

The Titi Wainui or Fairy Prion *Pachyptila turtur* (Kuhl).

PART I.

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This paper is the fourth of a series dealing with sea birds on the small island of Whero, close to Halfmoon Bay, Stewart Island, New Zealand. The first two have been published in *The Emu* (1942, pp. 85-105 and 1943, pp. 24-48, 97-107) and the third in the *Transactions, Royal Society of New Zealand* (1943, pp. 97-115, 217-232, 335-350). The data for the following paper were collected during a camp of 21 weeks on the island. When perusing the literature on the whole group of which the Titi Wainui is a member one is amazed at the paucity of the material dealing with the biology of the Prions. I sincerely hope the matter which follows will add a little more to that knowledge, and that it may also serve as a stimulus to others to take up the study. In recent years the status of the various species and races has been considerably elucidated by Murphy (1936), Falla (1937 and 1940), and Fleming (1939 and 1941).

THE PRE-LAYING PERIOD.

It has not been possible for me to glean much information concerning this phase of the Titi Wainui's life. After the end of February, 1942, when the last chick left the island I saw no more of this species during the remainder of my stay. A gradual diminution of the Titi Wainui population commenced during January, starting with the departure of the unemployed birds and gradually followed by the disappearance of the breeding birds during February as their chicks left the burrows. This phenomenon was noted on Lady Julia Percy Island, off the south coast of Victoria, by Wood Jones (1937, p. 188), but the significance of the behaviour of unemployed birds was not realised. His party was on the island from January 10 to February 22, 1936, when it was observed that the Prions which arrived regularly during the first ten days were less regular during February, and by February 22 had ceased to arrive at all. As Wood Jones (*op. cit.*, p. 186) had already been on Lawrence Rocks on November 28, 1935, when he found a bird incubating and an unattended clean egg in another burrow, it would seem from the above two sets of evidence that the breeding times of the species off the Victorian Coast and on Whero may coincide.

While sojourning on Whero from May 10 to 17, 1941, I saw no signs of these birds, and furthermore the palisades of sticks which I had erected the previous January were still intact. Obviously the

birds had not returned though the dark nights during this week favoured their discovery had they been present. While on Herekopare, a much larger island some miles north of Whero, from May 11 to 21, 1942, and again in May, 1943, I failed to observe the presence of this species in any of the bird remains left by cats.

From August 23 to 26, 1941, when I was again on Whero, a few birds were flying about each night, though judging by the scarcity of the excreta they had not long returned to the island. Some were calling out from the air, others from the burrows, but their behaviour did not compare with the noise and activity of the previous December and January. Of the 28 nests under observation in 1940-41, 11 showed no signs of reoccupation, while 17 had been excavated. Five of the latter had a single bird in occupation at least one night during my stay. None was present in the day-time, while one of the night occupants was not an owner of the previous season. On two successive nights a ringed bird was found on the surface of the ground three yards from its burrow. In another nest containing a chick the previous January I found an addled egg which, no doubt, had been unearthed by the excavations.

In a few burrows not previously watched, an occasional single bird and pair of birds were found in the day-time, one pair occupying the burrow of a Kuaka (*Pelecanoides urinatrix*) the previous year. During this period only ten birds were caught and ringed as they landed.

On Herekopare, from August 28 to 31, 1941, they were also present, though sparsely, but the depredations of cats might possibly have accounted for their scarcity. The following year, from August 26 to 30, I was again on Herekopare. For the first three nights, owing to the full moon on the 26th, I saw no Titi Wainuis, but on the night of the 29th August it was possible to have picked up some dozens.

Just when these Prions return to the island I do not know, but I incline to the opinion that these early visits, as with *Pachyptila vittata*, are spasmodic. I gained the impression that the vast majority of the Titi Wainuis during August had no purposeful mission to pursue during their period ashore.

At different times between September 22 and November 23, 1911, when on Herekopare, Guthrie-Smith (1914, pp. 17-43) recorded several observations on Titi Wainuis. During a six hours' visit on September 22 no Titi Wainuis were found in burrows during the day-time (*op. cit.*, p. 17). On October 2 he noted that they were occupying the burrows but were without eggs (*op. cit.*, pp. 23 and 28), and that they were numerous at night (*op. cit.*, p. 25). On October 23, on a neighbouring island, Piko-mamaku-iti, he found the species in burrows, but it is not clear whether they were incubating (*op. cit.*, p. 32). Back again on Herekopare on November 23 he found many Titi Wainuis with eggs (*op. cit.*, p. 42). At the base of the same page he states that the breeding season of the Titi Wainui precedes that of the Kuaka. I do not think this is correct, for on Whero the first chicks appear very early in November (Richdale, 1943, p. 34), whereas my first record of a Titi

Wainui chick is December 18 (see Table III). Finally, Plate XIV (*op. cit.*, opp. p. 36) does not depict a Titi Wainui but a Parara (*P. vittata*).

BURROWS, INCUBATION, AND EGGS.

Generally speaking the burrows of the Titi Wainuis are found over most parts of the island. A map indicating the zones of vegetation appears in my Whero paper (1942, p. 88). In the *Stilbocarpa* areas, however, this species is rarely found nesting while in the Poa strip from the north-west corner along the north side to the middle of the east side there were no nesting birds in 1940-41. This absence may be due to the shallow nature of the soil, which makes it difficult to excavate a burrow deeply enough. In 1941-42, however, there were three nests along the north side. In the sedge just inside the Poa strip the burrows are numerous. This fact, and the occupation by Titi Wainuis of several Kuaka and Storm Petrel (*Pelagodroma marina maoriana*) burrows inclines me to the opinion that the Prions are increasing.

