Vol. 4. No. 5. *July, 1951*

Notornis

In continuation of New Zealand Bird Notes.

Bulletin of the Ornithological Society of New Zealand.
Published Quarterly.

Photo: H. J. Ollerenshaw.

ADULT TAKAHE, December, 1949.

NOTORNIS

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Registered with the G.P.O., Wellington, as a Magazine.

Edited by R. H. D. STIDOLPH, 114 Cole Street, Masterton.

Annual Subscription, 5/-; Endowment Membership, 10/-; Life Membership, £5.

BACK NUMBERS AVAILABLE.—Vol. 1, 15/-; Vol. 2, 10/-; Vol. 3, 10/-.

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CONTENTS.

SPECIAL PUBLICATION.—The four articles in this number dealing with the **Notornis**, with the selected bibliography and the statement regarding the protection of this bird, have been issued as a special publication of the Society, for sale to the general public, under the title of "The Takahe." Members who wish to obtain copies should communicate with the Editor.

For purposes of reference it should be noted that page 1 of "The Takahe" corresponds to page 97 of Vol. 4 of "Notornis," and subsequent pages as follow: 2 (98), 3 (99), 4 (100), 5 (101), 6, (102), 7 (103), 8 (104), 9 (105), 10 (106), 11 (107), 12 (108), 13 (109), 14 (110) 15 (111), 16 (112), 17 (113), 18 (114), 19 (115), 20 (116), 21 (117), 22 (118). Similarly the frontispiece of "The Takahe" corresponds to Plate XXI. of Vol. 4 of "Notornis," and the others as follow:—Plate I. (Plate XXII.), II. (XXIII.), III. (XXIV.), IV. (XXV.), V. (XXVI.), VI. (XXVII.), VII. (XXVIII.), VIII. (XXIX.), IX. (XXX.)

SOCIETY'S ANNUAL MEETING.

The Ornithological Society of New Zealand held its annual general meeting in the Auckland Museum on Friday, 25th May, 1951. The president, Mr. E. G. Turbott, presided over an attendance of about 60.

A postal ballot for the position of Christchurch Regional Organiser resulted in the election of Mr. E. W. Dawson. Other officers were re-elected unopposed.

Mr. H. R. McKenzie moved: "That a sub-committee consisting of Dr. W. M. Hamilton, Messrs. C. A. Fleming, E. G. Turbott and J. M. Cunningham, with power to add, be appointed to draft a new constitution, acceptable to the Registrar of Incorporated Societies; that this be presented to a general meeting for adoption; and that the society then make application to the Registrar for incorporation under the Incorporated Societies Act, 1908." At the request of the committee, Mr. J. M. Cunningham explained to the meeting the reasons that had prompted several members to discuss incorporation and committee reorganisation. The resolution was passed.

The eleventh annual report, for the year ended March 31, 1951, stated:—

"In presenting the eleventh annual report of the society, your committee is again pleased to record progress in its activities. Field work continues to interest members to an increasing extent, and this is reflected in 'Notornis,' of which four numbers were issued during the year. Finances, owing to the splendid support of endowment members, donations and further increases in membership, have been buoyant. Because of the increase in membership, the average cost of 'Notornis' per member dropped slightly to 6s. 10d. We now have 393 ordinary members, 125 endowment, 34 life and one honorary, a total of 553 (an increase of 69 over last year), and of these, only 29 were in arrears with their subscriptions. Printing costs are, however, expected to rise further during the coming year, and the society will also be faced with several other heavy increases in expenditure. Reserves to meet part of these have been provided accordingly.

"As is shown in separate reports, the ringing scheme is now on a firm footing, and the checklist compilation has continued steadily. During the year a nest records scheme was launched with satisfactory response from 14 observers. Mr. J. King (Box 448, Masterton), to whom all records should be sent and requests for cards made, reports that 67 cards were returned, referring to 20 species. Fuller details will be published in 'Notornis.' All those interested should remember that even the scantiest information, provided it is authentic, can be of value when correlated with records of similar species from other observers. What is particularly desired is an accurate record of the date of every visit, and the number of eggs and young present on each occasion. In no case should anything be assumed, e.g., the sex of the sitting bird when this cannot be definitely recognised. From these results clutch size and incubation periods, etc., can then be calculated. As the cards accumulate the information will be available for research workers.

"A report from the hon. librarian, Mr. E. G. Turbott, reads: 'As indicated in the journal, the society's library is housed at the Auckland Museum. Members should use the following address in writing to borrow books: 'The Librarian, Ornithological Society of New Zealand, c/o Auckland Institute and Museum, P.O. Box 27, Newmarket, Auckland, S.E. 1.' The society now benefits particularly in that the cataloguing and loan of our books is carried out by arrangement with an established library. Members will wish especially to thank Miss Enid Evans, librarian of the Auckland Institute and Museum, for her very generous help to the society. Miss Evans has already catalogued the library, comprising 86 books and pamphlets (33 of these added during the year), 10 current serial publications, and nearly 100 reprints. She also drew

up the new library list published in "Notornis," Vol. 4, No. 4. It is hoped that members will now make use of these library facilities by applying regularly for the loan of the society's books, pamphlets and journals. Of these some are not available elsewhere: it is of interest to note that our copy of the "Wilson Bulletin" is the only one received by a library in New Zealand. The total borrowings during the year have been 36. In addition, two members have asked to receive issues of "The Emu" and "British Birds" as they arrive. Ten periodicals are now taken currently: of these the society subscribes to two, "The Emu" and "British Birds," and the remaining eight come in exchange for "Notornis."'

"'Two further exchanges were arranged during the year, with "Bird-Banding" and the British Museum (Natural History). Five other periodicals are received currently on exchange, but only issues of ornithological interest, e.g., certain museum publications. The library is contained at present in a steel stack and on this is the card catalogue of author and subject entries in steel filing drawers.'

"Your committee looks on the library as an increasingly valuable service to members, and reprints of the library list are available to those who desire them. It may be taken as a matter for congratulation that practically all important ornithological publications are now received in exchange for 'Notornis.'

"During the coming year, Miss H. Laing, of Masterton, is kindly assisting the hon. secretary-treasurer, and the society is fortunate in obtaining her help. The audit of the society's finances has again been carried out by Mr. F. E. Wells, and our thanks are offered to both of these."

INCOME AND EXPENDITURE ACCOUNT for the year ended 31/3/1951.

INCOME.	£	s.	d.	EXPENDITURE.	£	s.	d.
Subs., 1950 and arrears	173	5	0	"Notornis"—			
Donations, general and Illustrations Fund	11	8	1	Vol. 4, Nos. 1-4	75	13	10
Sales (back numbers)	24	5	3	Illustrations	65	17	5
Interest, P.O.S.B.	8	6	4	Envelopes	4	15	0
Sundry		3	6	Stationery	9	13	3
				Typing Envelopes, Etc.	8	3	6
				Postages	12	15	0
				Library Expenses		5	6
				Excess of Income over Expenditure, transferred to Check-list Publication Reserve	20	0	0
				General Reserve	20	4	8
	£217	8	2		£217	8	2

BALANCE SHEET as at 31/3/1951.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Subs. paid in Advance	182	10	0	Subs. in arrear, estimated to realise	3	0	0
Checklist Publication Reserve	20	0	0	Stationery on hand	4	11	0
General Reserve	153	17	6	Cash	2	0	0
				Bank of New Zealand	17	4	1
				P.O. Savings Bank	329	12	5
	£356	7	6		£356	7	6

(A more detailed Statement of Accounts, certified "audited and found to be correct.—F. E. Wells, 10/5/1951," was presented to the annual meeting, and copies may be obtained on application.)

The report of the Ringing Committee for the year ended March 31, 1951, stated:—"This is the first full year of the operation of the scheme, and we can report that every phase of operations has worked smoothly. Permits to handle the protected birds the society is authorised to ring have been issued to 15 members, 11 of whom have returned schedules. A number of interesting recoveries have already been made, including two gannets ringed at Cape Kidnappers and recovered in New South Wales.

"During the year a request for the society to encourage the ringing of banded dotterel was received from Messrs. C. A. Fleming and R. H. D.

Stidolph, and permission to ring these birds, and also New Zealand dotterel, has been obtained from the Hon. Minister of Internal Affairs. Next season it is intended to make a special effort to ring white-fronted tern and banded dotterel. For the latter, colour rings will be available, and each district will be allotted a certain colour. The use of colour rings has already resulted in two recoveries. Of three New Zealand dotterel colour ringed at Mataitai, Clevedon, two have been seen, one where ringed more than three months later, and another has taken up its abode at Karaka, to the west. These records show that any confusion of colour rings used would invalidate such sight records, and members are particularly requested not to use rings of other than the allotted colours.

"Special permission from the Hon. Minister was also obtained for certain members to ring limited numbers of other species. Their records, together with those of members who have used other than the society's rings, will be included without distinction in the annual summaries of ringing operations. These will show numbers of birds ringed and recovered up to March 31 each year, and this year's summary will show that 837 birds of 16 species have been ringed by 11 operators, and that four have been recovered. Details of recoveries will, however, be published as soon as possible, and at the time of making this report, 12 have been made.

"A request was received for rings to be supplied to the Australian National Antarctic Research Expedition, for use on Heard and Macquarrie islands, and this was complied with. The expedition has provided funds for the replacement of these rings, which have been despatched from America. Information of the operation of the scheme has been given to several overseas inquirers, including Australian States and representatives of the Federal Government. We look forward to close co-operation with the sponsors of the projected Australian scheme. We take this opportunity of again pointing out that protected birds may not be handled for ringing without written authority. It is by courtesy of the Hon. Minister of Internal Affairs that this may be granted by the hon. secretary of the society."

The reports and financial statement were adopted.

The society's delegate to the 10th International Ornithological Congress, at Upsala, Sweden, Mr. R. B. Sibson, spoke entertainingly of his experiences there. He was accorded a hearty vote of thanks.

The National Publicity Studios had kindly made available a fine display of bird photographs, chiefly by Mr. K. V. Bigwood, and these proved popular.

Mr. Sibson had on display an interesting collection of specimens found on beaches after storms.

Thanks were expressed to the Director of the Auckland Museum for the use of the Museum's facilities, and Mr. Turbott extended an invitation to members to visit his home the following evening.

Before supper, members enjoyed a fine display of colour slides of birds by Mr. G. J. H. Moon, and a colour film taken at Miranda by Mr. N. M. Gleeson. These were greatly appreciated.

At a committee meeting held at the Kaiaua Motor Camp on 26th May, Mr. H. R. McKenzie's resignation from the Ringing Committee was accepted and Mr. R. B. Sibson, who was on the committee before his overseas visit, was appointed in his place. The Checklist Committee was reappointed. A hearty vote of thanks was passed to the editor, Mr. R. H. D. Stidolph, and appreciation expressed of his work.

On the day following the annual meeting, a field trip was held at the Firth of Thames, which was attended by about 35 members. A feature of the day for many members was the presence of a flock of about 1500 wrybill and an Asiatic whimbrel. Many members spent a pleasant evening at the home of Mr. and Mrs. E. G. Turbott. A further field trip was held on Sunday when parts of the Manukau Harbour were visited, including the farm of Mr. and Mrs. Urquhart, who provided afternoon tea.

