petrels, muttonbirds and [flesh]-footed shearwaters. In May 1946, after three weeks of east wind, there was an enormous deposit — running to many hundreds — of little else save diving petrels, extending for some miles at least, east of Mt. Maunganui. That was, I think, the last of the big deposits, and numbers have been generally going down ever since." (M. Hodgkins, *in litt.* Aug. 1961).

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The authors are grateful to Mr. F. J. Tindall (Soil Bureau D.S.I.R.), who drew Fig. 1.

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OBSERVATIONS ON CHICK MORTALITY IN A COLONY OF BLACK-BILLED GULLS IN THE THERMAL AREA AT WHAKAREWAREWA

By M. J. DANIEL

INTRODUCTION

It is well known that the Black-billed Gull *(Larus bulleri)* and the Red-billed Gull *(Larus novaehollandiae scopulinus)* breed in several areas near Rotorua on the volcanic plateau of the central north island (Oliver; 1955), the largest colony of the Black-billed Gulls being at Sulphur Point on Lake Rotorua, with other smaller colonies on the same lake and at Lake Rotomahana (Black; 1954).

This communication reports some observations taken during the 1962/63 breeding season on the many hazards facing the eggs, chicks and adults of a small colony of Black-billed Gulls (c. 125 birds),

nesting on several areas around a thermal lakelet, Roto-a-Tamaheke, in the Whakarewarewa thermal reserve behind the Forest Research Institute.

Although this unusual and dangerous nesting site for gulls might seem unique, Oliver (1955), mentions that according to Phillipps and Lindsay, a colony of about 150 Red-billed Gulls once nested on warm ground beside a hot pool at the Waiotapu thermal reserve. The colony was forced to move however when the pools dried up after an earth movement.

DESCRIPTION OF THE THERMAL GULL COLONY

The thermal lakelet Roto-a-Tamaheke is of irregular outline and measures only about 100 yds. by 80 yds. (Fig. 1). The temperature of the water at present is hot to scalding, being from 70 degrees to about 98 degrees centigrade (158-208 degrees Fahr.) on the north side where a boiling geyser occasionally rises to over 20 ft. The ground around is warm and the mud on the edge of the nesting sites varies from about 50-65 degrees centigrade (122-149 degrees Fahr.). The only vegetation around the lakelet is manuka *(Leptospermum scoparium)* and kanuka *(L. ericoides)*, which have a high tolerance both for the hot ground and the sulphurous steam.

From Fig. 1, it can be seen that the gulls nest in five separate areas around the lakelet, all on the opposite side to the little-used footpath from the Institute to the village. Observations were recorded daily or twice daily from three vantage points using binoculars and telescope. However, at times observations were extremely difficult

