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BULLER'S MOLLYMAWK: INCUBATION DATA

by L. E. RICHDALE

To the south of New Zealand lie six widely separated groups of islands between the parallels 48° and 55°S, and 159° and 179° E longitude, all of which are of considerable interest to the ornithologist. The most northerly of these groups on latitude 48° and longitude 166° 35′ is The Snares which consist of two main islands, one much larger than the other, and a number of storm-swept rocks of small size. The larger of the two main islands is the one on which Mr. W. M. C. Denham of Invercargill and I camped from 9 January to 26 February 1948. The island extends over some 400 to 500 acres and is covered with low growing trees (largely *Olearia lyallii*) in the center and herbaceous plants on the edges. Around the coast line are precipitous cliffs averaging 400 feet high, except for a portion of the north-east coast where it is possible to effect a landing.

This paper is a survey of that part of the incubation period in Buller's Mollymawk, *Diomedea bulleri* Rothschild, from the laying of the first egg on 16 January to 26 February, when we left the island, and is part of the research accomplished by the expedition.

The field work was carried out in two distinct areas. The first, known as Northeast Colony, extends over a mile of coastal cliffs along the northeast coast from a point close to the camp. The second is composed of two separate compact colonies known as A and B respectively situated on the south coast nearly a mile away. Northeast Colony, which was visited daily, was the area where the detailed study was made. The other two colonies, inspected every third day and finally every sixth day, were used to supplement any phase of study which required amplification over a wider area.

All the nests were securely marked with numbered pegs. In the first colony, all birds, as soon as the eggs were laid, were banded with bands which, I know from experience, will stay on from 15 to 20 years. Altogether 161 birds were banded, 129 in Northeast Colony and a small group of 32 in Colony A.

When the study commenced two problems presented themselves. The first was the question of identifying the birds as individuals before being banded, and the second was the recognition of the sex of each. Fortunately, it was soon noticed that the majority of the birds had either their webs punctured, scarred, or nicked along the

edges so that, by using a method evolved for penguins under such circumstances, it was easy to distinguish individuals. Then, by observing that one particular sex (the male) was more frequently at the nest than the other before the egg was laid, by verifying this during coition, and by finding out in most cases which bird laid the egg, the question of sex was soon established. Therefore, by the time a bird was banded it could be recognized individually and its sex was known.

A Mollymawk incubating on top of a tussock. No raised nest has been made. Note peg in top left-hand corner.

INCUBATION BEHAVIOR

The Nest.—On The Snares, Buller's Mollymawk nests along the entire coastline, except for the halfmile which contains the landing place. At this point, the vegetation descends almost to the water's edge and what cliffs there are are low so that the birds would be unable to jump into the air for taking off.

The nests may be found in two major types of habitat as exemplified by Northeast Colony and Colony A. The former consists mainly of open coastal cliffs with a variety of sites as indicated in Table I. The birds land and take off at or near their nests. Some of the nests are on low cliffs as close as 15 feet from the water but the majority are much farther back and up as high as 400 feet. There is a

tendency for the birds to choose a rocky situation (fully 70 percent in Northeast Colony). Other nests, however, are under trees with no rocks handy, among tussocks, and a few occur (nearly 10 percent) in open grassy meadows.

TABLE I

An Analysis of the Types of Nesting Sites in Northeast Colony-

Description of nesting site	Number of nests	Percentage
Under rocks or among rocks	19	15.6
In the open but beside rocks	28	22.9
On edge of cliffs or down cliffs (Rocks are not far away)	21	17.2
Under trees, in some cases rocks are present	32	26.2
On points largely tussock-covered, with only the occasional presence of rocks	12	9.9
In Tataki grass meadows, free of rocks	10	8.2
Total	122	100

The other type of habitat, as exemplified by Colony A, is pure *Olearia* forest. There are several of these colonies at points where the trees are close to the cliff edge but the one under discussion is easily the largest. Landing on the forest edge, the birds walk through the trees to their nests which, except along the cliff edge, are rarely near rocks but are merely surrounded by soil.

Colony A extends some 234 yards along a 400-foot cliff edge and penetrates the forest, at its deepest point, 198 yards. At each end of the colony is a meadow of tall Tataki grass, *Poa foliosa*, so that the forest, at these points, is at least 30 feet back from the edge of the cliffs. No Mollymawks nest anywhere in the forest beyond this grass. The next forest colony (Colony B) begins when the trees once more touch the edge of the cliff.

