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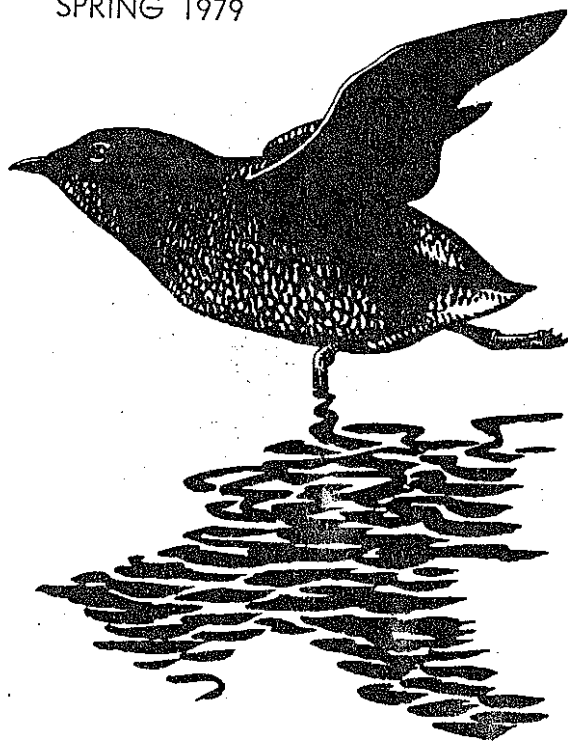
# The Murrelet

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Breeding biology and twinning experiments  
of Rhinoceros Auklets on Cleland Island,  
B.C. p 16-22

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## Breeding Biology and Twinning Experiments of Rhinoceros Auklets on Cleland Island, British Columbia

K. R. SUMMERS and R. H. DRENT

A study of the Rhinoceros Auklet (*Cerorhinca monocerata*) was conducted on Cleland Island, B.C. (49° 10'N, 126° 10'W). The second author initiated the major part of the project which was to test Lack's (1954) hypothesis that the clutch size of a bird species is determined through evolution by the average number of young the parents are able to fledge. To this end young birds were weighed daily in natural single-chick broods and in artificially doubled broods. Notes were also kept on nesting chronology, feeding behavior, and activity patterns of birds at the colony. This paper discusses the success, chronology, and behavior as observed in 1969, and relates the latter to the outcome of the twinning experiment.

### STUDY AREA

Cleland Island is a small seabird colony which has been set aside as an Ecological Reserve. The maximum elevation is 10.4 m, and the dimensions are approximately 600 m by 370 m. The 200 m square vegetated area is divided evenly between bushes 1 to 2 m high (mainly *Rubus spectabilis* and *Rosa* sp.), and a mixture of cow parsnip (*Heracleum lanatum*) and wild rye (*Elymus arenarius*).

Rhinoceros Auklets have arrived relatively recently. Burrows were first noted in 1961 (Campbell 1967). They were absent in 1930, the most recent record before that time (Drent and Guiguet 1961). Seabirds nesting here included Fork-tailed Storm-Petrels (*Oceanodroma furcata*), under 200 pairs; Leach's Storm-Petrels (*O. leucorhoa*), 5000 pairs; Glaucous-winged Gulls (*Larus glaucescens*), 1800 pairs; Pigeon Guillemots (*Cepphus columba*), 150 pairs; Cassin's Auklets (*Ptychoramphus aleuticus*), under 100 pairs; Rhinoceros Auklets, 350-450 pairs; and Tufted Puffins (*Lunda cirrhata*), 100 pairs.

### METHODS

A hole was excavated in the roof of each Rhinoceros Auklet burrow near the nest chamber and covered with a board and earth for future access. Initially burrows were checked daily. Later, burrows were examined every other day if eggs showed no sign of hatching; those containing an egg with a known laying date were left undisturbed for 30 days. Fifty percent of the nests examined were abandoned, usually within the first three nest checks.

All chicks were weighed daily to the nearest gram with a Pesola spring scale. Some broods were doubled by introducing a chick of the same age from another burrow when both were 1 or 2 days old. Twenty-six chicks (13 nests) were involved in the twinning experiment. There were 18 controls, four of which were found after hatching.

### RESULTS AND DISCUSSION

#### *Burrow Characteristics*

Rhinoceros Auklets nested in three types of terrain. One was along the edge of the

cow parsnip-wild rye grass association. This area was littered with driftwood logs, and the soil contained a large amount of shell fragments. The second habitat type consisted of dense stands of rye grass where the soil was soft and where no shell fragments occurred. The third habitat, where the majority of birds nested, was the salmonberry-rose association. This habitat was interspersed with exposed rock knolls from which birds were able to take flight. In 1973, Hatler et al. (1973) noted that auklets nested in a fourth habitat—the interior cow parsnip area.

Burrows were short (30-230 cm) and simple, seldom having more than one or two bends or more than one side extension. As the ground was nearly level, the burrows were seldom more than 30 cm deep. The nest was a shallow cup, often lined with dry grass and other vegetation.

Although most Rhinoceros Auklets nested in burrows, four nests were found on or above the surface. Two were covered by overhanging rye grass which in one instance was quite sparse while in the other it supported a driftwood board which covered the nest. A third nest was at the end of an overturned box. The fourth was off the ground in a hollow log. The latter two locations were still being used in 1973.

#### *Nocturnal Activity*

Mass arrival at the colony each evening was most prevalent after hatching began. Birds first appeared in rafts offshore about an hour before sunset. Their approach to land was characterized by a circling flight in which flocks increased in size and proximity to land until they reached their peak of activity just prior to sunset. From this time birds dropped into the salmonberry from one, combined flock each time it passed overland. Circling continued until dark, more than an hour after sunset. On overcast or foggy days the arrival was advanced about 15 minutes. The occurrence of rafting and circling at sunset varies among colonies (Scott et al. 1974, Manuwal pers. comm.).

Toward the end of the season, night-long watches were made from a blind within the salmonberry area. After landing, many birds walked to their burrows while others, possibly nonbreeders, seemed to wander around "aimlessly." Soon after the first birds arrived, adults and chicks began calling, and throughout the night both adults and nearly fledged chicks periodically wandered about the vicinity of their burrows, calling and flapping their wings. Activity was greater on cloudy nights than on clear ones.

Individual birds returned throughout the night, but none was seen leaving unless flushed by the observer. At dawn, birds in the brushy areas walked along well-used pathways to exposed rocky knolls from which they took flight. The departure took about half an hour, the last birds leaving about 15 minutes before sunrise. This observation was made when the sky was mostly clear.

#### *Nesting Chronology*

Egg-laying had already begun when we arrived in the second week of May. Forty-nine nests were followed through from the egg stage. Of the 44 chicks which hatched, 73 percent appeared between 9 and 21 June, with an abrupt decline in hatching after that time. Before this period 4 percent hatched, and between 22 June and 12 July, 23 percent hatched.

The incubation periods of two eggs laid after the nests were found were 39 to 45 days and 40 to 45 days. Leschner (1976) recorded a similar period on Destruction Island. Using a mean incubation period of 42 days, the peak laying would have occurred between 28 April and 10 May. Fledging occurred between 23 July and 27 August with a peak between 29 July and 15 August. There was considerable variation in the time until fledging, with extremes of 38 and 56 days and a mean of 50.0 days ( $n=12$ ). Leschner observed similar periods on Destruction Island.

### *Attendance of Parents*

During incubation the nest was generally tended daily. Limited observations suggest that there may have been daily alternation of the sexes. On several occasions eggs were temporarily abandoned at varying times before hatching. It is assumed that normally the egg is tended continuously and temporary absences were a result of disturbance. However, one egg was abandoned for 4 or 5 days after pipping and then hatched on the second or third day after the birds returned. The eggs thus appear to be unaffected by temporary absences. Matthews (1954) has noted such resistance to chilling in procellariform eggs, and Sealy (pers. comm.) has observed it in Ancient Murrelets (*Synthliboramphus antiquus*).

