visit his rookery during the day, they do not roost there in winter (pers. comm., 1956). It is possible that there is another small winter roost at Sunnyside, but this requires confirmation. It is interesting that Paparua and Sunnyside, which are the oldest surviving rookeries, are also the largest centres of the rook population in both spring and winter. In spring the three sub-rookeries at each of these two places together contain 57% of all the nests counted in the Christchurch area (Table 3). During the nesting season rooks appear to forage within a few miles of the rookery; and even in winter, judging by the localities where the birds are seen, the feeding areas usually lie within a radius of less than ten miles of the roosting place. Occasionally odd birds or small flocks are seen further afield. According to Mr Fairburn, rooks have been reported in varying numbers

from Burnt Hill, Kimberley, Darfield, Homebush, Hawkins, Greendale, Kirwee, Courtney and Sumner (Fig. 2). He has twice seen dead rooks on the road near Hinds. Mr Copp, of Crop Research, D.S.I.R., stated that rooks occasionally appear at Lincoln, but only in small numbers. Rooks were recorded at Darfield as early as 1947 (H.S.G. 1948). Except for the record from Burnt Hill, rooks do not appear to have been observed north of the Waimakariri River.

(g) Summary

Rooks were liberated in Christchurch in 1871 (five birds) and 1873 (thirty-five birds), and rookeries were soon established in eucalypt trees in the centre of the city and at Fendalton, but only the Fendalton one was occupied after 1900; it contained 400 birds in 1915 and 1000 in 1926, but the trees were already dying and the site was abandoned by 1938. By 1947, thirteen new rookeries, distributed over some sixty square miles and containing about 1600 nests, had been established in pines to the west of the city. A further spread to the west was observed in 1951, and again in 1956, when the most distant of the nineteen occupied rookeries (distributed over an area of about 100 square miles) was some fifteen miles to the west of Fendalton. Control measures, especially shooting and tree felling, may have had some effect in limiting the rate of population increase (only 1500 to 1880 nests were counted in 1955 - 56), but have probably accelerated the spread of rooks. The change from eucalypts to pines as preferred nesting trees is discussed, and limited observations are presented on breeding season, clutch size, hatching success, winter roosts and feeding range.

(C) THE HAWKE'S BAY POPULATION

(a) Introductory Remarks

Information on the present distribution of rookeries in Hawke's Bay was collected during two brief visits to the district in October 1956 and February 1957 respectively. The information collected, together with additional data obtained during subsequent correspondence with local residents, is summarised in Table 4. The table lists a total of 29 rookeries, and at least 26 of these were occupied during 1956, two (Poraiti and Otane) are of uncertain status, and one (Patoka) was definitely abandoned some years ago (H. E. Crosse, *in litt.* 14.2.57). The Poraiti rookery was reported by Mr R. Williams (D. H. Brathwaite, *in litt.* 5.12.56), and the Otane one by Mr E. A. Bloxham (pers. comm., 1957), who was uncertain of its exact location and present status. No counts are available from these two rookeries, nor from the ones at Glencoe and near Awatea which were reported by Mr E. Clarkson (pers. comm., 1957). All the other rookeries were counted, the one on the north side of Bluff Hill, Napier, by Mr J. Turnbull (D. H. Brathwaite, *in litt.* 5.12.56), the ones at Waipukurau and Mangarouhi by Mrs R. Giblin (*in litt.* 28.1.56), and the one at Mangakuri by Mr S. R. Williams (*in litt.* 17.3.57). Nests in the remaining twenty rookeries were counted by the author, seventeen of them in October 1956 and three (Atua, Taheke and Clareinch) in February 1957, when the birds were no longer present. For ease of reference, the Hawke's Bay data are presented below under the same headings and in the same order as in the account of the Christchurch population.

(b) Liberation and Early Spread (1871 - 1925)

The earliest reference to rooks in Hawke's Bay is supplied in an account of the introduced birds of Scinde Island (Hutchinson, 1900), where it is stated 'wanderers from the Puketapu rookery flap over the island at times'. The origin of this Puketapu rookery is uncertain. Thomson (1926) suggests that the rooks, originally liberated in Auckland, eventually moved to Hawke's Bay, but Guthrie-Smith (1921) stated that some rooks were liberated near Hastings. This latter view is still held by some Hawke's Bay residents, who believe that the original liberation was made at Fernhill. However, Mr V.