In summing up the question of nesting habitat, one significant feature is common to all and that is the proximity of, or easy access to, a taking-off place which either directly overlooks or slopes steeply to the water. The distance that the birds may nest from such a point is limited by the smoothness of the ground over which a bird might wish to travel.

The nests are not placed closely together in large colonies as occurs in some species of Mollymawk (Murphy, 1930: 513) but are scattered irregularly over the full length of the occupied coastline. There is, however, a certain amount of grouping which, after excluding an occasional isolated nest, may range from two to sometimes as many as a dozen. This feature obtains not only in the open groups along the cliff edge but also in the forest colonies even though the population, as in Colony A, is considerable.

The nest is constructed by the bird sitting down on the chosen site from which position it reaches out and loosens the soil all round it or, if the vicinity contains vegetation, this is torn to pieces. The debris is gradually placed under the bird as the nest is built higher

and higher. At first the sides slope considerably but as the building proceeds the sides gradually become vertical. The material is added beakful by beakful and is patted down with the side of the anterior end of the beak. The bird keeps turning slowly and its feathers, especially in wet weather, become very dirty in the process.

As a rule, the nest is begun and practically completed by the male for he is at the site for most of the time. The female puts the finishing touches to it when she is waiting for the egg to pass down the oviduct.

There is considerable variation, however, and the female alone may do the building. For example, at one nest the male was present at intervals for at least twelve days before the egg was laid yet no nest building was attempted until the female began and completed the task in the two days previous to egg deposition. In another case, a male began a nest on a new site on 4 February when alone; next day both birds were present with the female doing the building; from 6-8 February, neither bird was present; on 9 February, both were present with the female building; and next day there was an egg. In spite of the paucity of attendance, the nest was a good one, standing $6\frac{1}{2}$ inches high. A final example is of a male which occupied a site at intervals from 25 January to 26 February yet made no attempt whatsoever to build a nest. This bird may not have had a mate for we could not complete the observation.

As the eggs appeared, 74 nests were measured in Northeast Colony. The average height was 8.13 inches, the standard deviation 2.54 inches, the standard error of the mean .3, and the range 0 to 12 inches. Maximum height is influenced first, by the ability of the bird, perched on a high nest, to reach the ground for more material, secondly by the availability of that material, and thirdly, by the time occupied in building before the egg is laid.

One egg was deposited on the top of each of two tussocks from which had been plucked a few leaves making a rough sort of hollow so that in these cases no real nest was made because there was no material within reach. Other nests built on rocky ledges or rocky slopes suffered likewise. The nest, $6\frac{1}{2}$ inches high, noted in the preceding paragraph, could have been built higher but time was the limiting factor. Little attempt is made to heighten a nest after the egg is laid although some improvement may be effected on the sides and rim.

In Colony A, although the nests were not measured, their average height, built on a soil base was obviously much higher. Seven nests under comparable conditions in Northeast Colony averaged 10 inches with a range from 8 to 12 inches.

A final point concerning the nest is whether it is a previously-used one renovated or an entirely new one. In Northeast Colony 67.2 percent of the 122 nests were built in a previous season whereas 32.8 percent were entirely new or, in other words, I actually saw the beginning and complete construction of these nests. In Colony A, few indeed of the 137 nests were new.

The Egg.—To obtain a sufficient coverage of egg-laying dates, of which 241 were collected, all three colonies were worked. As Colony

A was not investigated for the first time until 20 January when ten eggs were present, it is possible that one or two eggs may have been laid in the 10-15 January interval. In Northeast Colony egg-laying certainly extended into the 27 February to 3 March interval and possibly into the 4-9 March interval, judging by certain behavior patterns with which I had become familiar.

In summary, the first egg was laid in Northeast Colony on 16 January, laying continued through February, and ceased some time early in March so that the range was fully seven weeks. The period from 22 January to 14 February witnessed the peak of egg-laying when approximately 80 percent of the eggs appeared.