Most of the burrows, especially those in the *Muehlenbeckia* and sedge areas are deep, being beyond arm's length. The shallowest are round the Poa area, where one was only a hand's depth. When the chick hatched in this particular burrow its squeaking betrayed the presence of the adult to the Skua (*Catharacta skua lonnbergi*) with fatal results. Two days later the chick disappeared also.

The nesting chamber at the end of the burrow is wider than the tunnel and is usually lined, where available, with Tete-a-weka (*Olearia angustifolia*) leaves, which are stiff and narrow and about three inches long. Failing these, any handy vegetation is used.

As I did not reach the island till December 21, 1940, and December 20, 1941, when hatching was on the verge of commencing, I was unable to find out very much about the incubation period. The incubation span for each parent before change of guard is effected, from rather meagre data at eight nests, appears to be six and seven days at a stretch. Incubation for more than a week is not unusual with petrels, for I have records of 13 days for mutton-birds (*Puffinus griseus*) (1942, p. 100) and 14 days for the Royal Albatross (*Diomedea epomophora sandfordi*) (1942, p. 253), while Lockley (1942, pp. 82 and 84) notes periods of ten and nine days for two of his Manx Shearwaters (*P. p. puffinus*).

The actual time for incubation I do not know, but the following table, if my assumptions are correct, should be a reliable guide:—

TABLE I.
An Estimation of the Peak Hatching Date of *Pachyptila vittata* Eggs and Peak Laying Date of *P. turtur* Eggs.

Species	Laying of Eggs	Hatching of Chicks	Departure of Chicks
<i>P. vittata</i>	Sept. 6	Nov. 1*	Dec. 20
<i>P. turtur</i>	Nov. 2*	Dec. 27	Feb. 14

* Estimated peak dates.

In working out the above table the hatching dates of 85 and departure dates of 115 *P. turtur* chicks were known for the season

1941-42. All these dates from the earliest to the latest for both hatching and departure were put down in a column. Alongside each date was recorded the number of chicks that hatched or departed that day. 65, or 86.5% hatched during the 11 days from December 22 to January 1, while 96, or 83.5% departed during the 11 days from February 9 to 19 inclusive. The centre days, i.e., December 27 and February 14 in each group formed the peak periods and in fact more chicks hatched or departed on those days than on any others. The time between these two dates is 49 days. The average time worked out statistically for 66 chicks during their life in the burrow proved to be 49.35 days, so that the time arrived at by the column system is almost identical.

Now, while on Whero from August 23 to 26, 1941, I did not find any eggs of *P. vittata*, although several birds were about. On Herekopare, from August 27 to September 1, I found a few fresh ones, but the great bulk of the birds had not commenced to lay. Further, when on Whero in January, 1939, 1941, and 1942, I discovered that the remnants of the departing *vittata* chicks had all left by January 3, thus acquainting myself with the extreme limits of the egg-laying and departure of the chicks of *vittata*. Assuming that the range of laying and hatching, and being aware that the range of departure dates are the same for *vittata* as for *turtur* I was able to work out the peak hatching date of *vittata* chicks and the peak laying date of *turtur*.

Taking January 3, the known departure date of the last *vittata* chick and using the departure range of 34 *vittata* chicks as worked out in 1942-43, and allowing that the latter season was three days earlier than usual, I found by using the aforesaid column system that the peak date was December 20. Working back 49 days from this, i.e., assuming that the average time for *vittata* ashore is the same as *turtur*, November 1 is obtained as the peak hatching date. Now taking August 26 as the beginning of the laying of *vittata* and drawing up a range of dates corresponding with the range of hatching dates for *turtur*, September 6 would be the peak laying date. The assumed incubation period for *vittata* is then 56 days.

Now 56 days back from December 27, i.e., the known peak hatching for *turtur*, is November 2. It is assumed that the incubation period of both Prions is the same. Since the range of the hatching date of 85 *turtur* chicks is known and also the number of chicks hatched each day, therefore the range of the egg-laying, provided the incubation period is 56 days, extends from October 24 to November 11. Moreover, 86.5% of the eggs will be laid between October 28 and November 7, a period of 11 days.

The statements of other observers may be compared with the above estimates of the laying dates of the Titi Wainui. Stead (1942, p. 5), when referring to Green Island which is 16 miles north-east of Whero (Richdale, 1942, map, p. 86), states that Titi Wainuis begin laying in the second week in November. It has already been stated that Guthrie-Smith found Titi Wainuis incubating on November 23 and that it could not be certain if this were so for October 23 (see p. 33). Fleming (1941, p. 147) quotes mid-October as the

commencement of the laying period. The information given by Falla (1934, p. 248) regarding breeding dates off the Auckland east coast area seems to indicate that the period coincides with that on Whero. Buddle's evidence (1941, p. 60), however, is different and shows quite clearly that the latter group breeds earlier. He was on the Poor Knights from November 24 to December 2, 1941, this being the same season that I began serious work on Whero. He records that by the last week of November all eggs had hatched and chicks in the first down ranged from a few days to perhaps 10 days old. On Whero the limits of my 29 hatching records that year were December 22 and January 8 (table III). In 1942-43, the first of 78 chicks under observation did not hatch till December 24 and the last on January 15. In summing up, it will be observed that all records, with the exception of Buddle's, approximate to mine.