TABLE 4: HAWKE'S BAY ROOKERIES

NAME OF ROOKERY	Serial No. Fig. 3	MILE TO INCH MAP Sheet No.	Grid Reference	NEST COUNTS (MID - OCTOBER 1956) A	B	C	D	Mean
Hospital, Hastings (A)	1	N.134	241229	104	104	99	–	102
Fernhill	2	N.134	182274	47	48	–	55	50
Marine Parade, Napier	3	N.134	334380	11	11	11	–	11
Irongate Road	4	N.134	185227	306	300	269	–	292
Valley Road (A), Maraekakaho	5	N.134	087168	132	141	126	–	133
Valley Road (B), Maraekakaho	6	N.134	079148	–	6	–	–	6
Raukawa	7	N.134	082104	38	36	33	–	36
Longlands	8	N.134	226175	–	61	61	–	61
High School, Hastings (B)	9	N.134	257205	6	6	–	6	6
Dartmoor	10	N.124	128402	48	46	–	42	45
Rissington	11	N.124	139442	134	140	–	142	139
Okawa (A)	12	N.134	120328	37	31	–	36	35
Okawa (B)	13	N.134	098334	75	90	–	86	84
Roy's Hill	14	N.134	123217	184	188	–	192	188
Maraekakaho Road	15	N.134	112207	17	16	–	17	17
Havelock North (A)	16	N.134	296178	1	1	–	–	1
Havelock North (B)	17	N.134	288182	9	9	–	–	9
Waipukurau	18	N.146	995725					3†
Mangarouhi	19	N.146	066703					9†
Glencoe	20	N.134	005155					?†
Near Awatea	21	N.134	986155					?†
Atua	22	N.141	238808					c.20*
Taheke	23	N.141	990089					c.20*
Clareinch	24	N.146	268735					c.10*
Napier	25	N.124	330410					c.7†
Mangakuri	26	N.141	303807					20†
Poraiti	27	N.124	260403					?
Otane	28	N.141	058905					?‡
Patoka	29	N.124	?					a

* Post breeding counts: 16 February 1957
† Reported by local residents
‡ Existence in doubt
a Abandoned (1948)

Hill, the present owner of the property on which the Fernhill rookery was situated, is emphatic that rooks were not introduced by his late father, but that they appeared of their own accord in the early years of the century, and established a rookery in a plantation of eucalypts behind Mr Hill's house. This information, together with Hutchinson's remark, suggests that the Puketapu rookery was established before the Fernhill one, and, since Thomson's suggestion of natural spread from Auckland seems improbable, it is likely that the birds reached Puketapu by human agency.*

As early as 1915, rooks were sufficiently numerous near Sherenden for a local farmer to request the lifting of protection, and in 1917 similar representations were made by orchardists near Hastings (File I.A. 47/82). Thomson (1922) recorded that a rookery had 'for long existed in Puketapu', and that one had started in Petane (just north of Napier and now called Bay View). A rookery at Rissington has been in existence for thirty-five years or more (Mr Absolom, pers. comm., 1956) and one at Maraekakaho for about twenty-five years (M. F. Greenwood in the 1952 questionnaire). The distribution of rookeries in the 1920's thus extended from Napier to Rissington and then south at least as far as Maraekakaho and Hastings.

(c) Changes in Distribution (1925 - 1956)

Apart from the information outlined in the previous section, nothing was known of the distribution of rookeries in Hawke's Bay until the author's survey was carried out in 1956. Fig. 3 shows that the Hawke's Bay rookeries are clustered in two groups, a large northern one centred on Hastings and a much smaller southern one in the Waipukurau - Elsthorpe area. On present knowledge, the two groups are separated by some 20 miles of country in which only one rookery (Otane) has been reported, and the exact location and status of this one are in doubt.

The 22 rookeries in the northern group extend from Rissington in the north to Raukawa in the south, and from the sea at Napier in the east to a distance of some 20 miles inland near Maraekakaho in the west. This distribution is substantially the same as that already reported as existing in the 1920's, and thus, during the last thirty years or so, there appears to have been no significant increase in the range of the species in this northern area. The establishment of a rookery at Patoka during the last war represented a temporary northward extension of the range, but the rookery gradually declined in size and was abandoned about 1948 (H. E. Crosse, *in litt.* 14.2.57).