TABLE 2

Laying Dates of 241 Eggs of Buller's Mollymawk

Class interval	Northeast, Colony	Colony A	Colony B	Total
16-21 January	4	14	1	19
22-27 "	12	24	10	46
28 Jan.- 2 February	18	23	19	60
3- 8 "	10	19	16	45
9-14 "	17	9	18	44
15-20 "	6	3	7	16
21-26 "	7	1	3	11
	74	93	74	241

In Table 3 are given the statistics, taken as the eggs were laid, of the first 100 (68 in Colony A and 32 in Northeast Colony). When further eggs were measured and weighed in Northeast Colony it was noted that many eggs appeared to be smaller than those in Colony A so when 64 sets of data were collected a comparison was made (Table 4).

Before allowing that a difference between means is significant, I have followed the ruling in all cases in this paper that it must be at least three times the value of the standard error of the difference. Applying this rule, the difference in width of eggs laid in the two colonies is significant which suggests that Northeast Colony contained a larger percentage of young birds than did Colony A.

TABLE 3

Measurements and Weights of First 100 Eggs Laid

Feature	Mean	σ[1]	SE_m[2]	Range
Length	102.15 mm.	3.44 mm.	.34	94¾ to 112 mm.
Width	65.96 mm.	1.80 mm.	.18	60½ to 69¾ mm.
Weight	250.15 gms.	16.35 gms.	1.64	218 to 290 gms.

[1] σ means standard deviation.
[2] SE_m means standard error of the mean.

TABLE 4

Statistics of First 64 Eggs Laid in Each of Northeast and A Colonies

Feature	Length		Width		Weight	
Colony	Northeast	A	Northeast	A	Northeast	A
	mm.	mm.	mm.	mm.	grams	grams
Mean	103.15	102.16	65.38	66.34	246.30	252.00
σ	3.72	3.55	1.98	1.55	17.90	15.30
SE_m[2]	.47	.45	.25	.19	2.24	1.91
Range	$93\frac{1}{2}$ to 111	$94\frac{3}{4}$ to 112	$60\frac{3}{4}$ to $69\frac{3}{4}$	$60\frac{1}{2}$ to $69\frac{3}{4}$	205 to 283	223 to 290
Difference	.99 mm.		.96 mm.		5.7 grams	
SE_d[3]	.65		.31		2.91	

[1] σ means standard deviation.
[2] SE_m means standard error of the mean.
[3] SE_d means standard error of the difference.

Two Mollymawks at nest at pre-egg stage. A typical built-up nest in the forest.

The eggs vary a great deal in markings and to a lesser extent in shape. All eggs are white with a certain amount of massed brownish-red spots which, in size, are from mere dots to as much as 5 to 10 millimeters in diameter. Some eggs are almost white whereas others are heavily spotted nearly all over. On the average, the top half of the egg is marked and the rest is white. As a rule, there is not much difference in the shape of the top and bottom ends. An unusually small egg was found in Colony B but is not included in the series given. Weighing 183 grams, its measurements were $89\frac{1}{4}$ x $60\frac{3}{4}$ millimeters.

A final point of interest regarding eggs was their size relative to their date of laying. There was no tendency for the large eggs to be laid first and the small ones later. All sizes were scattered indiscriminately throughout the laying period. For example, on 17 February a small egg weighing 228 grams and 63 millimeters wide was laid and, on 21 February, a large one weighing 285 grams with a width of $68\frac{3}{4}$ millimeters. Therefore, if my surmize is correct that young birds lay small eggs, age is not a factor in determining laying dates.

Span on Egg by Each Sex.—In order to work out the time each sex was in charge of the egg in the incubation period, the nests were visited daily at approximately the same time so that for statistical purposes the class interval is 24 hours. Although the complete incubation period was not covered, sufficient data were collected to treat the various items statistically.

The longest span of sitting without relief was by a female which was on the egg for the first 24 days from laying (Table 5). That this remarkable period is not exceptional is evidenced by other spans nearly as long (Tables 6 and 7). For example, a second female incubated for 23 days unfinished when my observations ceased. The shortest period, excluding the first span by the female, was five days.

Although the data are somewhat scanty, I do not think there is any significant difference in the incubation spans of the sexes (Table 8). For this reason, data from the spans by the male and female have been combined and compared with the first span of the female on the egg after it was laid. The mean for the latter was 5.92 days and for the former 10.80 days. As the difference is significant, this infers that there is some factor causing the female to deviate from subsequent procedure.

In Table 9, 24 pairs have been listed showing the time each sex sat in turn. This table gives a good idea of the considerable variation in procedure. Note nest 19 as compared with nest 16, for instance.