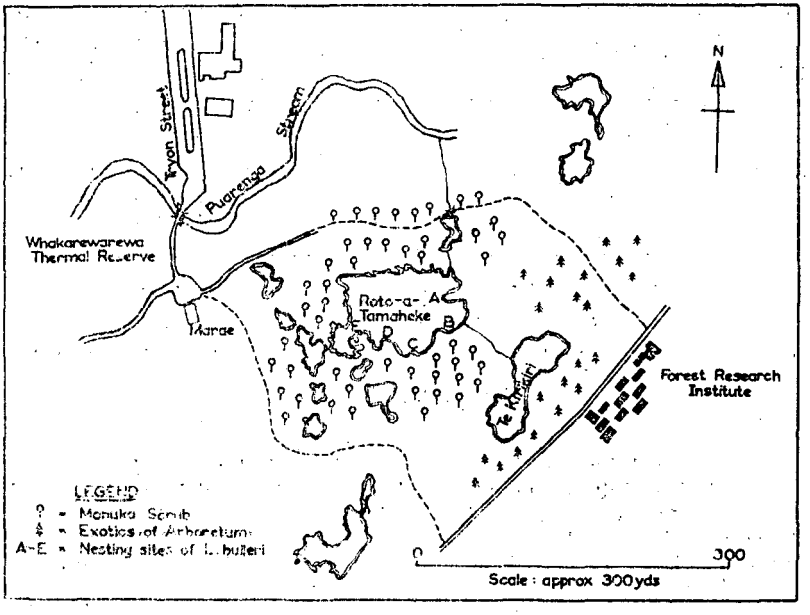
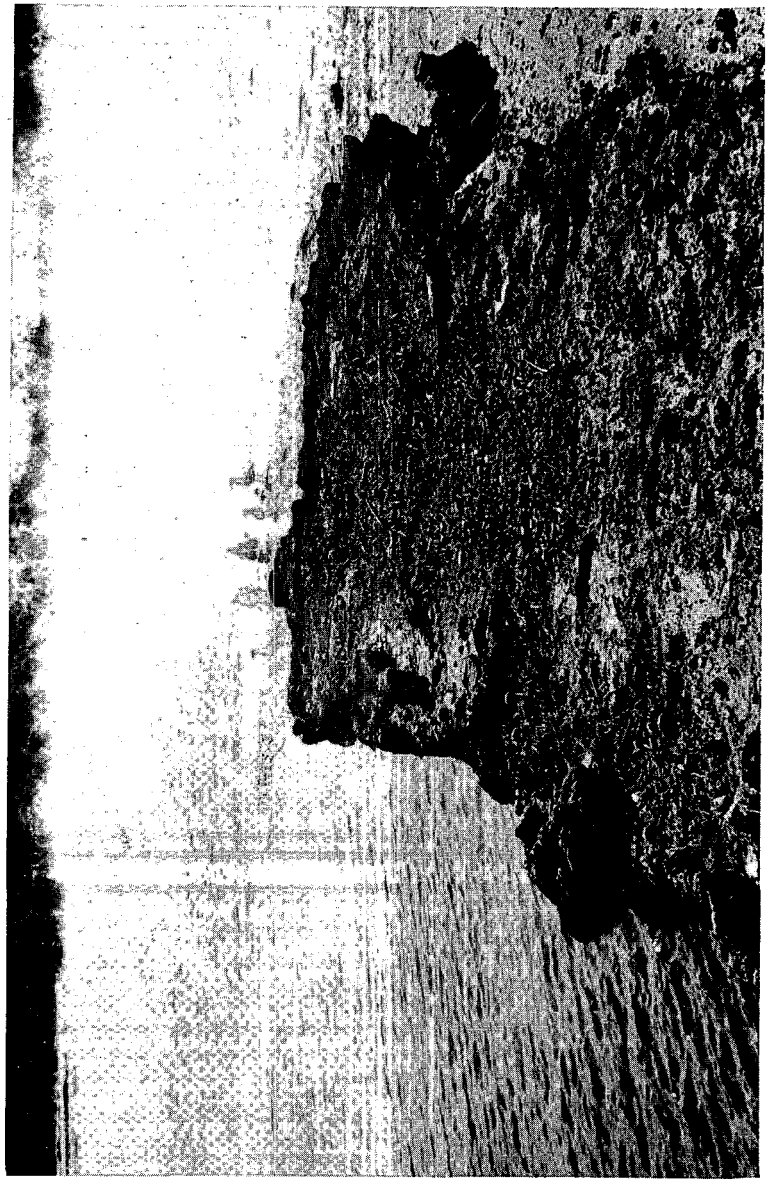


Fig. 1 — Map of thermal area showing location of five nesting areas of **L. bulleri** on lakelet Roto-a-Tamaheke.

[M. J. Daniel

XXXI (1) — Part of thermal lakelet Roto-a-Tamaheke looking across at nesting sites A, B and C of **L. bulleri.** Because of the sulphurous steam the visibility was rarely as good as this.



[M. J. Daniel

XXXII (2) — Colony A on lakelet Roto-a-Tamaheke, showing crude nests, desiccated eggs, two desiccated chicks and the remainder on the warm mud at the edge of the hot water.

because of the numerous hot pools, boiling mud-holes and the swirling sulphurous steam that sometimes covered the lakelet for hours (Plates 1 & 2).

OBSERVATIONS

The following condensed data clearly demonstrate the success or lack of it, in the 1962/63 breeding season.

Number of nesting areas in the colony:	= 5
Numbers of pairs of Black-billed Gulls:	= 40 (A - 9, B - 16, C - 11, D - 3, E - 1).
Number of pairs of Red-billed Gulls:	= 1 (E - 1)
Number of non-nesting juvenile gulls:	= approx. 43
Total number of gulls in the thermal colony:	= approx. 125
Total number of desiccated eggs found:	= 30 (others by Maoris)
Total number of desiccated chicks found:	= 9 (others by Maoris)
Total number of chicks killed by hot water:	= at least 12
Greatest number of live chicks seen on sites:	= 35
Number of young gulls successfully leaving colony:	= 1 or 2 only.

From this it can be seen that assuming an average of 2 eggs per breeding pair, the percentage failing to hatch as the result of desiccation was about 57%. Of the probable 82 eggs laid, only 2 young at the most successfully left the colony, a success of only 2.4%. Of the 21 chicks found dead, 9 or 43% were desiccated on the nesting sites (see Plate 2), the other 12 were killed by falling into the hot water either accidentally or driven in by Maori children. Instances of both of these were observed. On one occasion two young chicks were pushed into the hot water by several adult gulls squabbling over a nest site. Both were killed instantly. On another occasion, the silica rock supporting a nest was seen to crumble away into the water along with one chick and an adult gull. Both were killed, probably by shock, within a very short time.

From the eggs that were desiccated by the intense solar radiation, the warm rocks and the proximity of so much scalding water and steam, it was noticed that several chicks were dehydrated and killed while only partially out of the shell. Besides very rapid breathing, the only behavioural adaptation of the chicks that could be seen was complete prostration in the few depressions and cavities of the silica rock of the nest site. It was very noticeable that both the adults and the chicks were very wary of the water and when approached would stand huddled on the edge of the hot water as shown in Plate 2. Only with great difficulty could the Maori children drive the chicks into the water to their death.

