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THE LIFE HISTORY CYCLE OF LEACH'S PETREL
(*OCEANODROMA LEUCORHOA LEUCORHOA*) ON
THE OUTER SEA ISLANDS OF THE
BAY OF FUNDY.

BY WILLIAM A. O. GROSS.

Plates XVIII-XXI.

Introduction.—On the isolated islands at the mouth of the Bay of Fundy, Leach's Petrels have found a refuge from the persecution that has befallen them on many of the nesting colonies along the North Atlantic seaboard. Their continued existence in this part of the world is largely dependent upon the success of these breeding colonies. Tabulations of comparative numbers made over a three year period show that even in this region the birds are rapidly decreasing in numbers.

Kent's Island, which has recently been presented to Bowdoin College by Mr. J. Sterling Rockefeller as a bird sanctuary and a biological research station, is the site of a flourishing colony. It was there and at neighboring islands that this investigation of Leach's Petrel was made. Kent's Island offers many opportunities for the ornithologist and particularly the bird ecologist. It is the home of thousands of Herring and Black-backed Gulls, Eider Ducks, Guillemots, and other marine birds. Four species of Swallows (Tree, Barn, Cliff and Bank) are always in evidence about the laboratory. Scores of Savannah Sparrows nest in the field in the center of the island. The northern section is heavily wooded with a dense growth of virgin spruce which offers nesting sites for Flycatchers, Brown Creepers, and similar types of bird life. The majority of the Petrels nesting on the island were found in this section, and with this group I dealt particularly.

Kent's Island is about two miles long and a quarter of a mile wide at its narrowest point. Together with two smaller islands, it forms a group known as Three Islands. They appear on the Government charts at Lat. 44° 34' N. and Long. 66° 45' W.

Approximately a mile to the north of the group is a small barren island known as Green Island. This is one of the most thriving colonies of Petrels that I have ever visited. It is uninhabited by man, but a fisherman keeps cattle on the island which indirectly have been a factor in the survival of the colony. By trampling upon the nests of any Gulls which might attempt to establish themselves on the island, the cattle have rid the Petrels, which nest underground, of their worst enemy.

During the summer 325 Petrels were banded on this island alone. Green Island because of its small size and the character of its surface lends itself well for a study of Petrel populations and especially of fluctuating changes in their numbers from year to year.



UPPER. LEACH'S PETREL COLONY. THOUSANDS OF BURROWS AMONG THE ROOTS AND BRUSH OF THE CLEARING.

LOWER. BANDING PETRELS ON GREEN ISLAND; A TYPICAL COLONY.

Present Status.—It would be difficult to determine the number of Petrel burrows on any of these islands, but the following estimates will serve as approximations: Kent's Island 10,000, Green Island 2000, Little Wood Island 12,000, Machias Seal Island 3000, and White Head Island 500 burrows. A few years ago the colony on Little Wood Island had thrice its present population, and Machias Seal Island ranked as one of the largest breeding grounds. On several small islands where the Petrels were once abundant the species has completely disappeared. However, if adequate protection should be given the birds in colonies such as the one on Kent's Island, their numbers can be maintained and possibly greatly increased in the course of a few years.

One of the causes for the marked decrease of the species is the Herring and Black-backed Gulls; the indirect victims of Gull over-population are the Petrels. One can pick up the regurgitated remains of dozens of birds in the morning along the shore after a night of full moonlight. The awkward, erratic flight of the Petrels makes them easy prey for the Gulls who stand guard along the shore and exact a heavy toll upon the bewildered birds which come fluttering in from the sea at night time.

To test the ability of a Gull to swallow adult Petrels, an experiment was conducted with a captive Black-backed Gull at the laboratory. In twenty minutes this bird succeeded in swallowing five birds in their entirety! Furthermore, Petrels released during the day near a Gull colony were invariably captured and devoured by the more powerful and swifter flying Gulls.

Dogs, cats, rodents and man have also been contributing factors in the destruction of this bird. Records show some very devastating results caused by dogs running loose on island colonies. For example, on Machias Seal Island the entire Petrel colony was at one time being rapidly exterminated by a dog until the latter was removed by the National Audubon Society.¹ At this same colony I found that the lighthouse was responsible for the deaths of considerable numbers of birds. The Petrels attracted by the light flutter around the beacon in circles until exhaustion overtakes them. Bodies picked up at the base of the lighthouse showed no external injuries which would have been caused if the birds had crashed into the glass windows. The British have had good success in erecting perches around their beacons for any birds who might be attracted to the light.

Egging expeditions by natives have offered an opportunity for children to maraud Petrel burrows in their game of competitive egg collecting. On certain islands this pastime has proven to be the cause of no little nest destruction and disturbance to the birds.

Petrel Mythology.—Tales of Mother Carey's Chickens are present in the

¹ Bent, A. C., 1922, U. S. Nat. Mus. Bull. 121, p. 144.

folk lore of many nations. These little wanderers of the sea have also been the source of much speculation by ocean travellers. Sailors have said that the bird carried its egg beneath its wing and hatched the chick while flying at sea. A game warden in all seriousness told me that he had seen a strange incident on the fishing grounds in calm weather. The Petrels settled down on the glassy surface of the ocean, turned over on their backs, stuck their wings up in the air, and went sailing away like toy boats.

A member of the Life Saving Station crew on Little Wood Island became quite emphatic when I attempted to differ with his statement that the chicks are imprisoned by their parents in the burrows with sufficient food to live through the winter. He said that he had frequently unearthed chicks in the middle of winter when snows covered the entire surface of the ground. The young according to him were released when the melting ice and snow of spring left the burrows open.

