BREEDING BIOLOGY OF THE SOUTHERN BLACK-BACKED GULL

II: INCUBATION AND THE CHICK STAGE

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ABSTRACT

The study was made on Somes Island in Wellington Harbour during the 1961-62 breeding season. Incubation behaviour, development of the incubation drive and methods of nest relief are discussed. The average incubation period is 27 days, with extremes of 23 and 30 days. The average breaking period of the eggs is three days, with extremes of one and six days. Two-egg clutches hatch in one to five days, three-egg clutches in two to six days. In most two- and three-egg clutches incubation becomes effective on arrival of the second egg. Of all the eggs from first clutches, 66.1% hatched successfully. Half of those failing to hatch were addled or contained dead embryos. Three-egg clutches had a higher hatching percentage than two-egg clutches, which were in turn more successful than one-egg clutches. Egg losses are correlated with nesting density; greatest losses occurring in areas of highest density.

Brooding and defensive behaviour are outlined, and the feeding of chicks discussed. A wide variety of foods is offered the chicks, but in general they are fed whatever happens to be handy and available in quantity. Chicks leave the nest two to three days after hatching, are able to swim at five to six days of age, and fly at about seven weeks. The egg tooth is lost on the eighth or ninth day, the yolk-sac scar disappears by the end of the third week, and the beak becomes wholly black after five weeks. Young birds leave the colony within a month of fledging.

Minimum chick mortality to the flying stage was 19.8% — heaviest losses being sustained in the first week after hatching. The minimum overall mortality of eggs and chicks to the flying stage was 46.9%, and a mean of 1.3 chicks per breeding pair reached the flying stage. The majority of breeding adults found dead were males, most of which died from wounds inflicted by other gulls. A few immature birds in the colony showed incomplete breeding behaviour.

This paper concludes a description of the breeding of the Southern Black-backed Gull, *Larus dominicanus*, as recorded on Somes Island, Wellington Harbour, New Zealand, during the 1961-62 season. An earlier paper (Fordham, 1964) gave an account of the pre-egg and egg stages, and the present paper continues with descriptions of incubation, chick growth and behaviour, the breeding success of the colony, mortality of breeding adults, and the behaviour of non-breeding immature birds. Calls and postures mentioned have been described previously by Fordham (1963).

INCUBATION AND HATCHING

Incubation Behaviour

Before completing the clutch, the birds attend the nest but rarely incubate. Displacement preening is occasionally seen both in and out of the nest. Serious incubation, to which the following notes refer, begins after the last egg is laid. On settling, the incubating bird shuffles the eggs into place against the brood patches and then usually adjusts the nest material. This is achieved by shifting material about the nest with the beak and may be followed by foot-patting. Foot-patting is a nest-building activity (described by Fordham, 1964) which occurs with decreasing frequency as incubation progresses until after about 10 days it is rarely seen. Reduction in foot-patting is probably an expression of the waning of the nest-building drive, for a little nest-building often occurs in nests with new eggs. To turn the eggs the bird lowers its head and pulls them toward itself with the underside of the beak. Sitting birds make small "trampling movements" (Beer, 1961) with the feet, which tilt the body from side to side and eventually move the feet close to the eggs. By approaching incubating birds with a torch at night, and gentle handling, it was established that in fact the feet

usually are partly under the eggs. This helps to explain how eggs and small chicks are sometimes flicked out of nests when the parent departs abruptly.

While on the nest a bird spends much of the time sleeping, preening, simply sitting still, or on hot days gasping. Other activities include joining in contagious cries such as long calls or alarm calls, and there may be a little choking on occasions. Nests remain free of faeces or dirt until the eggs hatch, but in one nest a regurgitated casting of shellfish remains was found after a fortnight's incubation. Tinbergen (1953) concluded that incubation inhibits defecation. In bad weather the birds flushed as readily as during fine weather, but tended to return more promptly to the nest. Similarly for the Black-headed Gull, *L. ridibundus,* Baerends (1959) and Beer (1961) found that cold weather increased the tie to the eggs.

After a spell of incubation, parents usually fly off to feed and bathe. On return to the territory they occupy an area which is usually adjacent to the nearest neighbouring nest where they spend their time in preening, sleeping, stretching and, when necessary, in defence of the territory.

During laying and incubation there is a gradual intensification of brooding, difficult to detect from day to day, but recognisable over a longer interval by the birds' increasing reluctance to leave the nest and increasing use of defence measures. Following a disturbance in the early stages of incubation the parents usually circle overhead giving alarm and anxiety calls; later in incubation they begin to hover above the intruder and, as hatching draws near, may dive down giving the charge call. Diving attacks on intruders become more common when the chicks hatch, and occur with greatest frequency while the chicks are unfledged.

Incubation is shared between the male and female; each taking more or less regular turns on the nest and remaining there for anything from 20 minutes to seven hours. Pairs under observation showed variation in the amount of time spent on the nest by either bird, and records of time spent in incubation as well as observations of general behaviour did not suggest any consistent difference in the attitude of male or female towards brooding. Males and females alike were often frustrated in attempts to relieve their mates, especially after a short interval. Tinbergen (1953) considered the female Herring Gull, *L. argentatus,* is on the average a slightly more "devoted brooder" than the male, and Baerends (1959) found in the same species that the incubation instinct is possibly not activated so readily in the males as in the females. There is evidence in the Black-headed Gull that perhaps males spend slightly more total time sitting than females (Ytreberg, 1956; Beer, 1961).