After hatching, the chicks were usually brooded for 2 days. In the artificially twinned broods the parents remained an additional 2 days. After this time both parents spent the day at sea. Daily weight records of the young show that parents returned nightly to the burrows to feed the young. Temporary weight losses may have indicated absences. Richardson (1961) observed that burrows with chicks were normally visited once nightly by each parent. He also noted that some birds may make two trips to the burrow but conceded that this behavior may have been caused by the disturbance of trapping. In this study the parents appeared to make their nightly visits to the burrow at least until the chicks fledged.

### *Feeding*

Once hatching began birds were observed to bring in what appeared to be maximum loads of fish. Of the species left lying in the burrows two thirds were sandlance (*Ammodytes hexapterus*) and one third were a small rock fish (*Sebastes* sp.). Rock fish may have been common in the burrows because they were less preferred. Other observers have not recorded this species as a food item for chicks (Richardson 1961, Cody 1973, Manuwal pers. comm.). These "left over" fish were not measured but were smaller than the 10 to 15 cm recorded by Richardson (1961), so the chicks would have been able to swallow them. Other fish noted were one small herring (*Clupea harengus*) found in a burrow and a single reddish colored fish, possibly a blenny (Family Stichaeidae), being carried by a bird.

Once feeding began, the parents appeared to bring more food than was required. The amount brought did not seem to be an immediate response to the demands of the chick. There are three reasons for believing this. First, some birds were observed carrying large loads of fish when hatching first began. Second, fish were occasionally found in the burrows of normal, single-chick broods but never in those of twinned broods. The number of occurrences of fish left after feeding decreased with chick's age (table 1) up to about day 30. (Chicks reached maximum weight about day 44.) Most left-over fish may then have been eaten either by the parents or later by the chick. Third, of three twin broods in which both chicks were fed, the age at which one chick died (day 26 to 36) coincided approximately with the age of single chicks when uneaten food ceased to appear in their burrows (day 26 to 35).

Chicks apparently fed very little during their first 2 days while being brooded by an adult. There was little or no weight gain and often a loss of weight on the second or third day after hatching. After this period feeding generally occurred nightly at least until maximum weight was reached and possibly until fledging. Chicks near to fledging age were observed leaving the burrow at night to exercise their wings. This activity was observed by Richardson (1961) for this species and by Manuwal (1974) for Cassin's Auklets. The fluctuating weight losses observed prior to fledging may relate to greater energy expenditure and possibly to a decreased food intake during this restless period.

TABLE 1. Proportion of single-chick burrows in which fish were left after feeding.

Age in days	No. of nest days	Frequency of occurrence of fish	Percentage
1-5	54	6	11.1
6-10	46	4	8.7
11-15	44	3	6.8
16-20	46	2	4.3
21-25	39	1	2.6
26-30	42	0	0.0
31-35	52	2	3.8

*Growth*

*Natural Broods.* The mean daily weights of chicks are summarized in figure 1. Newly hatched chicks averaged 53.3 g (n=8), 13.5 percent of the adult weight of 518.6 g (n=10). After hatching, chicks generally failed to gain weight for 2 days. After this they increased steadily until reaching their peak weight. Their growth showed a constant trend from days 2 to 34, during which they grew from 10 to 90 percent of

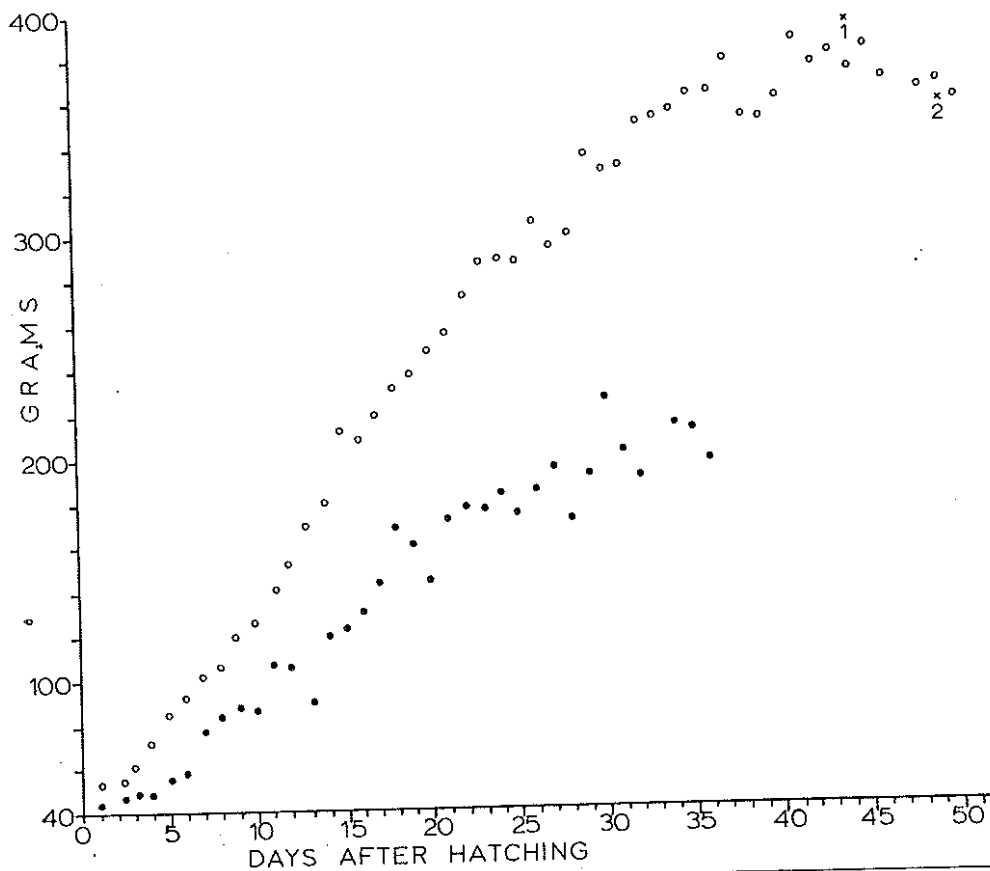


FIGURE 1. Mean daily weight of normal vs twinned Rhinoceros Auklet chicks. Open circles—single chicks. Solid circles—twin broods while chicks paired. 1—mean peak weight (396.6 g) at mean time of peak weight (day 44.2). 2—mean fledging weight (358.8 g) on day before mean fledging day (day 49.0).

their peak weight at an average of 10.1 g per day or an average of 2.4 percent per day. The mean daily growth rate until fledging was 6.1 g per day compared with 5.0 and 9.0 g per day on Destruction Island (Cody 1973) and Protection Island (Richardson 1961), respectively. The mean weight reached 396.6 g (n=16) or 76 percent of adult weight and then fell over a period of 4.8 days (n=16) to 358.8 g (n=14) the day prior to fledging. This loss equaled 2.0 percent per day or a total loss of 9.1 percent of peak weight. Other records of fledging weights of Rhinoceros Auklets are given in table 2.

TABLE 2. Mean fledging weights of Rhinoceros Auklets.

Location	Weight grams	Source
Cleland Island 1969	358.8	This study
Protection Island 1956-1959	410	Richardson 1961
Smith Island 1974	356	Manuwal, pers. comm.
Destruction Island 1969	339	Cody 1973
Destruction Island 1974	521	Leschner 1976

*Twinned Broods.* Mean daily weights of two-chick broods while they were still paired, are given in figure 1. In no case did both chicks of a pair survive to fledging. Of the 26 chicks involved, eight fledged. In only three cases did both chicks appear to be fed until the parents failed to supply enough food for both of them (see Feeding). Between days 5 and 16 growth was linear for both brood sizes. Regression equations for this period are: one-chick broods  $y=13.54 + 12.3x$ ; two-chick broods  $y=32.38 + 6x$ , where  $x$  is the time in days after hatching and  $y$  is the body weight in grams. The normal broods had a growth rate slightly more than twice that of the twins. The difference was tested with a  $t$ -test and proved to be highly significant ( $p < 0.001$ ).