On foggy nights mariners are said to tell the proximity of Petrel islands by the strong odor of the birds. This musk smell is an inherent characteristic. Museum specimens retain the odor almost indefinitely, and the entire body of the bird is scented with it. In bird banding we used this smell as an effective aid in readily determining whether the burrow was occupied.

The most inexplicable phenomenon which I and others have noticed is the absence of Leach's Petrels at sea during the day. There should be at least 10,000 members of the species flying about the outer reaches of the bay for food during the daytime. But seldom does one ever see a Leach's Petrel on the fishing banks while Wilson's Petrels can be tolled up to the boats at almost any time.

Many characters of Petrels would intimate that they have a strong sense of smell. Birds can be tolled up to the boat in a thick fog by putting out some odorous cod livers. In these instances the Petrels could not have located the bait by sight nor could they have come upon it by accident. The musk smell, which we associate with all Petrels, may be a highly differentiated characteristic of the individual bird. If the latter is true, we can explain the ability of the birds to single out their mates in the dead of night.

"Mother Carey's Chickens" is the usual common name of the Petrels. There are several variations in use in the Bay of Fundy such as "Kerry Chickens," "Mother Careys," and occasionally, "Stormy Petrel."

Geographic Range.—Leach's Petrel is a wanderer of the seas. Its range extends in the Atlantic from Iceland to the equator. In the Pacific it is found from Bering Sea to the Galapagos and the Hawaiian Islands. It breeds in the Kurile Islands, north to the Commander Islands, and east to the Aleutian chain. On the eastern side of the Atlantic ocean it is found on islands of northern Great Britain (St. Kilda, the Blaskets, and the Hebrides).

The southernmost record of its breeding along the New England coast is from Penikese Island at the mouth of Buzzard's Bay, Massachusetts.¹ In this instance the Petrels are said to have built their nests under a huge pile of rocks where it is impossible to reach the eggs. Although the nests have not been seen, the presence of the birds constitutes an important record which has been verified by competent ornithologists.

There are several colonies along the Maine coast, of which the one on Great Duck Island is the most important. The most extensive breeding grounds are on the islands in the outer reaches of the Bay of Fundy: Machias Seal Island, Little and Big Wood Islands, Kent's Island, Green Island, and Nova Scotia Seal Island. Other colonies are on Bird Rock and St. Paul's Island in the Gulf of St. Lawrence and on St. Peter's Island on the Newfoundland Labrador coast.

The most northerly breeding colony along the Atlantic coast is probably St. Peter's Island which is a short distance south of Battle Harbour. Petrels are known to have breeding colonies in Greenland and Iceland, but none to my knowledge exists farther north on the mainland of North America.

The earliest spring record of Leach's Petrel in the Bay of Fundy which I have been able to find is May 15. There are no indications of any Petrel breeding until the first or second week of June. As the period required to raise the young is more than a hundred days, few Petrels can start their fall migration before November. Indeed, I have records of Petrels in the breeding colonies until the end of December. When I left Kent's Island in September, numbers of Petrels were just beginning their breeding activities. This would indicate that there is a possibility that young Petrels do spend the winter in the burrows, but this fact I have not as yet been able to ascertain.

Food.—The examination of contents of the digestive tract of Petrels showed an oily, orange-colored mass of material. A very distinctive and rancid odor is associated with this food. By vomiting the contents of their stomachs at enemies, they apparently protect themselves to a certain extent. This oily, highly pungent substance is not only disagreeable but tends to temporarily blind an intruder of the nesting bird.

It is not known definitely where Leach's Petrel gleanes the greater part of its food. The refuse matter left by the whales and seals is at least one source. The concentration of Petrels at sea is a good indication that whales are in the vicinity. Detailed examinations of stomach contents also revealed the presence of tiny mollusks. Small transparent squids constituted the most important item of food of the birds examined in the Bay of Fundy. Mr. Ernest Joye, warden of the Keat's Island research station, also reports that he has frequently seen them feeding upon these animals.

¹ Townsend, C. W., Allen, F. H., 1933, *Auk*, vol. L, p. 427.

Calls and Notes.—The characteristic call of the Leach's Petrel is different from the notes of any other bird. To the fortunate naturalist who has heard the strange sounds of a Petrel colony this eerie call is unforgettable. The notes have been variously interpreted by different authors, and I shall not attempt to elaborate upon these descriptions. The call is a unique utterance of some eight notes given in an irregular guttural manner. To interpret the song into sounds intelligible to human beings only seems to make the confusion greater. Audubon (1840) describes the call as "*peur wit, peur-wit*" while Charles W. Townsend (1923) records three interpretations: "*ipter-ipta, ut, ut, ut; whipter-ipta, ha, ha, ha; upter-upta, ha, ha, ha.*" Popular interpretations include "*Got any terbacker*" and "*Jonny get your hair cut.*"

I have noticed that incubating birds who show the most aggressiveness towards the person who removes them from their nest utter a certain "squeek-like" note. This note is obviously one of either distress or anger. The bird would utter several of these "squeeks," snap at my fingers with its beak, and then oftentimes break out into the usual full many syllable call.

The adults also utter a note in relation to the young birds. After a youngster has been returned to the nest, the old bird soothes away the chick's mournful peeps with a sort of "choo shoo" which is delivered successively and half-purred.

During the mating performance the pairs of mating birds trill a warm rhythmic series of similar notes. Apparently one bird utters the call and the other joins in as soon as its mate has stopped. The calls sound like "Mmm-mm, mmmmmm-mm, mmmmmm-mm." There is a small break between the main part of the song and the last note. The only time that this humming sound is heard is when two birds are mating together in the burrow. I have never heard these notes uttered from the same burrow more than one night during the whole nesting season. These beautiful contented purrings are one of the most unique things in the whole courtship performance. To walk over the ground where these innocent little wanderers are cooing is one of the greatest thrills experienced in my study of the life history of Leach's Petrel.