Parents changed places on the nest at any time of day, although more attempts to relieve sitting birds were seen in the afternoon than at other times. This was probably an expression of the general increase of activity witnessed in the late afternoon. The methods by which one birds seeks to relieve the other are varied, ranging from voluntary departure from the nest by the sitting bird, to forcible ejection by the partner. The most common method was for the partner to approach the nest mewing, then start choking beside the sitting bird. Another common method is to carry nest material and occasionally food to the

sitting bird. Both these methods may be unsuccessful at first, but after two or three attempts the sitting bird may stand, step from the nest and either begin preening or fly away. Sometimes the brooding bird simply stands and walks out of the nest without any prior display, and similarly on other occasions the non-sitting bird may relieve its mate without any display or call being given. Repeated frustration of attempts to relieve the sitting bird usually leads to a forcible take-over by the partner. In these cases the bird steps on to the side of the nest, gradually edges its feet down between the nest wall and its partners, and then burrows its head under the chest of its mate so that the other is pushed up and out of the nest. Forcible nest relief usually follows vigorous choking by the non-sitting bird, which passes into "muffled" choking while the change-over is affected.

Length of Incubation

The incubation period extends from the laying of the last egg to the hatching of the last young (Nice, 1937). The effect of this definition is that records can be used only from nests in which the last egg hatches. On Somes Is. the mean incubation period in 172 clutches of one to three eggs was 27 days (range-23 - 30 days), and 161 of the clutches (93.6%) hatched in 26 - 28 days. Two clutches each containing two eggs were incubated steadily for 58 and 69 days respectively before being deserted.

The hatching of an egg usually takes several days and faint tapping and cheeping can be heard even the day before the first crack or pip appears. The length of time between the appearance of the first cracks in the shell and the moment when the chick emerges has been called the breaking period of the egg by Paludan (1951). Of 124 eggs recorded in the present study, 116 (93.5%) broke in two to four days, and the average length of time was three days; extreme records were one and six days. There are no significant differences between the breaking periods of first, second or third eggs; in each case three days is the most common length of time taken. Essentially similar findings were made by Paludan (1951) for Herring and Lesser Black-backed Gulls.

Hatching Sequence

The eggs of a clutch are laid over a period of days, and because some incubation usually occurs during the laying period, hatching is also spread. The order and time intervals at which the eggs hatch can be called the hatching sequence, and does not necessarily correspond to the intervals at which they were laid. The same phenomenon in the Lesser Black-back and Herring Gull was called the "hatching pattern" by Paludan (1951), who considered that from such patterns some evidence of incubation during the laying period could be gathered. When all the eggs in a clutch hatch on the same day it may be assumed that incubation began at or after the laying of the last egg, but when the eggs hatch on different days incubation must have begun some time between the laying of the first and last eggs. In the Southern Black-backed Gull two-egg clutches hatched in one to five days, and only 8.5% of the 60 clutches recorded took longer than three days to hatch. The hatching of three-egg clutches ranged from two to six days, and 17.7% of the 57 clutches recorded took longer than four days. It was clear from the hatching sequences recorded that in most

clutches of two or more eggs incubation becomes effective at about the stage of arrival of the second egg. In only one (two-egg) clutch did the second egg definitely hatch before the first, but in two further nests (one two-egg, and one three-egg), it appeared likely that the second egg may have hatched before the first. After intensive studies with Black-headed Gulls, Beer (1962) found that increase in effective incubation during the laying period accounts for the differences between laying and hatching intervals.

Hatching Success

Of 310 marked clutches, 125 (40.3%) remained intact up to hatching. Brief gales of two or three days' duration experienced periodically were responsible for destroying several nests either before or after the eggs had hatched. It is clear that only good fortune prevents more beach nests being damaged by high tides, since after the breeding season several nests were destroyed in this way. Of 741 eggs of first clutches, 490 (66.1%) hatched, and of the 251 (33.9%) that failed to hatch, 15 started to hatch but the chicks failed to emerge. The fates of the eggs that did not hatch are shown in Table 1.

TABLE 1 — FATES OF UNSUCCESSFUL EGGS

	Number	*Percentage*
Eggs that addled, or in which the embryo died	127	50.6
Eggs destroyed and/or eaten by gulls*	54	21.5
Eggs that disappeared	47	18.7
Eggs that began to hatch, but perished	15	6.0
Eggs lost when nest collapsed or was destroyed	4	1.6
Eggs that perished when the nest was abandoned	4	1.6
	251	100.0

* Two of the eggs listed as destroyed were broken by the observer.

Three-egg clutches showed a slightly higher (but statistically insignificant) hatching percentage than two-egg clutches, while the success of one-egg clutches was much lower than either two- or three-egg clutches (Table 2). Paynter (1949) found that the hatching success of two- and three-egg clutches of Herring Gulls did differ significantly.

TABLE 2 — CLUTCH SIZE AND HATCHING SUCCESS (FIRST CLUTCHES ONLY)

Clutch Size	*No. of Nests*	*Total No. of Eggs*	*Hatched*	*Percentage*
3	149	447	312	69.8
2	133	266	172	64.7
1	28	28	6	21.4
Total	310	741	490	66.1 (Aver.)