Our data are inadequate to document that parents were actually providing enough food to raise two chicks. The growth rates and survival of the two-chick broods appear to be strongly affected by interactions between the chicks. The following observations lead us to conclude that factors other than feeding capability were involved. First, in three cases the parents apparently reacted to the presence of two chicks either by killing both or by "evicting" one of them. They did not appear to discriminate between their own chick and the introduced one. Manuwal (1972) found that Cassin's Auklets reacted aggressively to the presence of two chicks. Second, in one case neither chick was fed and both died on the fourth day. Third, in the nine nests where one chick starved, it was obvious in at least five cases that one chick was being neglected, and in all nine that one eventually gained an advantage over the other. This was attributed to the fact that chicks soon acquired a specific location in the burrow and the one closest to the entrance received most of the food. Attempts in two burrows to switch their positions resulted in them switching back immediately. It was also noted that the crest of the culmen of surviving chicks of paired broods was chipped, perhaps the result of aggression during feeding. Finally, for the three twins that survived the longest, both chicks appeared to have equal opportunities to acquire food. Even initially though the growth rate of each individual chick was less than that of single chicks. Their combined weight continued to exceed that of singles until one of them died.

#### *Nesting Success*

Of the 49 eggs that were not deserted 90 percent hatched. Hatching failure was the result of egg infertility in two cases and embryonic mortality in three cases. In the latter

instances the shells disappeared, while the almost completely formed chick was undisturbed.

Fledging success was 72 percent for the 18 chicks that were used as controls. The overall breeding success was 66 percent. Chick losses were attributed to various causes. One chick was killed and another blinded by what appeared to be pecks at the head. One 18-day-old chick choked on a lump of four sandlances and a small rock fish. The other two causes of death were undetermined.

## SUMMARY AND CONCLUSIONS

The peak egg-laying period of Rhinoceros Auklets on Cleland Island in 1969 was between 28 April and 10 May. Peak hatching was between 9 and 21 June after an incubation period of about 42 days. Fledging averaged 50 days with the last burrow being vacated on 27 August.

After chicks began hatching, adults arrived at the colony in large flocks which gathered on the water about an hour before sunset and came to land during the first hour afterwards. About three quarters of an hour before sunrise (just after first light) there was a mass departure of adults over a period of half an hour. There is some evidence that birds alternated incubation duties each night.

Hatching success was about 90 percent. After the chicks hatched parents remained with them for 2 days, or for an additional 2 if broods were artificially doubled. After this period feeding occurred nightly. The amount of food brought to the nest may have exceeded the demands of a normal brood of one chick. Chicks grew until they were 76 percent of adult weight. At this time they were fully feathered and ready to fledge. About this time they emerged from the burrows at night and became quite active. From the mean peak weight of 396.6 g they fell to 358.8 g in about 4.8 days. The fledging success was 72 percent of the chicks which hatched. Overall, 66 percent of the pairs that produced an egg successfully fledged a chick.

Some broods were doubled in order to test Lack's (1954) hypothesis that clutch size of birds has been determined by the number of young that can be fledged. In 13 burrows a second chick was introduced which, like the original, was 1 or 2 days old. Thirty-one percent of 26 chicks fledged, and in no case did both chicks survive.

In this experiment behavioral restrictions prevented the Rhinoceros Auklets from raising two chicks. There was some indication that the amount of food brought was not a direct response to the demands of the chick(s). This observation was possibly obscured by aggressive behavior of adults to the chicks and between the chicks themselves. Thus this experiment was unable to test Lack's hypothesis. If the variations observed in fledging weights among different studies (table 2) is a result of available food resources it could be speculated that in a good year, and barring behavioral restrictions, Rhinoceros Auklets may be able to raise two chicks.

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## ACKNOWLEDGMENTS

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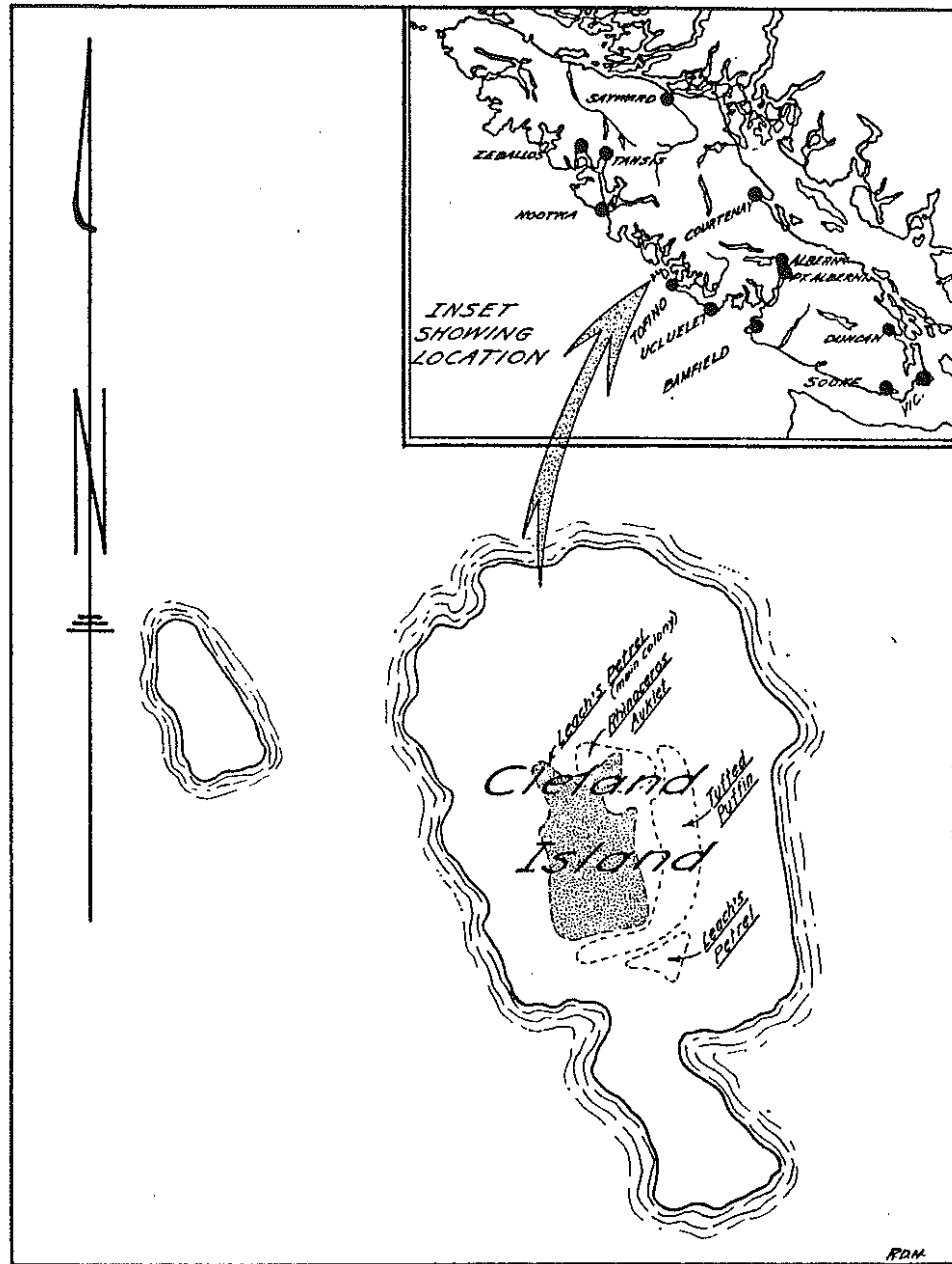
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BENTHONIC MARINE ALGÆ