Night Activities.—Normally the Petrel is never seen about the land during the daytime. Its going to and from the nest is accomplished under the cover of darkness. This habit has undoubtedly been acquired through evolutionary adaptation as a protection against enemies. So well do the birds realize the danger they run in going to the islands that their activity becomes important only on very foggy nights. After a long day at sea gathering food, they fly in silently with a miraculous sense of direction to their island home although it may be enshrouded with an impenetrable fog. Calling to their mates in their nests beneath the ground, they flutter over the island not unlike a swarm of bats.



UPPER. PETRELS HOVERING IN SEARCH FOR FOOD.

MIDDLE. STUMP PROVIDES PROTECTION FOR BURROWS.

LOWER. FLASHLIGHT PHOTO OF PETREL LEAVING BURROW AT NIGHT.

Excerpts from my journal describing a night's observations of the Petrels on Green Island will serve to convey a conception of this strange night activity. The date was August 24, 1934, the temperature about 45° F., the wind was blowing strongly from the south-east, and the whole night was dominated by occasional downpours and a heavy fog.

"8:40 P. M. (Standard time). Saw first Petrel fluttering over island.

"8:45 P. M. Heard first Petrel call. Others followed and more birds flew in from the sea. They fluttered several times over the island and then disappeared in the shadows. They seemed to be looking for their burrows and ascertaining whether they had reached their own particular island.

"9:00 P. M. Activity has greatly increased. Calls occur frequently and a dozen or more birds are always in the air.

"12:00 Midnight. More calls are coming from the birds in the air. The mating notes of a half-dozen birds can be heard clearly.

"1:00 A. M. Raining very hard. Petrels showing greatest activity of the entire evening. During the flashes of lightning I can clearly make out many birds in the air. Fear of the Gulls has been banished, and the birds are apparently enjoying their freedom from molestation to the utmost.

"4:00 A. M. Activity has steadily dwindled during the last two hours. I have just now heard the last call of a Petrel. Their notes no longer break through the waning storm. Birds can be seen flying out to sea again in ever-increasing numbers.

"4:20 A. M. The last Petrel has left the island and dawn is breaking."

On a night of full moonlight and a clear sky very little Petrel activity is noticeable. The birds fly in from the sea to their nests as quickly and silently as possible. Only an occasional Petrel call and the cry of a Gull's successful capture inform the listener that the birds are active.

The only natural pictures that can be obtained of Leach's Petrel in the daytime are flight pictures at sea. In order to photograph the bird leaving its burrow, intricate apparatus was devised. A "Flashbulb" filled with an illuminating gas and aluminum foil was used for light. By means of electrical magnets a Graflex camera was timed to record a rapid exposure at the moment of the flashlight. The whole mechanism was operated by a delicate switch which the bird closed. This was effected by stretching a thread across the burrow or by using a little metal trigger in the entrance.

The Burrow.—The nesting burrow of Leach's Petrel is one of the most unique characteristics of its breeding habits. They often represent considerable engineering skill and industry. The length of the burrow was in several instances as long as 87 centimeters (34 inches) and 40 centimeters (16 inches) beneath the surface. Burrows are found in diverse situations: in the loam of barren fields, at the base of stumps, under piles of brush, beneath huge boulders, and in banks along the shore. As a rule, the birds

show a tendency to dig under a substantial mass such as a stump or a rock as a protective measure against predatory animals and soil erosion. The burrow generally follows a downward course with numerous sharp right angle turns. In bird banding work we found that by forcing one's bare arm up the tunnel the bird could be removed without seriously injuring the burrow.

The male is responsible for all of the nest building. Seven birds collected in unfinished burrows, obviously in the act of digging, were all of this sex. In the construction of the burrow the bird uses both its bill and feet. The bill serves as a sort of pick to loosen up the wall of loam. The sharp toe nails scrape the dirt aside and the soles of the feet pat it down. The nails of the adult are very well developed and many are five millimeters or more in length. Little soil is actually removed from the mouth of the burrow. The ground is loosely packed, and the birds need only to press the earth into a compact mass on the floor of the burrow.

About three days are consumed in building the burrow. During the first evening the site is chosen and the entrance way is constructed. By the end of the second night the burrow is half completed, and the bird will remain at its digging during the following day instead of retreating out to sea. After three days the nest is completed, and the birds are usually found mating that very night.

Little or no material is placed in the nest. A feather and a twig or two generally suffice. One nest, however, contained ten heavy grass stalks about 12 centimeters long, and another had a mass of 56 spruce twigs measuring from one to six centimeters in length. The temperature of unoccupied nests ranged from 40° F. to 65° F. when determined during the middle of the day. Many burrows although containing nesting birds were very cold and damp.

If a bird is disturbed while incubating, it is not uncommon the next day to find the length of the burrow greatly increased, and the egg moved from its former position to the newer nest bowl. Several times the birds broke their egg after having been disturbed. They deserted the burrow for nearly a week and then returned to it. The length of the tunnel was increased, and an egg soon appeared in the remodeled home.

In the following table, the first ten sets of measurements contain at least one extreme figure for that particular measurement. The largest values in the forty burrows recorded are *italicized*; the smallest have been put in parentheses. The length of the burrow is taken from the entrance to the back wall of the cavity. The depth of the nest cavity is the line extending perpendicularly from the surface of the ground to the floor of the cavity. The entrance to the burrow is measured first horizontally and then vertically. The three values under the nest cavity dimensions are length, width, and height respectively.