THE NESTING SEASON OF NOTORNIS.

By R. A. Falla, Dominion Museum, Wellington.

Since Dr. G. B. Orbell's rediscovery of the bird in 1948, progress in field study of **Notornis** has been furthered by a series of investigatory visits. Preliminary notes on part of the nesting season 1948-49 have been published (Falla, Emu 48, 316-322, 1949) and an account of a winter survey of the valley, by Mr. E. G. Turbott, is published in this issue. pp. 107-113.

The Wild Life Branch of the Department of Internal Affairs has since arranged for three further visits of observers who were to cover as far as possible a complete nesting season. The first of these, known as Party No. 3, comprised three officers of the Branch, K. H. Miers, G. R. Williams and F. Woodrow, and was in the valley from the 16th October to 13th November, 1949. The next party, comprising H. J. Ollerenshaw and K. H. Miers, of the Wild Life Branch, L. Gurr, of Otago University, and the writer, was in the valley from 1st to 13th December, and was joined for the last few days by photographers of the National Film Unit and National Publicity Studios. From February 2nd to 7th, Party No. 5, led by Mr. Ollerenshaw, with Messrs. G. R. Williams and C. A. Fleming, as ornithological observers, and three others engaged in geological and archaeological work in the area, was in the valley. The following account is based mainly on the work of No. 4 Party, but acknowledgment is made to the reports of the parties preceding and following it.

OCCUPATION OF TERRITORY.

The valley already was clear of snow when No. 3 Party entered in October, and from the report of K. H. Miers it is evident that the **Notornis** were on approximately the same territories and in substantially the same numbers as they were the summer before. In that season, B. Wiseley had marked known territories on a sketch map, and the same procedure followed in 1949-50 defined the range of five pairs in the Tunnel Burn basin, one on the ridge north, and one at least in the Point Burn to the south. Two other pairs were reported as doubtfully distinct and their status uncertain. This record of birds in pairs, on territory, takes no account of unemployed or non-breeding birds unless any of the pairs whose nests were not found were in that category. If there are such immature and non-breeding birds not in pairs, they do not appear to frequent the valley. The pairs that are settling down range widely at first, according to Mr. Miers, and gradually the discarded blades of snowgrass and the droppings that mark their recent presence become more abundant in a narrowed zone. The next phase is the making of one or more nests (cf. Falla, 1949, p 320) round one of which a heavy accumulation of droppings finally indicates that an egg may be expected in that particular nest.

LAYING AND INCUBATION.

The first bird found in occupation of a nest was already sitting when discovered on 25th October, and the quantity of faeces in the vicinity was estimated by Messrs. Miers and Woodrow to be an accumulation of about five days. They appear to be deposited by the sitting bird, which never fouls the actual nest, and not by an attendant partner. Of this pair, designated E, the partner not sitting usually was ranging within a hundred yards or so but seldom seen in close proximity to the nest. No change of guard was ever seen, but frequently the free bird called loudly from a clearing at the bush edge about fifty yards from the nest and was promptly joined by the sitting bird which left the eggs unattended. We did not find out whether both sexes sit, nor, if only one sits, the sex of the one that does. It was thought prudent not to handle the birds for marking, and a method of recording distinctive yellow scars on the red bill proved unreliable because of flaking of the

bill sheath. In some pairs there was a slight difference in demeanour, but no constant plumage differences could be detected.

There were two eggs in the nest of pair E, one more strongly marked than the egg figured in an earlier paper (Falla, 1949, fig 2, pl. 42) and the other almost unspotted. It became apparent when one of the pair was found still sitting closely on December 1st that the eggs might be addled, and when there was no change by December 12th the close-sitting bird and nest were first made the subject of extensive photographic record and the eggs finally removed. They were much decomposed and infertile. A bird sat on the empty nest for one more day before the pair left the vicinity. Although this nest provided no information on incubation period it offered ample opportunity to observe a sitting bird. Unless approached abruptly it did not leave the nest in alarm. Normal arrival and departure were unobtrusive, making use of all available cover. On arrival, this bird, and another elsewhere, was seen to drive the bill several times into the floor of the nest at the side before shuffling forward on to the eggs. If these had been disarranged at departure the bird occasionally rearranged them, on one occasion getting two awkwardly placed eggs to lie side by side simply by passing the bill between them. When sitting, a bird generally improved its cover by pulling strands of snowgrass across any gap, and normally would be quite invisible at a distance of more than a foot. One reaction on being closely approached was to tuck head and bill completely out of sight, a process performed gradually. Although **Notornis** plumage is quickly bedraggled by rain, sitting birds usually managed to keep both themselves and the nests dry in all weathers. The only other incubating pair observed at all closely was pair A. They were on restricted territory when seen on 13th November by No. 3 Party, and on 1st December a bird was found sitting closely on two eggs at the spot which Mr. Miers had marked as likely. For two weeks following the same bird undoubtedly was on the nest most of the time, and a partner actually was seen in the vicinity only once. The eggs had not hatched when No. 4 Party left on 13th December.

CHICKS.

A leggy chick of two weeks or more was described and photographed by No. 1 party in January, 1949. In the following season the first chick seen was much younger, small enough to have been not more than two or three days old. Pair D had been noticed on 6th December near a nest containing a cold and addled egg. Later, this chick was heard in the grass and seen running rapidly after the old birds. Its down was jet black, legs purplish-brown, bill basally black with terminal two-thirds, including egg-tooth, ivory-white. (In older chick the white is reduced to a small sub-terminal patch, and then disappears.) The chick could hide completely by burrowing into thick grass, remaining completely silent, but when on the move it answered "contact" calls by the parents with a typical nestling "cheep." Its small droppings consisted entirely of slimy black animal debris including recognizable remains of larvae of stone-flies, mayflies, and other aquatic insects. These food traces explained why adult birds had been found pulling up sphagnum and other bog mosses and making no attempt to eat them. Mr. L. H. Gurr, who pulled up some moss in this way, discovered that the freshly-exposed damp earth was seething with the larvae of aquatic insects. Another manifestation of the insect-eating phase was noted in January, 1949, when a chick, with parents standing by, was seen pecking at the drift-line on the lake shore. In suitable winds, this line is well stocked with stranded insect larvae and pupae. Change to a diet of plant food seems to follow quickly as the chick develops. Pair J were found on 6th December to have a chick between two and three weeks old, and this youngster was first traced by the unusually small droppings composed of tender young shoots of **Poa**. The older fledgling watched by No. 5 Party early in February, 1950, had proportionately larger droppings also of vegetable matter. (See Fleming, this issue, p. 102.)

In their downy stage at least, all chicks seem to be brooded by an adult at night or during rain and snow, on any available nest. The feeding range of family parties was found by members of No. 5 Party to be at least as extensive as the pre-nesting territory of the parents and probably is more extensive.

BEHAVIOUR.

In the narrower sense of display patterns, behaviour was not recorded by the October and November observers. In December the opportunities for observing were limited to those provided by pair E when the sitting bird was called off by its mate. The bird responding darted with a crouching run to the caller and straightened up facing it with the two bill tips almost touching, and both necks upstretched. After some seconds one bird, I think the original caller, crouched and moved round the other with a gyratory movement which presented the spread white under-tail coverts to the other's view. Drooped wings and fluffed-out flank feathers gave the general impression of a round white target ringed with blue. Much of this performance was obscured from me by bushes, but it bore some resemblance to the display of the European black-cock **(Lyrurus tetrix).** The more typically gallinule spread of the white tuft with a deflection sideways, as described by Elliot Howard (The Nature of a Bird's World) in the waterhen, was not observed, but may well be used by **Notornis** as a variant of the above.

SUMMARY OF THE 1949-50 NESTING SEASON.

Eight, possibly nine, pairs of birds were located on territory. Of these, five (A, C. D. E. J) were on the valley floor in the Tunnel Burn, one (G) in the Point Burn, and two (B, H) on the tops.

Pair A laid two eggs and had a half-grown chick surviving on 7th February, 1950.

Pair B was not followed up.

Pair C were on territory from December to February but their breeding status was not discovered. A dead fledgling found in their territory in February may have been their's but could have strayed from J.

Pair D.—Laid two eggs and hatched only one chick, which did not survive.

Pair E.—Laid two eggs, both addled.

Pair F.—Existence doubtful.

Pair G.—Had one egg on 6th December; subsequent history unknown, but apparently without young in February.

Pair H.—Existence doubtful; report based on one bird.

Pair J.—Had a half-grown chick on 13th December, and, as the adults had left the territory by February, it may have accompanied them, or have been the decomposed body found in territory C in February.

Although observations did not cover the activities of all the birds known to be in the area, the indications are:—

(a) That not more than two eggs are laid.
(b) That families seem limited to one chick.
(c) That the percentage of fertile eggs laid may be low.

The causes of this state of affairs are not apparent, nor is it known for certain what are the natural hazards to which chicks may fall victims (e.g., G and J or C). Stoats and other predators may be suspected but there is no direct evidence of attacks on **Notornis,** and the possibility that **Notornis** themselves may attack chicks not their own, cannot be ignored. The general situation as it concerns such a small population

seems precarious. Increase is hardly to be expected, but even present numbers could scarcely be maintained if 1949-50 was a typical breeding season, unless there is a reserve of immature and non-breeding birds scattered through the surrounding country while nesters occupy the two valleys. It is now certain that the actual occupants of territory in the Tunnel Burn and Point Burn in the summer of 1949-50 did not exceed 20 birds, of which only half (five pairs) are known for certain to have nested, with results which would be disastrously inadequate if they were normal.

Naturally, predator pressure is to be feared, but so far direct evidence of it is lacking, and the traces of stoat feeding activity examined have consisted of remains of small passerine birds and mice. It is possible that weather is an even more serious and capricious factor, and that excessive rain or abnormal snowfall during the critical early days of incubation may determine the success or otherwise of a breeding season.

Some attempts have been made to estimate the total surviving population of **Notornis**, but, being based on an assumption that the Tunnel Burn and Point Burn might be the only nesting areas, they were premature. Late in the 1948-49 season it was thought that about half of the 40 empty nests found might have been used, suggesting that the number of birds scattered over the area might be 100 (with about 40 of them nesting). Longer observation in the next season showed fewer than 20 adult birds present and five pairs making amongst them about 20 nests, so that the estimate of total population was revised to 40-50 birds.* Since then a wider reconnaissance by officers of the Wildlife Branch in contiguous and adjacent valleys and tops (briefly outlined on page 118 of this issue) gives encouragement to hope that a less restricted basis on which to estimate population can now be adopted.

* The assumption is that the observer has a fair chance of seeing most of the birds that are "on territory," but actually will see very few of those non-breeders that are not.

SPARROWS TEARING PAPER.—On January 27, 1951, while sitting on a rocky ledge at Howick observing reef herons, my attention was diverted to two sparrows which I noticed were trying to carry a piece of brown-paper about a foot square up to the top of the cliff. First one bird and then the other (a cock and a hen) tried to lift the paper in its beak and then each had a turn at tearing quite large bits of the paper and flying off with them. Another example of paper-tearing by sparrows was found in a nest which was blown down from a tall palm tree in our garden. This contained a piece of the paper table-cloth which we use when we have meals in the garden. The piece was about 2½in. long and must have been torn off when the cloth was spread on the garden table some time when we were not looking.—Noelle Macdonald, Howick.