Owing to the long spans at incubation, change of guard was rarely seen, in fact only twice. On several other occasions, however, I arrived shortly afterwards and when both parents were still present.

At the first nest, at which relief was observed, the female arrived at 9:41 a.m. after a 14-day sojourn at sea. She flew straight in and landed on a tussock 18 inches above the nest which was in a hollow and could not be seen until she landed. Recognition was instant by each partner. At $9:45\frac{1}{2}$ a.m., the male shuffled off the egg and the

female shuffled on; at 10 a.m. the male showed signs of departing; and 45 seconds later he flew. The whole procedure took 19¾ minutes and during the period there was no elaborate display, unlike the pre-coitional behavior at the pre-egg stage.

At the second nest, the female was observed arriving at 11:45 a.m. in the same direct manner as the first. Six minutes later relief was effected. At 11:52, only one minute after relief, the male made an attempt to leave but owing to an unsuitable wind did not fly until 11:54½. Thus the complete process occupied only 9½ minutes.

There was evidence that the female does not always allow change of guard when the male arrives for the first time after the egg is laid. For example, at one nest which was under scrub, I was seated near the female not long after the egg appeared. A bird flew overhead and the female, glancing up quickly, gave me the impression that her glance was one of recognition. A moment later a Mollymawk broke through the bushes and as each bird greeted the other with so much enthusiasm I felt justified in assuming that the newcomer was the male partner. I stood back and watched for half an hour but although their mutual behavior was continuous the change over did not occur. The female stood up several times but immediately sat down again and shuffled around determinedly on the egg. Next day, the female was still there and nine days later when we left the island the change had not been effected so it was not possible to check up on the identity of the presumed mate.

TABLE 5

First Span of Female on Egg in Buller's Mollymawk

Number	Number of Spans		Number	Number of spans	
of days	completed	not completed	of days	completed	not completed
0*	4		13	1	
1	5	1	14	2	1
2	6	1	15	–	
3	10		16	1	
4	6	1	17	–	
5	11		18	1	
6	1		19	–	
7	3		20	–	
8	2		21	–	
9	2		22		
10	2	1	23		
11	2		24	1	
12	–				
			Total	60	5

0* means that the female was relieved some time after the egg was laid but before 24 hours had elapsed, and so for 1, 2, 3 days etc.

TABLE 6

Completed Spans on Eggs by Sexes in Buller's Mollymawk
(First span by female excluded)

Number of days	Number of spans ♂	♀	Total	Number of days	Number of spans ♂	♀	Total
5		1	1	14		1	1
6	3	1	4	15	–	–	–
7	4	5	9	16	–	–	–
8	5	2	7	17	3	–	3
9	7	–	7	18	–	1	1
10	7	1	8	19	1	1	2
11	5	2	7	20	–	1	1
12	–	–	–	21	1	–	–
13	3	–	3				
				Total	39	16	55

TABLE 7

Incomplete Spans on Eggs by Sexes in Buller's Mollymawk
(First span by female excluded)

Number of days	Number of spans ♂	♀	Total	Number of days	Number of spans ♂	♀	Total
1+	1	1	2	13+	2	–	2
2+	1	1	2	14+	1	4	5
3+	3	5	8	15+	2	–	2
4+	7	1	8	16+		1	1
5+	1	1	2	17+		–	–
6+	5	–	5	18+		–	–
7+	2	2	4	19+		–	–
8+	3	2	5	20+		1	1
9+	2	–	2	21+		–	–
10+	2	1	3	22+		–	–
11+	1	1	2	23+		1	1
12+	3	–	3	Total	36	22	58

TABLE 8

Spans by Sexes on Egg Treated Statistically
(Data from Tables 5 to 7)

Feature	n[1]	Mean days	♂[2] days	SEm[3]	Range days
(a) First span of ♀ on egg (Table 5)	60	5.92	4.71	.61	0 to 24
(b) Completed span of ♂ on egg (Table 6)	39	10.81	3.53	.57	6 to 21
(c) Completed span of ♀ on egg (Table 6)	16	10.76	4.73	1.18	5 to 20
(d) Completed span of ♂ and ♀ on egg (Table 6)	55	10.80	3.94	.53	5 to 21
(e) Incomplete span of ♂ and ♀ on egg (Table 7)	58	8.39	4.88	.64	1 to 23

[1]n means number.
[2]♂ means standard deviation.
[3]SEm means standard error of mean.
Note: difference between (a) and (d) is 4.88 days ± .84.