Of the 15 eggs that began to hatch, but from which the chicks chicks failed to emerge, most were found to be in a slightly squashed condition. The sequence of events was usually as follows: one or two days after beginning to pip, the shell would become very cracked and broken in the general area of the original pipping. Finally the egg would become slightly flattened about the cracked area of the shell

often with the beak of the now dead chick protruding. Eggs that became cracked or dented during incubation rarely hatched, and even small injuries in the early stages of incubation were apparently sufficient to cause addling. Only in the last stages of incubation did cracks and dents have no effect on the developing chick.

Egg losses have a positive correlation with nesting density, since the lowest and highest percentage of egg losses were found in the areas of lowest and highest nesting density respectively. Losses are caused largely by the predation of neighbouring gulls whose effect is accentuated when the nests are close together. The correlation of egg losses with nesting density is shown in Table 3 where the marked areas are listed in order of increasing nesting density.

TABLE 3 — EGG LOSSES AND NESTING DENSITY

Area	*Nests/Acre*	*No. of Eggs*	*No. not Hatched*	*Percentage*
F	65	120	29	24.1
A	80	85	22	25.9
B	86	112	34	30.4
G	88	86	32	37.2
D	109	261	108	41.3

In order to determine whether the presence of an observer affected egg losses in the marked areas, 320 nests in other parts of the colony were inspected. Nearly 20% of the nests contained broken or addled eggs. Although no statistical test was made, taking into account eggs lost without trace, embryos dead in apparently whole eggs, etc., it is considered that egg losses in the marked areas would probably not have differed significantly from those in other parts of the colony.

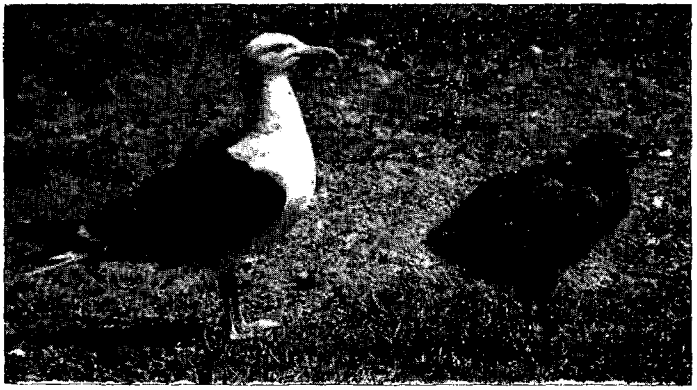
THE CHICKS

Parental Behaviour

The chicks are brooded by both parents, which seek to relieve each other in the same ways described for nest-relief during incubation, i.e. by mewing, choking, etc., but mewing is the commonest method. While the chicks are being brooded, food is often brought to them by the non-sitting bird. The nest itself is ignored by both parents. As the chicks hatch the posture of the incubating bird changes; it sits more lightly on the nest, wings drooped and held very slightly away from the body, and the wings and body are frequently lifted to accommodate the movements of the chicks. Apart from this posture there are no signs that the eggs are actually hatching; shortly after a chick hatches however, the parents usually take the egg shells from the nest and drop them a few feet away. Egg shell removal is thought by Tinbergen *et.al* (1962) to be of survival value in that eggs are more subject to predation than are cryptically-coloured chicks, and thus removal of egg shells reduces the likelihood of predation by neighbouring gulls.

On the first day chicks may struggle out from beneath the parent, and even when unable to stand may push their way around inside the nest bowl. They may also aim feeble darts at the beak of the parent, but this food begging is usually unsuccessful. If a small chick has difficulty finding its way back under the brooding bird, the parent will stand, bend its head forward, and apparently move the chick to a position under one wing. Chicks are brooded fairly constantly for

three to four days, after which they leave the nest for increasingly long intervals; the parents cover them only sporadically, and to all intents the nest is abandoned. Chicks 10 to 12 days and older are commonly buffeted by strong cold winds and have to find their own way to shelter in the surrounding vegetation while their parents remain apparently oblivious of their efforts. No matter how hot or wet the weather, only the smallest chicks are sheltered by the parents. A long period of rain leaves the older chicks so bedraggled that their wings droop, which causes the birds to flick them continually in order to lift them back into position. At night only the smallest chicks are sheltered by the parents, older chicks finding their own shelter beside or close to the nest, and there is no doubt that lack of shelter at certain times causes the death of some chicks. No "creche" system was found to operate in any part of the colony, and although a few chicks were associated in one or two clear spaces, family groups were not seen to mix.



I — Chick approximately 5 weeks old with parent on guard.

Until the chicks can fly there is nearly always at least one parent in the neighbourhood (Plate I). Later their attachment to the chicks rapidly weakens, so that, while most young birds accompany and beg food from their parents for some time after they are able to fly, their demands are rarely satisfied.

Wandering chicks are attacked by adults, and defended by their own parents. Many chicks are killed during the breeding season by these attacks, and some are eaten. R. M. Lockley *(pers. comm.)* informed me that wandering chicks of the Great Black-backed Gull *(L. marinus)* may be killed and eaten by neighbours, and the parents themselves may eat the dead chicks. Herring and Lesser Black-backed Gulls may also kill and devour young of their kind (Paludan, 1951).