RED-BILLED GULLS TAKING CRICKETS (?) IN FLIGHT.—At sunset on February 15, 1951, red-billed gulls were seen circling at heights from 20 to 200 feet over farm lands on the Awanui-Kaitaia Plain. Their actions in the air were reminiscent of those of some fly-catching birds seen in other countries, and careful observation with field-glasses revealed that they were taking large insects in flight. Crickets are present in the locality in vast numbers and were seen in flight nearer ground level at the same time. Until March 9, whenever calm conditions prevailed, gulls were seen behaving in the same manner at the same time of day. The evening performance began shortly before sunset, when birds commenced to fly about quickly overhead, their straight lines of flight criss-crossing the sky in all directions. Suddenly a bird would hesitate and circle, to be joined immediately by others. The circling was performed at just over stalling speed and was marked at intervals by sudden swerves and dartings. At times the whole sky, as far as one could see with binoculars, was filled with gulls similarly engaged.—A. H. Watt, Awanui.

NOTORNIS IN FEBRUARY, 1950.

By C. A. Fleming, Wellington.

The chief objectives of a visit to Takahe Valley in February, 1950, were to learn the plumage of the immature bird after juvenile down is shed, and to study the behaviour of adults during the period of moult which most birds enter at the end of their breeding season. In addition, observations in February were expected to help fill one of the gaps in the annual cycle that previous visits (in November, January, August and December) had begun to outline, and would allow a final check on the success of the 1949-50 breeding season. As it turned out, some time was spent observing a pair with their well-grown downy chick which was the only young bird of the 1949-50 season located.

I am grateful to Mr. G. F. Yerex, Controller, Wildlife Branch, Department of Internal Affairs, for the invitation to join the February Party (No. 5 party), and to Messrs. H. J. Ollerenshaw and G. R. Williams, of the same department, who, armed with previous field experience, initiated me into the joys and responsibilities of observing **Notornis**. Their observations are credited by quotation of initials. Both in the field and in preparation of this article, I have had the benefit of reference to the reports of previous expeditions by Dr. R. A. Falla and Mr. E. G. Turbott, to whom thanks are recorded for this courtesy. I have tried to avoid repeating observations published elsewhere (Falla, 1949, and in this number; Turbott, in this number; and Williams, 1950).

GENERAL SURVEY IN FEBRUARY.

In another article in this number, Dr. R. A. Falla has outlined the status of the several **Notornis** pairs studied by the December expedition (No. 4 party) in the Upper Tunnel Burn and adjacent Point Burn valleys. Pair A were attending a single healthy chick on February 3, 1950. Pair B, recorded at a high altitude north of the Tunnel Burn in 1949, were not located in February, although fresh feeding-sign, droppings, and empty nests were evidence of their presence (H.J.O., G.R.W.). Pair C (status uncertain in December) still occupied their territory in February; they appeared to be without young, but the decayed carcase of a fledgling was retrieved from their territory. Pair D, which had lost their chick in December, were still on territory near their nest but had apparently not laid again. Pair E, too, were located by H.J.O. three hundred yards up the valley beyond their nest. We found no evidence of other pairs in the Tunnel Burn area in February. In the Upper Point Burn, pair G were found, alone, on February 4, apparently without young; no chick droppings were seen. Neither birds nor fresh feeding-sign were seen outside the known or inferred breeding territories of the pairs enumerated. Pair A fed with their chick over their extensive territory; other birds, apparently "idle" in respect to reproductive activities, still maintained their association in pairs and still occupied what had been breeding territories, where they were feeding quietly when encountered, and were in various stages of moult. They, at least, had not dispersed away from their nesting areas at this season.

BEHAVIOUR OF PAIR WITH CHICK.

From February 3 to 6, the chick of pair A, then about six weeks old, was active and elusive, not permitting photography, and in view of the decision not to handle birds, it was studied and sketched from a distance, with the help of binoculars. It was a vigorous rather gawky-looking youngster, standing about twelve inches high, with conspicuous muscular thighs out of all proportion to its body, giving a fanciful resemblance to a miniature moa. Compared with the chick photographed by J. H. Sorensen in January, 1949, the February bird was larger, head relatively smaller, down less intensely black, wing-spurs inconspicuous. The down, like that of other adolescent rails, had faded in the weeks of fledging to a rather patchy brownish black, and a distinct whitish patch had appeared at the vent, foreshadowing the white under tail coverts of the

adult. Possibly, at this stage, down was shedding from tips of growing contour feathers which might contribute to the colour, but bleaching of down near the vent is equally likely. The bill was blackish, with white tip; legs, viewed at a distance, a rather pale warm orange-cream in front, darker behind.

Throughout the four days of our stay, the family party wandered extensively over the snowgrass and scrub bordering the north, east and north-east shores of Kohaka-takahea Lake and margining the outlet stream to the lip of the glacial valley. This feeding territory was estimated to occupy more than 15 acres and to extend about 1000 yards. Occasionally the family entered the bush edge, feeding there on fine grasses in moist gullies beneath the open beech forest. The supposed female* and the chick fed together with the male generally 20 to 50 yards away, maintaining contact by sight and sound. The chick sometimes fed with some independence, one to ten yards from its parent, but she once followed it up when it remained out of sight behind shrubs for several minutes, and also made directly for the chick in spite of the presence of a human observer between. The adults grazed on snowgrass leaf-bases, and, particularly, on seed-heads (as described in January; Falla, 1949) or rooted among **Poa** and sometimes took gentian and other herbs. The chick sometimes shared leaf bases, grass tips, and leaves plucked by its parent, stretching up to pick them from her bill, but just as often bit off its own food; grass tips, **Viola** leaves and grass seeds. Once the adult was seen (by H.J.O.) vigorously rooting with her bill among fine green grasses at the bush edge, making excavations like a kiwi prod but shallower. At this stage there was no evidence that insect food was sought or taken, other than this behaviour reminiscent of December chick-feeding (see Falla, p. 98).

The chick uttered a fairly constant cry: either a slow "wee-a" or a continuous repeated "weedle, weedle, weedle." Both parents, but generally the supposed female, used the "cowp, cowp" call (Falla, 1949) to keep contact with the chick. The weka-like call was heard perhaps on an average three times a day, usually when the pair was well separated, once at night (suggesting nocturnal activity), and once when the adults were on opposite sides of the stream. One bird begins a loud repeated "coo-eet," and the second joins in generally "out of phase" so that the call is continued as a two-part canon:

—/ —/ —/ —/ —/ —/ —/
coo-eet coo-eet coo-eet coo-eet coo-eet coo-eet coo-eet
—/ —/ —/ —/ —/ —/ —/
coo-eet coo-eet coo-eet coo-eet coo-eet coo-eet coo-eet

The weka has a similar duet call.

The amount of country covered by the family party during four days of feeding was striking; in a few hours, quite spontaneously, they would move several hundred yards. They twice voluntarily crossed the stream. We shared the experience of the January (1949) party in finding a large number of fresh-looking empty nests. One such nest, east of the lake and south of the stream, contained a shred of faded brownish nestling down and had recently been occupied; it was some hundred yards from the nest in which the chick had hatched and was apparently a brooding nest functioning for temporary shelter.

IMMATURE PLUMAGE.

The dead fledgling found in pair C's territory on February 3rd, is possibly the bird observed as a well-grown downy by Mr. K. H. Miers on December 6th some distance away, across the Upper Tunnel Burn. Its remains, consisting of feathers, bill sheaths, crop and skeleton, will be described by Dr. R. A. Falla elsewhere. When it died, the bird was, like

* Identification of sexes was based on slightly more robust characters of the supposed male, and on the consistent association between the chick and the supposed female, but the inference lacks more definite confirmation.

all fledgling rails, considerably smaller than an adult and was in almost complete first plumage, with a little down still attached to the tips of the pin feathers still largely in sheath. The bill had not acquired adult characters: it retained the dark colour of the downy chick's, and the frontal shield had not attained adult proportions. Body plumage resembled that of the adult in essential characters but the colours perhaps lacked the brilliance of an adult in full plumage. Thus the first teleoptyle plumage of **Notornis**, like that of **Porphyrio**, seems to be rather similar to the adult plumage.

MOULT.

Most adults were in less-brilliant plumage than in December (H.J.O.). Odd dropped feathers were found scattered through the feeding area and others concentrated at definite "moulting places." In the Point Burn, the pair identified with G were in rather brighter feather, and moulted feathers perhaps more abundant than elsewhere. The moulting places were almost invariably beneath the overhanging crown of a twiggy shrub of **Coprosma rigida** and were generally on a lush carpet of fine-leaved bright geen **Poa** growing round its trunk. Beneath the shelter of the shrub, groups of feathers and accumulations of droppings showed that a bird stood on the sunny northern side, facing the sun, and probably preened there, returning to the same spot several or many times to tramp into the grass on later visits the feathers dropped on earlier occasions. About 30 feathers and about 40 droppings were counted in a typical moulting place. The feathers came from practically every part of the body and included primaries as well as contour feathers. Such moulting places were found in the Point Burn and in several of the Tunnel Burn territories, including that of pair A (with chick). No birds were seen in occupation of moulting places, but on the morning of February 5th the inferred male of pair A was found sunning himself and preening below a rock face half a chain away from his feeding mate and chick. Cast feathers were also found in a brooding nest.

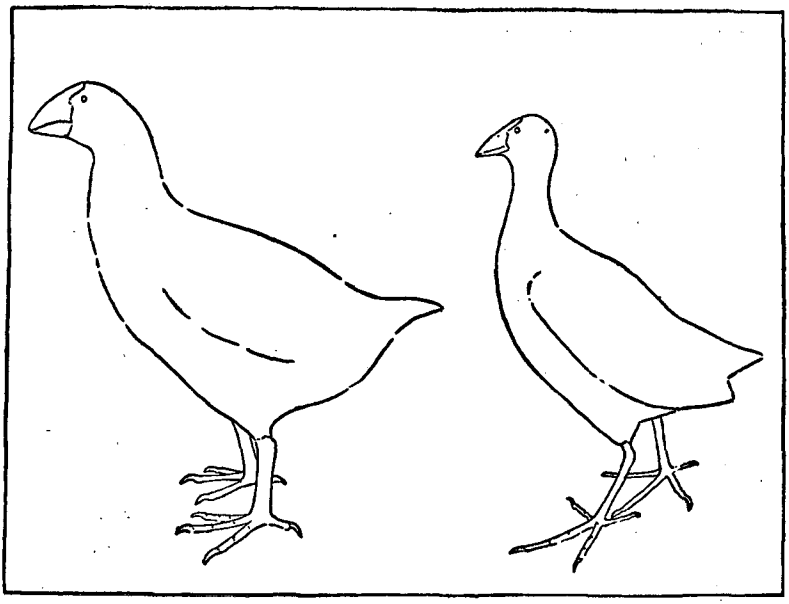
As reported in the press ("Evening Post," Feb. 14, 1950) there is evidence that **Notornis** and other birds have at some time used the dry powdery floors of nearby limestone shelters for dusting during the moult. There was no sign of this habit in February, 1950, and Miers (1950) suggests that the feathers were plucked by Maori hunters.