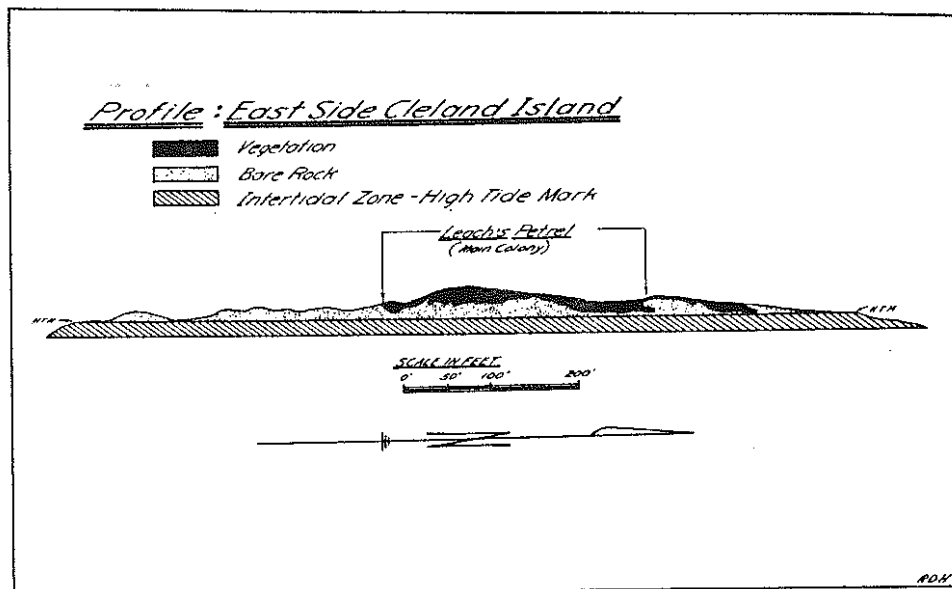
CHLOROPHYCOPHYTA (GREENS)

Ulvaceæ

Sea lettuce, *Ulva lactuca* Linnæus.

Codiaceæ

Sea staghorn, *Codium fragile* (Suringar) Hariot.



- PHÆOPHYCOPHYTA (BROWNS)
- Ralfsiaceæ  
Tar spot, *Ralfsia pacifica* Hollenberg.
- Punctariaceæ  
Oyster thief, *Colpomenia sinuosa* (Roth) Derbes and Solier.
- Laminariaceæ  
Sea girdle (tangle), *Laminaria platymeris* De La Pylaie.
- Lessoniaceæ  
Bull kelp, *Nereocystis luetkeana* (Mertens) Postels and Ruprecht.  
Sea palm, *Postelsia palmaeformis* Ruprecht.
- Alariaceæ  
Feather boa, *Egregia menziesii* (Turner) Areschoug.
- Fucaceæ  
Popping wrack, *Fucus furcatus* C. Agardh.
- RHODOPHYCOPHYTA (REDS)
- Corallinaceæ  
Tidepool coral, *Corallina chilensis* Decaisne.
- Gigartinaceæ  
Turkish towel, *Gigartina exasperata* Harvey and Bailey.  
Iridescent seaweed, *Iridophyous* sp. Setchell and Gardner.
- Rhodymeniaceæ  
Sea sac, *Halosaccion glandiforme* (Gmelin) Ruprecht.
- VASCULAR PLANTS
- Polypodiaceæ (Fern Family)  
Leathery polypody, *Polypodium scouleri* Hook. & Grev.  
Sword fern, *Polystichum munitum* (Kaulf.) Presl.  
Bracken fern, *Pteridium aquilinum* (L.) Kuhn.
- Zosteraceæ (Eelgrass Family)  
Eelgrass, *Zostera marina* L.  
False eelgrass, *Phyllospadix scouleri* Hooker.

- Gramineæ (Grass Family)  
Wild ryegrass, *Elymus mollis* Trin. ex Spreng.
- Cyperaceæ (Sedge Family)  
Sitka sedge, *Carex sitchensis* Prescott.
- Liliaceæ (Lily Family)  
Wild lily-of-the-valley, *Maianthemum canadense* Desf.
- Polygonaceæ (Buckwheat Family)  
Curly dock, *Rumex crispus* L.
- Portulacaceæ (Purslane Family)  
Siberia miner's lettuce, *Montia sibirica* (L.) Howell.
- Caryophyllaceæ (Pink Family)  
Seashore sandwort, *Honkenya peploides* (L.) Ehrh.  
Chickweed, *Stellaria calycantha* (Ledeb.) Bong.
- Cruciferae (Mustard Family)  
Sea-rocket, *Cakile edentula* (Bigel.) Hook.
- Saxifragaceæ (Saxifrage Family)  
Alumroot, *Heuchera micrantha* Dougl. ex Lindl.
- Rosaceæ (Rose Family)  
Wild strawberry, *Fragaria chiloensis* (L.) Duchesne.  
Silverweed, *Potentilla pacifica* Howell.  
Spray flower, *Potentilla villosa* Pall. ex Pursh.  
Wild rose, *Rosa nutkana* Presl.  
Little wild rose, *Rosa gymnocarpa* Nutt.  
Salmonberry, *Rubus spectabilis* Pursh.
- Onagraceæ (Evening Primrose Family)  
Fireweed, *Epilobium latifolium* L.
- Umbelliferae (Parsley Family)  
Angelica, *Angelica lucida* L.  
Conioselinum, *Conioselinum pacificum* (Wats.) Coult. & Rose.  
Cow parsnip, *Heracleum lanatum* Michx.
- Ericaceæ (Heath Family)  
Salal, *Gaultheria shallon* Pursh.
- Labiatae (Mint Family)  
Hedge Nettle, *Stachys cooleyæ* Dougl.
- Scrophulariaceæ (Figwort Family)  
Indian Paint-brush, *Castilleja* sp.  
Yellow mimulus, *Mimulus guttatus* Fisch. ex DC.
- Plantaginaceæ (Plantain Family)  
Common plantain, *Plantago major* L.  
Seaside plantain, *Plantago maritima* L.
- Rubiaceæ (Madder Family)  
Northern bedstraw, *Galium trifidum* L.
- Caprifoliaceæ (Honeysuckle Family)  
Twinflower, *Linnæa borealis* L.
- Compositæ (Composite Family)  
Yarrow, *Achillea millefolium* L.  
Douglas aster, *Aster subspicatus* Nees.  
Sow thistle, *Sonchus asper* (L.) Hill.

## ANIMALS

## COELENTERATA

*Anthopleura xanthogrammica* (Brandt)—Green Anemone

Quite common in rock crevices and sheltered tide pools below mean tide-level.

## ANNELIDA

*Arctonoë vittata* (Grube)—Scale Worm

A small commensal worm was found within the mantle cavity of *Diodora aspera*.

*Serpula vermicularis* (Linnæus)—Calcareous Tube Worm

Quite common on rocks about mid-tide and lower.

## ARTHROPODA

*Balanus cariosus* (Pallas)—Thatched Barnacle

Several large specimens, about 5 cm. long, were taken from their rocky bases about the mean tide-line.

*Balanus glandula* Darwin—Acorn Barnacle

The upper intertidal rocks are covered with this "foot cutter."

*Balanus nubilus* Darwin—Giant Barnacle

Two large clusters containing several barnacles each were found in about 15 feet of water.

*Mitella polymerus* (Sowerby)—Goose Barnacle

Large clusters were common among the larger beds of sea mussels in the intertidal zone.

*Pandalus danaë* Stimpson—Coon-striped Shrimp

Two specimens were taken near the base of a large boulder in about 25 feet of water.

*Petrolisthes cinctipes* (Randall)—Flat-topped Crab

A large specimen was secured from beneath a rock in the lower tide zone.

*Pugettia producta* (Randall)—Northern Kelp Crab

A few animals were seen in the small eelgrass-covered tide pools at low tides.

*Cancer magister* Dana—Commercial Crab

A small carapace of this species was collected in 15 feet of water near a kelp-bed.

*Cancer productus* Randall—Rock Crab

A cast shell of this species was found, fully intact, on the largest beach on Cleland.

*Hemigrapsus nudus* (Dana)—Purple Shore Crab

Fairly common in sheltered tide pools around the island.

*Hemigrapsus oregonensis* (Dana)—Hairy Shore Crab

Common under rocks about the middle tide zone.

## MOLLUSCS

*Katharina tunicata* Wood—Leather Chiton

Very common intertidally, usually seeking shelter from sunlight and predators in rock crevices during the day. This animal is a favourite food of the black oyster catcher.