In colour the eggs are white and there is considerable variation in size and shape. As I mentioned in my Kuaka paper (1943, p. 29), some of the small eggs are very difficult to distinguish from the large eggs of the Kuaka. The largest egg measured was $48\frac{1}{2} \times 34\frac{1}{2}$ mm. while the smallest were $41\frac{1}{2} \times 30\frac{1}{2}$, $42\frac{1}{4} \times 29$, and $41\frac{1}{2} \times 30$ mm. The weights were taken from eggs in all stages of incubation and one or two were addled.

TABLE II.

Measurements of 100 Eggs and Weights of 56 Titi Wainui Eggs Taken on Whero.

Feature	Mean	G	PE _m	Range
Length	45.12 mm.	1.61 mm.	.11	40½ to 48½
Width	32.64 mm.	.99 mm.	.06	29 to 34½
Weight	24.2 gms.	2.61 gms.	.24	18½ to 29½

When the egg is finally deserted, one or both birds occupy the burrow for a few nights before leaving the island entirely for that season. Frequently, though not always, the egg is scratched out of the burrow during these operations. Desertion with the Storm Petrel is followed by the return of the birds for a time after having had a spell at sea.

I found a considerable number of deserted eggs, many of them on the surface of the ground. Old addled eggs were also discovered in the burrows. In 1940-41, the birds at nest 7 deserted their egg. Next year the same pair was back sitting on an egg laid that season and were also covering the old one alongside. The second egg hatched.

HATCHING.

To my knowledge the first hatching of a Titi Wainui chick during my visits to Whero must have occurred on December 18, 1941. In my first season 50 nests were found with eggs, while in the second there were at least 98 either with eggs or young chicks. The age of the latter was easily determined when the down or feathers reached one of the stages shown in table IV. Below is given a table of the hatching dates grouped into two-day intervals for the two seasons separately of all the chicks I found. Some of the eggs for various reasons did not hatch.

TABLE III.

Hatching Dates of 104 Chicks Placed in Class Intervals of Two Days.

Dates of Class Intervals	No. of Hatchings		Total
	1940-41	1941-42	
Dec. 18-19		1	1
Dec. 20-21		2	2
Dec. 22-23	1	7	8
Dec. 24-25	3	13	16
Dec. 26-27	3	22	25
Dec. 28-29	6	16	22
Dec. 30-31	7	6	13
Jan. 1-2	6	3	9
Jan. 3-4		4	4
Jan. 5-6	2	1	3
Jan. 7-8	1		1

It will be noticed that in 1940-41 the hatching period ranged from December 23 to January 7, while in 1941-42 it was from December 18 to January 5. The total range of 20 days for 104 hatchings shows a restricted laying period. There seems to be a tendency in the latter season for a slightly earlier laying, which feature is far more pronounced in the Kuakas (Richdale, 1943, p.34). The peak hatching period extended from December 25 to 30, inclusive, when 63.5% of the chicks appeared.

Though it is difficult to ascertain just when the shell is first chipped, close observation on several eggs indicated that after chipping the chick took at least two full days to emerge. At one nest at 10 a.m. on December 28, 1940, a chick could be heard calling through a slight crack in the shell, but there was no hole. Next morning the chick, though still calling, seemed to have made no further progress. On the morning of December 30 there was a small hole in the shell, which by 4 p.m. had increased to about the size of three-pence. By 8.30 p.m. the chick, still calling, with its eyes closed, had just hatched and was wet. The final exit is always sudden and in this case the whole process took almost 2½ days.

Events at this same nest which was found on December 28 with No. 32 parent in charge are probably worth relating as being typical of events just before and after hatching. Next day the same bird was still there but the palisade of sticks which I had placed across the burrow on the previous day was flattened and facing in, indicating that another bird must have entered. Could it have been the other parent? I do not think so, for I have every reason to believe that when a parent returns it always changes guard. It is quite likely that a wandering unemployed Titi Wainui entered the burrow. I have several instances on record where this class of bird has entered Kuaka and Storm Petrel burrows when occupied by the owners. On December 30 the sticks were again pushed in and 32 was still in charge. The wet chick at 8.30 p.m. weighed 16 grams, while 12 hours later, at 8.30 a.m. on December 31, it weighed 18½ grams, indicating that it had been fed; this time No. 15 was on guard. On January 1 a parent was present all day, but I did not identify it. The following day the chick was alone, but on January 3 there was a parent present all day; this being the last occasion on which this chick was guarded during the day. At 9 p.m. on December 31, the chick, weighing 16

grams, showed a drop of $2\frac{1}{2}$ grams so that it was probably not fed during the day. At 9 a.m. next day, however, it was $28\frac{1}{2}$ grams, an enormous meal for so young a chick.

After hatching, the chick takes some time to dry. At 5.10 p.m. at one nest the chick was still wet, showing slight signs of drying on the tips of the down, and the cord was gone. Its weight of $18\frac{1}{2}$ grams made me suspect it had been fed; it defecated watery matter. Later on the same day at 8.45 p.m. it was nearly fluffy, though the down was still somewhat knotty. As it weighed 20 grams it had been fed since 5.10 p.m.

When the chick has emerged the egg shell is usually removed from the nest and is frequently found in the mouth of the burrow. I believe, too, that the chicks are hatched bright-eyed, for several of them opened their eyes when handled within the first 24 hours, but shut them again immediately. The excreta when the nestling is a day old contain something which looks like oil and some black material.

Eggs are sometimes hatched after they have been left cold for at least one day when incubation is far advanced. Two such cases occurred in 1941-42, but I did not determine the length of time of desertion. On December 26 both eggs were cold and unattended and when I next inspected the nests on January 3 both had chicks which were hatched the previous day. These two chicks completed the full life cycle in the burrow and then flew. At a third nest on December 25, 1940, No. 21 adult was covering an egg which I found deserted and cold the next day. On December 27 the egg was guarded by No. 10 adult, but in spite of this desertion the egg hatched on January 6.