DISCUSSION

Several of the adults were seen incubating their desiccated and dehydrated eggs for as long as 45 days. This is not as long, however, as the 75 days recorded for *Larus ridibundus* by Kirkman (1937).

Although young gulls are precocial and have some degree of thermoregulation at an early age, it seems as if in this case, the severe

stresses of this hostile environment imposed too great a strain on their powers of thermoregulation, both physiological and behavioural. According to Marshall (1960), the mean day temperature of gulls is about 41 degrees centigrade. Bartholomew and Dawson (1954), working on the thermoregulation of the Western Gull *(Larus occidentalis)* in the desert region of California, found that with intense solar radiation this can quickly rise to 43.3 degrees centigrade. To reach homoiothermy and avoid a higher and fatal temperature, the precocial young gulls must either seek shade in cracks and crevices on the nesting site or in the shadow of their parents or swim in water (Tinbergen, 1953; Bartholomew and Dawson, 1954). Also to avoid excessive and fatal desiccation and dehydration they must drink fresh water. Bartholomew and Dawson (1954), in another study on doves, found that at a body temperature of 39.5 degrees centigrade they drank four times as much water as at 23 degrees centigrade and that 24 hours without water caused a 15% loss in body weight. The Black-billed Gulls of this thermal colony had to rely on rain water collecting in fissures in the warm rocks for their only water. This soon evaporated on a hot day, leaving only the hot and highly saline water of the lakelet. It is not surprising that at least 26% of the chicks died of dehydration and heat distress.

Taking the mean body temperatures of the young gulls to be about 41 degrees centigrade and the saline water of the lakelet to be from 29-57 degrees centigrade above this body temperature, it is not surprising that death was almost instantaneous in the water, even for the adults falling in.

It seems probable that this colony was originally an offshoot of the main Lake Rotorua colony, where the gulls still go to feed. According to J. L. Nicholls (pers. comm.) they were nesting on this lakelet as early as 1941. At this time the lakelet was hot but by 1948 had cooled down enough for swimming. By 1951, however, it had heated up again to its present temperature. It seems likely that if the temperature remains high and the Maori children continue to molest the young gulls, this enterprising colony will be wiped out in a few years.

The only other species apparently not affected by the steam was the Myna *(Acridotheres tristis)*. Several of these were seen among the chicks, probably seeking regurgitated food. Also, large numbers of Black-backed Gulls *(Larus dominicanus)* were seen on occasion flying and soaring on the hot air currents several hundred feet above the thermal area, but they were never observed feeding on the dead gulls and abandoned eggs.

It is of some interest that in 1952, a Pied Stilt *(Himantopus leucocephalus)* nested on the edge of this same lakelet and successfully raised four young (Johnson, 1954).

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FOOD HABITS OF THE NORTH ISLAND WEKA

By A. L. K. CARROLL

Until comparatively recent years, Wekas, *Gallirallus australis greyi,* abounded throughout the North Island, ranging freely wherever there was food and cover sufficient for their needs. Reports from early settlers contain frequent references to the amusing antics and annoying habits of these flightless birds, which were numerous and enterprising enough to become pests in many places. Following settlement of the land, they decreased in numbers, but it was not until approximately 40 years ago that they had disappeared almost completely, leaving a small residual population in the East Coast district and a few birds in the vicinity of Waipu, Northland (R. T. Adams, pers. comm., Int. Affairs file). It is possible that the sudden disappearance was due to an epidemic, as reports were received from people who had at that time seen numbers of Wekas in poor condition and infested with ticks.

Those surviving in the East Coast area soon multiplied rapidly and are now to be found occupying roughly 1,200 square miles, with highest concentration of numbers in the Gisborne - Tolaga Bay district, cf. Fig. 1.

Here they continue to flourish to such an extent that they have become a nuisance to local farmers and market gardeners, particularly in the dry summer months, when they peck the succulent tomatoes, melons and pumpkins, rob fowl-yards and dig up plants in search of insects. Oliver (1955) writes that against the Wekas' misdeeds must be set the fact that they consume large quantities of grass-grubs and other noxious insects, as well as rats and mice. However, as a result of complaints made to the Department, Wekas are now being trapped in the Gisborne district for subsequent liberation in selected sites in the North Island. These operations have met with varying degrees of success. In some areas it would appear that colonies have become firmly established as a result of liberations.

The primary purpose of the present investigation was to examine food habits of the Weka, but other work of a more general nature was also undertaken.

From June 1961 to December 1962 Wekas were collected in the Gisborne area at the rate of approximately five a month. These were frozen and sent to Wellington for examination. Altogether 94 specimens were studied — weight and external measurements taken, condition of internal organs noted, bursa, caeca and adrenals measured, reproductive organs examined and stomach contents sorted, identified and measured. A collection was made of wings and tails of these specimens as a basis