*Tonicella lineata* Wood—Lined Chiton

Common under rocks and among sea palm holdfasts around the island's intertidal zone.

*Hinnites multirugosus* (Gale)—Purple-hinged Rock Scallop

A small specimen, 3 inches long, was collected in 15 feet of water by Miss D. Choquette. Pieces of this shell can be found in the upper beaches around the island.

*Mytilus californianus* Conrad—Sea Mussel

Large, dense beds skirt most rocky areas in the middle tide zone around the island. These beds offer excellent foraging grounds for long-billed shorebirds, gulls, and crows.

*Searlesia dira* Reeve—Dire Whelk

Fairly common in tide pools and sheltered rock crevices in the upper intertidal zone.

*Nassarius fossatus* Gould—Channeled Dog Whelk

No live specimens were found, but many unoccupied shells were seen on the beaches around the island.

*Amphissa columbiana* Dall—Wrinkled Amphissa

Very common, often clustered together in small masses in rock crevices or tide pools.

*Thais emarginata* Deshayes—Rock-dwelling Thais.

Uncommon. Only two specimens were collected from a tide pool in the lower intertidal zone.

*Thais lamellosa* Gmelin—Wrinkled Purple Snail

One live specimen extracted from a deep rock crevice in the lower intertidal zone.

*Diodora aspera* Eschscholtz—Rough Keyhole Limpet

Uncommon, only two specimens collected, both from the lower mussel beds.

*Acmaea digitalis* Eschscholtz—Fingered Limpet

Very common in clusters in rock crevices high up the intertidal zone.

*Acmaea mitra* Eschscholtz—Whitecap Limpet

Quite common on rocks subtidally, where several large specimens were collected.

*Haliotis kamtschatkana* Jonas—Northern Abalone

Two small specimens, 3 inches long, were collected from the side of a kelp-covered boulder in 15 feet of water. Many fragments of abalone shells dotted the island's beaches and occasionally an entire shell was found in the gull colony.

*Tegula funebris* (A. Adams)—Black Top-shell

Abundant in tide pools and often clustered together in rock crevices throughout the intertidal zone.

*Littorina scutulata* Gould—Checkered Littorine

Common in tide pools toward the upper intertidal zone. Seemingly less abundant than *L. sitkana*.

*Littorina sitkana* Philippi—Sitka Littorine

Very common throughout the middle tide zone.

*Crepidula adunca* Sowerby—Hooked Slipper-shell

No live specimens were collected, but several shells were collected from the island's beaches.

*Anigodoris nobilis* (MacFarland)—Sea Lemon

Several small specimens were seen and photographed in tide pools in the lower intertidal zone.

*Vespicola (Triodopsis) columbiana* (Henderson)—Hairy-shelled Snail

This terrestrial gastropod is easily identified by its small size, six body whorls, and the numerous stiff hairs covering the external surface of the shell. It inhabits the vegetative regions of the island and is often found under logs or deep in cracks in driftwood. This animal is nocturnal in its habits and is seldom seen on vegetation during daylight hours. It is often found with slugs and *Haplotrema vancouverense* during the day.

*Haplotrema (Ancomena) vancouverense* (Lea)—Vancouver Haplotreme

This snail is best identified by its large size, five body whorls, and the yellowish-green periostracum. It is very similar to *V. columbiana* in its habits and habitats on the island. Apparently this species is voracious and preys upon *V. columbiana* (Grass, 1966).

*Ariolimax columbianus* (Gould)—Large Spotted Slug

This large native slug is common on the island. Its colour varies from a spotted dull yellow to an olive brown. It is nocturnal and spends daylight hours in dark places. Favourite estivating places are petrel burrows. Here, as many as 13 slugs, both *A. columbianus* and *D. reticulatum*, were removed from a single burrow (see Table 1). During the early evening the slugs crawl from their hiding spots to feed on the nearby vegetation.

*Deroceras reticulatum* (Muller)—Netted Slug

This small yellow slug is very common and similar in habits to *A. columbianus*. It is more numerous in petrel burrows and driftwood cracks than the former species and is often found clustered together. Apparently this species was introduced from Europe.

TABLE 1.—SLUGS REMOVED FROM LEACH PETREL BURROWS DURING POPULATION ESTIMATIONS ON AUGUST 28, 1967

Quadrat	Slug Ranges per Quadrat	Total Slugs per Quadrat	Total Burrows per Quadrat	Average Slugs per Burrow
I	0-12	82	16	5.1
II	0-5	12	8	1.5
III	0-6	17	6	2.8
IV	2-12	46	9	5.1
V	0-13	39	17	2.3
VI	0-5	10	7	1.4
Averages	0.33-8.8	34.3	10.3	3.0

## ECHINODERMS

*Dermasterias imbricata* (Grube)—Leather Star

Two specimens, about 15 centimetres across, were collected from the underside of large boulders in 15 feet of water.

*Henricia leviuscula* (Stimpson)—Blood Star

One specimen, 7 centimetres from tip to tip, was collected from small rock near the mean tide-line.

*Pisaster ochraceus* (Brandt)—Purple Star

Very common on mussel beds around the lower tide zone. Both colour phases present.

*Strongylocentrotus drobachiensis* (Müller)—Green Sea Urchin

Quite common in sheltered *Zostera*-covered tide pools around the island.

*Strongylocentrotus purpuratus* (Stimpson)—Purple Sea Urchin

Uncommon in tide pools, but occasionally found half buried in a rock crevice.

## BIRDS

*Gavia immer* (Brunnich)—Common Loon

Usually seen on trip to Cleland, occasionally in bays near Tofino. Two sightings—two on July 24th and three on August 28th.

*Gavia arctica* (L.)—Arctic Loon

Five birds counted off outer islands on trip to Cleland August 28th.

*Puffinus griseus* (Gmelin)—Sooty Shearwater

A transient bird often seen in large flocks offshore "shearing" the water surface for food. On July 24th a flock of about 4,000 birds was seen on the water near Cleland, slowly moving about, grounded by a low heavy mist. On August 28th an active flock of about 1,500 birds was seen moving northwards past Cleland.

*Puffinus puffinus* (Brunnich)—Common Shearwater

On July 24th a contrasting brown and white shearwater was seen in association with sooty shearwaters near Cleland. The bird was smaller than the sooty shearwater, dark brown on the back, white below with a dark bill. Campbell had seen the pink-footed shearwater *P. crotopus* near Langara Island, Q.C.I., in April, 1965, so this sighting could not be mistaken for that species.

*Oceanodroma furcata* (Gmelin)—Fork-tailed Petrel

First recorded as a nesting species on Cleland in 1925 by S. J. Darcus (Drent and Guiguet, 1961). Five years later, I. McT. Cowan visited the island and suspected nesting. C. J. Guiguet (August 4, 1961) found tail and contour feathers of this species and also suspected nesting.



Fig. 3. Nestling fork-tailed petrel, Cleland Island, 1967.