THE CHICK.

As already stated the earliest chicks begin to hatch between December 18 and 21 and are covered with long medium violet grey down (40g*), 20 mm. long on the body and 10 mm. on the head; the weight is between 16 and 18 grams. The eyes, though hidden by the long down, I think are open at hatching, certainly very soon afterwards. The tip of the beak can be just seen protruding through the down, the youngster squeaks quite freely, and if the fingers are placed over the bill it performs feeding actions. The bare parts of the leg are dark blue (19d*) all over, except the webs which are a faint reddish violet (23u*), but all are obscured by the down. The chick resembles a beautiful fluffy powder puff (Plate 10, Fig. 1). Another feature at this stage is the manner in which the hand, covered with very short protoptyle protrudes beyond the long down of the rest of the body.

Growth is very rapid, and some of the large meals given, occasionally equal the weight of the chick. The parents soon leave their offspring, sometimes on the morning after the night it is hatched, though an attendance of two days immediately after hatching is more usual. On the seventh day the mesoptyle may be clearly seen through the skin on the scapulars to cover the whole body completely in the space of a few days, while at the beginning of the second week the

* The key to these colour numbers is given at the end of this part.

eyes are plainly visible through the long down of the forehead. Biting quite freely, chattering a great deal, the chick is a very agile little creature. The protoptyle loosens up considerably as the skin area increases and the mesoptyle grows. During its life in the burrow the various parts of the bill change considerably. Between the age of nine and 15 days the egg tooth slowly wears and falls off, this phenomenon varying greatly in different chicks. The number of chicks under study for this purpose was eight, and the average time proved to be the 13th day.

At the beginning of the third week the chick begins to develop feather quills on the scapulars, forearm, and the hand. On the eighteenth day the tail quills are pushing through, otherwise there is little outward change, except in bulk.

During the fourth week the most pronounced feature is the rapid growth of the long feathers of the wing and tail. The primaries reach a little over 30 mm. in length.

When 28 days old the chick is probably at its most beautiful stage, with its three coats of feathers practically intact. No outward sign of the teleoptyle is visible, though when the down is parted it can be plainly seen. Through the down of the body it is just possible to distinguish the tail feathers and the primaries. The bill having become elongated resembles that of the adult. Though hidden, the hand is practically free of down. Chicks that have been handled are very tame and playful. Others bite hard and have both raucous and canary-like calls.

At 36 days the chick still retains its fluffy appearance but the down is very loose and beginning to come off quickly. Most of the protoptyle is gone and when compared with a younger chick it is much lighter in colour. The mesoptyle on the forehead is rapidly disappearing and fairly closely grown feathers have filled up the bare patches round the base of the bill, gape, and eyes. As these feathers are white it gives the chick a characteristic appearance.

On the 43rd day, though still covered in a thin coating of down, the time is fast approaching when it will emerge as a fully-fledged chick. 60 mm. of the primaries and secondaries and 30 mm. of the tail are now clear, and free of down. The head and neck can be seen to be very well covered through the thin down. In fact, at this stage, the appearance of the chick is very like that of the adult.

During the next and final week the down suddenly disappears, as it were, overnight, and the chick emerges fully-fledged, perhaps with slight traces of down.

After a preliminary study on nine chicks in 1940-41 to discover the appearance of the several groups of features mentioned in the table below, I watched a further eight chicks in 1941-42 to check up my results. The measurements of the growth of the primaries were taken from one chick only.

In the table below is given an abbreviated list of data which could be utilised by other workers to enable them to estimate the age of Titi Wainui chicks found on islands they may visit. Instead of using such terms as "well-grown chicks" which are most unsatisfactory, the noting of some feature mentioned below should permit of a far more accurate comparison being made.

TABLE IV.

Data for Estimating Age of Titi Wainui Chicks.

Age in Days	Remarks
7th	Mesoptyle on scapulars appears
8th	Mesoptyle on forearm appears
9th	Mesoptyle on hand appears
14th	Feather quills on scapulars appear
15th	Feather quills on forearm appear
16th	Feather quills on hand appear
18th	Feather quills on tail appear
10th to 16th	Egg tooth goes, average on 13th day
17th	Length of longest primary, 3½ mm.
19th	Length of longest primary, 10 mm.
21st	Length of longest primary, 15 mm.
23rd	Length of longest primary, 19 mm.
25th	Length of longest primary, 24 mm.
27th	Length of longest primary, 30 mm.
31st	Length of longest primary, 40 mm.
35th	Length of longest primary, 61 mm.
39th	Length of longest primary, 80 mm.
43rd	Length of longest primary, 97 mm.
47th	Length of longest primary, 110 mm.

Different observers will no doubt arrive at different results from what I have given in the above table due to the difficulty in seeing and deciding when the feathers appear. It would be quite easy to overlook their appearance for some days. My method of measuring the primaries is to take the longest primary near the tip and measure on top of it with dividers. As soon as the third primary from the end can be definitely fixed this is chosen for measurement. With the growth of the feathers measuring along the top is obstructed so it is then necessary to measure under the wing.

The chicks at no stage cough up oil as is the case with the Storm Petrel, Mutton-bird, and Royal Albatross.

