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THE KAKAPO (*Strigops habroptilus*, Gray)

A REVIEW AND RE-APPRAISAL OF A NEAR-EXTINCT SPECIES

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Rarity is the attribute of a vast number of species of all classes in all countries. If we ask ourselves why this or that species is rare, we can answer that something is unfavourable in its conditions of life: but what that something is we can hardly ever tell.

C. Darwin (1859): *The Origin of Species*

Introduction

To write at some length on a species one has not yet seen may indicate temerity rather than wisdom unless sound justification can be offered for such action. In the case of the kakapo there are a number of good reasons for summarising the knowledge we at present have about this very interesting rare parrot—for, as will be seen later, some remarkable and unique habits have been ascribed to it.

First of all, there has been no comprehensive account of the species now for over half a century—the most valuable being those of Buller (1888 and 1905) and Henry (1903b), neither of which is readily available; and the shorter accounts by those few observers with first-hand knowledge (in particular, Hector, Haast, Henry and Douglas) are scattered and often to be found only in very inaccessible journals. Secondly, the history in the changes in the numbers and distribution of the bird needs to be more carefully discussed than before and brought up to date, for the ecological study of rare species or of the process of extinction is one that has been, so far, largely neglected. Finally, by making the information that exists about the species more readily available, those specially concerned with its protection will be placed in a better position than formerly to take action for ensuring as far as possible its conservation—either in captivity or in the wild—before it becomes too late.

Description

This may be found fairly fully described in Oliver (1955) or in great detail in Buller (1873 and 1888), and Newton (1893-96) lists some useful papers dealing with anatomy; but briefly the kakapo is a large parrot standing about two feet in height, moss-green and barred with black above, pale-yellow-green irregularly barred with dark-brown and lemon-yellow below. The well-developed and owl-like facial disc is yellowish-brown, and the shafts of the feathers at the base of the mandible are prolonged into hair-like processes rather reminiscent of cats' whiskers and perhaps serving a similar function. In its natural environment of the moss-covered forest floor the bird's colouration is highly cryptic—at least to human eyes—and this in an environment where mammalian predators were originally completely lacking and where the bird's mainly crepuscular and nocturnal activities would seem to keep it almost wholly out of the reach of the only two likely (falconiform) avian predators. Although the wings are well-developed and well-proportioned, the wing muscles are overlaid with fat and there is only a rudimentary keel to the sternum. Thus the kakapo

is usually capable only of downward gliding flight (up to about 90 yards having been recorded), and the wings are used mainly as balancing organs when it is running or climbing. However, Mr R. I. Kean has informed me that he once saw a kakapo make a distinctly *upward* flight of some feet, flapping its wings clumsily and with great vigour as it did so. According to Reischek (1884) and Henry (1903b) the male may be distinguished from the female by its larger size, heavier build and brighter plumage; and the same authors state that the young are much duller than their parents and that the nestlings are at first covered with white down which, in about a month, gives place to feathers, the down remaining upon the feathers until the birds are about three months old.

Colour plates have been published by Gray (1845a), Buller (1873 and 1888) and the Forest and Bird Protection Society of New Zealand (1948), and Buller gives an account of a number of colour variations in the plumage—a kind of variation commonly displayed by New Zealand parrots. Only about half a dozen photographs of the live bird have ever been taken, and of these few only those of Beattie (1930) and Clark (1939) are satisfactory, as they show—among other things—the well-developed wings.

Taxonomy

This traditionally thorny subject is one that, as far as the kakapo is concerned, I do not—at present—intend to discuss at any length. In any case, a careful review of the considerable amount of material housed in museums both in New Zealand and overseas is long overdue. A single genus is confined to New Zealand, and Oliver (1955) and Fleming *et al.* (1953) refer to the three subspecies recognized by Mathews and Iredale (1913): *Strigops h. habroptilus* Gray—the South Island 'lowland' race, *S. h. innominatus* Mathews and Iredale—the North Island race, and *S. h. parsoni* Mathews and Iredale—the South Island 'alpine' race. Goodwin (*in litt.*) has kindly supplied me with information about the two of these type specimens which are in the British Museum of Natural History: 'The type of *S. habroptilus* is a bird that had been mounted. The only locality on the label is "New Zealand", and it is down in the catalogue as having been purchased. *S. innominatus* is labelled "Wellington, New Zealand", and was presented by a Miss Potter.' Some additional remarks on each of these may be of interest: '*S. habroptilus*' is apparently the first specimen to come into European hands and is the one described by Gray (1845a and b, 1847) as having been collected from Dusky Sound in the south-western corner of the South Island; it is, of course, the type of its nominate subspecies. That of '*S. innominatus*' bears the rather unsatisfactory locality of 'Wellington' on its label and should therefore be regarded with some reserve meanwhile as a bona fide North Island specimen, for recent specimens from the south-western extremity of the North Island have not otherwise been recorded. If indeed it does belong to the North Island it may have come from the Kaimanawa Ranges (which do lie within Wellington Province) south of Lake Taupo—perhaps the only area in the North Island from which recent kakapo material has been obtained in European times. But one does rather wonder whether the locality given on the label may be no more than the city address of the donor! The third subspecies—*S. h. parsoni*—from the north-western mountains of the South Island (presumably the Tasman Mountains) was erected by Mathews and Iredale from a single specimen in the G. M. Mathews' collection, although Reischek (1887b) talks of having collected specimens of the 'rare alpine variety' between Dusky and Chalky Sounds in 1887; and Howe, an early surveyor quoted by Miss G. M. Mueller (*in litt.*), says that alpine kakapo were paler and yellower than those from the forest. It is arguable whether any alpine birds should be regarded as representing a true subspecies, for we know that kakapo range from the forest to the alpine meadows, and minor colour differences may be no more than temporary ones resulting from some time spent in either environment, and certainly one specimen is insufficient to establish

valid taxonomic differences in this case. Mayr, Linsley and Usinger (1953) define subspecies as 'geographically defined aggregates of local populations which differ taxonomically from other such sub-divisions of a species'. The so-called alpine subspecies hardly complies with this definition, though it may be one extreme of a cline. As for '*S. greyi*', now in the possession of the British Museum of Natural History, this is regarded as being a colour variant only. No specimens exist of kakapo from Stewart Island. If the birds that have been seen there are not descendants of those said to have been liberated about 60 years ago, we may have here another valid subspecies — parallelling, for example, those of the Stewart Island kiwi and weka.

As far as the affinities of the kakapo are concerned, Reichenow (1881) and Berlioz (1941) consider that a close one exists, between *Strigops* and the perhaps even rarer Australian ground parrot, *Geopsittacus occidentalis*.

Habitat

Kakapo may be found at any altitude between sea level and at least 4000 feet in country where the rainfall may lie between the limits of about 75 and perhaps 250 inches per year. They are primarily birds of the mossy beech (*Nothofagus* spp.) forest — more particularly that part adjoining open ground along river flats or the sub-alpine scrub belt which yields in turn to the expansive snow tussock (*Danthonia* spp.) meadows above the tree line. Henry (1903b) remarks that a favourite place was the tumbled mass of rocks and growth of shrubs (in particular, *Nothopanax* spp. and *Schefflera digitata*) that could be found on the site of a fairly recent landslide. Such areas, because of the abundance of food berries they supported, he called 'kakapo gardens'. Apart from these, however, one gains the impression that kakapo tend to be commoner at higher altitudes than at lower, and Henry frequently talks of them being plentiful above the tree line. Douglas (*unpubl.*) perhaps a little too sweepingly claims never to have seen them 'outside the white mountain birch' (*sic*); and Brodrick (1897), in describing his experience of the birds on an expedition between Lake Ohau and Paringa, remarks that the characteristic feeding signs could be seen on every grass flat visited, but that they were generally more plentiful just above the tree line. This apparent commonness of the birds at high altitudes (about 3000 feet and above) may be just a reflection of the greater obviousness of their sign in these more open places. Occasionally kakapo have been found in predominantly podocarp forest — such as occurs along the mid-west coast of the South Island. Such occurrences are few, however.

Distribution

General:

Originally kakapo existed over most of the two main islands of New Zealand and perhaps, as will be seen later, on Stewart Island and the Chathams as well. However, as the distribution of the sub-fossil remains shows, their range had already become considerably reduced before the beginning of the European era, and, judging from Maori tradition (Best 1908, 1909 and Brunner 1952), the reduction of the range in both the North and South Islands had been a process quite noticeably in progress in immediate pre-European times. In the last century or so the range has continued to shrink — at a pace no doubt accelerated more than it would otherwise have been — by the reduction of forest that invariably accompanies settlement — a reduction that has proceeded much further in the North Island than in the South; but the general discussion of this subject of accelerated diminution in range and numbers will be continued after past and present distribution has been described in more detail.