Chicks often choose to hide in the same place each time they are frightened, even though it may appear to lend scant protection; a two-day old chick was even seen pushing an empty egg shell round and round the nest while attempting to clamber into it. When the chicks are hiding they sometimes curb activities, such as gasping on hot days, if the predator approaches close to where they are concealed. The only parental calls to which they pay any attention are the alarm call which

sends them into hiding, and the mew call which is often used to bring them out of hiding. Alarm may often spread through small sections of the colony for no reason apparent to the hidden observer, so that chicks may rush into hiding when no predator is near. While chicks are travelling to and from their hiding places, following a disturbance in the colony, they encounter most attacks from neighbouring adults. Minor disturbances often result when foreign gulls, probably on the look-out for unprotected eggs or chicks, land in the midst of a group of incubating and brooding birds. Parents will drive other species of birds away from the vicinity of the chicks, and if the chicks are attacked will fly rapidly to defend them. The attackers are driven off with wing blows and pecking, the parents emitting vigorous long calls in the process.

Chicks commonly take to the water when alarmed and usually bunch together to a certain extent, especially when they are attacked by older gulls; yet banding showed that at such times older chicks sometimes exhibit aggression towards younger chicks of different clutches. Once the parents have warded off an attack on their chicks they shepherd them to safety, and on only one occasion was a young chick seen to be deserted by its parents during this stage. The chick which was attacked on the water by many birds was defended by its parents for a while, but they later departed, and it was almost killed before it managed to reach dry land.

Food and Feeding of the Chicks

Both parents feed the chicks. Food may be offered to the chick on the day it hatches, but may not be accepted, if only because the chick is too weak to make the appropriate responses with its beak. Feeding is usually sporadic for the first two days but becomes more frequent after that. One chick, watched for five hours the day it hatched, and for six hours the following day was offered food once only. It aimed feeble darts at the beaks of its parents, and gave small squeaky cries, but these food-begging movements remained unanswered. On hatching, chicks possess a certain amount of residual yolk in the abdomen, and these remains do not disappear for from five to seven days. It is likely that delayed feeding of the chicks in the first day or two is related to the presence of the yolk remains.

When a chick begs food it gives piping cries accompanied by vertical movements of the head and neck, and aims pecks at the beak of its parent. The parent then begins walking about, regurgitating with effort at intervals. Regurgitations are slow and controlled and, at least while the chicks are still small, the parent does not resist their begging to any extent. When the chicks are older a parent may run several yards pursued by its offspring before it is able to vomit in relative peace. Food is held loosely in the beak near the gonys while the chicks peck at it. There is no dispute between chicks over food. In the early stages food that drops to the ground is ignored but later, parents draw the chicks' attention to this food, and after five or six weeks chicks eat most of their food from the ground. Though it is usual for a parent to give the mew call before offering food, it is not always given, and a chick may miss a feed because it is out of sight of the parent as the other members of the brood are fed. If several feeds are missed by one chick, it could become weakened.

At one or two weeks of age chicks are fed on an average once

an hour, while at three weeks it may be about every two hours, and in general they are fed with decreasing frequency as they grow. There is a tendency for older chicks at least to be fed more often on cold days than very hot days, and some feeding almost certainly occurs on moonlit nights, though not on very dark nights.

Parents seem to have no concept of the size of food that small chicks are able to deal with. Often they regurgitate whole fish, earthworms, etc., which the chicks are not able to swallow. Sometimes the parents tug at the food, possibly attempting to break it up, but usually it is swallowed again by the parent, or left on the ground. Though items of any size may be offered chicks of any age, in general well fragmented food is given to very small chicks.

Chicks may accompany their parents for several months after they are able to feed themselves (i.e. shortly after they can fly) and juveniles up to at least six months old are often seen food-begging, but always unsuccessfully. Wilkinson (1952) records that parents stop feeding their chicks at about 12 weeks.

The Food

Stomach contents of chicks; regurgitated pellets from parents and chicks; other food remains in or by nests were examined, and a list of items identified is given below.

LIST OF IDENTIFIED FOOD ITEMS

Chordata.

Mammalia: Norwegian rat *Rattus norvegicus* (beheaded bodies regurgitated). Hedgehog *Erinaceus europaeus* (legs and jaws).

Aves: Starling *Sturnus vulgaris,* House Sparrow *Passer domesticus;* whole bodies regurgitated. Other remains of small birds (e.g. Dunnock *Prunella modularis,* Silvereye *Zosterops lateralis*).

Amphibia: *Hyla aurea* (Tadpoles).

Pisces: Short-finned Eel *Anguilla australis schmidtii* ca. 15 cm., and *Anguilla* sp., ca 50 cm. and one lb. wt. regurgitated.

Whole regurgitated bodies:
- Cockabully *Tripterygion* sp.
- Spotty *Pseudolabrus celidotus.*
- Yellow-eye Mullet *Aldrichetta forsteri.*
- Long-snouted Pipefish *Stigmatophora longirostris.*

Snapper *Chrysophrys auratus* (?)

Echinodermata.

Asteroidea: *Patiriella regularis.*

Echinoidea: Sea egg *Evechinus choloroticus.*

Arthropoda.

Insecta: *Coleoptera:* Green chafer *Chlorochiton suturalis.*
Grass grub, *Costelytra zealandica.*
Manuka beetle *Pyronota festiva.*
Eucalyptus tortoise beetle *Paropsis dilatata.*

Diptera: Syrphidae (Hoverflies): Larvae of *Eristalis sp.*
Calliphoridae: Blowfly *Calliophora quadrimaculata.*
Tipulidae (Crane flies): adults.