The behaviour of the Titi Wainui chicks after frequent handling is somewhat reminiscent of the Royal Albatross chick which becomes quite tame and playful. As early as January 2, No. 29 chick, then 29 days old, was quite lively with a bright look in its eyes. Besides biting playfully at my hand it would wave its wings, clamber about, sleep, bite and nibble at parasites, and not jump to the touch when handled. A week of two later when being described on the table it pulled, tugged and played with the cloth on which it was sitting. On January 20, I found for the first time an old chick which soon transformed from being wild and timid into a quiet and playful creature, and was a great favourite. The Kuaka chicks, on the other hand, never became playful, but when half-grown, constantly emitted a very mournful note when handled.

As regards external parasites Titi Wainui chicks tend to be much infested with fleas, especially if the burrows are dry. Attacking weak chicks in particular, they crowd round the eyes and face of the victim. Ticks, usually attached to the feet, but sometimes on the head and round the eyes, also molest the chicks; feather lice, too, are common, and these are also found on the adults,

Mortality among the chicks in 1940–41, which was a good, dry season, did not appear to be very great. Four of the 25 chicks under observation died. One succumbed owing to an excessively wet burrow, another from starvation as a Skua ate the parent, a third which was in a very shallow burrow probably also fell a victim to a Skua, and a fourth died from unknown reasons.

In 1941–42, also a dry season, of the 76 chicks that were under observation in burrows during their whole period ashore, only six did not leave the island. All of these, for some reason unknown to me, either died in the burrow or disappeared during the first two weeks. None of these chicks died when older than two weeks.

PARENT AND CHICK.

In this section some observations concerning the interesting relations of parent and chick will be discussed. Parents spend very little time with their chicks in daylight hours, during which period they are sometimes fed. Table V deals with observations taken in 1940–41 only.

TABLE V.
Appearance of Adult with Chick in Early Stages.

Age of Chick in Days	Parent in Charge					
	Nest 22	Nest 29	Nest 8	Nest 9	Nest 12	Nest 12a
1st	No. 2 HE	No. 22 HE	No. 31 HE	No. 33 HE	No. 36 HE	No. 34 HE
2nd	No. 6 ?	No. 22 FN NFD	No. 31 FN FD	No. 15 FN NFD	No. 36 FN FD	No. 34 FN NFD
3rd	None NFN	None FN	None NFD	No. 33 FN NFN	None FN	None NFN
4th	No. 6 FN FD	No. 22 FN NFD	No. 32 FN FD	-	No. 36 FN FD	No. 34 FN NFD
5th		None FN		-	No. 33 FN FD	None FN
6th		No. 8 FN FD				No. 34 FN NFD
7th						None NFN
8th						No. 35 FN NFD

Key.—HE, hatched that evening; FN, fed during previous night; NFN, not fed during previous night; FD, fed during day; NFD, not fed during day.

In the foregoing table is given the occurrence of the parent with the chick in the daytime during its first few days of life. After the occasions listed in the table the parent was never found again with a chick during the day. It will be noticed in all cases that the chick was hatched late in the day, the earliest being that at No. 9 nest, which appeared just before 8.30 p.m. In all the examples given the chick was fed presumably by the parent in charge before 9 o'clock next morning, while in two cases out of five it was fed during the day as well. My method of discovering these facts as well as others

was to weigh the chicks at 9 a.m. and 9 p.m. during their period in the burrow. On the second day, i.e., the day after hatching, a parent brooded each chick, but on the third day all but one had been left alone. On the fourth day the five that had been deserted the previous day were brooded while the sixth chick was alone. After this only some nests had parents in attendance again during the day. In three nests the parents were there twice during the day, in two cases three times, and in one case four times. This was the procedure in a number of other nests where the chicks were not weighed.

Feeding usually occurred at night and occasionally in the daytime. If the chick remained unfed at night it was a sign that the second bird had not come home and that the first had to leave without feeding. The chick at nest 12a was fed on the night preceding the sixth day, but not on that day, although a parent was present. On the night preceding the seventh day it was not fed, and by 9 p.m. that day had dropped to 18 grams. At 9 a.m. on the eighth day it had risen to 36½ grams, i.e., double its weight, and though the parent stayed with it, no food was transferred that day. Even so, its weight was lighter than the other five chicks taken on the eighth day.

It will be observed that the parents stayed with their chicks for a total of from three to five days and that these attendances were spread over from four to eight days. In every case noted, each parent brooded the chick during the day at least once. At nests 12, 29, and 12a it was not till the fifth, sixth, and eighth day respectively that the chick was brooded by the second bird. After that period it was not attended again. It would appear that each parent wishes to feel the presence of the chick beneath it before abandoning it during the daytime. Only once, at nest 12, did the first bird to brood a chick return to perform that operation after its mate had had a turn.

In 1941-42, when weighing a number of chicks twice daily from the age of 28 days until they flew, together with many more during their last 10 days ashore, I never once found an adult with the chick in the daytime. With the Storm Petrels and the Kuakas, however, there were occasional exceptions to this rule.

That parents are rarely found together with their chicks at night is amply demonstrated by the following activities. During the 1941-42 season the various nests were visited nightly till all the parents were ringed. On 102 occasions I found and ringed a single bird, while on many other unrecorded occasions while still searching for the second bird I again came across the first bird ringed. Having once ringed the second bird I did not search the burrow again. Only three times when making these visits were two birds found together in the burrow at night. This behaviour is similar to that of the Storm Petrel, but in great contrast to the Kuaka which is usually found in the burrow in pairs at the chick stage. With unemployed Titi Wainuis, however, a pair was found together far more often at night.