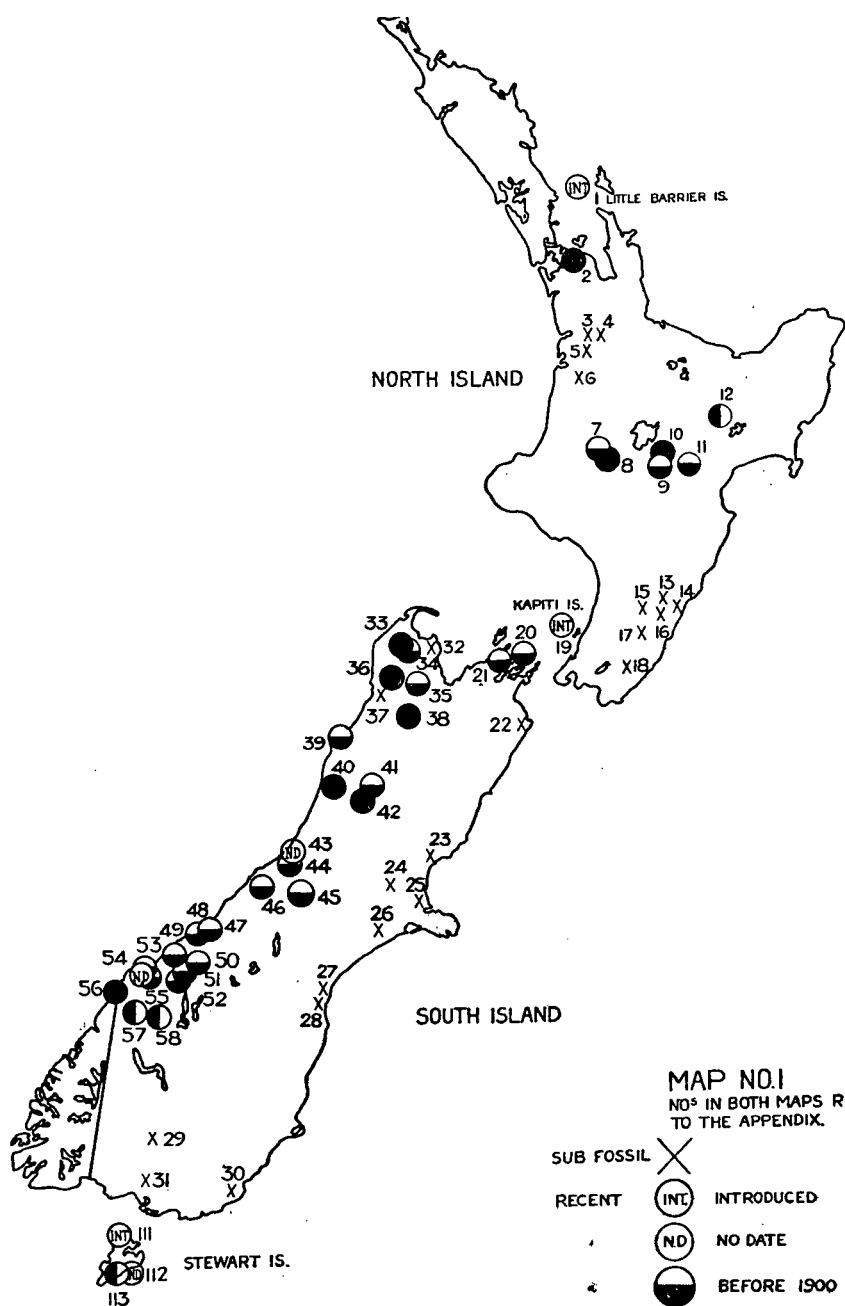
In mapping the detailed distribution (which, although as complete as possible, is not claimed to be exhaustive) I have used only actual sightings, museum records of skeletal remains, egg records and satisfactorily-identified

feathers found in the field. Accounts of calls, tracks, feeding signs and so on have not been entered on the maps because of the difficulty, in the majority of cases, of deciding upon their reliability. Even with the sight records some discretion has been necessary—reports reaching me second-hand have been accepted if the interviewer is an ornithologist willing to vouch for the reliability of the original observer and if it seems likely (whether the report be first- or second-hand) that kakapo have not been confused with kea (*Nestor notabilis*) or kaka (*N. meridionalis*). Only reports citing definite localities have been used, which means that much more museum material labelled 'South Island', 'West Coast', 'Nelson', etc., has had to be ignored; and in those instances when the locality given is definite enough but rather a large one—for example, 'Dusky Sound'—I have placed the record in what seems to be the most likely place from the relevant account. Furthermore, whenever dating has not been precise, but nevertheless useful—such as an account published in 1955 stating that kakapo had been seen in a particular place '50 or more years ago'—I have shown the observation as being made in the earlier of any of the two major mapping periods that may be offered as a choice by such a statement. These conventions may have given rise to minor errors of some miles or years in a few cases, but they at least ensure as full a use as possible of perhaps significant records that would otherwise have to be ignored.

NORTH ISLAND

Whatever the main cause of the 'natural' shrinkage of kakapo range before the arrival of European settlers at the beginning of the nineteenth century, a glance at Map No. 1 shows clearly that its effect had been more intense in the North Island than in the South. Acceptable records of recent specimens are very few indeed and, with but one exception, are limited to the central part of the island, though sub-fossil remains are more widely distributed (and occasionally plentiful, Yaldwin 1956). There are extensive areas from which no kakapo material of any kind has yet been reported—notably Northland, Taranaki and the Gisborne-East Cape-Opotiki district, but this may reflect a lack of study in the less-settled country or a relative lack of suitable places for the long preservation of material rather than a real absence of the species from these areas. In brief, as far as is known at present, the range of the kakapo once stretched over much of the mountainous centre of the island, with offshoots extending in a north-westerly direction towards Auckland and in a southerly direction towards Cook Strait. Mr D. H. Brathwaite has kindly drawn my attention to some second-hand reports in Drummond (1907) which imply that kakapo were still surviving as far north as Whangarei and even the Bay of Islands, as well as on the south-eastern coast of the North Island, at a date as recent as about 1905. I have, so far, been unable to find elsewhere any other information to support these rather surprising statements.

Records referring to European times suggest that kakapo have never been numerous during most of this period, though there may have been minor local exceptions (Buller 1892). Even as early as 1843 we have Dieffenbach's statement that they were rare; and Taylor (1855), whose missionary work had taken him over a considerable part of the centre of the North Island during the 1840s, hazarded the opinion that their extinction was already approaching. In his many publications between 1868 and 1905 Buller frequently includes reports of their diminishing numbers; and Best, who was in an unrivalled position to obtain reliable information from the older Urewera Maori, states that although kakapo were once numerous in parts of the Urewera country they had disappeared from there by the early nineteenth century. 'Disappeared' may be too strong a word, however: St Paul (1951) was informed that they were still being hunted in the 1870s. Maori traditions of once hunting the birds in the Tararua and neighbouring ranges are recounted by Stidolph (1935) and Gordon (1938).



MAP NO.1
 NOS IN BOTH MAPS REFER
 TO THE APPENDIX.

- SUB FOSSIL X
- RECENT (INT) INTRODUCED
- (ND) NO DATE
- (—) BEFORE 1900
- (●) 1901 - 1925
- (|) 1926 - 1956

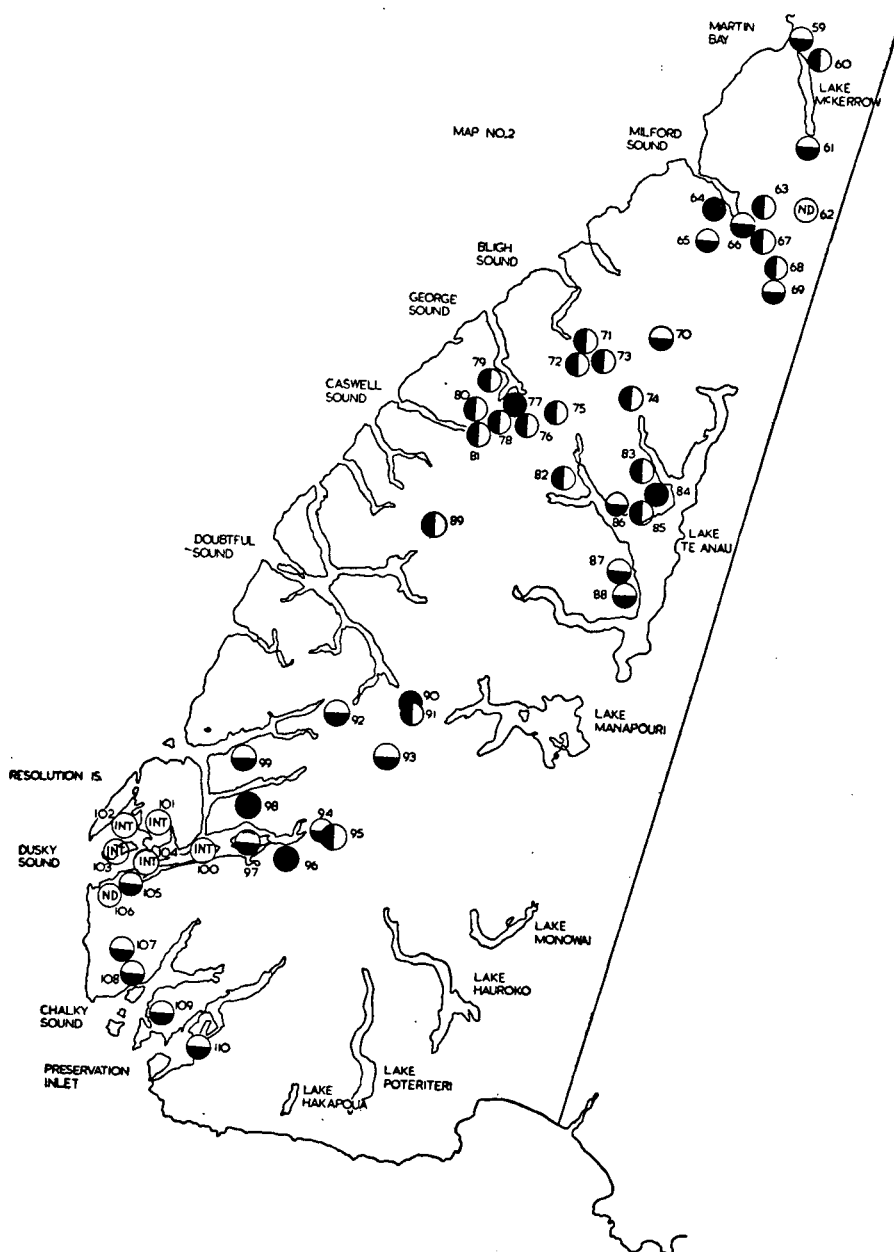
I have been able to find acceptable records of only about ten occasions of recent North Island kakapo having been seen or collected, and, to the best of my knowledge, the whereabouts of none of the collected material is known. (As stated earlier, the type specimen for the North Island subspecies I regard at present as suspect.) Some details of these occasions may be of interest:

Taylor (1855) was apparently the first European to record seeing the North Island kakapo, and in referring to the country at the upper reaches of the Wanganui River he states: 'I have seen only two caught there.' The next account comes from Buller (1868) for he remarks that he had seen an example brought from Taupo, and his paper of 1892 contains the information that a Captain Mair was shown feathers of two birds killed at the foot of the Kaimanawa Range, near Tokaanu, at the southern end of Lake Taupo. His reference (1888) to a specimen from Hikurangi owned by a Captain Preece is, unfortunately, of little help in mapping the species' range because there are at least six places with this name in the North Island. However, as this Captain Preece is almost certainly the one who spent a great deal of time in the Urewera country in the 1870s, the Hikurangi referred to is probably the mountain some eight miles to the north-east of the township of Galatea. There should be a good chance of tracing this specimen if it still exists, and the importance of making such an attempt is obvious.* Oliver (1955) reports that a bird was caught in the Kaimanawa Range in 1906; Mr J. H. Russell (*pers. comm.*) found a small colony in beech forest north-west of Raurimu near the upper Wanganui River in about 1910; and Mr H. R. McKenzie (*in litt.*) has passed on to me a detailed account, which he regards as reliable, of a kakapo having been seen about 1912 near Clevedon in the Hunua Range, not far to the south-east of Auckland. This report—admittedly from outside the recognised range—is comparable in interest to the two 'outlying' South Island records which are given later. I am also indebted to Mr McKenzie for the record of a kakapo seen in the Huiarau Range, Urewera country, in 1927. He says the observer is reliable and that he gave an excellent description without having had prior knowledge of the species. Bathgate's report (1955) of them having been seen in the headwaters of the Ngaruroro River about the beginning of this century would place them in the Kaweka Range, which lies close to the Kaimanawas, and lends support to another but less definite account referring to the Kawekas by Bestall (*in litt.*).

If the species does still exist in the North Island its occurrence would now seem most likely to be limited to very small numbers living in the higher beech forests of the Kaimanawa and Huiarau Ranges. (The beech forests and tops of the seldom-visited Raukumara Range in the Gisborne-East Cape-Opotiki district should be worth a careful examination. The highest peak in the vicinity is Mt Hikurangi, and this Hikurangi is one of the two that nowadays, at least, are commonly referred to without qualification; the other—near Whangarei—seems most unlikely to be the one from which Preece's specimen came.) It is significant that there seem to have been no plausible records of the kakapo having been seen in the North Island now for over twenty-five years and no confirmed record for fifty. If not already extinct it must be in grave danger of becoming so.

In the early years of this century liberations of some South Island kakapo were made on two of the offshore islands—on Little Barrier in 1903, when four were landed and not seen thereafter (Oliver 1922); and on Kapiti in 1912, when three were introduced. Some of these birds—or their offspring—were seen on rare occasions until as late as 1936 (Wilkinson and Wilkinson 1952) and give hope that another and larger liberation might result in successful establishment there.

* (In press). Mr A. H. Preece (son of the late Captain Preece) has informed me that he has no knowledge of the present whereabouts of this specimen.



SOUTH ISLAND

Kakapo have been well-known in the South Island since European settlement began and, of course, before that by the Maori. The distribution of their sub-fossil remains indicates that their range once extended over most of the island. However, with but two exceptions, all acceptable records of kakapo from east and beyond the chain of the Southern Alps are sub-fossil — as may be seen from Map No. 1 — so perhaps the early reduction of range here has had a cause similar to that bringing about the pre-European reduction of range in the North Island. Elsewhere the birds have become less numerous in immediate pre-European and European times, and although their recognised habitat has usually been more frequently traversed in recent years than formerly they seem to have disappeared over large areas.

Because of the great amount of information that is available about numbers and distribution I have found it convenient to divide the island into rather arbitrary districts and to discuss each in turn. The longitudinal main mountain chain is the most obvious basis for the primary division, and I will deal first with the whole eastern side of the island and then with the more important western side — moving consecutively from the most northerly areas to the most southerly.

The Eastern Side:

As just mentioned, there are only two reasonably likely records (both by the same observer) of live kakapo having been seen beyond the immediate vicinity of the Southern Alps, and for that reason alone the records are of considerable interest. Mr G. Garland (1950 and *in litt.*) describes how in 1878, when out looking for kaka, he saw two kakapo appear from a thicket of rata vines at the foot of Mt Stokes in northern Marlborough, and that in 1879 he saw several at the head of Maori Bay, Pelorus Sound, some fifteen miles to the west. The general tenor of the accounts is such as to give a measure of confidence to their claim to reliability, and each observation gives additional weight to the other, nevertheless both records are surprising. Further south, in Canterbury, there have been accounts of 'kakapo-like' tracks having been seen in the upper catchments of the Rakaia (Haast 1948) and Wilberforce Rivers (Finlayson *in litt.*). Both of these refer to last century and are supported to some extent by a skin in the University Museum, Oxford, labelled 'Rangitata', which was collected before 1872 (Cain *in litt.*). The so-called Banks Peninsula specimen in the Canterbury Museum is ascribed to that locality on traditional grounds only, according to Dr R. Forster (*pers. comm.*) and therefore must be ignored as such.

The Western Side:

Among the early explorers of Nelson Province, Brunner (1952), Mackay (1860) and Haast (1861) — apparently relying for their comparisons upon information given by the local Maori — state that the species had already become scarce in at least parts of southern and western Nelson at the time they passed through the country. Others such as Buller (1873), Guthrie-Smith (1936), Brereton (1947), Bell (1948) and Haast (1948) suggest that in other areas kakapo were still numerous — sometimes until the end of the nineteenth century. South of Collingwood, around Goulard Downs, the annual reports to the Department of Internal Affairs by R. E. Clouston, who was caretaker of the Goulard Downs Sanctuary from about 1915 to about 1930, contain frequent references to kakapo seen or to evidence that they were present. However, on reading these reports in full, the impression is obtained that, on the whole, numbers were decreasing over this time. Some idea of the numbers of kakapo on the Downs in the early 1920s may be gathered from the fact that a number were captured, apparently to be sent to the Wembley Exhibition in London, in 1924 (Falla *pers. comm.*). However, over about the last twenty-five years there seem to be no reliable records of kakapo having been seen in Nelson Province, although there are rumours that they still occur in some of the western mountain ranges.

There is little first-hand information referring to the northern part of Westland down to the vicinity of Bruce Bay. A few specimens have been collected from the area (see Map No. 1) — the last apparently in 1907 at Moonlight, near Atarau on the Grey River (Jackson *in litt.*). Three observers who had a good knowledge of the area and its birds fix, by implication, the last period of comparative abundance of the species before about 1870 (Hamilton 1878, Smith 1888 and Douglas *unpubl.*). Other reports seem to be derived from these or are second-hand from sources that cannot be traced.