Lepidoptera:	Hepialidae: Puriri Moth pupa *Hepialis virescens.*
	Noctuidae: Remains of adults and pupae.
Hemiptera:	Cicadidae: *Melampsalta cingulata* and other spp.
	Pentatomidae: Green vegetable bug *Nezara viridula.*
Crustacea.	
Natantia:	Crangonidae (remains of shrimps).
Decapoda:	Crab remains.
Annelida.	
Oligochaeta:	Lumbricidae: *Lumbricus rubellus* and other species.
	Megascolecidae: Remains of specimens ca. 25 cm.
Mollusca.	
Amphineura:	Chitons e.g. *Eudoxochiton* and *Amaurochiton.*
Gastropoda:	*Lunella smaragda.*
	Paua *Haliotis* sp.
	Cominella spp.
	Nerita melanotragus.
Pelecypoda:	*Chione stutchburyi.*
	Perna spp.
	Amphidesma spp.
Cephalopoda:	*Octopus.*

This list is not exhaustive, and additional to it would be grass and grit, major items such as offal, remains from rubbish tips, gull chicks, and possibly skinks, which are common on the island. Most of the animals were probably caught alive, or washed up on beaches, and illustrate the various habitats exploited by the parents. The rats' bodies probably came from a tip, but Burden (1949) saw a gull kill a rat in 10 minutes, and succeed in swallowing the corpse after half an hour. The habit of stealing eggs or young of other species such as terns, gulls and Gannets is well documented (Stead, 1932; Murphy, 1936; Taylor & Wodzicki, 1958; Williams, 1963) and Dr. R. A. Falla (*pers. comm.*) told me that Southern Black-backs often cruise low over open bush, looking for young birds in exposed nests. In practice the chicks are fed whatever is handy and available in quantity, so that earthworms are common food during wet weather, and shrimp, beetle or grass grub remains at numerous nests indicate the general abundance of those items at certain times. Thus Bell (1960) mentions that chicks in the Wairau River colony, Marlborough, were fed mainly on "army worms" *Persectania ewingi* (Noctuidae: Lepidoptera) and McMillan (1961) states that smelt *Retropinna anisodon* forms the bulk of the food of Southern Black-backs nesting in the Rangitata River, Canterbury.

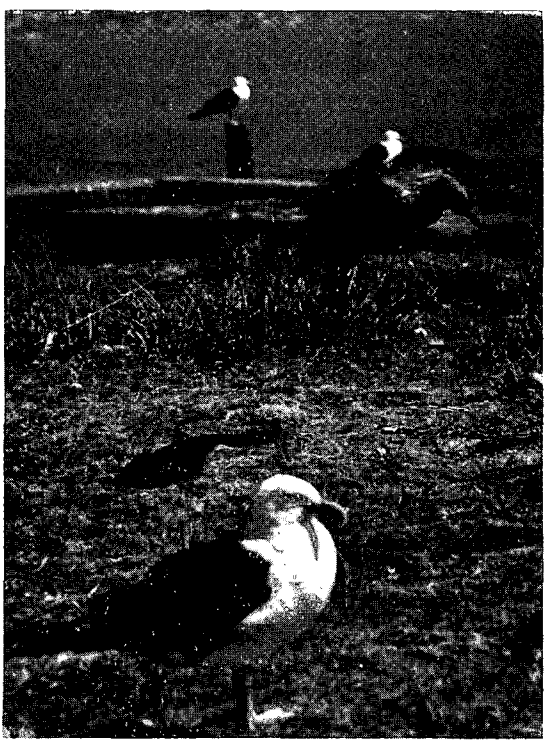
BEHAVIOUR AND AGE OF ACCOMPLISHMENTS

Although most chicks are unable to stand on the day they hatch, and may walk unsteadily for a week, a few chicks may struggle out of the nest if they are disturbed before their down is completely fluffed. Most chicks can move about outside the nest after two or three days, and in a week spend gradually less time under the parents, but they do not stray far from the nest.

Some chicks appear to wander less than others in their own nest areas; e.g. two chicks from one nest were seen every day for about six weeks on the same rock on which their nest was built, although they were quite capable of leaving it. Some parents and chicks abandon

the nest after a day or two and "shift camp" a few feet distant; thus the original nest is left comparatively clean and the chicks are brooded in a new place. Soon after hatching, when their down is dry, chicks begin food-begging, but the parents appear to take no notice for the first day at least. Gradually as the days pass the vibrating, reedy food call becomes a major activity for the chick. If given when the colony happens to be quiet, the call usually sets off a bout of long calling from all the neighbouring adults. The same call may accompany other activities such as jumping, wing-flapping, and retreat from predators, and will similarly cause contagious long calling. Preening and stretching begin at an early age (one chick two to three days old was seen to preen for a few seconds) and after a week are common activities.

At about a fortnight chicks voluntarily enter the sea and wash, without actually going right under the water. But from the time they are five to six days old chicks will enter the water if menaced by a predator, and are well able to swim after about 10 days. Their stay in the water is as brief as possible however, for their feathers very soon become water-logged, even when feathering of the body is largely completed. Chicks from beach nests are the first to enter the water.



II — Chick approximately 7 weeks old, jumping and flapping its wings in attempts at sustained flight.