My earliest record of a parent's homecoming is 10.45 p.m., about 15 minutes after complete darkness in summer in this latitude. Round 11 p.m. many of them arrive and till midnight many more. My method of watching was to place sticks across the burrows, re-

turning to make observations at frequent intervals during the night. At nest 8 on the night of January 27, the sticks had not been moved by 12.30 a.m., but in the morning the chick had advanced the record weight of 56 grams from 80 to 136 grams, so that probably two birds came in after 12.30 a.m. By 2.30 a.m. at the latest they would be gone. There is evidence, as shown by the removal of the sticks, that some of the parents at least do not stay more than 15 minutes. At another nest on the night of January 15 the sticks were not moved till after 1 a.m., and on this occasion 33 grams were given, so that it appears as if the birds may come in any time during the night. This particular night, however, it was just past full moon and the weather was squally at times. On two occasions, both on moonlight nights, I saw No. 4 parent fall through the Tete-a-weka trees some six feet from the nest and scuttle away immediately into its burrow which, situated as it was in bare ground under the trees, enabled me to watch the bird's behaviour clearly. From the air, the similarity presented by the canopy of trees makes this feat of falling through in close proximity to the burrow rather remarkable.

Both parents must feed the chicks on some nights as is probably indicated by the heavy meals. This was proved by means of sticks placed across the burrow at night; by keeping watch every 10 minutes or so I noted when a bird entered. If, after the sticks were replaced they were again pushed in, it probably indicated, unless there was an unemployed bird on the prowl, that the second parent had entered. On one such occasion a bird was ringed in a burrow at 10.45 p.m. on January 28, and at 11.15 p.m. a second bird was found with the chick.

I had been endeavouring for some time to watch an adult feed the chick, and one night at 11.15 p.m., noticing the sticks down at nest 22, I removed the plug and saw the adult sitting in the tunnel leading to the nest. The chick was asleep, apparently not aware of the adult's presence. Later it moved up to the chick which squeaked a little—just a few faint squeaks—a call with which I was not familiar. It was difficult to follow the feeding; the chick was higher up than the adult and the heavy down blocked my view. After a slight cough the adult appeared to open its beak, while the chick seemed to put its bill right in, pull it out, raise it and then swallow. As far as I could judge the method bore a close resemblance to that employed by the Kuaka. Subsequent attempts to watch on succeeding nights were less successful and I had to abandon the task.

FOOD AND RELATED TOPICS.

As the species under consideration frequently regurgitates its food when handled, samples for examination were easily obtained. In all cases they were found to contain a mass of Euphausiids about half an inch long.

In table VI is given the hatching dates of eight chicks in the 1940-41 season weighed twice daily up to January 30, and of ten chicks in 1941-42 weighed from January 26 till they left the island. The quantity of food received each night was determined by the difference between the evening and the following morning weights. Nights on which chicks were not fed are also noted. Weights in-

icated by an asterisk represent the amount of food given by a guarding parent during the day, and this occurs several times the first few days. The amount of food as shown by the table varies from 0 to 56 grams, but it must be remembered that these weights, owing to the method used, will be slightly less than the actual weights.

TABLE VI.

Nights Fed and Amount of Food Given to 8 Chicks in 1940-41 and 10 in 1941-42.

Chick	Hatched	Dec., 1940							Jan., 1941			
		24	25	26	27	28	29	30	31	1	2	3
	Dec. 1940		gm..									
		2*		4*								
22	23	NF	12	NF	NF	11½	20	9½	31½	NF	NF	
8	29						3½*	NF	1½*			
9	30							2½	8½	-1½	12½	
								5½*	12½	0	11	
12	28						2½*		5*			
12a	29						3	1½	8½	3	2½	18½
								3½	NF	10	½	11½
29	24		3½	2½	8	0	10½	NF	12½	13	13	12
4	25						NF	12½	7	19	NF	12½

TABLE VI (Continued).

Chick	Jan., 1941														
	4	5	6	7	8	9	10	11	12	13†	14	15	16		
22	25	15	30	4	10	NF	32½	NF	18½	15	21½	19	17		
8	4½	9½	16½	15½	22	NF	18½	3	10½	16	6½	15	15½		
9	4	8½	14½	8	23½	18½	13	NF	13½	19	12	15½	11½		
12	19½	12	7½	8	15	NF	28½	21½	28½	4	12½	12½	8		
12a	NF	18½	4½	17	17½	5	14	NF	12	12	8	26½	5½		
29	6	12½	24	17	10	NF	20	14	6	33½	3	NF	17½		
4	2	NF	14½	8½	28	NF	22½	16	3½	11½	7	12½	32		

TABLE VI (Continued).

Chick	Jan., 1941													
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
22	13	14	22	NF	16	9	NF	13	4	26	16	6	8	13
8	19	9½	18½	2½	10	5½	40	2	NF	NF	56	18	40	10
9	45½	15	27	11½	8	33	NF	41	30	NF	37	5	15	NF
12	11½	12	12	8	5	10	NF	13	NF	34	28	NF	39	NF
12a	20	4½	10½	14½	11½	NF	NF	23½	5	19	6	13	4	NF
29	15	27½	NF	6	18	4	NF	10	8	7	7	15	NF	31
4	12	NF	NF	23	25	11	24	3	NF	NF	16	11	18	32
56 (Dec. 18)				12	34	NF	16	6	NF	9	NF	41	20	

TABLE VI (Continued).