SOME GENERAL REFLECTIONS ON NOTORNIS.

The stimulating experience of studying **Notornis** in the field has prompted the following observations on the bird's functional morphology, some of which, although trite in their general application to animals, have not previously been made, so far as I know, in respect to **Notornis**.

The systematic affinities of **Notornis** (recently emphasised by Mayr, 1949) are with gallinules of the genera **Porphyrula and Porphyrio**. The pukeko is the New Zealand representative of this group, which comprises moderate-sized waterfowl of swamp and lake-shore with adequate powers of flight, occupying relatively large distribution areas, chiefly in the Southern Hemisphere. We may infer that **Notornis** sprang from similar stock and developed its peculiar characters in New Zealand. The pattern of differentiation from the supposed ancestral form is one that is shared by other island birds, and it may help us to appreciate the distinctive characters of **Notornis** if we try to assess their functional significance in relation to the bird's environment.

The outstanding characters of **Notornis**, compared with its nearest relatives, are its large size, stout legs and neck, short toes and tarsus, flightlessness and oversized beak. All who have studied the bird since its re-discovery have been impressed with its herbivorous habits, which suggests that it once had the role of a grazing animal in the extensive tussock-grasslands of New Zealand (Duff, 1949).



SKETCHES OF NOTORNIS (left) and PORPHYRIO (right), based on photographs, to show differences in size and proportions.

Increase in size has been a common tendency among vertebrate animals, particularly among vegetarians, and has a simple physiological basis, recently emphasised by Watson (1949). The food requirements of an animal consist of a maintenance ration, the amount required to maintain life, and a production ration, which provides the energy for all activity, locomotion, reproduction, growth, etc. The maintenance ration is related to the weight of an animal, but is not proportionate to it, increasing roughly as the animal's surface area, i.e., as the two-thirds power of the weight, but the production ration is directly proportional to the energy used, and thus to the weight of the animal. "Thus the total food consumption of an animal is built up by a maintenance ration varying as the square of a linear dimension, plus a production ration varying with its cube" (Watson, 1949, pp. 50-51). This means that, for the same amount of activity, a larger animal has greater thermodynamic efficiency than a small one, and to this advantage is attributed the increase in size that characterised evolution of the horses, the elephants and other groups. Clearly, a gallinule weighing 6 pounds (Williams, 1950, p. 218) has a similar physiological advantage over one half that weight* provided that other factors allow the survival of a bird of that size.

There are simple aerodynamic reasons why flight is more difficult in large birds than in small ones. "The bigger a heavier-than-air machine, whether living or not, the faster it must fly to keep itself from crashing" (Wells, 1938), and to develop this speed more power and relatively larger wing muscles are needed. Other things being equal, the efficiency of a wing is a function of its surface area, which is proportional to the square of a linear dimension. The load to be carried, however, is proportional to the cube of a linear dimension so that a bird exactly twice the linear size of another would have to support eight times the weight of its smaller fellow with only four times the area of

* Two male pukeko weighed 1 lb. 14½ oz. and 2 lb. 7oz.

wing. A gallinule about twice the weight of a pukeko would have much less efficient wings unless the proportions of the wing and its muscles changed in compensation. But the energy used in flight is a debit against the production ration of a bird, and is a more expensive item in a large bird than in a small bird.

Feather weight, in birds of different sizes, is known to be almost directly proportional to their body weight, but the number of feathers increases at a lower rate, even lower than does the surface area (Brody, 1945, p. 639). Thus larger birds have relatively fewer feathers of relatively greater weight per unit area of skin, than smaller birds. For mechanical reasons, however, the weight of the supporting quill of a feather is relatively greater and that of the vanes relatively less in large birds than in small birds (Brody, p. 640). These are additional reasons why large birds have become flightless when flight was no longer necessary for survival. In most birds, needless to say, flight is so important that its maintenance is essential for survival. This has kept their average size low.

Difference in size also accounts for the robust legs and neck of **Notornis** in comparison with those of a pukeko, for the strength of a supporting column is related to its cross-section (i.e., to the square of a linear dimension). To keep pace with a cubic increase in weight, the cross-section of limb bones must increase disproportionately. Allee and others (1949, p. 132) note that the capacity of a column to support weight varies inversely as the square of its length (Euler's principle) so that "the leg bones of a heavy vertebrate tend to be shorter than those of a related lighter species." The tarsus of **Notornis** (82-90 mm. according to Buller and Oliver) is, in fact, a little shorter than that of the slender-legged lighter pukeko (99-100mm., 3 measurements). The long toes which support the pukeko on the boggy ground of its swamp habitat are unnecessary and indeed undesirable in a terrestrial feeder which tends to shun swampy ground (Miers, 1950).

In grass-eating mammals, there is a direct relationship between size and the relative area of the teeth that triturate, bruise and disrupt the grass to allow digestion of its cell contents. The consequent effects on the shape of the face in horses have been discussed by Watson (1949). In grass-eating birds some of the functions of teeth are served by the sharp shear-like edges of the horny beak-sheaths and by the hard spiny armature of the palate and tongue: still more trituration goes on in the gizzard. Now, to maintain their triturating functions in a larger bird, the relevant parts of the palate must increase in proportion to increasing food and body weight, that is, in proportion to the cube of a linear dimension. Brain size does not increase proportionately with increased weight, but varies more nearly as its two-thirds power, and this accounts for many differences in the shape of the face in vertebrates. "The value of the exponent for birds is considerably less than for mammals, meaning that, in comparison to small birds, large birds have relatively smaller brains than mammals" (Brody, 1945, p. 626). The differences between **Notornis** and **Porphyrio** in the proportions of the head and beak may be due in large part to inevitable functional consequences of the differences in their body weight. Comparison of the oblique frontal view of the head of **Notornis** published by Buller with a similar view of **Porphyrio** suggests that the former has a smaller brain than the latter, relative to its large beak, jaws and cheek muscles.

Most of the characters of **Notornis** discussed above would follow naturally as a result of an increase in size which leads to greater metabolic efficiency. In most birds, flight is too valuable an attribute to jeopardise by gain in weight, but, as Romer (1945) points out, "for many birds which seek their food on the ground, flight is necessary mainly as a protection from enemies. With freedom from carnivores, there is no reason why flight should be maintained." Rails spend much of their time skulking through the undergrowth, and by avoiding flight a bird "can escape from the mechanical limitations which flight

imposes'' (Wells, 1938). New Zealand has long been quoted as an area where many flightless birds developed in the virtual absence of predators.

The fate of many animals adapted to a special set of conditions has been extinction, which, in general, can be attributed to a change in the environment; for specialised animals lose the power to adapt themselves to changed conditions. ''Forms on the verge of extinction'' according to Romer (1949) ''are frequently found to be individually large; abundant in numbers; and . . . . herbivorous rather than carnivorous.'' **Notornis**, certainly large and herbivorous, was probably abundant when it ranged the tussock grasslands of both islands of New Zealand before the onset of conditions which led to its restriction. Like the moa, **Notornis** had survived the vast climatic changes of the Ice Age, but it had apparently become restricted to Western Southland by the time European settlement began a century ago. Despite much discussion, no one has satisfactorily accounted for the extinction of the moas and their contemporaries, which coincided in time with the restriction of the range of **Notornis**. What has seldom been emphasised is that the extinction (or near-extinction) of large herbivorous animals in New Zealand is not an isolated phenomenon but is paralleled in many parts of the world in post-glacial times. Romer (1945) concludes that the only widespread change of conditions to which such extinction can be attributed is that due to the development and spread of man. The arrival of Polynesian man with his domestic animals (dog and rat) seems to be the chief ecologic change in New Zealand during the few thousand years prior to 1774 and is the basis of perhaps the most popular (and in the writer's opinion, the best) hypothesis for the extinction of moas. If dogs came with the first Polynesian settlers, and if, contrary to tradition, they tended to become wild and hunt in packs, they would have been important factors in the extermination of flightless birds. Certainly, changes in climate and vegetation during post-glacial times may have reduced their range, but such changes as are known, in New Zealand and elsewhere, were small compared with the large scale fluctuations of the glacial and inter-glacial periods which New Zealand flightless birds survived.

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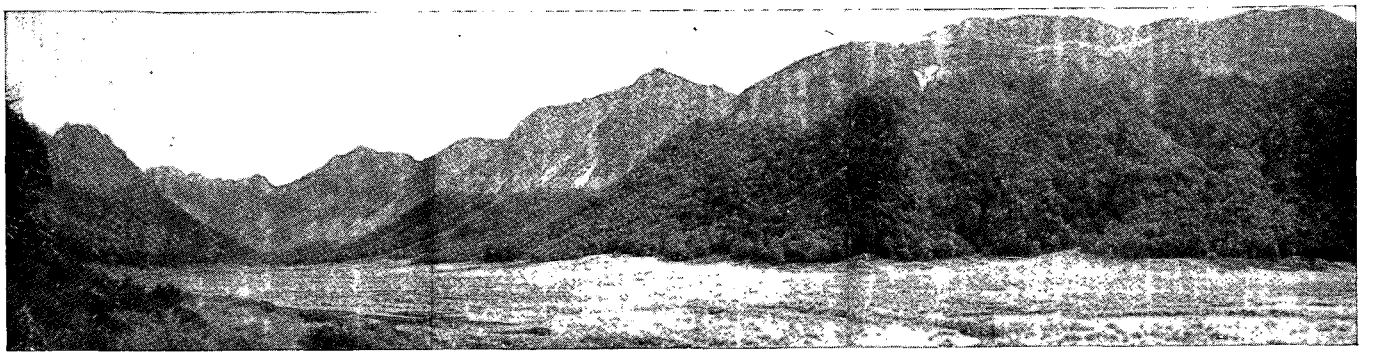
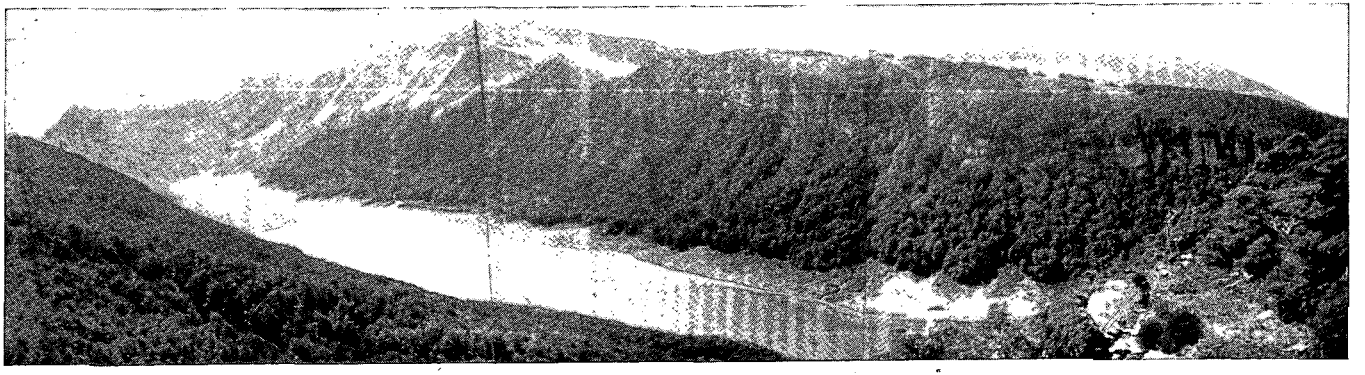


UPPER TUNNEL BURN VALLEY.—In the 1949-50 season, the broad valley-floor, clothed in snowgrass and bog vegetation, supported three or four breeding pairs of **Notornis**. The view shows the area occupied by pairs C (right), D (left of centre) and E (head of valley, left). Photo: C. A. Fleming.