The five known rookeries in the southern group (Waipukurau - Elsthorpe area) are all fairly small (Table 4), and most of them are of recent origin. The Mangarouhi one was established about 1952 and the Waipukurau one a year later (Mrs R. Giblin, *in litt.* 28.1.57). According to local residents, the Atua and Clareinch rookeries are both less than ten years old. The oldest of these southern rookeries appears to be the one at Mangakuri, which has been in existence for 'many years' (S. R. Williams, *in litt.*, 17.3.57). Although it is possible that these five rookeries developed from some unrecorded liberation, their small size and comparatively recent origin strongly suggest that they represent a southern extension of the northern group. Assuming that in 1925 the southern limit of distribution of the Hawke's Bay rookeries was in the vicinity of Maraekakaho, the new Waipukurau and Mangarouhi rookeries represent a southern extension of the range by some twenty-six miles in twenty-eight years, or about one mile per year. This is a maximum rate of spread because it is quite possible that rookeries existed south of Maraekakaho even in 1925. Thus, the Hawke's

*According to Mr O. R. Bostock, a very old identity of Fernhill, rooks were first brought to Hawke's Bay by the Acclimatisation Society, who released them at Meeanee. These birds soon moved to Puketapu, where they increased in numbers and then established a second rookery at Fernhill (O. R. Bostock, pers. comm., 15.5.57).

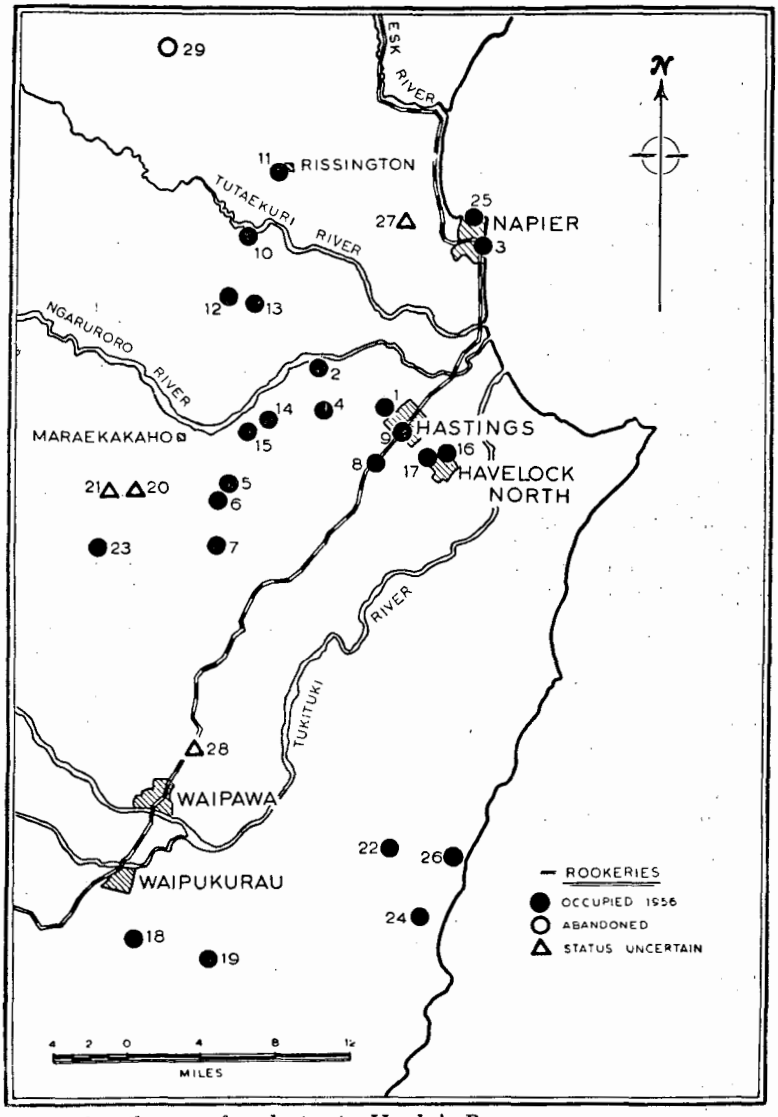

Fig. 3: Distribution of rookeries in Hawke's Bay.

Bay rook population has been extending its breeding range to the south only slightly faster than the slow westerly spread of the Christchurch population described in Section B (c) above.

(d) Changes in Numbers

No estimates of the size of the Hawke's Bay rook population in past years have been found, but some indication of the size of the breeding population in 1956 may be obtained from the nest counts summarised in Table 4. The twenty-three rookeries for which counts are available contain a total

of 1304 ± 253 nests (Table 4), but this is a minimum figure. Allowing for nests which were overlooked in the counting, and also for the four uncounted rookeries, a total breeding population of the order of three or four thousand adult birds is indicated.