Chick	Hatched							Feb., 1942				
	Dec., 1941	Jan., 26	Jan., 27	28	29	30	31	1†	2	3	4	5
3R	28	12	5	0	10	15	7	11	8	21	37	43
7R	26	20	10	20	13	NF	NF	5	9	17	16	16
22	27	19	NF	10	NF	15	43	0	-6	NF	NF	33
4	27	NF	18	44	30	NF	18	7	24	39	24	NF
5	28	7	11	20	4	5	27	3	7	4	2	13
12R	27	26	NF	NF	NF	12	36	9	25	26	NF	NF
lbs	22	33	14	10	NF	15	24	11	37	15	5	28
22R	22	12	16	14	8	9	22	NF	18	12	4	11
24R	28		10	35	33	NF	NF	4	24	35	-4	7
25	29		17	17	9	51	NF	0	9	15	34	33

TABLE VI (Continued).

Chick	Feb.												
	6	7	8	9	10	11	12	13	14	15	16	17	18
3R	5	-3	6	5	NF	NF	NF	NF					
7R	4	20	23	11	15	7	5	NF	22	NF	13	17	NF
22	51	17	4	0	NF	NF							
4	44	12	NF	11	0	24	-2	NF	NF	NF			
5	13	11	11	NF	9	19	-1	26	NF	NF			
12R	44	25	24	NF	NF	NF	11	19	NF	NF			
lbs	NF	NF	NF	NF									
22R	NF	NF	NF	NF									
24R	24	7	NF	NF	25	8	4	11	5	0	0	-2	NF
25	15	NF	NF	20	NF	6	14	25	1	-1	NF	NF	NF

* Means amount of food given to chick during the day by a guarding parent.

† Means full moon.

NF Means not fed during night.

- i.e., a minus sign prefixed to a figure indicates that the morning weight was less than the previous evening weight.

TABLE VII.

Weights of 455 Meals Given to 17 Titi Wainui Chicks, Grouped into Class

Class Interval	Intervals of 10 Grams.	
	No. of Meals	Percentage
No meal	102	22.4
0 to 9.9 gms.	124	27.2
10 to 19.9 gms.	141	31
20 to 29.9 gms.	50	11
30 to 39.9 gms.	25	5.5
40 to 49.9 gms.	10	2.2
50 to 59.9 gms.	3	.7

The data for the above table were compiled by weighing seven chicks from hatching to January 30, 1941, and a further ten from the age of 28 days to their departure in February, 1942. In addition to this 65 chicks were weighed during their last ten days or so ashore. It will be noted from the table that slightly over 75% of the meals given ranged between 0 and 19.9 grams.

The following table deals with two sets of chicks already enumerated. From a perusal of Tables VI and VIII it will be seen that the number of times a chick is not fed is considerable, and this phenomenon occurred in both seasons. The range in 1940-41 varied from 12.5 to 23.7%, and in 1941-42 from 14.3 to 47.6%. If the final days not fed after the last meals ashore are excluded the range is 0 to 42.1%. For both years the average is 22.75%, but if the final nights not fed are excluded it is 16.7%. In other words, while parents are feeding their chicks they omit to feed them on 16.7% of the nights; with Storm Petrels the percentage is 28.4.

The average amount of food given per meal varied in the first year from 11.4 to 16.8 grams, and in the second (in this year they were older) from 10.4 to 23.4 grams. The case of the chick at 12R is interesting. At the end of its period ashore it was weighed on 21 occasions, yet it was unfed 10 times. Its total quantity of food received was the third greatest of all the chicks that year and its

TABLE VIII.
Data Relative to the Irregularity of the Feeding Process.

Nest.	Days in Burrow	Nights When Not Fed			No. of Days of Days Weighed	% of Days Not Fed	Quantity of Food Received					
		Amount of Times Down at Departure	No. of Days Not Fed	DNF*			No. of Nights When Fed	Amount Received in grs.	Average in grs. for Each Night Fed	Average per Day in grs.		
	1940-41											
22		9			38	23.7	29	467	16.1	12.4		
8		4			32	12.5	28	415	14.8	13		
9		4			31	12.9	27	455½	16.8	14.7		
12		5			33	15.1	28	388	13.9	11.8		
12a		6			32	18.7	26	297½	11.4	9.6		
29		7			37	18.9	30	389½	13	10.5		
4		7			33	21.2	26	407	15.7	12.4		
	1941-42											
3R	47	4	4		19	21	17	182	10.7	9.6		
7R	55	6	3		25	24 (13.6)	19	263	13.8	10.5		
22	46	0	2		17	35.3 (26.6)	11	186	17	11		
4	50	7	3		21	33.3 (22.2)	14	293	21	14		
5	49	3	2		21	14.3 (5.3)	18	187	10.4	9		
12R	50	10	2		21	47.6 (42.1)	11	257	23.4	12.2		
lbs	48	4	3		14	28.6 (9.1)	10	192	19.2	13.7		
22R	49	5	4		15	33.3 (9.1)	10	126	12.6	8.4		
24R	52	5	1		23	21.7 (18.2)	18	226	12.5	9.8		
25	51	7	3		23	30.4 (20)	16	265	16.6	11.6		

* Means days not fed after last meal ashore (included in previous column).

** Means percentage of nights not fed when days not fed after last meal ashore are excluded.

T Means trace of down.

ND Means no down for 1 day before leaving.

average amount per meal was the highest. The other two chicks which missed many nights, i.e., seven, also record the highest aggregates of food. It would seem, therefore, that missing meals is no hardship, the large quantities per meal amply compensating for the omitted feedings.

When, however, the total amount of food received is divided by the total number of weighings, including the nights unfed, it will be noted, as shown in table VIII that there is a tendency for the amounts to level up. For example, chick 12R which received the greatest average amount (23.4 grams) per meal when fed was

only third in the list when the total weighings were divided into the total amount of food received. When compared with the Storm Petrel (Richdale, 1943, p. 221) this levelling process is by no means so striking and uniform.