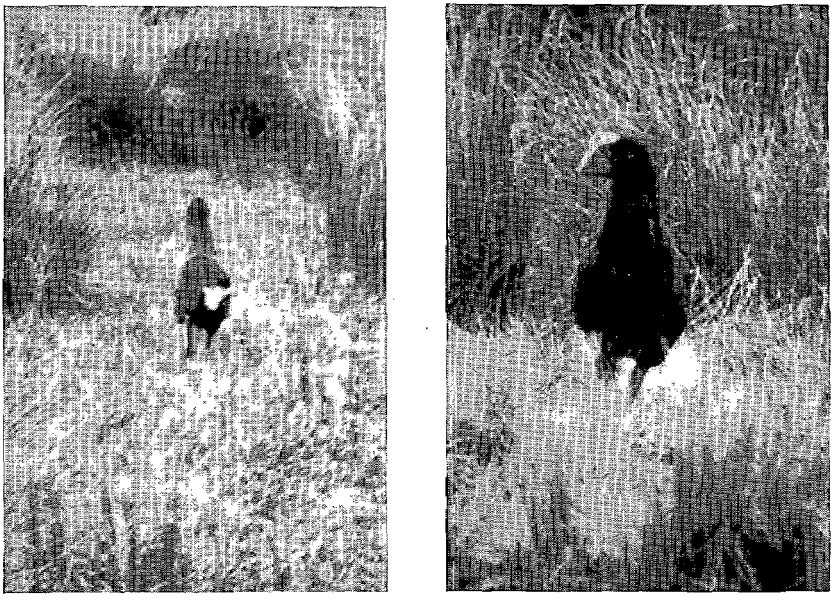
GENERAL VIEW, LOOKING NORTH ACROSS KOHAKA-TAKAHEA LAKE, towards limestone bluffs forming the north side of Tunnel Burn Valley. **Notornis** pair A ranged the strip of snowgrass margining the lake (centre and right); traces of pair B were found on the ridge above, and other pairs occupied the valley-head (left). Photo: C. A. Fleming.

ADULT TAKAHE, December, 1949.

Photo: R. A. Falla.

Photo: National Publicity Studios.

TAKAHE ON NEST, December 12, 1949.



Photos: R. A. Falla.

TAKAHE ATTITUDES, December, 1949.

Photo: R. A. Falla.

NEST AND EGGS OF TAKAHE, December 3, 1949.

Photo: R. A. Falla.

MOSS PULLED UP TO UNCOVER INSECT FOOD FOR YOUNG TAKAHE, December, 1949.

Photo: H. J. Ollerenshaw.

CHARACTERISTIC ACCUMULATION OF DROPPINGS NEAR TAKAHE NEST.

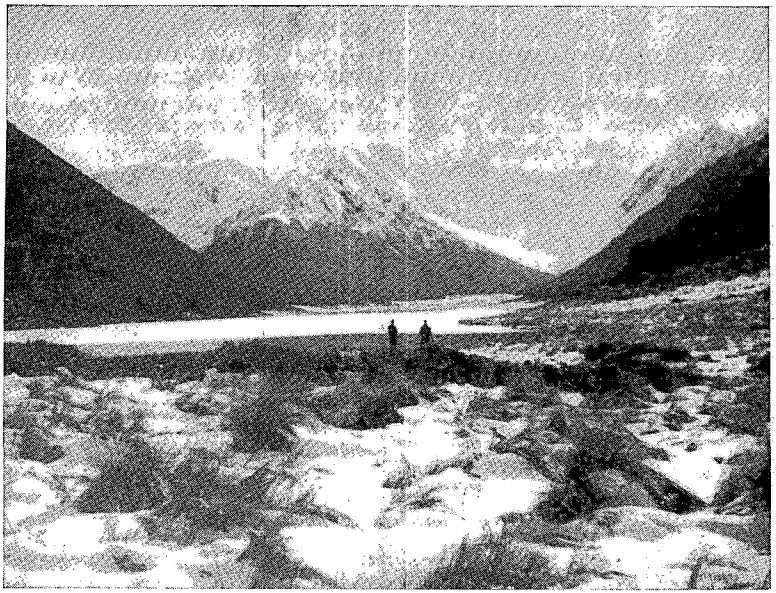


Photo: E. G. Turbott.

LOOKING UP TAKAHE VALLEY before heavy snowfall, showing clear water at end of frozen lake. 24th August, 1949.

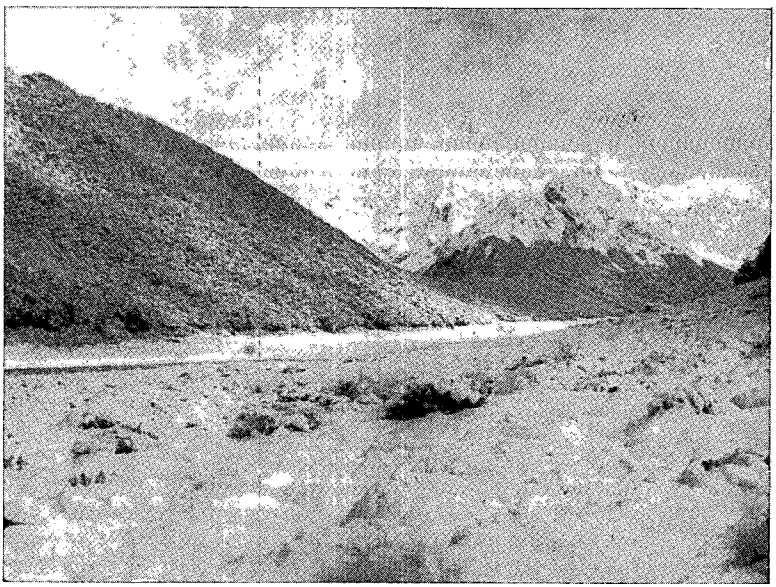


Photo: E. G. Turbott.

VALLEY IMMEDIATELY AFTER HEAVY SNOWFALL; the snow-grass and scrub of the nesting ground covered in foreground. 26th August.

Photo: E. G. Turbott.

TRACKS OF NOTORNIS IN SNOW, TAKAHE VALLEY, 28th August.

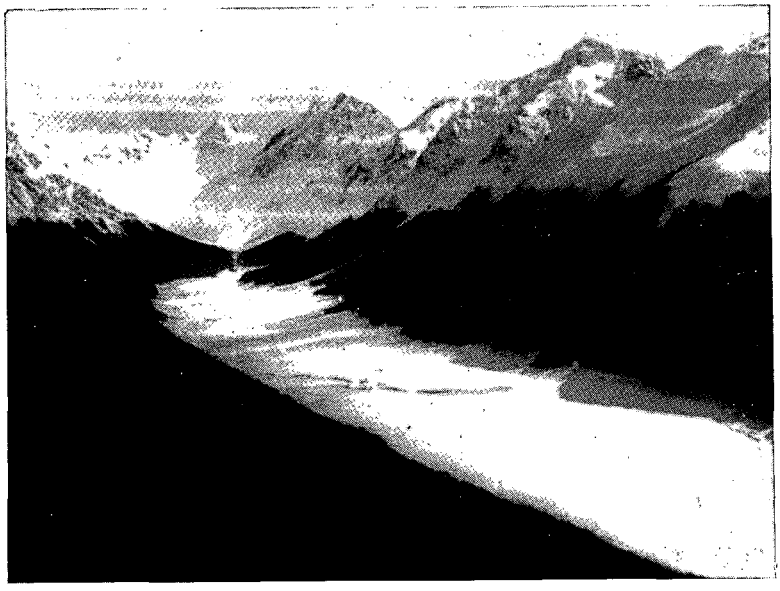


Photo: E. G. Turbott.

TAKAHE VALLEY from neighbouring ridge. The frozen lake in right foreground, tussock at head of valley in middle distance under cloud shadow. Note the dark band of beech forest. 27th August.

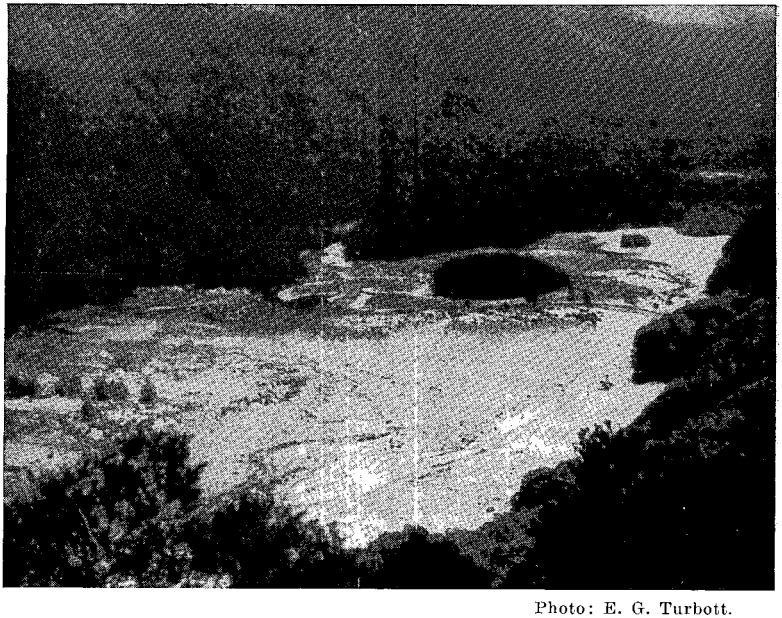


Photo: E. G. Turbott.

LOOKING DOWN ON THE POINT BURN VALLEY showing tussock flats, with less snow than Takahe Valley. 27th August.

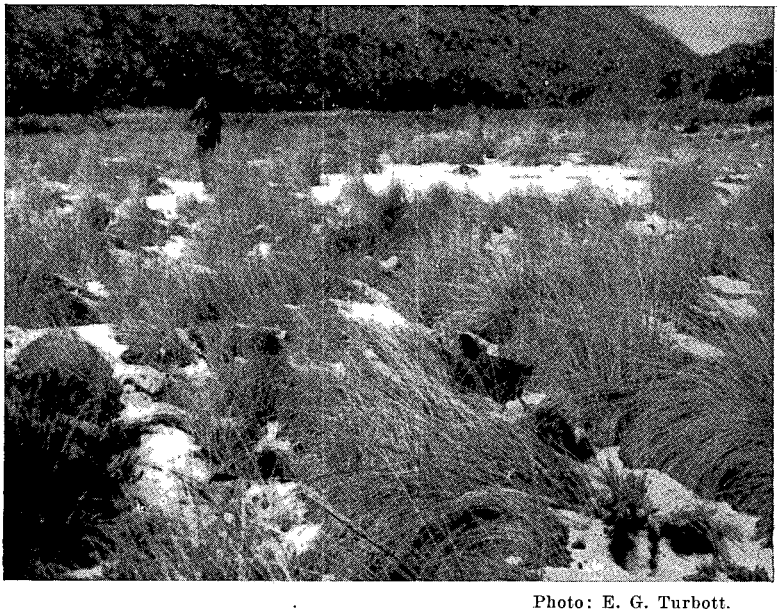


Photo: E. G. Turbott.