From Bruce Bay to about Jackson Bay and Lake Wanaka accounts of kakapo are frequent before 1900, and most observers comment upon their abundance in many places (Haast 1864, Douglas, Harper *in litt.*, Howe *in litt.*, and Haast 1948). Douglas states, perhaps a little picturesquely: 'I have seen as many as half a dozen . . . knocked off one tutu bush.' This particular observer, who has the reputation of being reliable and of possessing excellent first-hand knowledge of the kakapo, implies that their numbers were already on the wane before the end of this century, for he wrote in 1899: 'At one time the kakapo swarmed in that country from the sea beach to near the snow line'; and Mueller (1890), who also explored the area, suggests that the decline was noticeable before 1890. Park's comments (1890) on the abundance of kakapo in a number of places must be treated with reserve, for it is plain in his controversy with Melland on takahe and kakapo calls that he was unfamiliar with either. The Douglas papers are a valuable source of information about the Landsborough River district, and at the time that Douglas was most active here (about 1880) the birds were plentiful, for he says: 'To know what it is to be like in the kakapo country before the appearance of the stoat, the flats of the Landsborough River was the place to go — they were literally in hundreds round the camp. . . . Sometimes it was not possible to sleep for the noise'; and Harper, referring to the same area, states: 'In December 1894 . . . I found kakapo in the bush on the western slopes of the Divide — not in any great numbers, but they were still there. On the western bank of the river I could hear them in hundreds on the Hooker Range.' Brodrick (1890 and 1897), too, about this time considered them numerous in the Landsborough Valley. Reports of kakapo having been seen in the Bruce Bay-Jackson Bay district since 1900 seem limited to Baigent's (*in litt.*) for the Red Pike Gorge in 1951, and Holloway's (1936) which refers to kakapo seen that year in the Five Fingers Range. A reliable second-hand one that the late Mr W. O'Leary had seen them on several occasions in the sub-alpine scrub zone on the seaward end of the Haast Range and in the Joe River Valley has been passed on to me by Mr J. T. Holloway (*in litt.*) The actual dates are not known, for Holloway comments: 'These observations might have been made anytime between 1890 and 1930; but "Arawhata Bill" was seldom in error about his identification of birds.' The year 1935 was fixed by Gunn (*in litt.*) as the date for the main disappearance of ground birds throughout the area he knew. He held 'an invasion' of stoats responsible and said the damage was completed in about six months.

For the Martin Bay-Milford Sound area there is little information about the occurrence of kakapo before 1900 or even before 1930; but since that date there have been occasional sight records mainly from the Cleddau Valley and the Tutoko Valley which joins it near Milford Sound itself. In fact, sight records from this district are probably far more numerous in proportion to area than those from any other part of New Zealand during the last twenty-five years — perhaps because it is regularly frequented by large numbers of tourists and trampers, and because of fairly continuous occupation of that part of the Cleddau Valley along which the motor road to Milford Sound has been built. If the frequency of reports is actually connected with the degree to which the area has been covered, then this obviously will have a bearing on any rough qualitative estimates made of the present distribution and numbers of this species throughout its likely range in New Zealand.

The next block of country that may be conveniently considered is that between *Milford Sound*, *Doubtful Sound* and *Lake Te Anau* (see Map No. 2). Before 1900 we have testimony from reliable explorers and naturalists such as Caples (1863), Hügel (1875), Henry, Melland (1889), Wilmot (1897) and Mackenzie (1894) — all of whom had first-hand knowledge — that kakapo were common, to about 1890 at least, over much of the area. The next period for which I have any information is that extending over approximately the last thirty years. For this I am dependent mainly upon data supplied by Mr K. R. Sutherland, who knows the area well and has always been particularly interested in the kakapo; and subsidiary information has come from the late Mr L. Murrell, of Manapouri, who had excellent opportunities during his long sojourn in the area to learn a great deal about the local bird species, their numbers, habits and distribution. The general tenor of their reports is that kakapo were still in fair numbers until about fifteen years ago, but that they have become distinctly rare since, particularly on the Te Anau or eastern ends of the Franklin, Stuart, Murchison and Kepler Ranges. The eastern ends of these mountains are frequently visited these days by hunters of wapiti and deer — and even ornithologists — but apart from an occasional feather or report of an old and disused track there are extremely few sight records for the last ten years or so (though Tily 1949 passes on information that they had been seen about Lake Manapouri in 1945), and this in country that, according to Hügel, Henry (1903a) and Melland, abounded in kakapo sixty to seventy years ago and where they were still common in some places twenty-five years ago at the most — judging from Sutherland's various reports (*in litt.*). Whatever may have been their original abundance further to the west (there appear to be no reliable comments or records), kakapo do not seem to be numerous there in recent times, for the five-month occupation of the George and Caswell Sounds area by the New Zealand-United States Fiordland Expedition of 1949 produced only two sight records and little other evidence of their presence in spite of a great deal of exploration and movement by a large party (Poole 1951). In early 1956 a special expedition to the area at the head of George Sound found some tracks, 'dusting bowls', feeding sign and a few recent bones — all indicative of active occupation, but no birds were seen (Hall-Jones *in litt.*).

The last area to be considered on the western side of the South Island is that between *Doubtful Sound* and *Lake Hauroko*. As may be seen from Map No. 2 there have been many early sight records and specimens from here, but the two most valuable sources of information are the papers of Reischek and, in particular, the papers and reports of Henry. Starting in 1894, Henry lived as caretaker of Resolution Island in Dusky Sound until 1908, and during his stay explored much of the nearby mainland and other islands. In the beginning kakapo were plentiful in a number of places on the mainland, but of the many islands only Cooper, which is separated from the mainland at one point by a channel less than 100 yards wide, possessed 'native' kakapo. Over the next few years Henry trapped and transferred between three and four hundred from the mainland to these various islands — chiefly Resolution, where he set free about 270, and Long Island, where he landed about 70. (Earlier accounts by others of Henry's activities have over-estimated the number of liberations made.) By 1904, however, he was already remarking on their diminution in numbers everywhere (he had caught most of his birds before 1899) and says: 'They are few and far apart even in their favourite places', and in 1908 he states that they were scarce everywhere — even on Resolution. Reischek found kakapo common in Dusky and Chalky Sounds during his collecting visits in the mid-1880s, but from 1900 onwards reliable reports are few. Apart from one sight record about 1932 (Miers *pers. comm.*) there are only very general accounts which tell of diminishing numbers; and recent efforts to find kakapo on Resolution Island and in part of Chalky Sound have been unsuccessful. Although they are said to have been known in earlier years from around Lakes Hapoua and Hauroko, I have been unable to discover any sight

records from this area, but tracks and burrows that appear to have but only recently fallen into disuse have been reported from the Electric River, which flows into Lake Monowai (Kershaw *pers. comm.*).

STEWART ISLAND

In spite of reports that kakapo — or their sign — had been occasionally seen on the southern side of the island over approximately the last seventy years, little weight had been given to them until in 1949 Mr H. Vipond, a Wildlife Division field officer, actually caught and set one free near Seal Point. Two years later feathers were found at Port Pegasus, which lies nearby (Sansom *in litt.*) and which is the site of the earlier records. There are statements that kakapo from the West Coast fiords were liberated on the north coast of the island near the end of the last century (Woodrow *in litt.*); whether the birds that have been reported since are descendants of these, or whether — in spite of local bushmen's opinions to the contrary — there has always been a resident population are questions that at present must remain undecided.

CHATHAM ISLANDS

The earliest writers on the birds of these islands (which lie some 400 miles ESE of New Zealand) claim that kakapo once occurred there (Travers 1867 and Mackay 1867); and a bone in the Travers Collection has been identified by Dawson (1952) as belonging to this species. Nevertheless, it must still be regarded as doubtful whether kakapo ever did occur there, for even by 1872 the two Travers were convinced that the earlier claim was erroneous; and the mere fact that a kakapo bone occurs in the Travers Collection is no guarantee that it did, in fact, come from the Chathams — carelessness in labelling specimens was a notoriously common fault among naturalists last century. What, then, is one to make of the statement made by Forbes (1893) that he had been told by two locally-born residents that the species was common there 'in the early days of the Settlement' and that their burrows could be seen? In my opinion judgement should be reserved until more information is obtained.

Breeding and Nesting Behaviour

Alternation of breeding and non-breeding seasons:

On a number of occasions Henry claims that kakapo do not breed every year, but usually in alternate years. He uses as his main criterion of breeding activity the 'drumming' of the males, though he says (1903b), 'when there is no drumming in the early summer there are no eggs or young ones'. Furthermore, he claims that there are no exceptions in any one year — either all mature birds breed or none at all — 'It is a great puzzle to naturalists why some do not breed in the off season or how they all come to such a unanimous agreement about it' (1903b); Melland, however, remarks that a few birds do drum in the off years. Sometimes more than one year is missed, and on one occasion the kakapos drummed in two succeeding years. This particular exception is apparently the only one of its kind that Henry accepted, and it is rather a satisfactory vindication of Henry's reliability that an independent observer cites exactly the same exception as applying in the Clinton River valley at the northern end of Lake Te Anau. Here, it is said, in contrast to their usual behaviour, the birds drummed in both the 1901-02 and the 1902-03 seasons (Fairclough and Fenwick 1903). From his various reports I have made a list of the 'drumming years'. All except the first refer to Dusky Sound, but as Henry claims that unanimity is reached on both side of the mountains I have included a date given by him for Lake Te Anau. Here then are the breeding seasons he recognised: 1890-91, 1894-95, 1897-98, 1899-1900, 1901-02, 1902-03, 1904-05, and 1907-08. For Dusky Sound the mean frequency is every second year. Because he takes 'drumming' as the sure sign of breeding activity, Henry is hard put to reconcile it with an abundance of food, for bound up with his theory is his claim that the

male has an air sac in the throat region with which it produces the noise and that this organ begins development months before the appointed breeding season. How then, he asks, can a connection be established between the start of development of the air sac and the good berry season which lies months ahead? As we shall see later in the section on calls, there is some reason to accept this air sac-drumming hypothesis with reserve; and if indeed kakapo did not breed every year it would be quite possible to make some sort of explanation in terms of dependence of food supply. A modification of his theory which Henry thinks the most acceptable is worth quoting in full, for it has a curiously modern ring about it and could have been taken almost as it stands from any of the more up-to-date text books of animal ecology: 'But should it be the density of the population, and consequently the supply of food during the previous winter, that modifies their conduct, it is a very beautiful arrangement. . . .'