The northern group of rookeries alone contains a total of at least 1242 ± 241 nests distributed among twenty-two rookeries, and these are distributed over an area of some 300 square miles, which is about three times the area occupied by the twenty Christchurch rookeries with a slightly larger number of nests, 1371 ± 267 to 1806 ± 351 (Table 3). Inclusion of the southern group of Hawke's Bay rookeries in these figures would greatly increase this difference in density between the Hawke's Bay and Christchurch rook populations.

Although the available data are inadequate to demonstrate any changes in the size of the rook population as a whole, there have been considerable fluctuations in the number of birds breeding at individual rookeries. However, most of these changes are associated with the application of control measures, and, for this reason, it is convenient to describe them in Section *(e)* below.

(e) Some Effects of Control Operations

In Hawke's Bay, as in Canterbury, rook control has involved mainly shooting drives and the felling of trees in which rookeries are located. For many years these activities were carried out sporadically by individual farmers, but, after the last war, a Rook Extermination Committee was formed in Hastings by local farmers and by firms concerned with the freezing and canning of vegetables (M. F. Greenwood, 1952 questionnaire); control activities were then applied with more vigour and co-ordination. Over the years these control operations have caused changes in the size and location of rookeries; some of the older ones have declined in size, but several new ones have been established.

A few years after its establishment at the beginning of the century the original Fernhill rookery contained 'thousands' of birds, but the population began to decline during the early 1920's; this decline, which finally resulted in the rookery being abandoned, coincided with the cutting down of trees and the holding of shooting drives organised by the County Council (Mr V. Hill, pers. comm., 1957). There has also been a decline in the number of rooks breeding at the Maraekakaho and Dartmoor rookeries (numbers 5 and 10 in Table 4). Mr M. F. Greenwood stated that his rookery (No. 5) had declined as a result of shooting (650 young birds were shot in 1950) and the cutting down of some trees. According to Mr Lowry, the number of birds in the Dartmoor rookery (No. 10) had been reduced from over 3000 to about 500 by regular shooting and poisoning. It is also possible that loss of suitable nesting sites has been a contributing factor in the declines of certain rookeries. At Dartmoor, several nests were located in dead trees which could not remain standing many more years. Similarly, several of the poplar trees occupied by nests in the Longlands rookery (No. 8) were dying from the top. At Rissington, however, the cutting down of trees merely resulted in some of the rooks moving to other trees across the river, and the total population has remained roughly constant for a period of some 35 years (Mr Absolom, pers. comm., 1956).

Among new rookeries, the one near Hastings Hospital is of interest on account of the rapidity of its growth. According to a local resident, the first rooks appeared about 1954, and six pairs nested; there were many more birds in the following year and more still in 1956 (102 nests, Table 4). Increases of such magnitude can only be explained by the arrival of adult birds from other rookeries, and it is perhaps significant that shooting drives were being held in the district shortly before the hospital rookery was established. Several other small rookeries also came into being about the same time. The Okawa rookery (No. 12) was first occupied about 1954

(Mr Lowry, pers. comm., 1956), the Napier one (No. 3) also about this time (D. H. Brathwaite, pers. comm., 1956), and the Mangarouhi and Waipukurau ones in 1952 and 1953 respectively (Mrs R. Giblin, *in litt.* 28.1.57). The Roy's Hill rookery (No. 14), which is alleged to be of long standing, was deserted in 1955 (B. Slade, pers. comm., 1956), but reoccupied in strength in 1956 (Table 4). Shooting and tree-felling at the original Fernhill rookery caused first a splitting up of the rookery into sub-rookeries, and then final abandonment of the site (Mr V. Hill, pers. comm., 1956); the present rookery behind the Fernhill Hotel probably represents a modern remnant of the original large one on Mr Hill's property half a mile away.

(f) Miscellaneous Observations

Of the twenty-nine rookeries listed in Table 4, twelve are in eucalypt trees, four (Nos. 1, 2, 4 and 14) in both eucalypts and pines, one (No. 11) in eucalypts and poplars, two (Nos. 8 and 10) in poplars and pines, and one (No. 3) in Norfolk Island pines; in nine rookeries (Nos. 18 - 21 and 25 - 29) the kind of trees involved is unknown. Thus, in Hawke's Bay, four different kinds of trees are used by rooks for nesting, but, unlike the situation in Canterbury, most of the rookeries are in eucalypts.