MEASUREMENTS OF BURROWS

Length of Burrow	Depth of Cavity	Dimensions of Entrance	Dimensions of Cavity
87 cm.	34 cm.	8 × 7 cm.	22 × 14 × 7 cm.
(28)	30	7 × 6.5	13 × 12 × 8
84	40	9.5 × 6.5	15 × 23 × 8
37	(12)	13 × 6	16 × 14 × 15.5
45	18	14 × 6	16 × (3) × 7
56	32	(5.5) × (5.5)	19 × 14 × (6)
50	30	7 × 9	18 × 11 × 8
54	25	5 × 7	25 × 23 × 9
58	16	6 × 5	(11) × 14 × 7
60	20	7 × 4	12 × 17 × 17.5

Average Measurements of Forty Burrows

50.8	25.1	8.2 × 6.5	16.2 × 16.3 × 8.7
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Mating.—To the observer the courtship of Leach's Petrel is a weird performance. Under the cover of darkness the females of the species flutter over the Petrel islands. From the depths of their burrows the males utter the staccato-like call of their clan. From the air the females hear the calls and answer similarly. By calling back and forth, the birds become mutually attracted and finally mate.

During copulation, the mating birds purr a tender love theme which has been hitherto discussed under "Calls and Notes." After the first night of courtship the nest is usually deserted for a day. The following night the female lays the egg. Sometimes two birds apparently misjudge the approach of dawn and are forced to spend the following day in the burrow. The purring is never made during the day time, but at night it is a certain sign of mating birds.

The Egg.—The Petrel has never been known to lay more than one egg in its nest. There is some evidence that a second may be laid if the first is destroyed—an egg removed from one burrow was replaced two weeks later by another. The ground color of the smooth shell is pure white. About one half of the eggs have a band consisting of minute mottled spots of lilac arranged around the larger end. This band is generally between six and seven millimeters wide. The distance from the band's outer edge to the center point of the egg is usually about sixteen millimeters. Sometimes the entire tip of the egg is marked or a small irregular blotch may occur near the end. The lilac color is varied with purplish and reddish tints, but often there are no markings present on the pure white egg.

It is interesting to note that the colored band may be darker or lighter on the inner side of the shell than on the exterior. A band present on one surface of the shell may or may not be discernible on the opposite side.

In most cases the egg soon becomes heavily nest-stained. They are often colored such a dark brown that both the lilac and the white color of the egg are concealed. This discoloration is caused by vegetable juices of the dank, brown soil in which the burrows are constructed.

The measurements of 45 eggs on Green and Kent's Islands averaged 32.6 by 23.7 millimeters and the average weight was 8.8 grams. The six extremes were 35.5 x 24. mm. and 10.3 gm.; (30.8) x 23.5 mm. and 8.4 gm.; 33.5 x 25. mm. and 10.4 gm.; 32.5 x (22.5) mm. and 8.3 gm.; 31. x 22.5 mm. and (6.9) gms. Ten eggs chosen at random were used for complete determinations:

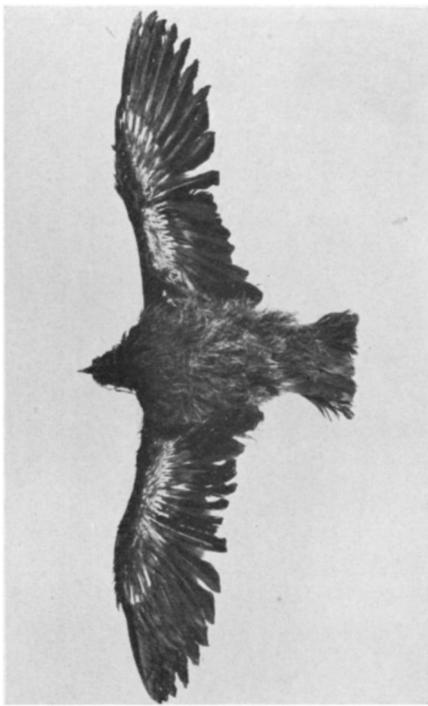
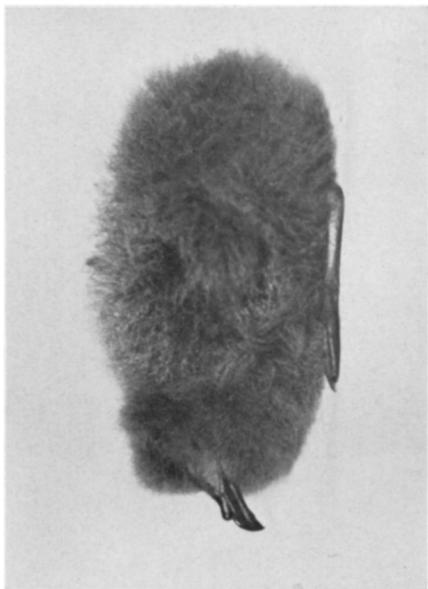
No.	Long Diam.	Short Diam.	Weight	Weight of Shell	Volume of Egg	Weight of Embryo
1.	31. mm.	23.5 mm.	7.5 gm.	.5 gm.	8.5 cc.	4.4 gm.
2.	32.8	23.5	7.7	.5	9.5	6.2
3.	31.4	24.4	7.9	.45	10.	5.6
4.	32.	23.8	8.4	.5	9.5	4.7
5.	31.	23.8	8.5	.6	9.5	fresh
6.	31.	23.5	8.5	.6	8.5	3.5
7.	30.8	23.5	8.4	.5	8.4	4.
8.	32.	24.	9.4	.65	9.	.6
9.	35.	24.5	9.5	.55	10.5	
10.	33.	23.5	9.6	.6	9.5	1.6

Determinations are presented in the metric system: millimeters, grams and cubic centimeters.