Although Lack (1954) has reviewed published data on the effect of food supply on the degree of success of breeding seasons of birds and other animals, and it is known that raptorial and some other birds will sometimes forego breeding in seasons of food shortage, it is rather hard to accept the relative regularity and complete unanimity claimed by Henry—even though he disarmingly discourages criticism with the remark (1904): 'This is one of the true stories that will not be believed in the future—"Can't understand it, won't believe it".' Reischek (1952), in quoting Maori tradition that the kakapo breeds only once in five years, at least offers some support for Henry's claims: 'I myself, for example, in the year 1884 found eggs and young in various stages of development, whereas in the following three years I saw no signs of breeding whatsoever in precisely the same neighbourhood'; and Andersen (*unpubl.*) has a similar comment that may, however, have been derived from Reischek's.

With all due deference to Henry and his valuable observations, we have here a subject that needs critical investigation. If this should prove him essentially correct, we are faced with a phenomenon remarkable for its relative regularity and near-unanimity and which is not explicable, insofar as present indications suggest, in terms of a greatly-prolonged nesting and fledgling period such as occurs among the larger albatrosses which do breed in alternate years (Richdale 1950). Certainly a species which showed such breeding behaviour as is described by Henry would run grave risks of extinction under certain circumstances. Unfortunately the status of the species is now such that the opportunity for a proper study of breeding behaviour in the wild may never again arise.

Breeding season, nest construction, clutch size, etc:

From the various papers of Henry and from Reischek (1884), Potts, Buller (1888), Haast (1948), Andersen and the occasional dated museum specimen of egg or chick, it appears that eggs are usually laid in January and February in the southern part of the range, with the odd nest being found as early as December or as late as mid-May (Reischek 1884)—this latter probably being a result of re-nesting. If the available records give a reliable picture of the timing of the laying activity, then kakapo are distinctly late nesters as far as New Zealand birds are concerned, and we should not be surprised to find that this is connected with the time of maximum abundance of the berries that the birds apparently mainly rely upon for food. Comments from the authors just mentioned indicate that the clutch size usually varies between two and four eggs (Andersen mentions two clutches of five), but I have been able to find only one record of more than two chicks occurring in a nest. This is Andersen's second-hand record that out of a clutch of four, three hatched. Because either well-developed chicks of different sizes or chicks and eggs have been found together in the same nest, Lyall (1852) and Potts are of the opinion that the eggs are laid with a considerable interval between each. The smaller bird—presumed to be the female—being wholly responsible for incubation (the time for which is unknown) and, according to Henry, for the caring for

the young as well. (In the case of the takahe, *Notornis mantelli*, a similar state of affairs seems to exist as far as clutch size and successful hatching is concerned: Although two is the larger and commoner clutch, it is apparently unusual for the two eggs to hatch on those occasions when both are fertile. The intervals between laying are not known, but in one instance, at least, it is known that of two eggs near hatching one was more advanced than the other, which suggests that incubation begins with the laying of the first egg. Observations on the brooding behaviour of adults towards chicks suggest that the extent of the time difference in development between two such eggs may be the crucial factor affecting the second egg's chance of being successfully hatched, for the adults quit the nest within a very few days after a chick has hatched and no doubt neglect the second egg in their solicitude for the chick even before this (Williams, *unpubl.*))

Kakapo nests are usually situated in large crevices between rocks or tree roots, and, according to Lyall, Reischek (1884) and Potts, often have two entrances which lead to tunnels some feet long in which are excavated one or two chambers a foot or so high and about two feet in diameter. One of these chambers is used as the nest proper and may have its floor covered with feathers or wood dust. Haast (1864) is of the opinion that the birds may sometimes construct the whole nest complex themselves in soft ground instead of making use of natural crevices. A number of authors state that, in spite of the roominess of the burrows, only one bird is found in them at a time and that they are used throughout the year. Buller (1888), on the other hand, includes a report that, outside of the breeding season, up to six kakapo have been found in one burrow, and this is at least one contradiction of the opinion held by Henry that the birds were remarkably solitary in their habits.

Food

As an adult, at least, the kakapo is vegetarian in its diet, although Hügel found lizards in some birds taken on the western shore of Lake Te Anau. Berries of various shrubs are popular, particularly those of pate (*Schefflera digitata*), five-finger (*Nothopanax aboreum*), tutu (*Coriaria aborea*), mapou (*Suttonia australis*) and kotukutuku (*Fuschia excorticata*). Kakapo also feed on the leaves of various shrubs (some of which have just been listed) and on snow tussock shoots (*Danthonia* spp.), fern roots, moss, some fungi, reeds, toetoe (*Arundo conspicua*), flax (*Phormium* spp.) and even honey (Henry 1903b). In the North Island the diet includes — according to Maori tradition — the berries of hinau (*Elaeocarpus dentatus*) and tawa (*Beilschmeddia tawa*) and shoots of ti or cabbage tree (*Cordyline* spp.) and native broom (*Carmichaelia* spp.).

The method of feeding on leaves and twigs is peculiar, and, as with the takahe, feeding sign affords one of the most characteristic indications of the presence of kakapo. In fact, in these days when those with a first-hand knowledge of the species' calls are so few and its runways may be confused with those made by deer, the feeding sign should be the most reliable token of the bird's recent occupation of an area, for feathers and droppings may remain well-preserved in some places for a very long time indeed. Henry (1903b) states that kakapo 'chew their food more effectually than any other birds . . . for this purpose there are diagonal grooves in the upper mandible in contact with which the lower acts in the manner of a steel mill'; and Brodrick (1897) remarks: 'Kakapo when feeding on grass never swallow the fibre; it is invariably rolled into pellets about the size of a marble, sucked until it has the appearance of tow and then put out again.' This macerated fibrous material is left dangling from the plant and, bleaching rapidly, soon becomes a conspicuous feature in the feeding area. I have examined material collected by R. I. Kean and K. H. Miers from known recent and near-recent kakapo range which fits the early descriptions very well. Potts (1873), describing feeding sign on native flax, says: 'Leaves had been chewed quite two feet from the point; this peculiar process caused

the used portion of the leaf to look as though it had been roughly scutched and plaited.'

Tracks

A notable habit is the making of well-marked and carefully-tended tracks which apparently play an important part in the ecology of the species. All authors at all familiar with the bird make much of this characteristic. Generally the tracks are found on the summits of spurs and run out into the snow tussock. Henry (1903b) describes them thus: 'In the virgin forest, where nothing heavier than themselves has ever trodden the yielding moss, they have very distinct pathways, especially going up some small hill, where in the driest place on top a gleam of sunshine may enter among the trees. Here will be several "dusting holes" and signs of traffic, as if many birds go up there occasionally either singly or in companies.' Reischek (1884) mentions some of the behaviour connected with their use: 'It was very amusing to watch these creatures — generally one at a time — coming along the track feeding and giving a passing peck at any root or twig that might be in the way. Thus the tracks are always kept clean; in fact they very much resemble the native tracks, with the exception that they are rather narrower, being from eight to fourteen inches wide. . . . I was curious to know how the birds would manage when their tracks were covered with snow . . . I found that they travelled on the surface of the frozen snow and that their tracks were soon plainly visible though not more than an inch below the level of the surrounding snow.' Sutherland (*in litt.*) says that he has known their main runway to extend unbroken for at least two miles; and he and Kean (*pers. comm.*) have both made the interesting suggestion that one of the factors causing the reduction in kakapo numbers has been the taking over of their tracks by the introduced species of deer.

Associated with the tracks are often 'dusting holes' (we cannot at present be certain of their true function), and Henry (1903b) describes them in detail: 'I climbed a high ridge . . . and all along its narrow top for half a mile were "dusting holes" . . . they were about eighteen inches in diameter, fairly level on the bottom, and three inches deep with steep sides. In some the peaty earth was pressed down firmly as if by the naked hand, while in others it was freshly raked up and loose. They were all connected by fresh well-beaten pathways. . . . We found a hilltop that was nearly covered with pathways and "scratching holes". The ground all round looked as if there had been an attempt made to clear it of ferns and sticks, and every root was bitten and peeled as if they had tried to remove it.' Henry adds that he never found these 'dusting holes' below an altitude of 500 to 600 feet.