TABLE 9

Alternate Spans of Incubation by the Sexes

Nest	Days on egg	Nest	Days on egg
1	♀2, ♂6, ♀20, ♂12+	13	♀7, ♂19, ♀2+
2	♀5, ♂10, ♀5, ♂6+	14	♀0, ♂8, ♀11, ♂8+
3	♀5, ♂13, ♀10+	15	♀1, ♂10, ♀7, ♂9, ♀7+
4	♀4, ♂7, ♀14, ♂4+	16	♀24, ♂3+
5	♀11, ♂6, ♀7, ♂4+	17	♀4, ♂9, ♀7, ♂6+
6	♀2, ♂9, ♀20+	18	♀7, ♂10, ♀14+
7	♀2, ♂17, ♀8+	19	♀1, ♂7, ♀7, ♂9, ♀10, ♂2+
8	♀4, ♂17, ♀11+	20	♀9, ♂11, ♀14+
9	♀3, ♂8, ♀7, ♂10, ♀3+	21	♀5, ♂8, ♀19, ♂4+
10	♀1, ♂9, ♀18, ♂7+	22	♀6, ♂13, ♀11, ♂12+
11	♀2, ♂14, ♀8, ♂5+	23	♀5, ♂10, ♀16+
12	♀3, ♂21, ♀7+	24	♀3, ♂11, ♀23+

Coition.—A careful watch was kept for examples of coition among incubating birds and three attempts were noted. It was observed also that there were males, whose exact status I could not determine in the short time available, which forcibly copulated or attempted to copulate with females not their mates. In making any survey on coition a knowledge of the behavior of these intruder males is essential and due allowance made for such a possibility.

In Colony A an unbanded female with dirty feathers was sitting on a newly-laid egg. Alongside her was an unbanded male with clean plumage but I could not say whether these birds were mated, even though they were paying some attention to each other. The male

suddenly jumped onto the female's back and stayed there three minutes (which is a long time), as noted by my watch. He made determined efforts to copulate but the female not only kept her tail down but allowed her primaries to cross her tail, so that the male was unsuccessful. When I returned 75 minutes later, the male was gone. The bird may have been one of those males of undetermined status.

In the second instance, I was near a banded female which was in the second day of her turn on the egg, laid 14 days earlier. Twelve feet away was a solitary male sitting on an empty nest in which his mate was to lay an egg eight days later. This male suddenly left the nest, walked straight over to the incubating female, jumped on her back, and quickly maneuvered himself into the copulating position. The female did not rise but croaked and tried to bite him by raising her bill. The male persisted in his fruitless efforts for one minute and then returned to his nest.

The third case involved members of a banded pair which were known to be mated. When I arrived, the male which had been off duty for seven days, had preceded me. After a little mutual preening and croaking, the male mounted the female and made a feeble attempt at copulation. The female offered no co-operation and the male, in a short time, just slid off; the egg had been incubated 15 days. This subject will be further treated in the discussion.

Territory.—The question of territory will be more fully discussed in a future paper when dealing with the pre-egg period. Suffice it to say that infringements of the territorial laws occur and involve action by rightful owners. The females of two pairs laid eggs in nests apparently not their own and were ejected whilst incubating; each pair then took up residence in a neighboring unoccupied nest. I maintained their new interest in each case by giving an egg, which was accepted, to each ejected bird so that uninterrupted incubation was continued. In a third case, a small egg, probably laid by a young female, appeared in a nest in the temporary absence of the owners. I did not see this female at all.

Subsequently, a second egg appeared in each of these three nests, laid in each case by the rightful female. Here is an explanation why two eggs are sometimes found in petrel nests. Two eggs were not found in any of the other 238 nests under observation.

DISCUSSION

The tendency for mated pairs of Buller's Mollymawk to form little groups, even within a colony, is not a matter of chance but is apparently the expression of a social inclination. I frequently saw mated pairs lay the foundation of a new nest close to an incubating pair and ultimately produce eggs themselves. An extreme case of this social inclination was the building of a nest only 22 inches away from a nest containing an egg. This occurred in the forest of Colony A where there was no dearth of sites. The only reason for choosing such a place would appear to be the satisfaction of a social urge.