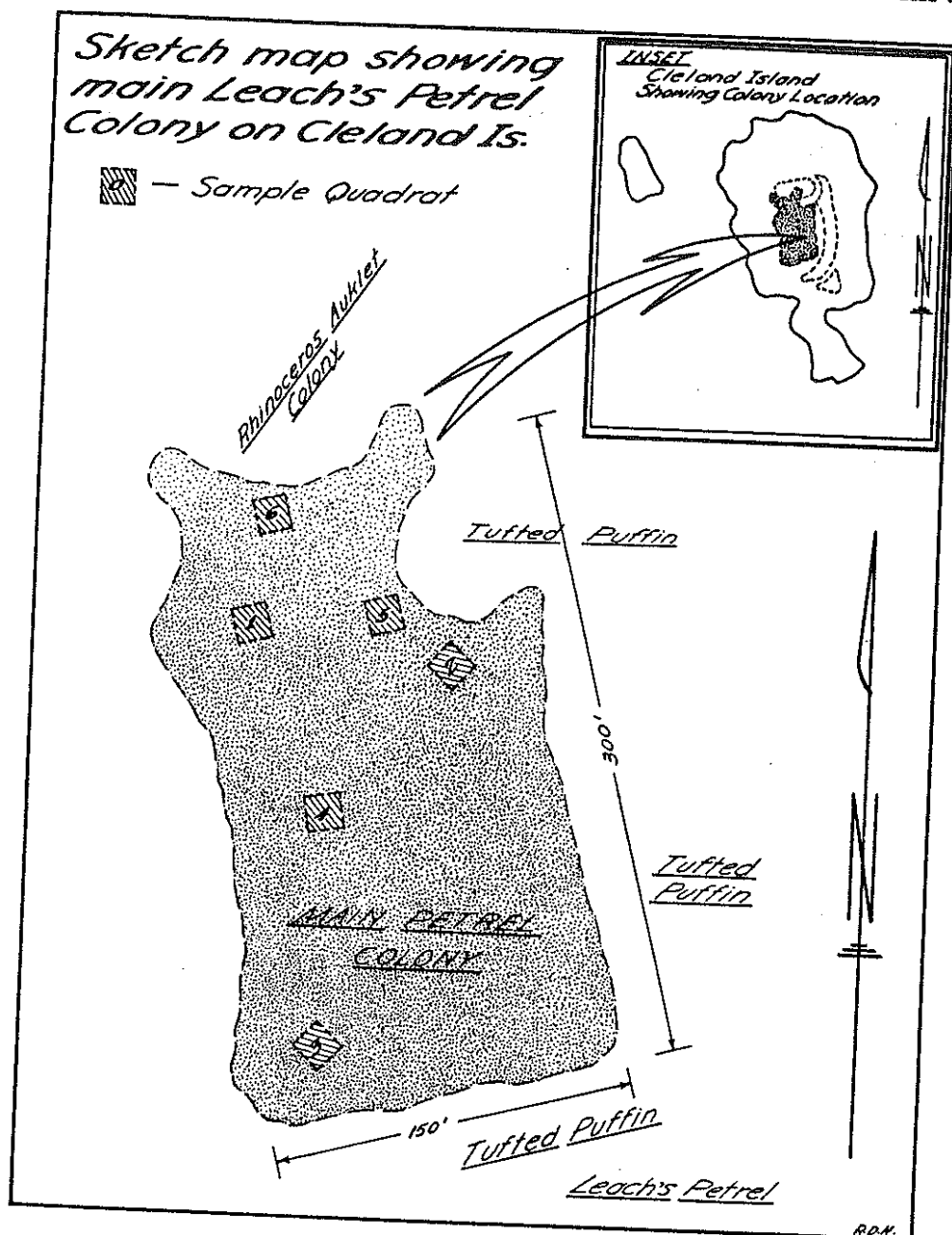
The fork-tailed petrel as a nesting species on Cleland has been confirmed. Two nests were found. Each had a large young. No adult birds were seen on the island, but on August 14th the writers saw an adult fork-tailed petrel just off Cleland. One nestling was banded on August 28th (band number 31-105900).

Unlike the Leach's petrel burrow, both fork-tailed petrel nests were under drift logs at the edge of the Leach's colony. No actual burrow had been excavated, and no nesting materials were visible.

A thorough check of the island may reveal a few more fork-tailed petrels' nests, but it is unlikely that its present status as an uncommon breeder will change appreciably.

*Oceanodroma leucorhoa* (Vieillot)—Leach's Petrel

This petrel was reported breeding on Cleland by Drent and Guiguet (1961). Guiguet (1965) collected a fully incubated egg and a large downy young.



Leach's petrel is undoubtedly the most abundant breeding bird on Cleland Island. At first glance the island seems devoid of petrels, but closer examination of the extensive grassy areas of the island reveals hundreds of small holes, entrances to petrel burrows. During daylight hours the adults are either far at sea feeding or incubating in the protection and shelter of their burrows.

The main petrel colony is situated in a broad grassy area on the north-east side of the island. The area, approximately 300 feet in length and 150 feet wide, has associated vegetation of *Aster subspicatus*, *Stachys cooleyæ*, *Elymus mollis*, *Heuchera micrantha*, and *Heracleum lanatum*, with scattered driftwood throughout.





Fig. 5. Typical breeding habitat of Leach's petrel, Cleland Island, 1967.

Burrows are very numerous. Entrances average 3 inches in diameter and 1½ feet in length. Most burrows angle into the soft earth. Burrows are excavated wherever soils permit easy digging, especially under drift logs and plant roots. Nesting materials are usually few, but occasionally grasses line the burrow chamber. The eggs are white, and one collected July 24th measured 1.15 by 0.93 inches. (Incubation was not advanced.)

On July 24th, 12 burrows in the main colony were checked. Five burrows contained a single large young, and the remaining seven contained a single well-advanced egg with an incubating adult.

On our next visit, 11 burrows were checked; nine contained a single well-advanced egg with an incubating parent. The remainder of the burrows had a single large young with an adult. All adults were banded, numbers 31-105864 through 31-105874.

On August 25th, three adults and five nestlings were banded, and another 17 nestlings were banded on August 28th (numbers 31-105874 through 31-105899). In total, 14 adults and 22 nestlings were banded.

An attempt to estimate the breeding population was made on August 28th by Campbell and Morrison. We marked off six sample quadrats, 10 by 10 feet, randomly over the main petrel colony. The following data were recorded:—

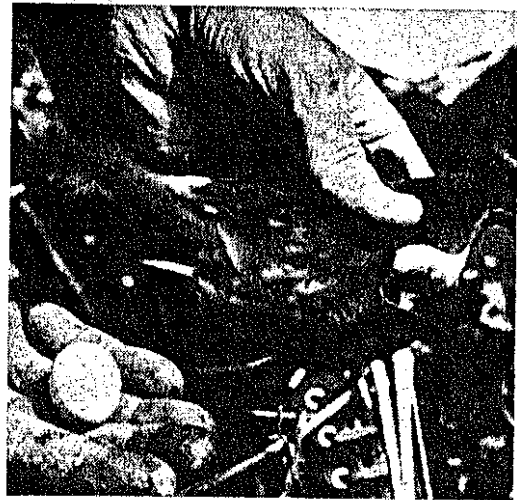


Fig. 6. Leach's petrel and egg, Cleland Island, 1967.

#### Typical Plant Associations

- Quadrat I: Grasses, *Aster subspicatus*, *Stachys cooleyæ*, driftwood.
- Quadrat II: *Rubus spectabilis*, *Rosa nutkana*, *Stachys cooleyæ*.
- Quadrat III: Grasses, *Elymus mollis*, *Sonchis asper*, driftwood.
- Quadrat IV: Grasses, *Stachys cooleyæ*, *Heracleum lanatum*, driftwood.
- Quadrat V: *Heracleum lanatum*, *Rubus spectabilis*, *Epilobium latifolium*.
- Quadrat VI: *Elymus mollis*, *Heracleum lanatum*, grasses, *Sonchus asper*.

TABLE 2.—QUADRAT DATA

Quadrat	Total Burrows per Quadrat	Total Unoccupied Burrows	Total Burrows with Single Young	Total Slugs in Total Burrows	Average Slugs per Burrow per Quadrat
I	16	5	11	82	5.1
II	8	2	6	12	1.5
III	6	2	4	17	2.8
IV	9	4	5	46	5.1
V	17	3	14	39	2.3
VI	7	2	5	10	1.4
Average	10.3	3	7.5	34.3	3.0

From data recorded and by simple mathematics, we calculated the petrel population in the main colony to be 4,635 pairs. Many more petrel burrows were found in other small grassy areas, so the breeding population perhaps approaches 5,000 pairs.

Throughout the summer many dead adult petrels were found on the island. Causes of their deaths remain unknown, but slugs are suspected of playing a part.



Fig. 7. Leach's petrel chick taken from burrow on Cleland Island, 1967.

During the day, slugs seek cover and coolness in petrel burrows, often lining them so that penetration by hand is impossible. Perhaps the parent birds, anxious to change their incubation duties, force themselves through the slug-lined burrow. In doing so the sticky slime from the slugs mats the bird's feathers, rendering the bird incapable of extended flight. The bird then probably starves to death. We noticed no evidence of these petrel carcasses being used for food.