Incubation.—Both the male and the female share the incubation of the egg. A period of 24 hours or more elapses after the egg is laid before actual incubation commences. By placing a light network of twigs over the burrow entrances and banding the adults, accurate information was secured about the incubation procedure.

Each bird sits on the egg for a period of about 96 consecutive hours. It is then relieved by the mate who incubates for a similar period. During these periods the bird does not leave the nest and the mate does not bring it food nor even enter the burrow. The longest record of this self-imposed fast that I determined was 144 hours.

The period of incubation of Leach's Petrel is extremely long. The longest record that I could obtain of continuous incubation was 42 days, but in all probability incubation endures for at least 50 days. This long period has been affirmed by natives who live on the islands where the birds breed. In the instance of the 42 day record I have no evidence of the time when the egg was laid before the nest was recorded. Since the bird lays only one egg, it is extremely difficult to determine when incubation actually starts. If



UPPER LEFT. PETREL CHICK REMOVED FROM PIPPED EGG COMPARED WITH AN EGG.

LOWER LEFT. PETREL 25 DAYS OLD. UPPER RIGHT. PETREL 40 DAYS OLD.

LOWER RIGHT. PETREL 55 DAYS OLD, SEPTEMBER 1, THE MOST ADVANCED CHICK AT THAT DATE.

nests and eggs are examined during the early stages of incubation or mating, the adults invariably desert the nest.

The egg often loses more than two grams or about 20 per cent in weight during incubation. The embryo shows a great tenacity for life. Four eggs which were kept on a table in the laboratory for eight days contained living embryos at the end of this period. During this time the temperature ranged from 45° F. to 85° F. Under actual conditions the egg is often left unincubated by the adults for several days. The parent birds become greatly attached to their egg as the hatching date draws near; I have been able to remove certain individuals from their burrows on three or four consecutive days without desertion occurring. This would be impossible during the first week or so after the egg is laid.

The long incubation period may be correlated with the low temperature and great humidity of the burrow, and to the low body temperature of the adults (106° F.). To be sure the hereditary influence is important but in what way it has played its role we cannot determine.

Although several hundred burrows were examined during the period of greatest hatching, I was not fortunate enough to find an egg in the actual process. A chick can hatch and have dry down within twelve hours at the most. A piped egg was brought back from Machias Seal Island to the laboratory. It was kept at a warm temperature but failed to hatch probably because of improper control of moisture, after living for several days. During that time the imprisoned chick peeped loudly and vehemently at short intervals and picked away at the shell.

A chart shows daily incubation shifts taken by each adult on the nest: (Symbols "a" and "b" are used to distinguish the two birds "Y" represents presence of chick and "O" symbolizes the absence of the adult bird.) Four burrows from Kent's Island were chosen for the following record. The symbols "N-4, N-14, N-15, N-16" are the record numbers of these particular nests.

Growth.—By the end of August, most of the occupied Petrel burrows contain a young chick. The young Petrels are seldom brooded during the daytime after they are five days old. Occasionally the adult does stay a day or so longer with the young bird. While in the burrow with the young, the old bird is very aggressive toward anyone who attempts to remove the

Date	N-4	N-14	N-15	N-16	Date	N-4	N-14	N-15	N-16
July 25	b				Aug. 1	b	a	a	a
" 26	b				" 2	b	a	a	a
" 27	b				" 3	b	bY	a	a
" 28	b	b	b	b	" 4	b	bY	a	b
" 29	a		b	b	" 5	a	aY		b
" 30	a	a	b	b	" 6	a	bY	b	b
" 31	a	a	a	a	" 7	a	aY	b	b

Date	N-4	N-14	N-15	N-16	Date	N-4	N-14	N-15	N-16
Aug. 8	a	Y	0	b	Aug. 16	Y	Y	O	b
" 9	bY	bY		a	" 17	Daily Records			O
" 10	aY	aY	a	a	" 18	Discontinued			a
" 11	bY	Y	a	a	" 19				a
" 12	Y	Y	a	a	" 20				a
" 13	Y	Y	a	b	" 21				a
" 14	Y	Y	a	b	" 22				b
" 15	Y	Y	a		" 24				O

infant Petrel. It snaps at my fingers and even tries to retain the youngster by pulling on the chick's down with its beak when I drag the chick from the burrow. It is probable that when the chick is 25 to 30 days old both birds visit the burrow each night with food.

Natal Plumage.—This discussion of the tracts of natal down is based on an examination of embryos and freshly-hatched young.

A crown tract covers the top of the head extending from the base of the bill to a point slightly posterior to the eyes. The posterior part of the crown is naked and forms a distinct apterium. There is a well defined tract in the region of the nape. The dorsal tract of down begins in the mid-dorsal region of the neck which is separated by a narrow apterium posteriorly. In the region of the rump the two parts of the dorsal tracts are connected to form a very broad tract of down which extends to the extreme posterior end of the body. There are also distinct scapular, alar and femoral tracts.

Examining the bird from a ventral aspect, we note that the chin and throat are naked. The ventral tract begins on the neck and extends to the breast where it divides into two well-defined lateral ventral tracts that extend to the region of the anus. The ventral parts of the wings are naked. The down of a chick when dry completely conceals the aptera.

One Day Old Chick.—The newly-hatched chick is a feeble, helpless, little mite. Its movements show no greater strength than those of the day old passerine birds. It rests its body equally on breast and belly while the bill rests on the ground and supports the head. The only sign of life in this dark ball of down is the chick's constant peeping while being handled.