On 15 October 1956 the breeding season was already well advanced in Hawke's Bay; most of the eggs appeared to have hatched and a few young birds were already fluttering about in branches near the nests. This observation suggests that rooks in Hawke's Bay may start laying a week or so ahead of those in Canterbury.

Large communal winter roosts occur in Hawke's Bay as well as in Canterbury. According to Mr Absolom (pers. comm., 1956), in winter large numbers of rooks — more than the number breeding at the rookery — roost in a plantation behind his home near Rissington. A second roost is probably located between Maraekakaho and Tikokino, because a flock of about one thousand rooks was seen in this area at dusk on 16 February 1957.

(g) Summary

The origin of the Hawke's Bay rook population is unknown, but a rookery existed at Puketapu in 1900, and by the middle 1920's there were others near Napier, Rissington, Fernhill, Hastings and Maraekakaho. In 1956 at least twenty-six rookeries, mostly in eucalypts, were occupied, and twenty-four of these contained a minimum of 1304 $\pm$ 253 nests; rookeries recently established in the Waipukurau - Elsthorpe area represent a southern extension of the breeding range which is much larger, though less densely populated, than that of the Christchurch population. A post-war intensification of control measures has been accompanied by changes in the distribution of the rook population, and by the establishment of several new rookeries. Winter roosts occur near Rissington and in the Maraekakaho - Tikokino area.

4. DISCUSSION

The restricted distribution and slow rate of spread of rooks in New Zealand (Figs. 1 and 2) are of particular interest. Many other passerine birds, introduced about the same time as the rooks, soon spread to all parts of the country (Thomson, 1922) and subsequently to many of the outlying islands (Williams, 1953). It is unlikely that rooks have already filled all the habitats which are suitable to them in New Zealand because the species has a wide distribution in Europe, and, although it prefers agricultural country, it is generally distributed throughout the British Isles in places where trees exist (Witherby, *et al.*, 1943). In New Zealand the differences between, for example, central and southern Hawke's Bay or between Christchurch and Timaru are unlikely to constitute barriers to the spread of such a species. Indeed, there is good evidence that rooks are in fact increasing their breeding range in Hawke's Bay and Canterbury, but the rate of spread — one mile per year or less — is very slow. It is evident from Table 2

that, under New Zealand conditions, individual rooks have considerable powers of dispersal. Why then is the spread of the species in New Zealand so slow? A provisional answer to this question may be obtained from the history of some of the early rookeries.

Rooks survived at Nelson and Auckland for a few years after their liberation, but they finally disappeared (Table 1). In Auckland, where a large number of rooks were liberated, some of the birds died from disease, and it was suggested that the climate was too warm (Thomson, 1922). Early liberations in Christchurch were also unsuccessful, but the species eventually became established after the liberation of a substantial number of birds in 1873. Rooks soon appeared in remote parts of the country (Table 2), but few, if any, of these vagrant birds were able to establish new colonies. Rookeries in the centre of Christchurch were abandoned by the turn of the century, and for many years the carefully protected Fendalton rookery was the only one in the district. The number of breeding birds at Fendalton apparently remained fairly constant for a large part of the period during which the rookery was occupied, and perhaps the number of young that could be reared was limited by the availability of food within convenient flying distance of the rookery. The rooks apparently showed a very strong tendency to return to the bluegums at Fendalton for nesting, and for many years any dispersal of young birds that may have occurred failed to result in the establishment of new rookeries. Eventually the trees began to die and the birds were gradually forced to move to new nesting sites in pine trees at Sunnyside, Islington and Paparua. Perhaps as a result of the new food supplies now available, or the more secure nesting sites provided by the pine trees, each of the new rookeries increased in size. Some years later, a similar fragmentation process was repeated at Islington, where the break-up of a large rookery was caused by persistent shooting. Numerous small rookeries were at first formed, but many of these were soon abandoned, the birds presumably moving to join other rookeries in more favourable sites. The history of the Hawke's Bay rookeries is less complete, but shows a similar trend. For many years the only known rookeries were located at Puketapu and Fernhill, and the eventual disruption of these by shooting led to the formation of several new rookeries.