ON POINT BURN FLAT. Takahe in right foreground. 26th August.

WINTER OBSERVATIONS ON NOTORNIS IN 1949.

By E. G. Turbott, Auckland Museum.

The party which I accompanied in August, 1949, was the second to carry out observations in the valleys inhabited by **Notornis**, following upon Dr. G. B. Orbell's original visits of discovery on 11th April and 20th November, 1948. The field investigation of **Notornis** began with a visit in January, 1949, by a party including Dr. R. A. Falla and Dr. Orbell, which surveyed habitat and nesting habits in some detail, and discovered the second **Notornis** colony in the valley of the Point Burn (Falla, 1949). (References are to selected bibliography at end.—Ed.)

Now a visit was planned to examine these valleys under the conditions characteristic of this high country in winter. The object was to record winter habits and distribution, and possibly pre-breeding behaviour in preparation for observations during the next nesting season. As described in Dr. Falla's account in this issue, these expeditions have been followed by three in the summer of 1949-50, so that during the two seasons since its rediscovery, a fairly comprehensive survey has been made of the behaviour and life history of **Notornis**.

Our party of three—K. H. Miers, Field Officer and G. R. Williams, Biologist of the Department of Internal Affairs, and the writer, climbed to Takahe Valley from the shore of Lake Te Anau on Monday, 22nd August. We spent seven days at the camp established in January, 1949, returning to Te Anau on Monday, 29th August.

Our stores and equipment were dropped by air at the end of the preceding week, when Mr. Miers with Mr. C. E. McIvor, officer of the Department of Internal Affairs at Te Anau, had made a preliminary visit, to which further reference is made below.

Before our departure word was also received through the Department's office in Queenstown from Dr. Orbell, who had made a brief trip into the **Notornis** country on Saturday, 13th August: nine days before we reached camp. Dr. Orbell's information was that the Lake had proved to be thickly frozen over and that around the camp were large patches of snow and ice. The remainder of his report, as described in the present account, proved of very considerable interest in relation to our observations. On his visit Dr. Orbell saw two birds in Takahe Valley, three in the Point Burn Valley and two more in the lower part of the latter valley.

CLIMATE OF TAKAHE VALLEY: WEATHER DURING THE VISIT.

Experience of this region had suggested that the winter climate must be rigorous. This had been indicated during the January investigation, when the north-westerly aspect of the valley and strips of snow still lying at the valley head suggested cold wind and heavy snow in winter. Although the valley (approximately 3000 feet above sea level) is below the winter snow-line, the combined effect of altitude and aspect would be sufficient to render winter conditions particularly bleak, especially during the period from June to September.

This was our experience during the present visit, when severe weather conditions were encountered. Heavy rain fell at Te Anau on Sunday, August 21st, followed by cloudy weather on Monday, 22nd, during the climb to the valley. Snow was lying on the forest floor at c. 1500 feet, increasing towards the valley, which was covered unevenly to a depth of some 12-14 inches. Tuesday, 23rd, brought rain until 11 a.m.: a survey of the valley in the afternoon revealed snow-bound conditions, the subalpine scrub being heavily snow-laden and the snow-grass partly buried. The lake occupying the centre of the valley was heavily frozen, but for dark clear water at the entry and outlet of the vigorously flowing stream; this day rain began again at 4.30 p.m., with north-westerly winds, becoming continuous and heavy by nightfall. On

Wednesday, 24th, snow began just after daylight continuing to noon, approximately three inches having fallen, but the afternoon was clear and sunny. Snow was continuous throughout Thursday, 25th, the total fall being some 9-10 inches. The two following days, Friday, 26th, and Saturday, 27th, were fine and partly sunny with westerly winds. The depth of snow, approximately two feet, was now sufficient to cover all but the tips of the snowgrass, and lay heavily on the scrub and forest floor; but heavy snow bearing down the beech forest canopy was shed fairly rapidly, especially on the southern face of the valley. Sunday, 28th, brought intermittent falls of snow and rain, becoming heavy towards evening, and continuing until the morning of our departure, Monday, 29th.

Our visit thus coincided with a period of north-westerly weather bringing deep snow, but had evidently been preceded by a thaw period, during which the depth of snow had been to some degree reduced.

That such conditions are characteristic of the area in winter can best be judged over the longer period covered by Dr. Orbell's visit on August 13th; and by the trip in preparation for the present expedition by Messrs. Miers and McIvor between August 18th and 20th. Dr. Orbell described the snow in Takahe Valley as lying in patches, perhaps less deeply than at any time during our stay. Messrs. Miers and McIvor found the valley under a recent fall of snow. Both parties referred to the thickly frozen lake, the firm ice providing an easy passage up the valley.

OBSERVATION OF NOTORNIS: FEEDING HABITS AND DISTRIBUTION IN TAKAHE VALLEY.

The rain temporarily eased by the early afternoon of Tuesday, 23rd. It was then that at last we came out through the fringe of beech forest about the camp, through the waist-high scrub and on to the snowgrass, upon which a patchy accumulation of thick snow was beaten flat by rain.

We listened to the clear whistle of a pair of blue ducks as we ascended a slope beside the stream. Then, on reaching the top, we found that we could look far up the valley over the frozen lake to the peaks of the main range. The valley gleamed under a white mantle, with the lake glistening icily in the afternoon light. The tall beech forest rising up the steep sides of the valley was dark green, as yet without its canopy of snow; but below this the spreading fringe of subalpine scrub was snow-laden.

A few moments later we had our first sight of **Notornis** as we walked over partly-buried tussock and through low scattered scrub along the northern shore of the lake. We had been moving in line abreast, covering the distance between the bush and lake shore, when we heard behind us the double whistle, ending sharply on the second note. Gordon Williams shouted as he saw the bird: it had remained hidden close to us as we passed, and now ran swiftly towards the forest. It kicked up a spurt of snow as it plunged beneath the fringing scrub. All gained a brief glimpse, and it was last seen 30-40 yards away beneath the open forest.

My first impression was of the massive body and long stride, and of the running posture with neck stretched well forward. The gait is strong, yet not clumsy; and the large triangular bill is a marked character in silhouette.

Examining the ground a little off our tracks, we found that the bird had been feeding on the leaf-bases of snowgrass.* A characteristic litter of discarded leaves was scattered about, as described in accounts of the January investigation, the leaf bases having been nipped cleanly

* **Danthonia (flavescens) affine. For this and following plant identifications I am grateful to Miss Alison Lush, Botanist, Dominion Museum, who compared material with the comprehensive collections made in January by Mr. J. H. Sorensen.**

off. In many cases the leaves had been pulled out in tufts, the bases of which were scooped away, evidently with the tip of the beak. Such material included that of the smaller tussock **Poa colensoi**, but was mostly of **Danthonia.**

Continuing up this northern shore of the lake, we found footprints of different size, droppings and remains of tussock indicating that as far as could be judged three additional **Notornis** had been feeding.

Evidence of the presence of several birds was found again on Wednesday, 24th, but there were no signs of feeding when we examined the valley after the subsequent heavy snowfall of Thursday, 25th. As mentioned above most of the tussock and other ground vegetation was by this time deeply covered, and evidently could not have been reached by the **Notornis.** The period of thaw up to Wednesday, 24th, had uncovered a small amount of tussock, but enough to provide only a limited food supply.

After the heavy snowfall on Thursday, 25th, tracks were seen in the snow, and could be traced for some distance across the valley; in one case a bird had stepped out of the main stream below the lake, apparently after wading for some distance through the water.

We identified the double whistle which revealed the birds on Tuesday, 23rd, with that referred to by Falla (1949) as a scream "kee-ew," the first note like that of the kiwi, but the second more clipped. This call also bears some resemblance to the whistle of the paradise duck and oystercatcher. The loud piping call variously described was also heard from across the lake.

Altogether it was considered that there was evidence of five **Notornis** in the valley, one being heard on the south side of the stream opposite the camp. This last bird had a particularly weka-like call heard after dark on three evenings, and again on the morning of our departure; Ken Miers found unmistakable **Notornis** footprints, which we considered verification that the call was of **Notornis.** The observation is of interest as an indication of nocturnal habits, and of some degree of territorial behaviour.

On Dr. Orbell's visit on 13th, two **Notornis** were seen in the upper part of the valley at the edge of the bush, and there was little sign of feeding. None was seen by Messrs. Miers and McIvor, August 18th-20th.

Of vegetation other than ground plants which might have provided food, the seed heads of grasses mentioned as an important item in January reports were merely weathered remains. There were a few small red fruits on the low shrub **Coprosma (rigida)** affine which could have been reached by the birds, and may prove to be present in the droppings collected.

An interesting observation was made in examining the base of the limestone cliffs along the north side of the valley on Friday, 26th, after the heavy snowfall of the previous day. Beech forest rises to these cliffs from the open valley for about 500 yards but immediately below the cliffs and on wider ledges, there is a fringe of the soft tussock **Poa colensoi** mixed with such herbaceous plants as **Hydrocotyle novae-zealandiae.** This band of ground vegetation, being partly sheltered by the overhanging forest, was frequently quite free of snow, but although much sought after by deer, showed no sign of having been eaten by **Notornis** (see below).

DROPPINGS.

The fresh droppings found where the birds had been feeding were dark green in colour with no visible limy coating, and different in texture from the chaff-like material of most of those collected in January. Most were cylindrical, but some were soft and formless and in two cases

almost liquid. Older but fairly recent droppings (unweathered) were found, these also containing less fibrous material than in summer.

NOTES ON THE VEGETATION.

The following brief notes were made for the purpose of description, but may be of interest pending a full botanical account of the area:—

The beech forest of the lower slopes and on the ridge between the two valleys is composed as far as could be seen mainly of mountain-beech **(Nothofagus cliffortioides)**. Silver-beech **(N. menziesii)** occurs in the underscrub together with **Archeria traversii.**

The vegetation of the valley floor, especially in Takahe Valley, is particularly colourful. The golden snowgrass along the northern side of the lake was snow covered during the greater part of our visit; and between this and the dark green beech forest is a many-coloured zone of scrub. The latter consists principally of the red **Dracophyllum uniflorum**, fresh green **Hebe buxifolia**, golden-green **Dacrydium biforme**; together with mountain toatoa **(Phyllocladus alpinus)**, **Olearia lineata** and **Coprosma (rigida)** affine.

DISTRIBUTION IN POINT BURN VALLEY.