Calls

The most characteristic call of the kakapo is that commonly heard before and during the breeding season and described by most of the earlier authors as 'drumming' or 'booming'. Henry (1903b) describes it, frequently claims that it is usually heard only in alternate years, and takes its occurrence as indicating that the birds are about to breed, or, conversely, that when it is not heard no breeding will take place. He maintains that only males boom and that the noise is produced by the inflation of an air sac in the throat which develops before the beginning of the breeding season and that, when fully inflated, it is nearly as big as the body. I have been unable to find these last two statements confirmed by any other observer; nor, to the best of my knowledge, has any dissector of the species described such an air sac, although Henry (1898) notes that he had sent some of the 'drums' for examination to the professor of biology at the University of Otago at the time. He admits that he had never *seen* a kakapo boom and allows the possibility — perhaps suggested to him by Professor Parker — that the air sac might be a normal part of the respiratory system. Anyone must be chary of challenging Henry's unrivalled observations, but his claim that this genus of the *Psittacidae* possesses an inflatable air sac as part of the

vocal equipment should be treated with some scepticism at present, for such an organ is, to the best of my knowledge, unknown among the rest of the parrots.

Booming begins about Dusky Sound in late November and ends about mid-February, according to Henry, and a typical cycle proceeds as follows: 'They start with a couple of short grunts, and then five or six deep measured notes like the sound of a muffled drum, the loudest in the middle. This series will be repeated about three times in the daylight, and then there will be silence until some others take up the cry, perhaps miles away. . . . We got quite close to one when drumming and it was a powerful note. I could feel the tremble of it, and my boy, who was holding the dog 30 yards away, could also feel it. I thought the drumming was just at my feet . . . but we found him 40 yards away.' Elsewhere in the same publication (1903b), Henry says the note is similar to that of a bittern and may be heard at a great distance. Melland remarks that he has heard 'this powerful and alarming sound' from across Lake Te Anau — a distance of at least three miles; and Scarlett (1952), reporting an observation made in early February by J. Ede in Tutoko Valley, near Milford Sound, quotes him as describing a suspected kakapo cry as 'a booming call . . . answered in a similar manner by another bird further down the valley. The calls averaged from fourteen to sixteen booms, starting quietly and reaching a crescendo at the seventh boom'. This description tallies well with Henry's; and Mr Newton McConochie, who was familiar with the kakapo when they were common in inland Nelson, has kindly supplied me with his notation for the call: 'I would spell it "groom", with the emphasis on the double "o" and a drawl on the "m". The other tone [from a female?] was shriller, but of the same pattern.' Douglas, who knew the species well, refers frequently to the 'drumming' and comments upon its ventriloquistic quality.

It is rather interesting that Park, in a spirited argument with Melland about kakapo and takahe, is able to quote such authorities as Reischek, Hector and Docherty — all of whom knew kakapo in the field — as saying that the loud booming note at short intervals and described by him in an earlier paper (1888) was not recognised by any of them as being a call of the kakapo. (Park had claimed instead that it was the note of the takahe; Melland that it was a kakapo. We now know that Park, at least, was wrong and in general the honours seem to be solidly with Melland.) That kakapo do in fact 'boom', though they have never been seen to do so, is established beyond doubt by observations made upon a captive bird in Christchurch in the summer of 1904 and reported to Henry. This bird called only at night or when it was in its shelter.

As for other calls Lyall says: 'The cry . . . is a hoarse croak, varied occasionally by a discordant shriek when irritated or hungry', and Park (1890) quotes Grey as remarking that a grunting noise is made while feeding. Sale (1870) makes similar comments, but all these authors are referring to captive birds. Hector, Hügel, Henry (1898), Douglas and Sutherland (*pers. comm.*) variously describe the usual cries of the wild birds as screams, squeals, coughs, grunts or mewings; and Douglas less prosaically remarks that in the heyday of the kakapo in the Landsborough Valley they could be heard 'screeching and yelling after dark like a lot of demons'. As two final variations on this theme there is the comment by Haast (1861) that the call of the kakapo heard during the night very much resembles the gobble of the turkey, and that by Hassing (1930) that a call he heard reminded him of 'a donkey in distress'. In spite of the rich variety of descriptions which indicates a similar richness either in the kakapo's repertoire or in the imaginations of the various authors, there seems little doubt that the calls are sufficiently different from those of all other birds likely to be heard in the deep forest — especially at night — to make tentative identification of the species possible.

Parasites

Reischek (1884) and Douglas report that they frequently found kakapo to be infected with tapeworms which apparently did not always cause the birds great inconvenience, for Reischek says he had found fat birds with a number of worms six inches to two feet long. He goes on to say that only alpine kakapo harboured these parasites, for all his attempts to find them in the bush-dwelling birds were unsuccessful. There is no reason at present to suspect that these tapeworms are other than native species, and if so they may be of considerable interest as far as the taxonomic relationships of the kakapo are concerned (c.f. Cameron 1952).

Miscellaneous

A lot of miscellaneous data—often anecdotal—about less important characteristics of the bird and its behaviour in captivity may be found in Buller (1873, 1888, 1905) and Henry's various articles and papers, and these may be read in their original contexts by those particularly interested in the species, for they cannot easily be included in this paper. In addition, both Buller and Best recount some Maori lore that, although interesting, I have largely ignored. However, the tradition that kakapo showed marked flocking behaviour in the winter is one worth special mention, even though European authors have not themselves recorded it.

The Near-Extinction of the Kakapo

Speculation about the causes of the reduction in the range and numbers of the kakapo must, at this late stage, always remain no more than just speculation. Nevertheless, the subject is of considerable interest, and we are perhaps in a better position now than were earlier writers to review the various suggestions that have been made. The problem is, of course, bound up intimately with the larger one of the diminution in range and numbers of a number of species of the New Zealand avifauna; and it would be foolish to hope that any single simple theory will satisfactorily account for all the facts. As far as the kakapo is concerned, let us review the various hypotheses that have been put forward:

Destruction by Introduced Predators:

This is the most popular—no doubt because it appears to offer the most obvious explanation. Within European times three known avian predators have commonly occurred in kakapo range: the black rat (*Rattus rattus*), the brown rat (*R. norvegicus*) and the stoat (*Mustela erminea*); the other possible introduced mammalian predators—feral cats and European dogs, etc.—are usually confined to the forest fringes near settlements. Although the rats have been present since the early nineteenth century, it must have taken some time for them to spread throughout the country. Mustelids, of which stoats are the main forest dwellers, were introduced about 1885—at about the same time, or just before, kakapo began to become noticeably scarce in the southern and western parts of the South Island. To connect the spread of these carnivorous mammals with an approximately contemporaneous decrease in a number of native bird species would seem a reasonable assumption if there were not some facts that appear not to be in harmony with it. For example, it is strange that at least two genera of flightless ground-nesting birds still occur in good numbers in kakapo range and each of these would appear to be at least as vulnerable to rat or stoat attack as the kakapo itself, which, according to Henry's and Haast's experience, is quite able to punish a dog severely with its powerful beak and claws as well as being able to climb trees and make short gliding flights. In these last two accomplishments, at least, it has an advantage over the kiwi (*Apteryx* spp.) and the weka (*Gallirallus* spp.). Even the recently-discovered takahe, which is also flightless and ground-nesting, has been able to survive in modest numbers in one area where kakapo once occurred and where nowadays stoats, but not 'European' rats, are present.



Plate I: Kakapo — a mounted specimen. Bird lent by the Dominion Museum.