The one-day old chick has well defined tracts of long, heavy natal down which are 5 or more millimeters in length. This thick down varies from hair brown at the base to a smoke gray at the tips. The longest filaments of the crown are about 13 millimeters in length. The main mass of down on the head is about 7 millimeters long. The shortest down is on the ventral tracts (5 mm.). The back is covered with 17 millimeter filaments and the rump with down 13 millimeters long.

Only 5 millimeters of the bill is tipped with black. The remainder and the skin around the bill is not pigmented. At the age of 6 or 7 days this

region becomes blackened. The eyes of the young bird are tightly closed. The skin of the eye-lids and the naked region around the eyes is gray-blue. The tarsus and feet are light gray or in some instances they are flesh colored. At this stage the veins show conspicuously through the skin of the naked areas.

Five Day Old Chick.—The young Petrel has during the first five days of its existence doubled its weight. It weighs about twelve grams and is quite a sizable bird. It peeps a great deal while being handled and is only quiet when covered, as I often did, with a handkerchief. The eyes are opened only at intervals and are shut up tight when it is placed in the bright light. The feet are unable to support the plump body, and the chick still supports itself on its breast and belly.

Much of the down of the 5-day old bird is considerably longer than at the time of hatching. Except on the ventral tracts where no growth was noticeable, the down has increased its length by several millimeters. On the back and rump this change was most conspicuous. In this region the down of the chick was about 15 millimeters long while at the end of 5 days it is 20 millimeters, but for the most part it has not changed in coloration. This is due to the fact that the young bird is not exposed to sunlight which shows a tendency to fade the natal plumage of other birds which nest in the open. On the down particularly of the femoral tracts a brownish ashy coloration can be distinguished. The inner extremity of the down is almost hair brown while the tips are generally blue-gray slate color.

The mandible is black except for a light ashy gray area on the edge next to the skull. The maxilla is blackened posteriorly to the nares. The latter and the rest of the upper mandible is ashy gray. The feet and legs are blue gray. The skin around the eyes is grayish blue. The outer toenails are ashy pearly gray while the middle nails are nearly black.

Ten Day Old Chick.—The ten day old Petrel chick is able to brace itself on its feet, to turn completely around, and to turn its head meaningfully from side to side. Its former complete helplessness is not so evident, and it shows some signs of intelligence. Its peeping is loud and emphatic when it is removed from the burrow where it now dwells alone. Only at night when it receives food, does it ever see its parents.

The bill and the nares are now completely black and the last vestiges of the egg tooth are gone. The toes are a dark gray while the webs are tinted with grayish buff. The tarsus is lighter gray than the toes while the bottom of both toes and tarsus is light steel gray. The toe nails are black with brown tips about half a millimeter long. The only feathers of the juvenal plumage that have made their appearance are in the region of the femoral and dorsal tracts.

Fifteen Day Old Chick.—The young Petrel has not greatly altered its

appearance except in bulk. It weighs more than three times as much as it did at hatching. At this point the rapidly growing wings give an extent that is nearly twice as great as that of the 1-day old bird. The youngster responds more calmly to handling and does not peep so vehemently during the measuring process. The eyes are opened more frequently now and the nestling seems to be able to make out objects in the shade. In the direct sunlight the eye-lids are tightly closed. The color of the toes is becoming darker. The tarsus has a mottled dark and light gray appearance. The brown tips on the toe nails still persist. The chin is still unfeathered as well as the side of the face and eye region. The flesh on the chin is gray flesh color. The down is sooty gray, broken up in places by browns and blues particularly on the crown, back and ventral tracts. The remiges and rectrices have made their appearance and numerous papillae are appearing on the ventral tracts.

Twenty-Five Day Old Petrel.—At this age the tips of the remiges of the juvenal plumage are unsheathed. The tarsus, the foot, and the web are dark gray. Light down on the chin and throat is coming out. Until this time there has been an area of bare skin around the neck and on the chin and face. The tips of the down which still cling to the feathers of the juvenal plumage has faded to a light gray.

The young chick is more at ease now than ever before. It seldom, if ever, utters the familiar peeping of its early days. It holds its head up and takes more notice of the surroundings. When removed from its burrow and placed near the entrance, it will proceed to return to the nest upon its own volition. It cannot support its large bulk with its feet but manages to slide along on its belly with the two small feet pushing on the sides. On a smooth surface where the bird cannot secure a hold, the feet move back and forth uselessly. As far as I know, the chick utters no other sounds or notes than an occasional peep.

Forty Day Old Petrel.—At this stage the Petrel is very peaceful and takes the measuring routine as a matter of course. It scratches its head with its foot, twitches its tail, and moves its head from side to side keeping its eye on the observer. By making quick, hop-like movements, it can move over the ground quite rapidly.

The 40-day old chick is a very curious looking specimen. The wing and tail feathers protude through the persistent covering of down. The tail, primary, and secondary feathers are black. The wing coverts vary from white on the edges to fuscous near the shaft. The white rump feathers are well advanced and measure 20 millimeters. The down persists on the tips of these feathers and its gray color contrasts with the white. The neck, throat, and cheek are covered with a growth of small juvenal feathers which average about three millimeters in length. The down still remains on the majority of the feathers although little is now left on the wing feathers.