The considerably lower Point Burn Valley was visited twice, on Friday, 26th, and Saturday, 27th, our only two fine days. Although snow was heavy on Takahe Valley after the heavy fall of Thursday, 25th, we found the covering in this milder valley only patchy and the tussock almost free of snow.

The climb between these two valleys, often in deep snow drifts, impressed us particularly with its contrasting views—looking back we could survey the bleak expanse of the snow-filled Takahe Valley, with the frozen lake over which we had just walked. On the other side, we looked down on the tussock flats of the Point Burn with its comparatively benign aspect, and obviously less severe conditions.

In the Point Burn Valley, tussock stretches vividly to scrub fringing the beech forest. The scattered scrub of the often boggy flats here contains the same species as in Takahe Valley, although grey-green **Olearia lineata** and **Coprosma (rigida)** affine are more abundant, with correspondingly less of the reds and yellow-greens of **Dracophyllum, Hebe** and **Dacrydium.**

When we reached the western end of the flat early in the afternoon on Friday, 26th, a **Notornis** was seen almost immediately, feeding amongst the snowgrass. This, the second bird seen by our party, remained in full view some twenty yards away, keeping at this distance as it walked between the tussocks of tall snow-grass. We were able to watch it closely, and hear the soft alarm note, "oomp, oomp . . . ." which is not easily heard unless close at hand. In walking, the tail is flicked in the manner of the pukeko.

Its plumage was bright and no sign of moult could be observed. The colour of the bill—pink with scarlet base—was the same as in summer, but a slight difference from Dr. Falla's sketch was noted in the greater extent of the scarlet area at the base, an excellent colour photograph of this sketch being available for comparison. This pattern on the beak may differ both in individuals and seasonally.

When we came closer the bird broke suddenly into a run towards an isolated clump of beech forest, but was easily approached again. At last, when further disturbed, it ran straight through the shallow, swiftly-flowing Point Burn, lurking behind the tussock but finally breaking into a strong run towards the forest.

The tussock flat was examined at some length on both visits, but no further **Notornis** were seen although a set of tracks at the eastern end

was taken as evidence of the presence here of one additional bird. Although a considerable amount of broken tussock was observed during our examination of the valley, only a small amount of this was recently pulled out, and there was no other evidence of the presence of **Notornis.**

Fresh and fairly recent droppings found here were lighter in colour and more fibrous than those from Takahe Valley, and closely resembled specimens collected in January.

Dr. Orbell referred in his report to two adult and one young **Notornis** seen here on his visit of August 13th; in addition two were seen in the bush about one mile below the flats.

Our experience was the same as that of previous observers that **Notornis** is at first slow to react to human intrusion, but makes off at a fast run when finally disturbed. At neither locality in which **Notornis** was seen could the birds be found on the following day, possibly to be taken as an indication of their greater tendency to wander afield during the winter.

CONCLUSION: HABITS AND RANGE IN WINTER.

Although the time available for the work was so short and travelling conditions were difficult, our observations would seem to point to the dispersal of at least part of the population away from Takahe Valley with the coming of winter. The summer population is estimated at less than 20, five pairs being known to have been established in the area during the 1949-50 nesting season following the present expedition. Until the status of the breeding population is better known conclusions on the basis of the winter observations must remain indefinite.

Thus we could not account for more than five birds in the open portion, and as far as it was possible to examine the forest we obtained no evidence that there were others in the area around the valley floor, or on the neighbouring ridge. After the heavy snowfall on Thursday, 25th, the only signs on the floor of the valley were the footprints of the birds which had wandered widely across the snow. As mentioned above, there were no signs that **Notornis** had fed upon ground vegetation at the base of the cliffs, and we could find no other evidence of feeding except in the open valley.

Whether the birds of which we found evidence were individuals which had not dispersed, or were seen in the valley by chance could be decided only by much longer periods of observation; and possibly it may be found that the marking of individual birds might be undertaken without danger of disturbance. It was apparent that heavy snowfalls, such as must occur throughout the winter, would make it impossible for **Notornis** to feed regularly upon snow-grass and other ground vegetation. Should **Notornis** remain in the valley throughout the winter, thaw periods between successive cycles of north-westerly weather (e.g. during Dr. Orbell's visit and the first few days of the present expedition) would enable a certain quantity of snowgrass and other ground plants to be obtained, although, as suggested by Mr. Miers' local experience, heavy snow may lie for a period of at least a fortnight.

We kept a careful watch for any evidence of the extent of the area over which the birds may wander, both between the Takahe and Point Burn valleys and on the route down to Lake Te Anau. The only indication found was a track of **Notornis** in the snow on the forest floor seen by Mr. Miers (18th-20th) about halfway up the ascent to the valley from the Te Anau landing. There is, in addition, Dr. Orbell's record of two seen in the bush about a mile below the flats of the Point Burn. This observation is the more significant as, unless the Point Burn has a greater population of **Notornis** than the single pair recorded so far, these birds must have come from Takahe Valley; or, as Dr. Falla suggests, a surplus population of immature and non-breeding **Notornis** may exist which would remain scattered over the surrounding country at all seasons.

Evidence of the feeding habits of the birds observed in Takahe Valley may be furnished by the droppings brought back for analysis. These, as mentioned above, differed in colour and texture from those collected in summer, and may show that they had been feeding largely upon animal food, together with mosses and vegetation which would be obtained within the forest.

In the milder Point Burn Valley the one bird observed was feeding, as in summer, on the readily available snow-grass, and it would seem possible for **Notornis** to remain under normal conditions in this valley during the winter. The chaff-like droppings found here provided evidence that the birds were existing mainly on a diet of snowgrass and associated plants.

As mentioned above, no birds were seen in this valley after the early part of our first visit, which indicates their readiness to stray into the neighbouring forest. Dr. Orbell observed two adult **Notornis** and one young one on these flats on August 13th.

The problem remains as to whether dispersal may simply occur at random into the forest or whether the birds descend to lower levels. The latter view is to some degree supported by the discovery of the 1898 specimen on the shore of Middle Fiord, Lake Te Anau, on 7th August; and, apart from uncertainty as to the exact date of capture, by the first two specimens taken near sea level respectively in Dusky Sound and Thompson Sound.

Unfortunately there appears to be no evidence in the case of these two first specimens of **Notornis** as to the month in which they were taken, although in the case of the first, Dr. Gideon Mantell's description (Mantell, 1850) refers to the "snow with which the ground was then covered," undoubtedly suggesting that this was in winter. This specimen, as is well known, was obtained by Dr. Mantell's son, Mr. Walter Mantell, from sealers "pursuing their avocations in Dusky Bay."*

Neither have I been able to find evidence of the season in which the third was captured in 1879 south-east of Lake Te Anau.† It remains an interesting conjecture as to whether this and the 1884 specimen found as a skeleton in the same area (Parker, 1886) had been driven down from higher level or were from colonies which were locally resident. It is of interest to note in relation to these early specimens Benham's comment, quoted by Buller (1905) in a description of the capture of the fourth specimen in the "Otago Daily Times" of 23rd August, 1898:— "Like its predecessors, it was caught in winter on low-lying grounds near the water; but there is no doubt that it lives usually in the higher and rougher bush, and that it was probably driven down to the water's edge by stress of weather and the consequent difficulty of getting enough to eat."

The fourth specimen is of especial interest as it evidently might have come from the colony rediscovered by Dr. Orbell. This specimen was a young female (Benham, 1899 a, b); and in the article quoted above (Buller, 1905) Benham notes that "though thoroughly healthy in every way, there was no fat in the body such as one finds in a normally well-fed bird." The same author's reference (1899 b, p. 151, footnote) to a report on the gizzard contents by G. M. Thomson is significant in relation to winter feeding habits and may be given in full: "Mr. Thomson writes to me as follows: 'It is almost certain that the bird has fed chiefly on species of **Carex** and **Uncinia** (cutting-grasses), and what strengthens this view is that these plants are particularly common at the edge of the bush. . . . At the same time, there probably are some pieces of true grasses among the debris, but I looked at over a score of pieces and they all belonged to the Cyperaceous type."

* Dr. R. A. Falla has commented that at this time, c 1849, sealing was being carried out in winter in the south-west Sounds.

† After "exceptionally severe" weather (Buller, 1882, p. 240).

Thus as regards the data provided by this fourth specimen the point stands out that the marshy vegetation of the lake shore, despite the distance which the birds would travel, might well form an attractive source of food in winter while snow is in the Valley. Alternatively this particular specimen, a young bird, might, in accordance with Dr. Falla's suggestion (see his account in this issue) have wandered further afield than would the adults of the breeding population.

As regards the preservation of **Notornis**, the possibility that the birds disperse to a considerable distance and to lower levels gives support to the setting aside of the present large area of protective reserve.

BRIEF GENERAL NOTES ON BIRDS.

Kiwis were heard at night from the camp, and footprints and borings seen in the Valley. The double kiwi call, heard after experience of **Notornis**, seemed closely similar but the end whistle sounded slovenly and more drawn out in comparison.

A pair of grey ducks was seen in both Takahe and Point Burn valleys; and at least one pair of blue ducks in Takahe Valley, feeding in the rapids, from which their whistle could be heard after dark—this species was once seen at the head of the lake, although this may have been the same pair. One scaup was observed on the unfrozen water at the eastern end of the lake.

Single pigeons were recorded on two occasions. There was at least one kea close to the camp, calling from the southern limestone cliffs and once investigating the camp at close quarters.

The bush birds most frequently observed were rifleman and brown creeper, the latter, although not plentiful, being heard constantly in the beech forest, especially towards the eastern end of the Valley; the chirping note was that commonly heard, but on several occasions a creeper was noted singing quite strongly. Bellbird and yellow-breasted tit were noted only occasionally, and in fine weather passing between Takahe Valley and the Point Burn we heard the trill of a grey warbler strongly delivered.

One pipit was recorded on the swampy ground at the head of the lake.

Of introduced birds, chaffinches were heard in full song (the penetrating breeding-season call was noted near the shore of Te Anau). Redpolls were heard on the ridge between the Valley and the Point Burn; and a flock of 5-6 yellowhammers seen on the Point Burn flats. The full song of the hedge sparrow was heard several times by the camp.

Nothing was seen of paradise duck, robin, fantail, blackbird and song thrush recorded during the January visit, or of the orange-wattled crow, although a careful watch was kept for this species. On the other hand, the above represents a fairly well-established bird list for this high valley in winter, and it is noteworthy that the full song of two early-breeding species, hedge sparrow and chaffinch, was already to be heard.

On the trip down to Lake Te Anau there was a fairly marked increase in the amount of song, and apparently in the numbers of bush birds. Towards lower levels bell birds were heard more frequently and a kaka was noted; a flock of goldfinches was also observed.

ACKNOWLEDGMENTS.

I take this opportunity of thanking Mr. G. F. Yerex, officer-in-charge of the Wildlife Branch, Department of Internal Affairs, for giving me the opportunity of joining the party and of taking part in the work on **Notornis**. My thanks are due also to Mr. B. A. Vercoe, Conservator of Wildlife, Queenstown, for his kind assistance.

FOOD OF THE CHICK OF NOTORNIS HOCHSTETTERI.

By L. Gurr, Nelson.