It should be noted that occasionally when extracting an excited adult petrel from a burrow, a blood-red substance is ejected from the tube on the bird's bill. The spray is strong, so that it is advisable to keep the head of the bird away from the face.

#### *Phalacrocorax penicillatus* (Brandt)—Brandt's Cormorant

About 70 birds were seen roosting regularly on the lower rocks on the south-east side of the island. Just prior to dusk, cormorants arrive from adjacent islands and feeding-grounds to spend the evening on Cleland. The evening roosting population is probably around 300 birds. By early morning most cormorants have left to feed.

No nests or nesting attempts were found.

#### *Phalacrocorax pelagicus* Pallas—Pelagic Cormorant

Common but less abundant than *P. penicillatus*. About one pelagic for every ten Brandt's recorded. No nests were found.

*Branta bernicla* (L.)—Black Brant

Recorded on three visits, feeding and resting in the intertidal zone. Sightings: July 24th, two; August 14th, seven; and August 28th, six.

*Anas platyrhynchos* L.—Mallard

A female, presumably the same bird, was flushed from rain pools around the island on July 24th, August 25th and 28th.

*Anas acuta* L.—Pintail

A male pintail was observed on August 28th flying southward, low over the island.

*Anas carolinensis* Gmelin—Green-winged Teal

A female was flushed from an algæ-covered rain pool near the centre of the island on August 28th.

*Histrionicus histrionicus* (L.)—Harlequin

About six birds were usually seen swimming and feeding close to the outer islands on trips to Cleland. On August 28th, 17 harlequins were counted on a trip around Cleland.

*Melanitta fusca* (L.)—White-winged Scoter

A flock of 20 birds was recorded on July 24th off Cleland.

*Melanitta perspicillata* (L.)—Surf Scoter

A common sight in sheltered bays near the shore. On June 24th a flock of 30 birds flew low over the water past Cleland.

*Oidemia nigra* (L.)—Common Scoter

Three birds seen in association with white-winged scoters on July 24th.

*Haliaëtus leucocephalus* (L.)—Bald Eagle

An adult eagle was seen circling high over the island on July 24th. No other eagles were sighted.

*Pandion haliaëtus* (L.)—Osprey

On July 24th two ospreys were seen in the air off Cleland. Later a nest, with at least two large young, was found on Vargas Island.

*Falco peregrinus* Tunstall—Peregrine Falcon

One record only of a female flushed from a rocky outcropping on August 28th. The bird flew to a nearby island and, surprisingly, gulls gave little notice.

*Rallus limicola* Vieillot—Virginia Rail

An unexpected pleasure was the two sightings of this rail on July 24th and August 25th. The bird, presumably the same one, was flushed from the thick grasses bordering a small algæ-covered rain pool near the centre of the island. Once flushed the bird would fly a short distance, perhaps 30 feet, and remain inconspicuous in the protection of the tall grasses at the edge of the petrel colony.

*Hæmatopus bachmani* Audubon—Black Oyster Catcher

A very common bird frequenting the rocky areas of the island, resting on the upper parts and feeding extensively among the lower intertidal zone. Numbers varied from 20 to about 100 each visit.

On July 24th a nest containing two eggs in advanced stages of incubation was found in a rock crevice. The shallow nest was lined with small shell fragments of

sea mussels. Two other nests, both empty, were also found on the upper shell-covered beaches. Two large young with black-tipped bills and traces of natal down were found on July 24th. None was banded.

*Aphriza virgata* (Gmelin)—Surfbird

A flock of seven surfbirds was seen on July 24th in association with ruddy and black turnstones.

Guiguet (1961) mentions that this species was seen in numbers on August 4th. Surfbirds are transient along the outer coast, and numbers probably increase as the summer progresses.

*Arenaria interpres* (L.)—Ruddy Turnstone

Ten birds were counted among surfbirds and black turnstones on July 24th.

*Arenaria melanocephala* (Vigors)—Black Turnstone

Approximately 50 birds frequented the lower parts of the island during the summer, feeding on small animal life among the dense beds of mussels and barnacles. During the nocturnal hours the birds frequented the higher rocky parts of the island, no doubt seeking shelter from the brisk winds.

*Actitis macularia* (L.)—Spotted Sandpiper

This nervous "teeter" was startled on two occasions from the rocky edges of rain pools—two on July 24th and one on August 14th.

*Heteroscelus incanum* (Gmelin)—Wandering Tattler

On our first visit to Cleland we recorded about 40 birds on the lower rocks around the island, often associated with black turnstones and surfbirds. Wandering tattlers, however, seemed more solitary in their habits than the turnstones or surfbirds. By August 25th the tattler population had decreased to about six birds.

*Totanus melanoleucus* (Gmelin)—Greater Yellowlegs

One record only of two birds on July 24th.

*Erolia minutilla* (Vieillot)—Least Sandpiper

On July 24th five birds were seen wading and feeding in shallow tide pools at ebb tide. These birds were a regular sight among the tide wrack on the upper beaches for the remainder of the summer, but they were never numerous.

*Limnodromus griseus* (Gmelin)—Dowitcher

Two records only—three on July 24th and seven on August 25th.

*Ereunetes mauri* Cabanis—Western Sandpiper

One record only of two birds with least sandpipers on July 24th.

*Limosa fedoa* (L.)—Marbled Godwit

This large reddish-brown shorebird was first seen on August 14th wading in a shallow tide pool. On August 25th one was seen resting on the upper beach with several least sandpipers.

*Larus glaucescens* Naumann—Glaucous-winged Gull

The most conspicuous bird on the island. The summer population is probably around 2,000 birds, with a breeding population of perhaps three to five hundred pairs. Nesting is confined to rocky areas around the lower parts of the island. On July 24th a quick nest census was made along the southern side of the island:—

Nest Contents	Number of Nests
0 eggs	8
1 egg	10
2 eggs	15
3 eggs	7
1 egg, 1 young	5
2 eggs, 1 young	7
1 egg, 2 young	11
1 young	8
2 young	17
3 young	14
Total (101 eggs, 118 young)	102



Fig. 8. Bare rock habitat used by breeding and loafing gulls.

All young found were small, indicating a slightly later hatching period than that of our more southern gull colonies.

On July 24th 133 nestlings were banded, and on August 2nd another 300 were banded. Band series were as follows: 667-12168 through 667-12500, 697-51101 through 697-51200, a total of 433.

During banding, nestlings sometimes become excited and cough up partially digested food. Three foods recorded were an 8-inch sea pen (*Leioptilus guerneyi*), Pacific sand-lance (*Ammodytes hexapterus*), and fragments of small purple sea stars (*Pisaster ochraceus*).

#### *Larus occidentalis* Audubon—Western Gull

On our first visit, three westerns were seen resting near the water's edge with glaucous-winged gulls. On August 14th we observed a western gull on territory with glaucous-winged gulls. On closer inspection the bird flew off and did not return before our departure. Pearse (1946) suggests that a few pairs of western gulls may breed with glaucous-winged gulls on the outer west coast and also that hybridization may occur between the two.

#### *Larus californicus* Lawrence—California Gull

About 50 birds frequented the island and adjacent waters in late July, numbers decreasing to about six birds by the end of August.

#### *Larus delawarensis* Ord—Ring-billed Gull

One bird seen on August 25th resting with California gulls on seaweed-covered rocks close to Cleland.

#### *Larus canus* L.—Mew Gull (Short-billed)

Two sightings only—three on July 24th and two on August 28th.

*Larus philadelphia* (Ord)—Bonaparte Gull

A small flock of seven immature birds was seen on the water near the island on July 24th.

*Larus heermanni* Cassin—Heermann Gull

Uncommon on Cleland but quite common on nearby rocky islets. On July 24th about 100 birds were estimated roosting on Plover Reef, off the north-east corner of Cleland. Guiguet (1961) reports 50 to 60 birds roosting on the north side of the island.

*Xema sabini* (Sabine)—Sabine Gull

One record of an adult bird flying low over the water near Cleland on August 25th.