Long before flight, chicks jump up and down, flapping wings and giving shrill cries. (Plate II.) The age of flying appears to vary slightly, but no birds were seen to fly properly before seven weeks. Wilkinson (1952) wrote that chicks fly at six weeks, but no doubt this refers to the fact that before true flight some chicks can flutter weakly in a downwards direction if pursued. When the first true flight occurs some down may still be present at the chin and pelvis, and the tenth primary may still be shorter than

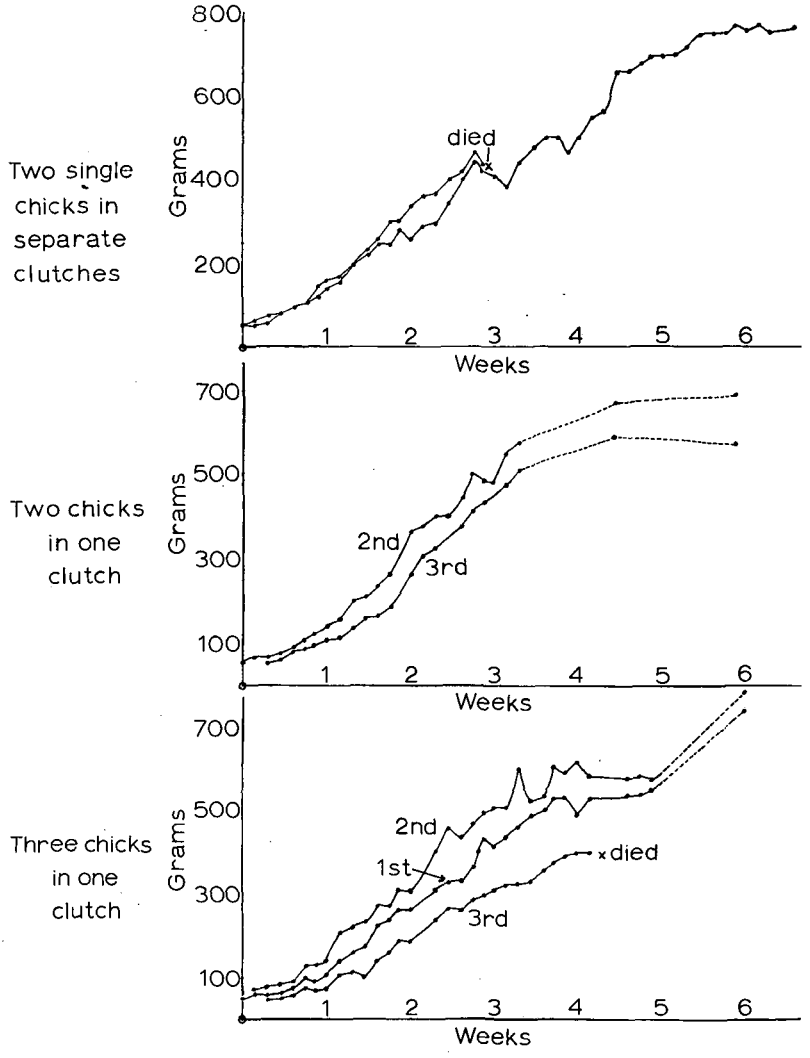


Fig. 1 — Growth rates of four broods of chicks.

the ninth. Chicks from cliff edges or upper slopes can fly as soon as those from beaches or lower slopes, but are reluctant. A tendency towards retarded flight has survival value for chicks from cliff edges for whom a return flight to the nest would be strenuous. During practice flights chicks often land yards away from their nests and are too weak to fly back. They are often attacked and occasionally killed by neighbouring adults as they move back to their own nests.

Fear of predators develops gradually, but there is some individual variation. Chicks up to three days old have squealed at me from their nests, but in a few seconds have gaped at a red pen in a feeding response. After a few days chicks will run from an observer, except those from cliff-edge nests. Having nowhere to run, such chicks usually show displacement activities such as preening, stretching and looking at their feet. At three weeks a chick may squeal at and defy an attacking adult gull.

GROWTH RATES

Weight. Five nests were each surrounded at a distance by low wire-netting fences, so that capture of the chicks for weighing was made easier. Two single chicks, a brood of two, and two broods of three chicks were weighed daily in a cloth bag until they died, disappeared, or managed to flutter over the low barricades. The growth rates of these broods (except those of one of the broods of three) are shown in Fig. 1. Bearing in mind the small size of the sample, chicks

TABLE 4 — GROWTH OF SOME BODY CHARACTERS

	Beak Colour	Yolk-sac Scar	Egg Tooth	Juvenal Plumage
1 day	black with white band from tip to ½ way between tip and nares			natal down completely fluffy after one day.
1 week			begins to lift	
8-10th day			falls off	remiges, rectrices & scapulars appear. 2ry. remiges a day later than 1ry. remiges.
10-12th day				natal down reaches maximum thickness.
2 weeks	band is now grey to dark grey.	the abdominal opening of this sac remains as a scab or lump to 18-19 days.		
3 weeks		all signs of scab or lump disappear completely.		remiges ca. 3.5 cm. & may protrude 5-6mm from sheaths. Coverts of 11th 1ry. present Rectrices not 1 cm, but clear of sheaths. Scapulars well
		clear of sheaths & wing & scapular coverts formed. (Greater wing coverts are first of wing series to appear, but are slower than scapular coverts.) Contour feathers appear.		
3½ weeks		11th. 1ry, visible, & main tail coverts appears. Upper wing coverts well formed, but only greater coverts present under wing.		
5 weeks	whole beak is black with tiny horn-coloured tip.			
5½-6 weeks		Under wing coverts grown. Remiges & rectrices not fully grown.		
7 weeks		Plumage complete and flight achieved. 10th. 1ry. may still be shorter than 9th., but soon surpasses it.		

from all broods grew at approximately the same rate, although the heaviest chicks from the two- and three-chick broods grew slightly faster than the single chicks. This may have been the result of greater stimulation of the parents by the presence of more than one chick which led to more frequent feeding of all the chicks. The brood of three not shown in Fig. 1 all died in a starved condition at about four weeks of age. In both broods of three the second chick (hatching from the second egg laid) had a slightly faster rate of growth than the first chick. This can perhaps be explained in one brood where the second egg was heavier than the first, but there may also have been minor set-backs suffered by both the first chicks.