In heavily populated petrel areas, it is impossible to observe this social phenomenon. I have had an opportunity to note it, however,

in a small community of Broad-billed Prions, *Pachyptila vittata* [=*forsteri*] (1944a: 191-217), on the small half-acre island of Whero. Here, in a population of approximately 200 individuals, the burrows were definitely grouped in scattered places, the factor being a social tendency and not one of terrain.

This social tendency has also been noted in my colony of Royal Albatrosses, *Diomedea epomophora sanfordi* Murphy. In the three consecutive years before one of these Albatross females disappeared, her nest was placed close to that of a neighbor (different in each year) under circumstances which made it clear that the birds possessed a social tendency (Richdale, 1942a: 180 and 262). Observations from other investigators on petrels would be of interest in elucidating this phenomenon.

The period in which eggs are laid, fully seven weeks in Buller's Mollymawk, would appear to be somewhat lengthy for a sub-Atlantic petrel. In other species which I have studied, all north of The Snares, it was 13 days in the Royal Albatross (1944b: 99); 18 days in the Sooty Shearwater, *Puffinus griseus* (Gmelin), (1945b: 46); 21 days in the Broad-billed Prion and Fairy Prion, *Pachyptila turtur* (Kuhl), (1944a: 210, and 1944c: 37); 41 days in the White-faced Storm Petrel, *Pelagodroma marina* (Latham), (1943: 107); and 52 days in the Diving Petrel, *Pelecanoides urinatrix* (Gmelin), (1945a: 45, 46). On The Snares, Diving Petrel fledglings were seen on the surface of the ground from 14 January to 20 February so that the egg-laying period would appear to coincide with that farther north. On the same island the Mottled Petrel, *Pterodroma inexpectata* (Forster), from the few observations made, has a restricted laying period.

As regards age in relation to size of egg and effect on laying dates, my statements made earlier in reference to Buller's Mollymawk were influenced by unpublished exact data which I possess on the Yellow-eyed Penguin, *Megadyptes antipodes* (Hombron and Jacquinot). It was found, in this species, that 53 eggs laid by two-year-olds were significantly lighter and narrower than 89 eggs laid by three-year-olds. Further, the latter group was comparably significant when compared with 64 eggs laid by four-year-olds. Beyond that there was no significant difference nor was there any difference in the length of the egg for the various ages.

On the question of age and date of laying, it was found that 104 two-year-old Yellow-eyed Penguins laid on the average on September 26.06, and 100 older birds on September 27.45. The difference is not significant. Because of these proved facts on the Yellow-eyed Penguin, it has occurred to me that a comparable situation may obtain in Buller's Mollymawk, that is to say, young females lay small eggs but age does not affect laying dates.

The span of each sex on the egg in Buller's Mollymawk is phenomally long and prompts a review of what happens in other species of petrels. The time, according to my own observations, varies from one day in the Diving Petrel which changes regularly each night (1945a: 43), to 14 days in the Royal Albatross (1942a: 253) and 13

days in the Sooty Shearwater (1942b: 100, and 1944b: 100). Hadden (1941: 210) for the Laysan Albatross, *Diomedea immutabilis* Rothschild, gives "2 or 3 weeks" and "about every 18 days."

In the White-faced Storm Petrel the period varies from 2 to 9 days (Richdale, 1943: 100-101) and comparable data have been given for other species of Storm Petrels by Roberts (1940: 162-163), by Lockley (1932: 210), by Gross (1935: 390), and by Ainslee and Atkinson (1937: 239). For the Fairy Prion, my study of eight nests gives periods of 6 and 7 days (1944c: 34). Lockley (1942: 32, 82, 84) records spans from 3 to 10 days in the Manx Shearwater, *Puffinus puffinus puffinus* (Brünnich).

In summary, it is obvious that in many species of petrels each sex sits on the egg for a lengthy period but, at the same time, there is considerable individual variation. A striking exception to this rule is the Diving Petrel which changes nightly.

In the Yellow-eyed Penguin (Richdale, 1947: 160-164), the female tends to fast immediately before and in the period of egg-laying resulting in a heavy loss in weight, but soon after the clutch is completed the male takes charge seeming to suggest a natural provision which allows the female to recuperate. These factors cannot apply in the quick relief of the female Buller's Mollymawk by the male after the egg is laid. At the pre-egg stage, the female is rarely at the nest and further is rarely there for more than two days at a stretch just previous to egg deposition. Her weight, therefore, cannot be appreciably affected. It would seem that once the male is present his behavior reactions urge him to incubate. He exerts pressure on the female which is inclined to give way, but, as already noted, she does not always do so. This refusal by the female may account for some of the exceptionally long first spans by the female (Table 5).