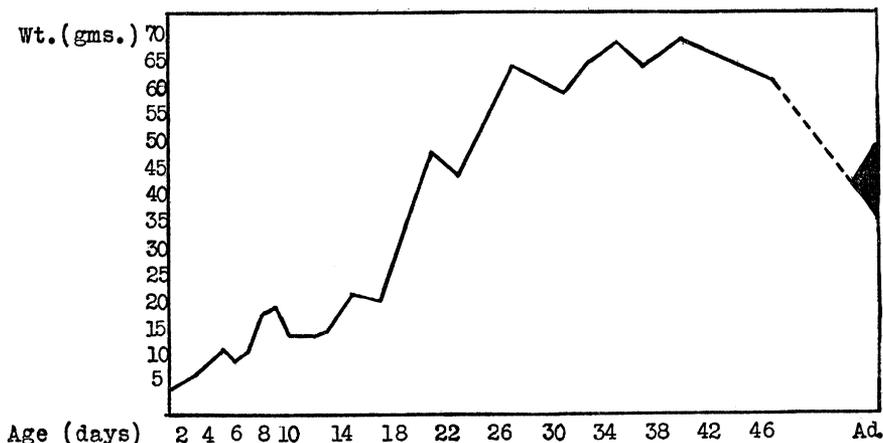
UPPER. STUMP, IN CENTER, WITH FOUR PETREL BURROWS.
NESTS OF HERRING GULL AND AMERICAN EIDER ON EITHER SIDE.
LOWER. THIS BLACK BACKED GULL SWALLOWED FOUR PETRELS IN TWENTY MINUTES.

Fifty Day Old Chick.—We left the island during the first week of September and it was impossible to secure further information concerning growth. The most mature bird at this time was a bird 50 days old. Only the wing feathers were well developed. It is probable that this bird would remain several weeks more in the burrow. After the young are about 40 days old, they apparently loose weight gradually until they assume the size of an adult.

This 50-day old Petrel was taken back with the party. It lived for 10 days during which time it lost strength and weight daily. The only food that it received or would take was cod-liver oil. That it survived for 10 days on this diet would intimate that similar material may constitute part of the Petrel's food supply.

The length of time required to raise a young Petrel including the incubation period is about 120 days.

Measurements.—Several tables and a graph have been used to illustrate growth studies. The graph showing the daily weight variations of the young Petrel shows considerable irregularity on the part of the feeding by the adult Petrels. This may be caused to a certain extent upon the conditions of the food supply at sea. Seldom does the chick receive similar meals on consecutive days. The weighings, which were made at 10:00 A. M., are daily for the first ten days and every other day thereafter. A dotted line connects the 46-day old chick's weight to a pyramid representing the limits of weight variation in the adults. Determinations of sixteen adult Petrels showed a range from 37 to 50 grams in individual weights. In the instances of the flanks and the ventral tracts it was impossible to make consecutive time measurements of the same individual feather.



Daily weight variations of the young Petrel.

GROWTH RECORD OF LEACH'S PETREL.

Age (days)	1	2	3	4	5	6	7	8	9	10	12	14	16
Weight (grams.)	6.4	7.2	9.5	12.2	11.9	12.2	18.3	19.5	15.9	15.7	15.2	23.2	22.7
Length (mm.)	65.	68.	74.	78.	79.	79.5	80.	84.	87.	92.	93.	95.	98.
Extent	58.	63.	68.	70.	70.5	73.	78.	83.	84.	90.	93.	100.	104.
Wing	13.	14.	15.	17.	17.1	17.5	17.5	17.5	17.5	17.5	17.8	18.2	19.
Tail	—	—	—	—	—	—	—	—	—	—	—	—	2.
Bill-Nares	5.	5.5	5.8	6.	6.	6.2	6.2	6.4	6.4	6.5	6.5	6.5	(1.)
Bill-Gape	12.	12.2	12.5	13.	13.5	14.	14.3	15.	15.5	16.5	16.5	17.	17.5
Right Tarsus	8.	8.8	9.5	10.	10.5	10.8	11.	11.5	12.	12.3	12.8	13.	14.
Right Toes (2)	9.	9.5	9.7	10.	10.5	10.5	10.5	11.	11.3	11.6	12.	12.8	13.
" (3)	11.	11.5	11.8	12.	12.8	12.8	12.8	13.	14.	14.5	14.8	15.3	16.
" (4)	10.	10.6	10.8	11.	11.4	11.7	12.	12.5	12.8	13.	13.5	14.	14.2
Right Nails (2)	1.8	1.8	1.9	2.	2.	2.	2.	2.	2.	2.	2.1	2.3	2.3
" (3)	2.7	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.	3.	3.	3.
" (4)	1.1	1.1	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.6	1.7	1.7
6th Primary	—	—	—	—	—	—	—	—	—	—	—	—	—
6th Secondary	—	—	—	—	—	—	—	—	—	—	—	—	—
Flanks	—	—	—	—	—	—	1.	2.	2.5	3.	5.	6.	6.8
Ventral Tracts	—	—	—	—	—	—	—	—	—	(2.8)	(3.1)	(4.)	(4.5)
	—	—	—	—	—	—	—	—	—	—	—	1.	2.5

GROWTH RECORD OF LEACH'S PETREL.—(Cont.)