Juvenal Plumage. Development of the juvenal plumage has been tabulated (Table 4) together with some other body characters so that growth can be more readily correlated with age.

DEPARTURE FROM THE COLONY

Soon after flight is achieved the young birds are absent from the colony at least during the day. Initially however, they may travel about the island, and single birds are seen swimming off-shore or standing in empty paddocks. The departure of chicks is a little hard to detect, because the island is a night roost as well as a breeding colony, but banding on the island as well as in other colonies which are not important night roosts has shown that young birds leave at least within the first month of flight. It is not known whether flying chicks return to their nest areas at night in the early days of flight, but at the end

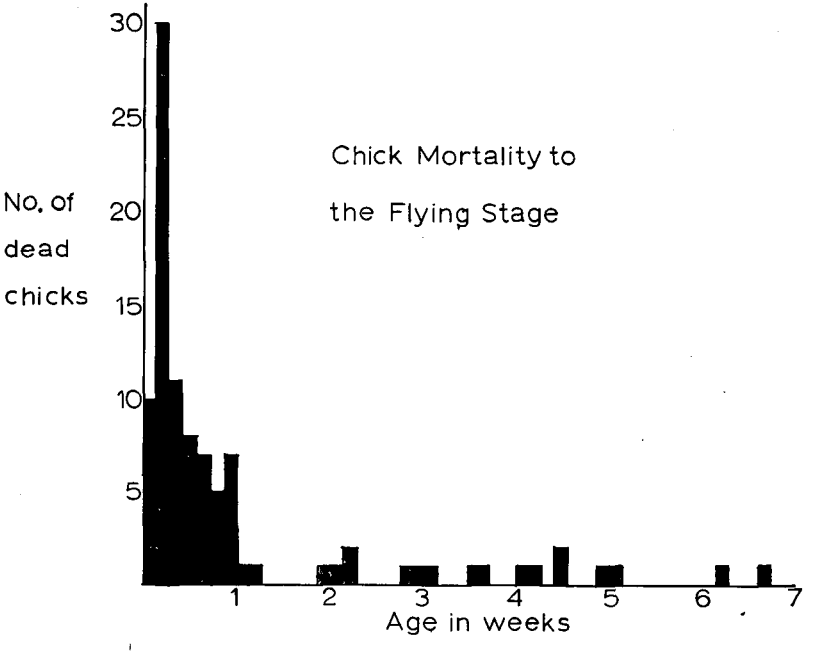


Fig. 2 — Mortality of chicks up to the flying stage

of the breeding season, i.e. January and February, there appear to be loose associations of adults and young throughout the colony at night, and these are without reference to individual nest areas.

By the end of February the main roosting flocks of adult (and immature) birds begin to form on the island, and chicks of the season are present in small numbers. By May and June nearly all the first year birds have joined the main roosting flocks, though small groups are occasionally found roosting or foraging together, apart from the main adult flocks.

BREEDING SUCCESS

Chick Mortality to the Flying Stage

Of 741 eggs comprising first clutches, 490 (66.1%) hatched. Daily observations and banding showed that at least 97 of the 490 chicks died before flying age, giving a minimum chick mortality of 19.8%. Most losses occurred in the first week, following which time the number of deaths dropped steadily till flight was achieved at a little over seven weeks. The age dispersal of the deaths is shown in Fig. 2. A similar pattern of loss was found in the Herring Gull by Paynter (1949). "Last sight" records of many other chicks ranged from the second day after hatching to just before flying age, but no estimates can be made of the numbers of these chicks that actually died.

Since chicks hatched from marked eggs it was often possible to distinguish for a time the first, second and third chicks of the brood. Considering broods of one, two and three chicks, almost equal numbers of first, second and third chicks died, but in broods of three, 26 (78.7%) out of the 33 that died were third chicks. Paynter (1949) found no significant differences in the survival of Herring Gull chicks from broods of one, two or three. The fates of the dead chicks are listed below:

Dead in nest	29
Disappeared on hatching or on following day	25
Uninjured outside nest	23
Killed by adult gulls	12
Fell out of nest	4
Exposure	3
Accidentally killed by author	1
	97

Chicks dead in their nests were generally only a few day old. Those killed by adult gulls were pecked heavily about the head and body, bone-damage often resulting especially in the head region. The chicks thought to have died of exposure were found during or following cold wet weather. The only animal other than gulls which may have killed some chicks was a Harrier *Circus approximans*. One was seen occasionally in flight, but was always driven off by adults, so was probably unsuccessful most, if not all, of the time. As far as could be determined, there was no correlation between chick mortality and nesting density similar to that between egg mortality and nesting density.