Grouping all chicks together and excluding the days when chicks were not fed after their last meal ashore there were 41 occasions on which they missed a meal for one night only, 11 occasions when there was a span of two nights, and only twice a span of three days. The two spans of three days missed were experienced by chick 12R which averaged the highest quantity per meal.

Some of the weight increases of the different chicks not already given are worthy of note. Chick 22 (1940-41) when nine days old weighed 39 grams at 9 p.m., and next morning it was 70½ grams. On the following two mornings it dropped to 46 and 38 grams respectively without being fed, so that evidently chicks can accommodate a large meal and fast, if necessary, for a short time. On its third evening of life this same chick weighed 17½ grams and next morning was 29½ grams, an increase of 12 grams which, is a huge proportion.

Still another chick, No. 8, which, to my knowledge, accommodated the largest amount of food (56 grams at 30 days old), advanced, on the morning when 26 days old, 40 grams, which was more than double its previous highest of 19 grams. Next day, having acquired overnight, a light meal of only two grams, it dropped from 134 to 123 grams. On the following two days it had dropped to 97 and 85 grams respectively without receiving any food, and on the final afternoon it was down to 80 grams. On the 30th day it rose sharply to 136 grams, having received, as I mentioned earlier, the enormous meal of 56 grams. By the 32nd day, after another meal of 40 grams, it reached 172 grams, this figure representing the heaviest weight I had for any of the seven chicks. Daytime meals were never very large, the highest being only 5½ grams.

TABLE IX.

Average Weight and Number of Meals Given Daily to 7 Titi Wainui Chicks in 1940-41 and 10 in 1941-42, Grouped into Class Intervals of Four Days.

Class Interval in days	No. of Meals	Avg. Weight in grms.	Class Interval in days	No. of Meals	Avg. Weight in grms.
1-4	15	6.57	29-32	42	17.43
5-8	23	10.43	33-36	43	15.35
9-12	23	13.17	37-40	41	18.17
13-16	25	16.6	41-44	33	16.91
17-20	24	15.2	45-48	22	11.32
21-24	27	14.68	49-52	6	5.33
25-28	19	17.07			

To construct table IX the nightly meals were put down in columns according to the age of the 17 chicks concerned. Thus the first column recorded the weight in grams of the food received by each chick on the first day after the hatching; the second column the amount received by each on the next, and so on. These columns were then grouped into four, the totals of each set of four columns found and divided by the number of nights when feeding occurred. I could not estimate the average of each four columns owing to the number of times when feeding was omitted.

TABLE X.
Average Weights of Meals Given to Titi Wainui Chicks at Various Periods.

Occasion When Weights Taken	No. of Cases	Avg. in gms.
After missing 1 meal	42	18.2
After missing 2 meals	11	24.54
After missing 3 meals	2	11.5
1st meal after a fast	56	19.1
2nd meal after a fast	44	15.5
3rd meal after a fast	39	16.1
4th meal after a fast	30	15.7
5th meal after a fast	25	11.5
6th meal after a fast	9	19.3

The above table has been made out to check up to what extent, if any, the average weights of food given, are influenced by periods of fast and by successive meals. The top part of the table would seem to indicate that heavier meals are given after two nights of fast than after one. To show the effect of longer fasts I have not sufficient data. Meals after fast periods seem to be larger than at ordinary times. As regards successive meals after a fast of any length the second, third, and fourth are much the same and are all lower than the first meal after a fast. The weight of the fifth meal drops considerably and probably after that rises again, but the data I have with regard to it is meagre.

NOTE.

In the section on the chick, colour numbers and letters as found in Radde's Colour Chart are used. A list of the colours referred to in the text with their respective numbers appears below. The darkest shade of each colour is given the letter "a" and the lightest the letter "v".

19.—Blau.

23.—Violet, Erster Uebergang nach Purpur.

40.—Violetgrau.

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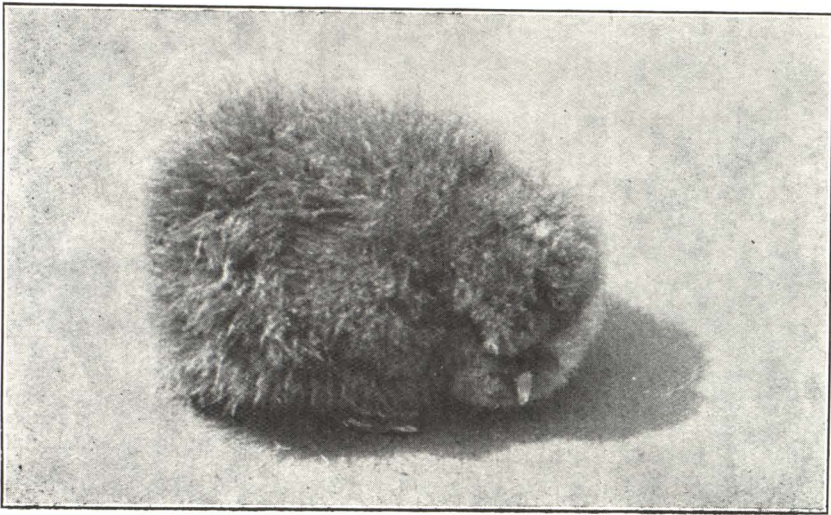


Fig. 1.—Titi Wainui Chick, Two Days Old, 25/12/40. Note Egg Tooth on Tip of Bill.



Fig. 2.—Adult Titi Wainui, 18/12/38.