PHOTOGRAPH BY P. BUSH — WILDLIFE PHOTOGRAPH

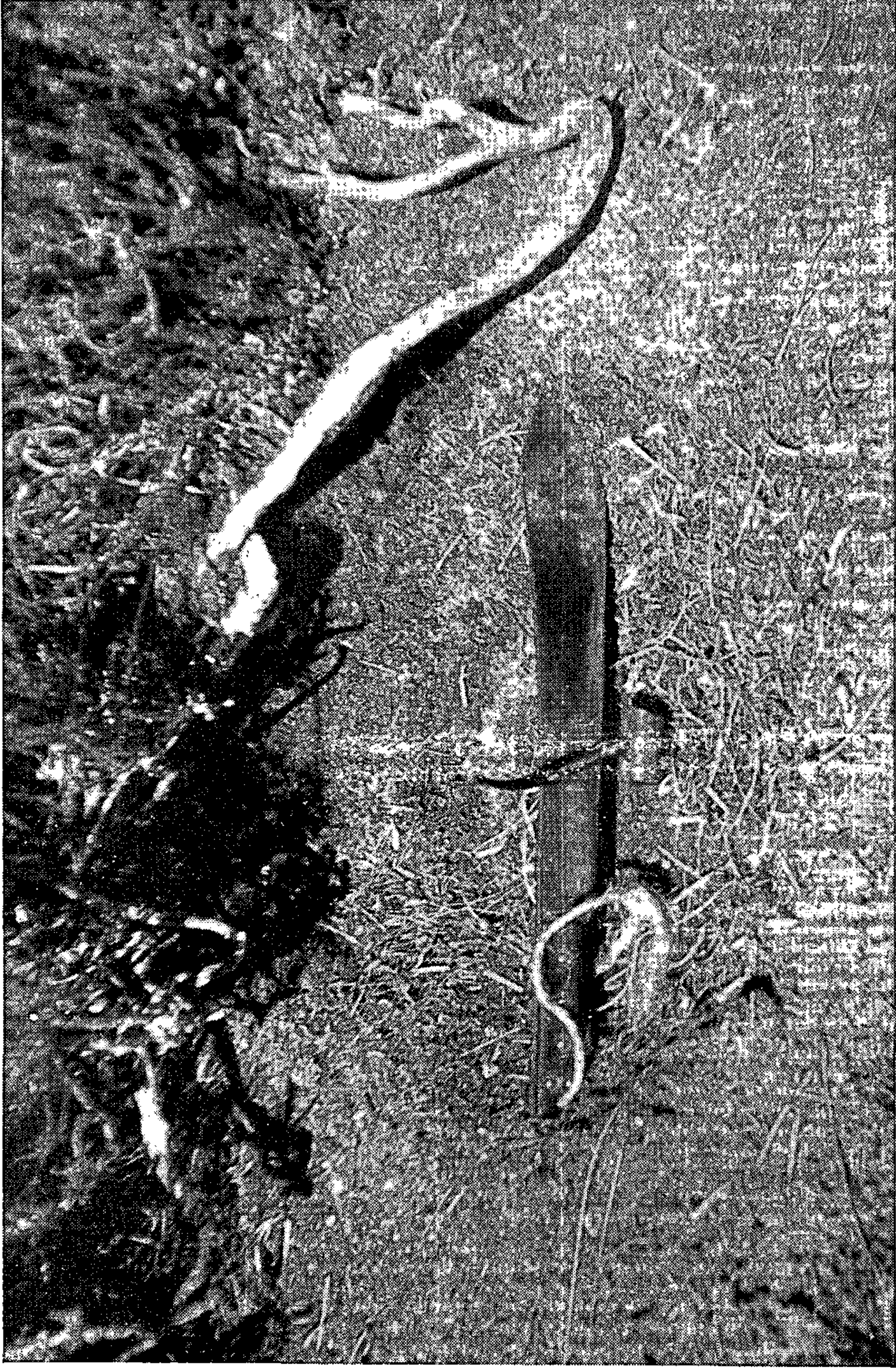


Plate II: A Kakapo 'dusting-bowl'. Diameter about 2ft. Depth about 4in. At 3,300ft. on Saddle Hill, George Sound.

PHOTOGRAPH BY BRIAN REID

However, these rats have been known to kill captive kakapo (Reischek 1887a) and it seems likely that they were responsible for the main destruction of the avifauna of Lord Howe Island (Hindwood 1940). Only rats have been established in New Zealand long enough to be a possible cause of the early reduction in some of the native species—a reduction which certainly antedates the establishment of all other likely predatory mammals*. However, it is recognised that any particular species' ability to resist predation may depend on factors too subtle for easy analysis. (For historical accounts of early changes in the avifauna see Buller (1873, 1888, 1905) and Oliver (1955), and for the progress of acclimatization of the various mammals see Thomson (1922) and Wodzicki (1950).) A special case of mammalian predation is that by Man, and the activities of collectors and settlers have been held by some to have had an appreciable effect on the numbers of some species. As far as the kakapo is concerned, the effect, if any, would have been only local and then only a proximate cause of the species' general near-extinction rather than an ultimate or major cause, for we must remember that there are still large areas of former kakapo range that even yet have been but rarely penetrated by Man.

Introduced Parasites and Diseases:

The suggestion has been made on a number of occasions (Doré 1918, Myers 1923, Laird 1950) that the native avifauna, because of its geographical isolation, would have had no opportunity to build up resistance to introduced parasites or to diseases such as avian malaria and ornithosis brought in by introduced species and that these new infections would wreak havoc as a result. The hypothesis is an interesting one, but would need a great deal of work to establish the likelihood of its truth. The little work that has been done so far by Doré and Laird is inconclusive, and the opportunity for studying the crucial native bird species may never occur because of their great rarity. In any case, it seems that a number of *a posteriori* assumptions would have to be made, and the possibility must always be kept in mind that the various migratory species visiting New Zealand may have been a means of introducing some of these infections over a very long time. Furthermore, as far as the acclimatized species of birds are concerned, a similar objection may be made (but perhaps with less force) to that already made in the instance of the introduced mammalian predators—that is, that some native species had already become scarce before the exotic avifauna could have had sufficient time to exert any widespread effect by spreading infection. The kakapo in the North Island and in parts of the north-west of the South Island would seem to be such an example of too early a diminution.

Competition for Food with Introduced Birds:

This hypothesis is perhaps second in its popular acceptance to that of the introduced predators and is the one favoured by Henry (1907) even though he viewed with such misgiving the arrival of the first mustelid on Resolution Island about 1900. However, general agreement with this suggestion has been far too uncritical in the past, even among professional ornithologists and ecologists, for even qualitative food habit studies of birds in New Zealand are not very far advanced at present, and it is a little unjustified to

* That is, if we except the Polynesian rat (*R. exulans*), which is regarded as being a vegetarian, and the now extinct feral 'Maori' dog—both of which were brought to New Zealand by the early Polynesian immigrants centuries ago. Some of the early explorers (see, for example, Brunner) report the Maori opinion that numerous packs of these feral dogs were responsible for a considerable reduction in the numbers of kakapo in pre-European times; but the same objections may be made to this suggestion as have already been made to the theory involving the other carnivorous mammals. Furthermore, feral 'Maori' dogs have apparently always been absent from the south-western part of the South Island.

assume that the food requirements of birds as different as large parrots and small passerines should show a great overlap.

Altered Habitat:

This hypothesis takes a number of forms, ranging from the rather obvious one of its direct alteration or destruction by Man to the subtler suggestions that changes have come about either by interaction between the introduced browsing mammals and the original environment—through, for example, their taking over of important food plants or the runways; or by (and even, perhaps, together with) secular changes in climate which would profoundly alter the vegetational environment in which the animals live; and Holloway (1954) has given a detailed account of changes in the forest now going on in parts of the South Island which he regards as being of this kind. In passing, there seems some difficulty—superficially at any rate—in satisfactorily explaining the disappearance of the kakapo strictly in terms of Holloway's theory as it applies to *existing* forests; for he maintains that the general tendency is for beech forests to replace those of podocarps and therefore we might expect a predominantly beech-inhabiting species like the kakapo at least to have held its own. But on the eastern side of the South Island the apparently climatically-induced replacement of the original forest by tussock grassland would appear a sufficient reason in itself for the disappearance of the kakapo from there. However, speculation has already gone far enough to justify the inclusion of the quotation from *The Origin of Species* which heads this paper.

To sum up:

The distribution of sub-fossil remains indicates that the kakapo was a diminishing species before Man was able to exert any marked effect on the birds or their environment; so vegetational changes resulting from—but lagging behind—climatic changes may have been the primary cause of this diminution which was later accelerated by European settlement bringing about destruction of much of the forest—especially in the North Island. To what extent predation by introduced carnivorous mammals, competition for food or space by introduced browsing mammals or the introduction of disease may have intensified the process we do not know. However, it must be remembered that species (for example, kiwi, weka and takahe) perhaps just as sensitive to predation, and others (for example, kea, kaka and the parakeets) perhaps just as sensitive to diseases still survive—sometimes in good numbers—in areas where they once co-existed with kakapo. Thus, only the hypothesis that climatic change has been the fundamental cause of the main decrease seems relatively satisfactory. In recent times direct destruction of habitat by fire and axe has caused a major shrinkage of range in some areas, but apart from this we have no plausible explanation to offer for the otherwise apparently accelerated rate of extinction of the kakapo over the last seventy-five years.

Conservation

Courses of action that promise good prospects for the indefinite preservation of the kakapo are few. In fact only two merit serious consideration: (1) the keeping and breeding of them in captivity and, at the same time, (ii) the liberation of as many as possible on a suitable island sanctuary—Kapiti being perhaps the first choice. Although an island liberation is the more attractive course for scientific and sentimental reasons, preservation in captivity is surer; and it seems certain that no practical action can be taken to ensure that a mainland area will offer the species permanent security. Accounts by some nineteenth century authors (c.f. Buller 1888) show that kakapo take well to captivity, but should they prove unready to breed even under the best conditions of confinement, no doubt they could be stimulated to do so. A strictly 'let-alone' policy, even when combined with full legal protection against molestation, although uncontroversial—and even popular—is likely to be as ineffective as it is unventuresome. Such a sentimental

attitude has not saved some other species from near or complete extinction.

From present knowledge it appears that the best area to search for the birds is that between Milford and George Sounds and the best time spring and early summer, when they are most active and vocal. There are a number of reports in recent years of them being seen or heard in the valleys of the Tutoko, Cleddau and Wild Native Rivers and in the vicinity of George Sound near Saddle Hill. But whenever an expedition makes a search (which should be soon), a dog, preferably trained and muzzled, will be essential; for, among others, Haast and Henry make a point of stating that it is just a matter of luck to find kakapo without one. In fact, it may be partly because dogs are forbidden entry to the various National Parks—in which a great deal of kakapo habitat lies—that the birds are so seldom seen nowadays.

APPENDIX

The numbers refer to the corresponding ones in Maps 1 and 2, and for each locality is given the date of the observation or of the collecting of the specimen (except with sub-fossil material) and the literature reference. If no date follows the author's name the information is in litt. on the kakapo files of the Department of Internal Affairs, Wellington. A detailed list of the material in overseas and local museums is being prepared and will be published later. The following have so far kindly supplied details of the material in their possession: British Museum (Natural History), University Museum, Oxford; Museum of Zoology, Cambridge; Vienna Museum, American Museum of Natural History, Australian Museum, Sydney; National Museum of Victoria, Dominion Museum, Wellington; Auckland Institute and Museum, Canterbury Museum, Christchurch; Otago Museum, Dunedin; Wanganui Public Museum.