Overall Losses

Of 741 eggs, 251 (33.9%) were lost or failed to hatch. Of the remaining 490 eggs that hatched, at least 97 (19.8%) chicks died before

reaching the flying stage. This gives a total loss of 348 eggs and chicks from first clutches, providing a minimum overall mortality of 46.9% to the flying stage. As these figures are based on records from 310 nests, the mean number of chicks to reach the flying stage is 1.3 per breeding pair.

BREEDING ADULT MORTALITY

Twenty-two adults were found dead during the breeding season, including two, both females, from marked nests. Thirteen of the 22 deaths could be attributed to injuries received during fighting; these and other causes are listed in Table 5.

TABLE 5 — ADULT MORTALITY

Signs or Causes of Death	Male	Female	Totals
Extensive scalp, neck & body wounds caused by gulls	9	4	13
No visible injuries	3	2	5
Diseased (T.B. or Aspergillosus)	1	1	2
Heavy tick infestation on the head	1	—	1
Minor injuries seemingly insufficient to cause death	1	—	1
	15	7	22

More males than females were killed by other gulls, but this is not surprising since most fighting is done by males. It is not known if all the dead birds were actually breeding; the gonads of the diseased specimens were small and undeveloped. A heavy infestation of large ticks belonging to the Ixodoidea (J. R. H. Andrews, *pers. comm.*) on the head of one bird may have been a contributing cause of its death. Thirteen of the deaths were in the last week of November and the first week of December. No dead adults were found during the peak laying period in early November and the first was found shortly after the earliest clutches hatched. This is significant because gulls are most aggressive towards predators from just before till just after the chicks hatch, and when chicks begin wandering about their nest areas predatory gulls become more active so that opportunities for fighting occur more frequently. Maximum adult mortality corresponds with peak hatching and the two are probably correlated.

THE NON-BREEDING BIRDS

Throughout the breeding season first and second year birds were occasionally seen flying about the colony during the day, and at night small numbers of these birds were present in the main roosting flocks. During the rest of the day only solitary immature birds were seen in the group of non-breeders which made up the club. The club often formed by the lighthouse in one of the main roosting areas and was usually present the whole day. In daytime immature birds were attacked (in two cases killed) almost straight away by breeding birds, but often one would manage to land in a nesting area, though usually displaying the utmost caution and departing rapidly at the first signs of hostility. A few foreign birds would, however, while keeping a safe distance from incubating birds, walk about inspecting nests and incubating birds carefully. As mentioned before, such birds were undoubtedly searching for exposed eggs or small chicks. Disturbances in the colony caused breeding birds to give alarm cries repeatedly, but it was noticeable that any immature birds circling in the air with

the breeding birds at such times never gave cries of alarm. Although failing to give cries of alarm, a few instances were observed of immature birds displaying breeding behaviour at the end of December and in early January, i.e. late in the season. The displays, which were marked by brevity and incompleteness were all from birds at the end of their second year or beginning of their third year; none were seen from birds at the end of their first year or start of their second year. The displays seen were as follows:

1. A second year bird (male?) was seen collecting grass (for nest material?) in a rather haphazard manner.
2. A second year male emitted a long call, after which an adult female walked around him a few feet distant in the mewing posture, but giving no sound.
3. A second year male was seen mewing and choking vigorously with an adult (female?) but was driven away by a neighbour.
4. In January an adult was seen in company with another bird just starting its third year (clearly identifiable by the plumage). The adult mewed, and led the way to a nest which did not belong to it. The third-year bird followed but made no display or noise, and eventually flew away.

These observations show that birds at the end of their second year may display for the first time at least some of the calls and postures associated with breeding, even though they are probably not actually breeding, or even mated. The gonads of 30 first and second year birds examined in summer were considerably smaller than those of breeding adults, suggesting that it may not have been possible for them to breed.

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SHORT NOTE

TWO FORMS OF REDPOLL IN HIGH COUNTRY

At a Field Study Course held at Rotorua last Labour Week-end (1963), it was brought to my notice that the status of the Redpoll in this country was under review. I was informed that besides the Lesser Redpoll *(Carduelis flammea cabaret)* the nominate race the Mealy Redpoll *(Carduelis f. flammea)* was also thought to be present. I have some information of my own which I would like to add in support of this opinion.

Before I moved to Rotorua I lived on a sheep station between the upper reaches of the Rangitikei and the Ngaruroro on the Napier-Taihape road. Here Redpolls were very common; each year in the early spring large flocks of them would be seen about the homestead feeding on the willow trees that had just come into leaf. They would stay for about three months until December, when they dispersed for breeding.

I used to keep them under close observation, and was after a while struck by the fact that among all the smaller Redpolls there were certain birds that looked definitely larger and more conspicuous. These larger birds were never common, one or two only being present in a flock of twenty birds. They were more shy and tended to keep apart from the smaller redpolls, and were usually observed sitting out on a branch by themselves. In appearance not only did they look larger, but the rosy colouring on the breast was spread over a wider area, with the white on the lower abdomen more conspicuous than in the smaller Redpolls. I had no opportunity to observe them from the rear, nor was I able to distinguish any female birds that matched them in size.

I at first took them to be Linnets *(C. cannabina)* as according to the reference books I had at that time, Linnets were still considered to be present in New Zealand. However, as the description of the Linnet did not appear to fit these birds, I was forced to the conclusion that the larger birds were older, and that the smaller ones had yet to reach maturity. I consequently thought no more of the matter until I was told just recently that there might be two subspecies of redpoll in New Zealand.

— HAMISH LYALL