From the above summary it seems that three sets of factors have been important in controlling the distribution and rate of spread of rooks in New Zealand. These are the behaviour of the bird, the influence of man and the nature of the environment. Unlike most other introduced passerines, the rook is a gregarious species at all seasons of the year, engaging in communal displays (Witherby, *et al.*, 1943), nesting in colonies, feeding in flocks, and in winter occupying large communal roosts. It seems probable that an integrated flock of certain minimum size is a necessary component of an optimum environment for the species. Secondly, the birds have a strong tradition of breeding in the same place in successive years, provided they are undisturbed. The long persistence of single rookeries of large size at Fendalton, Puketapu and Fernhill provides a striking demonstration of the importance of traditional nesting places to both the adults and young of the species. Although some birds disperse far from the main rookeries (Table 2), these individuals rarely succeed in establishing new rookeries. The need for a flock of a certain minimum size may explain the failure of some of the early introductions involving the liberation of only a few individuals; the eventual disappearance of the few birds which were resident for several years at Porirua and Nelson (Section 3A) may have a similar explanation. Admittedly, some rookeries contain very few nests (Nos. 6, 9 and 16 in Table 4), but such rookeries are usually of recent origin and may have been started by birds driven from older rookeries by human disturbance, as at Islington. Such rookeries are often soon abandoned (Nos. 3 and 6 in Table 3), or increase in size at a much faster rate than would

be expected from reproduction (No. 1 in Table 4), thus implying that the rookery is being swelled by immigrants from less favourable rookeries.

Human influence affects the distribution and spread of rooks in several ways. Pre-European New Zealand contained few suitable habitats for rooks, but the clearing of bush and scrub, the planting of introduced trees for shelter and the growing of crops, especially cereals, have changed large areas of the country into a condition resembling the normal habitat of the species in Europe. Man has also been important in determining the points of liberation. The present rook population in the Christchurch district has certainly developed from birds liberated there by man (Thomson, 1922), and the Hawke's Bay and Peel Forest populations probably have a similar history (Section 3A). The origin of the Pirinoa and Banks Peninsula rookeries is unknown, but the influence of man cannot be excluded absolutely even from these. Thus the modern distribution of the species still reflects strongly the pattern of the original introductions, although subsequently there has been some natural spread into districts adjacent to the points of liberation. Finally, man has an important influence in increasing the rate of spread. The adoption of control measures involving the disturbance of nesting birds has sometimes caused the fragmentation of large rookeries much sooner than would be expected by natural means. The protected Fendalton rookery existed for over fifty years before the death of the trees forced the birds to establish new rookeries; at Islington the same result was achieved by man's influence in less than twenty years. In both instances the fragmentation of the single large rookery was apparently followed by a substantial increase in the total rook population. It might be thought that the large number of young birds shot at the Christchurch rookeries would be important in controlling the growth of the rook population, yet many farmers consider that the birds have continued to increase at an alarming rate, a view which is not supported by the data presented in this paper. However, even if the growth rate of the population has declined since 1947, this could be explained by factors other than the effects of human control. It is well known that, given a favourable environment, many animal populations follow the same growth curve. This involves three components: a slow initial phase of increase, then an extremely rapid one, and finally a gradual levelling-off, often with minor fluctuations. The Canterbury rook population seems to have passed through the first two of these stages, the period of rapid increase occurring between 1935 and 1950. The population density is now comparable to that characteristic of many parts of Britain (see below), and one might therefore expect a decline in the rate of increase. The large number of young birds shot may be doing no more than forestalling natural mortality. This interesting and important point is worthy of detailed study.

The influence of the environment on the distribution of rooks in New Zealand is largely unknown. Certainly the species appears to tolerate a wide range of conditions in Europe, but it is possible that some of the less favourable environments are populated mainly by birds reared in nearby favourable ones. It is perhaps significant that the relatively large number of rooks liberated in the sub-tropical climate of Auckland should have failed to survive (Table 1)*, because in Europe rooks occur mainly in areas with sub-arctic to temperate climates and reach the Mediterranean only

* This statement is based on Thomson (1922), whose last reference to rooks in Auckland is 'not doing well' in 1874. However, information recently supplied by Mr E. G. Turbott (*in litt.* 16.4.57) shows that rooks probably survived in Auckland until about 1905, and that they were quite numerous in the 1880's. Rookeries were known at Newton Road, Carlton Gore Road, Cowie Road and near Government House, and there were probably two others in the Auckland Domain and near St Mary's Hall, Parnell, respectively; these six rookeries were not all in use simultaneously.