NORTH ISLAND: 1: Little Barrier Island 1903 (Oliver 1922); 2: Hunua Range abt. 1912 (McKenzie); 3: Frankton (Turbott); 4: Matiri (Duff); 5: Karamu (Turbott); 6: Waitomo (Falla, pers. comm.); 7: Upper Wanganui River 1840s (Taylor 1855); 8: Raurimu - Wanganui R. abt. 1910 (Russell, pers. comm.); 9 and 10: Kaimanawa Ra. various dates (Buller 1868, 1892, Oliver 1955); 11: Ngaruroro R. abt. 1900 (Bathgate 1955); 12: Huiarau Ra. 1927 (McKenzie); 13: Coonoor (Falla, pers. comm.); 14: Akitio (Forster); 15: Pahiatua (Forster); 16: Waewaepa (Falla, pers. comm.); 17: Mauriceville (Anon. 1884); 18: Martinborough (Yaldwin 1956); 19: Kapiti Island 1912 (Wilkinson and Wilkinson 1952).

SOUTH ISLAND

Eastern Side: 20: Mt Stokes 1878 (Garland); 21: Maori Bay 1879 (Garland 1950); 22: Lake Grassmere (Dawson 1949); 23: Pyramid Valley (Duff 1952a); 24: Broken R. (Skinner); 25: Sumner (Haast 1874); 26: Mt Somers (Duff); 27: Pareora (Forster); 28: Timaru (Forster); 29: Castle Rock (Falla*, Hamilton 1892); 30: Owaka (Skinner); 31: Forest Hills (Skinner).

Nelson Province: 32: Takaka (Forster); 33 and 34: Goulard Downs 1860 and 1920s (Mackay 1860, Clouston, Phillips, Falla, pers. comm.); 35: Leslie Valley abt. 1895 (Brereton 1947), Kakapo Valley ND (Chisholm); 36: Mt Arthur 1906 (Oliver); 37: Karamea (Forster); 38: Mt Owen 1912 (McConochie).

Northern Westland: 39: Westport area 1899 (McConochie); 40: Moonlight 1907 (Jackson); 41: Grey-Inangahua Saddle 1848 (Brunner 1952); 42: Robinson R. abt. 1925 (Jackson); 43: Bold Head ND (O'Donoghue 1924); 44: Ross before 1900 (Buller 1905, Douglas unpubl.); 45: Rangitata before 1872 (Cain); 46: Okarito before 1900 and ND (Potts 1885, Forster); 47: Bruce Bay before 1900 (Haast 1864, Haast 1948).

* This sub-fossil record of Falla's could refer to **Castlepoint**, on the south-eastern coast of the North Island.

Bruce Bay - Jackson Bay - Lake Wanaka: 48: Paringa before 1900 (Cain, Rikitsansky); 49: Okuru-Haast divide (1883-84 (Howe); 50: Haast-Clarke junct. 1863 (Haast 1864); 51: Haast Pass 1863 (Haast 1864); 52: Burke R. abt. 1865 (Hassing 1930); 53: Jackson Bay before 1900 (Buller 1888, Amadon); 54: Jackson Bay ND (Keast, Holloway, Fleming pers. comm.); 55: Jackson Bay 1863 (Haast 1864); 56: Big Bay abt. 1903 (Henry 1904); 57: Five Fingers Ra. 1926 (Holloway 1936), ND (Holloway), Joe R. ND (Holloway); 58: Red Pike R. 1951 (Baigent).

Martin Bay - Milford Sound: 59: Martin Bay before 1900 (Goodwin), ND (Skinner), Sara Hills 1863 (Hector 1863); 60: Martin Bay area 1929 (Dept Int. Affairs); 61: L. McKerrow 1894 (Turbott); 62: Hollyford Valley 1906 (Falla), ND (Forster, Skinner); 63: Tutoko Valley 1933-37 (Anon. 1949a, Clark 1939); 64: Mitre Peak 1914 (Williams); 65: L. Ada 1900 (Thomson 1949); 66: Milford Sound before 1900 (Lyll 1852, Amadon, Goodwin, Skinner, Turbott); 67: Cleddau Valley 1935-49 (Anon. 1949b, Brewer 1949, Long 1949, Miers pers. comm.); 68: Homer Tunnel 1952 (Sansom); 69: Upper Hollyford Valley before 1900 (Turbott).

Milford Sound - Doubtful Sound - Lake Te Anau: 70: Franklin Ra. abt. 1900 (Crozier 1950); 71: Wild Native R. 1952 (Miers pers. comm.); 72: L. Beddoes abt. 1951 (Sutherland); 73: Glaisnock-Wild Native divide 1951 (Sutherland); 74: Glaisnock Valley 1938 (Sutherland), Nitz Ck. 1938 (Bell pers. comm.); 75: Henry Saddle 1947 (Frazer pers. comm.); 76: Stillwater R. 1949 (Wisely); 77: George Sound 1923 (Anon. 1923); 78: Vigil Peak 1949 (Poole 1951), Ethne Saddle area 1956 (Hall-Jones); 79: East of Whitewater R. abt. 1930 (Dalrymple pers. comm.); 80: Leslie Clearing 1949 (Poole 1951); 81: Caswell Sound after 1926 (Sutherland); 82: Mt Pisgah 1954 (Purdon); 83: Birch Creek 1948 (McConochie); 84: Turret Peaks 1924 (Sutherland); 85: Mid Burn abt. 1937 (Miers pers. comm.); 86: Middle Fiord area 1863 (Caples 1863); 87: Etrick Burn area 1875 (Hugel 1875); 88: Takahe Valley before 1900 (Duff 1952b); 89: Coronation Peak area 1955 (Duff); 90 and 91: Wilmot Pass area 1924 (Sutherland), 1927 (Oliver), 1930 (Beattie 1930), ND (Scarlett).

Doubtful Sound - Lake Hauroko: 92: Vancouver Arm - Hall Arm divide 1898 (Henry 1898); 93: Mackenzie R. area 1896 (Wilmot 1897); 94 and 95: Roa Stm. 1895 (Mackenzie 1896), abt. 1932 (Miers pers. comm.); 96: Green Point 1895 (Henry 1895c); 97: Cooper I. 1895 ff. (Henry various repts.); 98: Wet Jacket Arm 1895 ff. (Henry var. repts.); 99: Breaksea Sound area 1895 ff. (Henry var. repts.); 100: Long I. 1895 ff. (Henry var. repts.); 101: Resolution I. 1895 ff. (Henry var. repts.); 102: Parrot I. 1898 ff. (Henry var. repts.); 103: Anchor I. 1897 ff. (Henry var. repts.); 104: Indian I. 1895 ff. (Henry var. repts.); 105: Cascade Cove and 106: Pickersgill Harbour before 1900 or ND (Hall 1878, Reischek 1884, Buller 1888, Henry 1903a, Ogilvie-Grant 1905, Gray 1845a, Lyll 1852, Forster, Goodwin, Rikitsansky, Skinner, Turbott, Woodrow, Falla); 107: Tableland 1887 (Reischek 1887b); 108: Northport 1863 (Hector 1863), 1887 (Reischek 1887a); 109: Chalky Sound area 1899 (Goodwin); 110: Preservation Inlet area before 1900 (Buller 1888, Andersen unpubl.), 1898 (Forster).

STEWART ISLAND: 111: Christmas Village abt. 1898 (Woodrow); 112: Port Pegasus ND (Oliver 1926, Anon. 1949b, Traill); 113: Port Pegasus - Seal Pt 1951 (Sansom), 1949 (Corboy).

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is often taken to extremes in reviews!) the date of publication of papers by authors who have written only one is given in the text only at the first citation; when this author is mentioned or quoted thereafter it may be taken for granted that this same paper is the one referred to. Thus any mention of Lyall implies that his paper of 1852 contains the information being discussed.

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NOTES ON SOME RARE BIRDS RECENTLY RECORDED IN HAWKE'S BAY

By D. H. BRATHWAITE

During 1954 and the first half of 1956 some interesting records of rare birds have been made in Hawke's Bay, and the writer also has further comments to make on birds previously recorded.

AUSTRALIAN COOT (*Fulica atra australis*): Among the notes of his observations at Lake Tutira, by the late Rev. F. R. Robertson, is the following reference to a sight record of this species. He states, 'As we walked round the bay on the s(outh) side of the pines we heard a number of pukeko. Some of these flew across to the prom(entary) on which the silver birches are growing (below the new church). As we walked round, a pair of mallard and a pair of greys moved out from the raupo into the bay, and with them a bird which was at first sight a pukeko, but (a) it was swimming, (b) it took the lead, (c) instead of showing a red plate it showed a white one. It was clearly not a pukeko. On 14/9/54 I returned to the lake and soon found the bird feeding off the end of a little strip of reeds on the n(orth) side of this bay. I was able to add another diagnostic