*Uria aalge* (Pontoppidan)—Common Murre

Very common in littoral waters along the coast, usually not venturing too close to the island. The population seemed to decrease as the summer passed.

*Cephus columba* Pallas—Pigeon Guillemot

Fig. 9. Young banded pigeon guillemot, Cleland Island, 1967.

Very common. Guiguet (1961) estimated 1,000 birds flying around the island. This summer about 700 birds frequented the island, with a breeding population of about 200 pairs.

The pigeon guillemot seems to have no preference as to nesting location on Cleland. Nests were found in rock crevices, under clumps of fireweed, under drift logs, in abandoned puffin burrows, and among thick grasses. On July 24th six nests were found—three contained one advanced egg each, the remainder a single small young.

Three large young were banded on August 14th (band numbers 524-78908 through 524-78910).

*Brachyramphus marmoratum* (Gmelin)—Marbled Murrelet

Very common in waters near Cleland and adjacent islands. On July 24th, 105 birds were counted by telescope from atop the island.

*Ptychoramphus aleuticus* (Pallas)—Cassin Auklet

No live birds were seen or active burrows found, but three freshly dead adults were found—two on July 24th and one on August 14th:

We suspect this auklet may nest on the island; perhaps their burrows are beneath the impenetrable rose bushes toward the top of the island. Guiguet (1961) suspected their nesting here.

*Cerorhinca monocerata* (Pallas)—Rhinoceros Auklet

On our first visit to the island we noticed immature rhinoceros auklets were quite common along the outer shores and especially so near Cleland. We suspected

that this species might nest on Cleland as Guiguet recorded its burrows there in 1961. After a thorough search of the island, we found a small (perhaps 75 feet square) soft-soil area riddled with large burrows. The entrances were about 6 inches



Fig. 10. Rhinoceros auklet burrow.

The colony is divided in two by a large rocky outcropping. The main colony is situated near the eastern end of Cleland and starts where vegetation meets bare rock. Several burrows were found below the main colony beside the petrel nesting area. These burrows were checked, but none was occupied. We have reason to suspect, however, that they were used this year.

Unlike most rhinoceros auklet colonies in British Columbia (Drent and Guiguet, 1961), this colony has a horizontal aspect; that is, on a relatively level terrain. No steep wooded or brush-covered cliffs are to be found, so the birds must either scramble several hundred feet through thick grasses and over bare rock to reach water or scamper to higher parts of the island before they can take wing.

On August 25th three young rhinoceros auklets were banded (numbers 626-32834 through 626-32836).

Drent and Guiguet (1961) list Pine Island, off the northern tip of Vancouver Island, as the southernmost rhinoceros auklet breeding colony in British Columbia. The discovery this summer of this small but seemingly flourishing colony extends the known breeding range of

in diameter and the burrows themselves long and twisted. Some burrows paralleled the surface soils, while others angled deep into the soft earth before levelling off. Few burrows were straight; many side branches gave the small colony a honeycomb effect. Walking over colony was almost impossible, and consequently only extreme caution would prevent a foot from penetrating a burrow. We counted 47 burrows and checked four of these by digging. We found four large young and one adult bird. Nesting materials were few, but occasionally a few grasses lined the end of a burrow.



Fig. 11. Young rhinoceros auklet, Cleland Island, 1967.

this species another 160 miles southward along the outer coast of British Columbia. South of the Canadian border there are colonies along the coast of Washington State.

*Lunda cirrhata* (Pallas)—Tufted Puffin

A common breeding bird on Cleland and active in daylight. On July 24th, 75 to 100 birds were estimated using the island for nesting purposes. Most burrows were found toward the upper reaches of the island, usually located in the sides of the steeper grassy rock outcroppings where quick flight to the water was possible.

Two burrows, about 6 feet in length, were dug out. Each contained a large young. Both were banded (626-32831 and 626-32832). On August 25th an immature puffin was captured on the bare rocks near the puffin burrows by night-lighting and banded (626-32833).

Puffins are most abundant around 8 p.m., when roosting flights to the island are made.

Puffins have been recorded on Cleland previously. Cowan (I. McT., MS.) collected an adult on May 9, 1930, and Guiguet (1961) collected an adult on August 4th.

*Selasphorus rufus* (Gmelin)—Rufous Hummingbird

At least 10 birds were seen around the vegetated areas of the island until mid-August. From observations of aggressive action of these birds, we suspect nesting on the island.

*Corvus corax* L.—Raven

Not recorded from the island, but two were seen on July 24th flying high past Cleland toward Vargas Island.

*Corvus caurinus* Baird—Northwestern Crow

Six to ten birds frequent the island throughout the summer. On July 24th an empty nest was found at the base of a rose bush near the top of the island. No evidence of predation was noticed, although it seems likely that the seabird colony could certainly support a small crow population.

*Melospiza melodia* (Wilson)—Song Sparrow

The only abundant songbird frequenting every conceivable niche on the island. On July 24th we counted 36 birds. The population is probably closer to 50 birds. No nest was found, but we suspect nesting.

MAMMALS

*Peromyscus maniculatus* (Wagner)—White-footed Mouse

It is interesting to note that no evidence was found of mice inhabiting the island. Traps were set on several occasions with negative results, and food placed in strategic locations around the island was untouched.

Guiguet (1961) set out four dozen traps with negative results.

*Orcinus orca* (Cope)—Pacific Killer Whale

A large male and female were seen about one-quarter mile offshore July 24th.

*Eumetopias jubata* (Schreber)—Northern Sea-lion

Five were scared from Seal Rocks, a tiny rocky islet just north of Cleland.



## AMPHIBIANS

*Aneides ferreus* Cope—Clouded Salamander

Quite common under driftwood and in rotten logs throughout the main Leach's petrel colony and rhinoceros auklet colony. Specimens were sent to the Provincial Museum, Victoria.

## SUMMARY AND CONCLUSIONS

Cleland Island, though small, supports a large and flourishing population of breeding seabirds. Most niches on the island are used by seven species. The breeding birds include fork-tailed petrel (few), Leach's petrel (5,000 pairs), black oyster catcher (3-6), glaucous-winged gull (400 pairs), pigeon guillemot (200 pairs), rhinoceros auklet (25 pairs), and tufted puffin (50 pairs). From behaviour and evidence recorded, we suspect Cassin's auklet, rufous hummingbird, northwestern crow, and song sparrow also breed on Cleland.

According to Drent and Guiguet (1961), both petrels needed confirmation as breeding on Cleland in recent years. This has been done. The breeding rhinoceros auklets are a new record for the island. This extends their known breeding range from the Pine Island colony, off the northern tip of Vancouver Island, about 160 miles south along the coast of British Columbia. There is, however, a large colony of breeding rhinoceros auklets on Destruction Island, off the coast of the State of Washington.

Four hundred and seventy-nine individuals of six species were banded on Cleland. Banding summary: Fork-tailed petrel, 1; Leach's petrel, 36; glaucous-winged gull, 433; pigeon guillemot, 3; rhinoceros auklet, 3; and tufted puffin, 3.

The island itself appears to be devoid of both reptiles and mammals. Perhaps their absence helps to explain the abundant seabird populations on the island. Just what effect, if any, the slugs have on the seabirds is difficult to determine. Future studies might solve this interesting problem.

Comparing past and present records, it appears that the seabird colony on Cleland Island is gradually increasing both in species and numbers. This is most encouraging since many of our small and seemingly insignificant islands that provide sites for colonies (for example, Passage Island near the entrance to Howe Sound) are being lost to real estate.

The west coast of Vancouver Island, especially between the Villages of Ucluelet and Tofino, is now a popular tourist attraction. Land here, except for Long Beach, is being sold privately and is now hard to obtain. Tourists wanting land for summer cottages are now seeking it on the larger islands north of Tofino. In time many of our smaller islands and seabird colonies will be lost forever if naturalists and conservationists do not combine their time and efforts to have them set aside as bird refuges. Reserving Cleland Island would be a good start.

## ACKNOWLEDGMENTS

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