In the Royal Albatross, within my experience, the male is rarely more than two days in taking his first turn on the egg. It was by watching the behavior of this species that I noted the pressure put on the female by the male. The pre-egg behavior of the sexes in the Royal Albatross resembles that in Buller's Mollymawk. The observations of Lockley (1942: 82-84) on the Manx Shearwater are suggestive in the preceding discussion. He records that the female of one pair was relieved only two days after the egg was laid and that subsequent spans were much longer.

In summary, the early relief of the female by the male after the egg is laid in some petrels, at least, is probably due to an urge by the male to incubate.

The performance of coition by breeding birds after the eggs have been laid and even in the period when chicks are fed, has been reported at fairly frequent intervals. This discussion, however, will be confined to petrels. It seems to me that many of the observed acts of coition were not by breeding petrels at all but by the unemployed members of the community and further, the observations were not made on banded birds.

Two essentials in an endeavor to unravel this problem are, to have the birds under observation marked, and to know, if possible, some-

thing of their previous and subsequent history. Coition among breeding petrels after the eggs are laid, if it occurs at all, is rare for two reasons. (1) The urge normally ceases when the egg is laid. Cessation of the urge to copulate is especially characteristic of the female, although it is well known that the male of many species remains potent for a longer period. These points are amply illustrated in the examples of attempted coition by Buller's Mollymawk noted in the text. The female did not respond to the male and all three cases occurred early in the incubation period. Finally, in the Royal Albatross, I have never seen any suggestion of coition among mated birds at the incubation or chick stages. (2) Coition fails to occur because of the lack of opportunity. As already noted in petrels, members of a mated pair see but little of each other in the period of incubation and at the chick stage once the chick is left unguarded, which occurs in the first day or two in many species; the parents rarely meet at all at the nest.

Among unemployed petrels, however, the situation is entirely different and there is evidence that while the breeding birds are busy with reproductive duties the unemployed members of the community indulge in coition. All the acts of coition which I have witnessed among Royal Albatrosses at the post-egg stage have been by birds definitely known to be unemployed. With Buller's Mollymawk, laying had not ceased when we left the island but, even so, the many acts of coition still going on at that time, especially in places where there was no sign of a nest, suggested a pattern resembling that in the Royal Albatross.

In summary, coition does not appear to occur among breeding petrels at the post-egg stage. Two factors prevent its occurrence—the falling off of the urge and the lack of opportunity. Coition, however, does occur among the unemployed members of a community when breeding birds are busy with reproductive duties.

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Department of Zoology, University of Otago, Dunedin, New Zealand.

OBSERVATIONS AT A NIGHTHAWK'S NEST

By GEORGE MIKSCH SUTTON and HAVEN H. SPENCER

Several pairs of Nighthawks, *Chordeiles minor* (Forster), nested on flat roofed buildings in the city of Ann Arbor, Washtenaw County, Michigan, in the summer of 1948. Some pairs nested in the main business district or on apartment buildings between this district and the University of Michigan campus. At least three pairs nested on the campus. Two of these nested about 93 yards apart at opposite corners of the gravelled roof of the Natural Science Building. The nests were separated by the brick walls which surrounded an open court. The third pair nested on the tar-paper roof of the Museum of Zoology, about 350 yards to the east of the Natural Science Building. No pair nested on the Chemistry Building between the Natural Science Building and the Museum of Zoology, or on the Hill Auditorium directly across the street from the Natural Science Building. During late May we heard and saw the birds about the Museum building evening after evening; but not until early June did we learn through the janitors that there was a nest on the roof. The two eggs were at the extreme east end of the building's north wing, at the base of the 8-foot brick wall which enclosed the roof.

Throughout the period of our observations the only bird which we saw incubating the eggs or brooding the young was the female. We did not visit the nest regularly, however, nor did we ascertain which bird spent the night on the nest. At several nests which A. O. Gross observed at Brunswick, Maine, he never saw a male incubating. One of these nests was "subject to study day and night by a relay