in winter (Witherby, *et al.*, 1943). The New Zealand rookeries are all situated on the drier eastern side of the country (Fig. 1), and, except for Banks Peninsula, are in districts where cropping is an important aspect of farming practice. The distribution of this kind of farming is considerably greater than that of rooks in both Hawke's Bay and Canterbury, and, other factors being equal, an eventual further extension in the range of the birds is therefore to be expected in the future. On the basis of population density, the Christchurch district appears to be no less favourable to the birds than are many parts of the British Isles. According to Witherby, *et al.* (1943), the average density of rooks' nests over extensive areas of the British Isles is sixteen per square mile, and this is well within the range of nest counts (fourteen to eighteen per square mile) made over the hundred square miles where rookeries occur in the Christchurch district (Table 3). The New Zealand environment has necessitated some modification in the nesting habits of rooks. In the British Isles, the birds usually nest in tall deciduous trees (J. S. Watson, pers. comm., 1957), but such trees are rare in many districts in New Zealand, and were probably still more so before 1900. So far as is known, the first rookeries established in New Zealand were in introduced eucalypt trees. These remain the favourite nesting trees of rooks in Hawke's Bay, but in Canterbury most of the rookeries are now in pines, the change-over occurring with the break up of the Fendalton rookery in the late 1920's. Mr C. M. Smith has pointed out (*in litt.* 8.3.57) that the sequence of tree introductions to New Zealand and the time it took for introduced trees to grow to a height and form acceptable to rooks for nesting purposes may have been important in determining which species would be utilised for rookeries. From information supplied by Mr Smith it would seem that eucalypts, especially blue-gums, *E. globulus*, are likely to have been the trees most generally available to rooks before about 1900. The change over to pines (mainly *P. radiata*) in Canterbury may have been brought about, at least in part, by a widespread epidemic caused by a scale insect which attacked certain species of eucalypts, but especially *E. globulus*. The reason for the persistence of rookeries in eucalypts in Hawke's Bay is unknown; possibly the epidemic was less severe there, or perhaps in addition to *E. globulus* there were other eucalypts more resistant to scale insect attacks.

In an earlier paragraph it was suggested that human control activities had caused an increase in both the distribution and abundance of rooks. The available data are inadequate to prove that this has in fact occurred, and another explanation for the observed facts is possible. It may be that rooks have required a considerable time to adapt themselves to the New Zealand environment, and that they are only now reaching a stage which enables them to increase their range. A phenomenon of this kind appears to have occurred in the myna (*Acridotheres tristis*), which, after many years of restricted distribution, has recently shown a remarkable ability to populate new country in the Auckland Province (Cunningham, 1948). However, this recent spread of the myna may be due, at least in part, to a change in the environment (land development and closer settlement), but, in any event, the necessity for a lengthy period of adaptation to the New Zealand environment is perhaps more to be expected for the tropical myna than the temperate rook. Further, the disturbance at the rookeries has certainly coincided with an increase in the range, and possibly also in the abundance, of rooks – even though these cannot at present be proved as cause and effect. Data on the number of young reared by rooks nesting in colonies of different size would be most useful in obtaining a clear understanding of the factors involved.

To sum up, the slow spread of rooks in New Zealand is thought to be due mainly to the conservative nesting habits of the bird and to the presumed requirement of a certain minimum number of individuals before a rookery can become established. The number of birds originally liberated

and the nature of the environment into which they were released are probably also important. The shooting of birds at rookeries, and the cutting down of trees used for nesting are regarded as favouring both the spread of the bird and the increase of the total population. In reaching these conclusions, it has been necessary to rely heavily on rather limited and subjective historical data. The conclusions are therefore of a tentative nature, and are advanced at this stage so that they can be tested. However, until better information is available, it would seem wise for the authorities concerned with rook control to abandon the system of bounties and such other control activities as involve disturbing the birds at the rookeries, and, where control is clearly necessary, to concentrate on the poisoning methods which have been used recently with such conspicuous success by the Department of Agriculture in Canterbury.

5. SUMMARY

Rooks, originally liberated in Auckland, Nelson and Christchurch between 1862 and 1873, are now established in Hawke's Bay (28 rookeries), southern Wairarapa (1), Christchurch (19), Banks Peninsula (3) and near Peel Forest (3 rookeries). The Hawke's Bay and Peel Forest populations are probably derived from subsequent liberations.

The existing rook populations are located on the eastern side of the country and mostly in districts where grain is grown (yellow-grey earths).

The Hawke's Bay population (1242 nests counted over 300 square miles) is less dense than the Christchurch one (1371 to 1806 nests over 100 square miles).