Age (days)	18	20	22	24	26	28	30	32	34	36	39	45	55
Weight (grams.)	35.	48.5	44.9	57.2	57.9	65.9	62.9	65.5	69.5	65.5	69.5	57.	36.
Length (mm.)	100.	105.	107.	115.	125.	127.	129.	130.	130.5	132.	143.	161.	165.
Extent	116.	125.	144.	195.	230.	248.	257.	266.	285.	295.	324.	365.	389.
Wing	21.	23.	26.5	35.	50.	54.	56.	62.	68.	69.	84.	108.	119.
Tail	4.	5.	7.	11.	13.	15.	17.	21.	24.	30.	39.	54.	62.
	(3.)	(4.)	(4.5)	(5.)	(5.)	(6.5)	(8.)	(9.)	(14.)	(19.)	(23.)	(25.)	(46.)
Bill-Nares	6.8	7.	7.	8.2	8.3	8.6	8.6	8.6	8.6	9.	9.5	10.5	10.5
Bill-Gape	17.7	18.2	19.	20.2	20.6	21.	21.5	22.	22.5	23.	24.0	24.0	24.0
Right Tarsus	17.	18.2	19.	20.8	21.6	22.5	23.	24.	24.	24.3	24.5	24.5	24.5
Right Toes (2)	14.	14.	16.	19.	19.	19.5	19.6	20.	20.	20.2	20.2	20.6	20.6
" (3)	17.	17.6	19.	23.1	23.2	23.4	23.6	24.	24.5	24.6	25.0	25.5	26.
" (4)	15.	15.5	18.	22.	22.	22.	22.5	23.	23.5	24.	24.5	24.8	25.
Right Nails (2)	2.5	2.5	2.7	3.	3.	3.	3.	3.	3.	3.2	3.5	3.8	4.8
" (3)	3.	3.1	3.5	4.	4.	4.	4.	4.	4.	4.3	4.8	4.8	5.6
" (4)	1.7	1.8	2.	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.7	2.8	2.9
6th Primary	1.	1.5	2.	2.5	2.5	2.8	3.	3.	3.	3.	3.7.	67.	77.
			(1.5)	(2.)	(1.8)	(2.)	(3.)	(3.5)	(4.)	(5.)	(14.5)	(43.)	(61.)
6th Secondary	2.5	2.6	7.	13.6	18.	23.8	25.	27.	31.5	33.5	45.	52.	
			(2.5)	(2.6)	(6.)	(12.)	(11.)	(8.)	(16.)	(19.)	(30.)	(41.)	
Flanks	7.5	10.5	13.	21.	19.	19.	19.5	19.5	21.5	25.	31.		
	(5.)	(8.5)	(10.)	(15.)	(15.)	(15.)	(15.)	(13.)	(17.)	(19.)	(23.)		
Ventral Tracts	4.	5.2	9.	10.5	11.	11.	12.	13.	13.	18.	19.	34.	
	(3.8)	(5.)	(6.)	(7.)	(7.)	(7.)	(6.)	(7.)	(9.)	(11.)	(16.)		

Figures in parentheses represent the amount of unsheathing of the feather.

In the table of growth measurements typical feathers and parts of the body were used. Although some variation occurs with different chicks, comparisons with these measurements should enable one to ascertain the age of a young Petrel within a few days.

MEASUREMENTS OF ADULT MALE LEACH'S PETRELS 1934.

Date	Jun. 29	Jul. 2	Jul. 10	Jul. 13	Jul. 13	Jul. 25	Aug. 15	Aug. 15
Weight	44.5	42.7	44.9	44.7	45.4	46.8	41.7	43.7
Length	199.	200.	205.5	198.	200.	205.	204.	205.
Extent	460.	455.	441.	460.	460.	455.	475.	470.
Wing	151.	157.	150.	157.	157.	157.	159.	155.
Wing-Body..	210.	210.	197.	213.	212.	220.	213.	222.
Tail	93.	90.	93.	90.	93.	90.	83.5	85.
M. T. F.	75.	67.	74.	72.	71.	70.	65.	65.
Bill-Gape	25.	23.5			26.	25.9	27.	26.5
Bill-Nares	12.	10.	10.7	10.2	10.	11.2	10.5	11.
Bill-Eye	31.	30.	29.	29.	28.	31.	28.	29.
R. Tarsus	26.	23.	22.4	25.	22.5	24.	25.5	24.5
R. Toes (2)..	23.	21.	24.	22.	20.	20.4	21.	21.
(3)..	24.5	25.	26.4	24.	24.	26.		26.3
(4)..	20.	24.	21.	19.	23.	24.		25.
Testes								
Long								
Diam.	5.6	4.9	4.7	5.	5.6	5.	4.	5.
Short								
Diam.	4.	3.	3.8	3.5	5.	4.	3.	3.5

MEASUREMENTS OF ADULT FEMALE LEACH'S PETRELS 1934.

Date	Jul. 25	Aug. 13	Aug. 13	Aug. 13	Aug. 15	Aug. 15	Aug. 15	Aug. 15
Weight	49.4	40.5	44.	47.5	43.5	39.8	39.9	37.
Length	206.	214.	204.	203.	207.	213.	205.	204.
Extent	470.	464.	464.	458.	479.	480.	477.	472.
Wing	156.	161.	163.	155.	159.	169.	162.	159.
Wing-Body..	216.	221.	222.	213.	222.	220.	223.	220.
Tail	92.	93.5	83.	88.	84.	91.	91.	84.
M. T. F.	70.	69.	68.	67.5	68.	64.	68.	63.
Bill-Gape	26.	26.	25.	29.	26.6	27.	27.	27.5
Bill-Nares	11.5	11.	10.5	11.4	11.4	10.	10.	10.4
Bill-Eye	28.	30.5	29.	29.	30.	28.5	28.	27.5
R. Tarsus	25.	24.	23.	24.5	25.8		24.	23.5
R. Toes (2)..	20.	21.	20.4	20.3	22.	21.	21.5	21.
(3)..	28.	26.5	25.4	27.	27.	26.5	26.	26.
(4)..	25.8	24.	26.	26.	26.	26.	25.	25.
Largest								
Ovum	2.	1.5		.4	2.	2.	3.	1.5

The foregoing measurements of adult Leach's Petrels clearly show that there is no difference in size between male and female birds in the long run. The specimens were either birds killed on Kent's Island to determine their sex or individuals picked up dead at the foot of Machias Seal Island light.

Bowdoin Biological Station,

Kent's Island, Bay of Fundy.