The Christchurch population has increased from 1000 birds (one rookery) in 1925 to 7000 - 10,000 birds (thirteen rookeries) in 1947, and then remained at about this level, but with nineteen rookeries.

Control operations, especially shooting and tree-felling, have been important in causing a reduction in some large rookeries, the establishment of several small new ones, and a slow increase in the breeding range of the species, to the south in Hawke's Bay and to the west near Christchurch.

The restricted distribution and slow rate of spread are attributed to the behaviour of the species (gregarious habits and use of traditional nesting places), the restricted distribution of liberations and the nature of the environment (climate and land-use).

The Christchurch rookeries were all in eucalypts until about 1926, but later ones are mostly in pines, the change over following an epidemic in eucalypts; eucalypts remain the favourite nesting trees in Hawke's Bay.

Limited data are presented on breeding season, clutch size and the location of winter roosts.

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7. REFERENCES

CUNNINGHAM, J. M., 1948: Distribution of Myna in New Zealand. *New Zealand Bird Notes*, 3: 57 - 64.

DEAR, E., 1951: Rooks in Feilding District. *Notornis*, 4: 69.

FALLA, R. A., 1947: Destruction of Rooks (*Corvus frugilegus*). *New Zealand Bird Notes,* 2: 70.

GIBAN, J., 1947: Données fournies par le baguage sur la biologie du freux (*Corvus frugilegus* L.) en France et sur la migration de l'espèce en Europe occidentale. *Ann. Epiphyties,* 13: 19-41.

GUTHRIE-SMITH, H., 1921: "Tutira", first edition, p. 338. Blackwood, Edinburgh and London.

H.S.G. (Halkett School Group), 1948: Classified Summarised Notes. *New Zealand Bird Notes,* 2: 176.

HUTCHINSON, F., 1900: Introduced Birds of Scinde Island. East Coast Naturalist, No. 5, p. 28. (Manuscript Periodical in Alexander Turnbull Library.)

LOCKIE, J. D., 1955: The Breeding and Feeding of Jackdaws and Rooks, with Notes on Carrion Crows and other Corvidae. *Ibis,* 97: 341-69.

STEAD, E. F., 1927: The Native and Introduced Birds of Canterbury, p. 224 in Natural History of Canterbury, edited by R. Speight, Arnold Wall and R. M. Laing. Simpson and Williams, Christchurch, 299 pp.

STIDOLPH, R. H. D., 1943: Summarised Classified Notes. *New Zealand Bird Notes,* 1: 32.

THOMSON, G. M., 1922: The Naturalisation of Animals and Plants in New Zealand, pp. 152-4. Cambridge University Press, 607 pp.

THOMSON, G. M., 1926: Wild Life in New Zealand, Part II. Introduced Birds and Fishes, *New Zealand Board of Science and Art, Manual No.* 5, Government Printer, Wellington, p. 42.

TURBOTT, E. G., 1954: Summarised Classified Notes. *Notornis,* 5: 238.

WILLIAMS, G. R., 1953: The Dispersal from New Zealand and Australia of Some Introduced European Passerines. *Ibis,* 95: 676-692.

WITHERBY, H. F., JOURDAIN, F. C. R., TICEHURST, N. F., and TUCKER, B. W., 1943: The Handbook of British Birds, Vol. 1, pp. 19-20. H. F. & G. Witherby, London.

REVIEW

THE ORNITHOLOGISTS' GUIDE, edited by Major-General H. P. W. Hutson, 1956. pp. i-xix and 1-287 (British Ornithologists' Union, London, 21/.)

There was a great need for a comprehensive guide to various aspects of bird study because, except for the collecting manuals of the British Museum, there was little which could serve as a guide to the field man. Dr O. S. Pettingill's *Laboratory and Field Manual of Ornithology** came nearest to the goal, but this book has been designed for both the laboratory student and the field worker. The task undertaken by General Hutson as editor was ambitious, because it aimed to cover adequately all the modern techniques of bird study. This was achieved by mustering an unusually large team of experts (46) from many lands, most of them specialists in their own right.

The Guide is divided into the following nine sections: General, Geographical Aspects, General Behaviour, Breeding, Protection, Study Techniques, Suggestions for Special Study, and Regional and General Information. Each of these main sections contains 4 to 20 original articles, most of which are written by acknowledged authorities in various techniques. Each article has some key references for further reading, and it is pleasing to see cross-references throughout the text, resulting in a reduction of unavoidable repe-

*Reviewed in *Notornis* 7, 2: 64.