The following observations were made during a visit to the nesting area of **Notornis hochstetteri** from 1st to 11th December, 1949. Adjacent to the nest the parent birds scrape up with their claws the sphagnum and tussock bases in search of insects and other animal food for the chick. These "scrapes" (see Plate XXVI.) cover areas up to six or eight square yards, and are quite unlike the normal evidence of feeding of the adults. The presence of these scrapes is an indication that a young chick is being fed in the locality. Three other pairs of birds were under observation, two had nests with eggs and the breeding status of the third pair was doubtful; in none of these birds' territories were feeding scrapes found.

A freshly dropped faecal pellet of the chick (age one week) belonging to the territory where the scrapes were found was collected. This measured approximately 40 x 5 mm., was cylindrical and pointed at both ends and consisted of a loosely bound wet mass of chitinous animal matter with a small amount (about a quarter of its bulk) of vegetable matter. Its colour was brownish black. A subsequent examination of the faecal pellets revealed the following recognisable animal remains:—

Insecta—
Diptera—Calliphora sp.—2 larvae, 3 pupae.
Tipulidae—1 pupa.
Tabanidae (?)—36 black eggs.
Lepidoptera—1 pupa, 1 larva.

Arachnida—
Opiliones—2.
Araneida—1

Annelida—
Oligochaeta—Several Plagiochaeta sp. fragments of skin.

The vegetable matter was mainly very finely divided snowgrass **(Danthonia sp.)**

In order to check the available fauna of the feeding area, collections were made in the sphagnum and tussock bases adjacent to the scrapes. The results of which, in order of abundance, were:—

In Sphagnum.

Insecta—
Diptera—Tipulidae larvae and pupae.
Tabanidae larvae.
Annelida—
Oligochaeta—Plagiochaeta sp.

In Tussock Bases.

Insecta—
Coleoptera—Tenebrionid sp. adults.
Lepidoptera cocoons.
Myriapoda—
Chilopoda—centipedes.

All the above with the exception of centipedes were represented in the faecal pellet.

Mr. C. A. Fleming, in February, 1950, collected a chick faecal pellet, which must have been from a chick approximately two months old at that time, and kindly submitted it to me for examination. It was cylindrical and tapered at either end and measured approximately 60 x. 8 mm. It consisted entirely of vegetable matter, mostly leaf bases of snowgrass, and except in shape and size was the same as an adult faecal pellet. The animal diet of the young chick had by this time been forsaken for the entirely vegetable diet of the adult.

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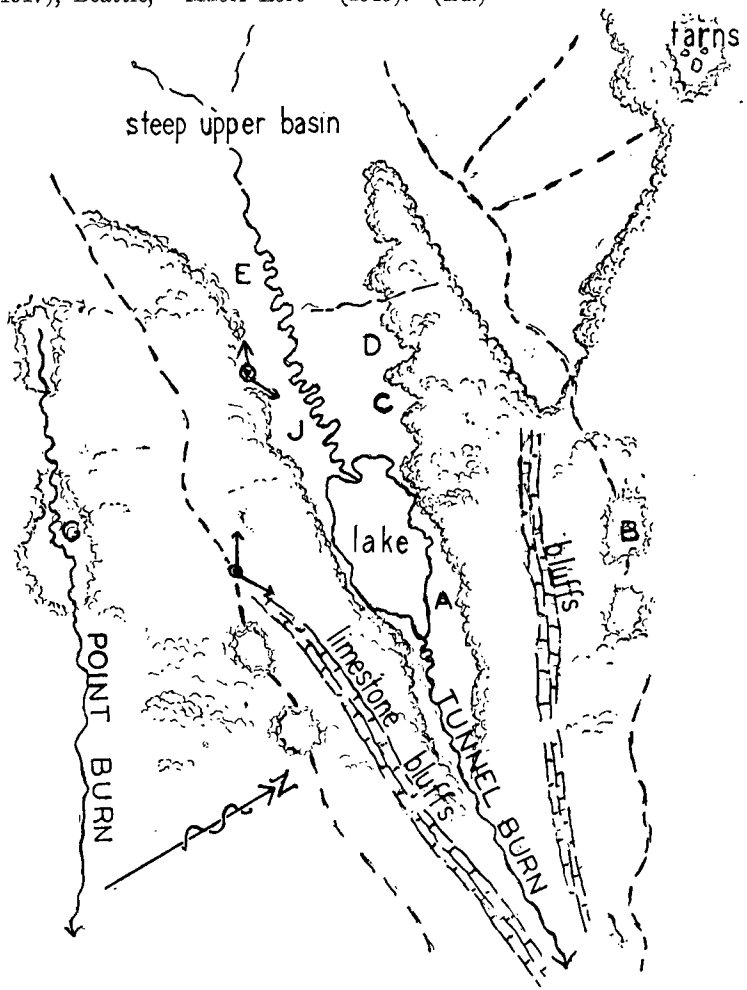
NOTE.—"Takahe" and "takahea," probably local variations of the name, are both used in literature: see Williams, "Dictionary" (1917), Beattie, "Maori Lore" (1945).—(Ed.)



SKETCH MAP OF THE UPPER TUNNEL BURN AND POINT BURN VALLEYS, showing ridge-tops (broken line), limestone bluffs, bush edges and location of Notornis pairs during 1949-50 breeding season. Panoramic photographs were taken from the points marked with circles and arrows. Notornis territories marked A—J (see text). Based on sketch map by officers of the Department of Internal Affairs. Scale (very roughly) one inch equals 140 chains.

PROTECTION OF NOTORNIS.

The following communication, dated April 23, 1951, addressed to the secretary of the Ornithological Society of New Zealand from the Secretary for Internal Affairs, Mr. A. G. Harper, sets out the position regarding the protection of the **Notornis**:—

"As you are aware, a large area of the Fiordland National Park was given special protection after the rediscovery of the takahe in 1948. Before entry into this area can be effected a permit is required from the Commissioner of Crown Lands, Invercargill.

"Within this area is the known breeding ground of the takahe. At a recent meeting of a committee advisory to this Department on rare birds the absolute necessity for unauthorized persons to keep out of the valleys in question was emphasized. This prohibition is an essential part of the work being carried out in an endeavour to preserve the birds. It would be greatly appreciated if your organisation could give all possible backing to the restrictions in force by using its influence in the bringing of this necessity for co-operation with the authorities to the notice of members.

"It may be of interest to your Society to be informed briefly on the protective measures which have been taken. First of all there was the setting aside of the large area of Fiordland National Park as a special reserve for the birds, pending the fixing of their range.

"Secondly, under the legislation setting aside the area there was the restriction on entry, unless authority was obtained from the appropriate person to whom the powers of the Minister of Lands were delegated. This Department's Ranger at Te Anau is in the position to keep a check on persons going across the lake, either privately or as tourists on the tourist launch which takes visitors to the Glow Worm Cave situated in the prohibited area. The Ranger also supervises the running of tourists to the cave to see that advantage is not thereby taken by persons to proceed further afield than the caves or to stay longer within the time allowed for this.

"Thirdly, a Field Officer of the Wildlife Branch has been carrying out guard duties in the takahe country for a good proportion of the year to see that there is no interference with the birds through unauthorised entrance. Fourthly, this Field Officer, Mr. Woodrow, has carried out control work with respect to the introduced animals found in the area. This has involved the destruction of stoats by trapping in such a manner that there is no likelihood of the **Notornis** or other ground birds being caught; the snaring of deer so that there is no possibility of the birds being disturbed by shooting and finally the trapping of opossums in the restricted areas where they occur. Fortunately there is no evidence that either rats or cats exist in the known **Notornis** range.

"Fifthly, officers of the Wildlife Branch have been active in reconnaissance work in an endeavour to fix limits to the habitat of the birds. This has involved numerous expeditions into valleys along the whole western side of Lake Te Anau for which suggestions have emanated that the birds might be present. During last spring and summer Mr. Woodrow continued with this reconnaissance as he was able to fit it in with his guard duties. With work previously done by other officers, the birds are now known to occur in seven valleys, while there is an area of country lying between these valleys which has still to be covered. The known number of birds has also been greatly increased to somewhere between thirty and forty and the valleys in which the birds are known to breed are now known to be four, instead of one, with a possible further valley.

"Further work will be planned after the next meeting of the Rare Birds Advisory Committee."

STILTS NESTING AT ARDMORE, 1950-51 SEASON.

By A. F. Stokes, Ardmore, Papakura.

One pair of stilts nested on my farm this season (1950-51). The first nest met with misfortune. The female had been incubating for 24 days, when, on September 29, 1950, a cow ran over the nest and broke all the eggs. The birds were not to be deterred, however, for on the ninth day after the loss of the first clutch, a new nest had been made and an egg laid.

The four eggs were laid on October 8, 9, 10 and 11. The first three eggs were marked on the days they were laid, the fourth it was not necessary to mark. Incubation commenced early on October 10.

Hatching.—November 3, at 7.30 a.m., two chicks, Nos. 2 and 3, had hatched and left the nest, while No. 1 had just broken open the egg, the marked shell still adhering to the chick. The fourth egg was not then chipped, but it hatched on November 4 at noon.

Flying.—November 29, young birds stretching wings. December 1, one flew five yards. December 2, one flew about four chains, one three yards and the other two ran. December 3, three flying. December 4, three flying strongly, the other missing. (It was not seen again.) December 6, now flying freely. December 7, the family departed.

The incubation period, including October 10, was 25 days for each chick; No. 4, of course, one day behind the others as to beginning of incubation and hatching.

The hatching to flying period was 29, 30 and 30 days, taking December 2 for one and December 3 for the other two as their first days of flight. It is, of course, not known which bird was lost. If No. 4 survived, then one day would have to be deducted from one of the tallies.

Both incubation and hatching to flying periods are normal according to the records shown in "N.Z. Bird Notes," Vol. 3, No. 4, p. 108.

This was a very fine brood, even in size, active and healthy. As small chicks they behaved in a manner I had not previously witnessed. When feeding they were seldom more than one yard apart and often kept so closely together as to touch each other. Usually chicks scatter widely, only coming together to be brooded by a parent when cold or needing rest.

REVIEW.

The Moas of New Zealand and Australia, by W. R. B. Oliver. Dominion Museum Bulletin, No. 15, Wellington, 1949.

This book marks an important advance in the study of the Dinornithiformes. Until it appeared, the standard work was Dr. Gilbert Archey's "The Moa," (Auckland, 1944). Dr. Oliver's conclusions differ in many particulars from those of Dr. Archey.

The book under review begins with a summary of the history of the discovery of moa remains and a survey of the chief deposits. It goes on to consider the moa's structure and classification, follows this with a description of the genera and species, and ends with a discussion of their habits, origin, evolution and geological history, and a very useful bibliography, arranged according to subject. Incidentally, since no one is omniscient, neither the bibliographies of Archey nor Oliver, although very extensive, are complete, e.g., the second edition of Hutton's "The Lesson of Evolution" contains several pages of discussion and measurements of **Syornis casuarinus–Emeus crassus**, which they do not mention.

Dr. Oliver proposes several new species, sub-genera and genera and restores some species which Archey had suppressed, while rearranging others which had been founded on mixed bones. The new sub-genera for **Pachyornis** are **Mauiornis** and **Pounamua.** Two species formerly classified as **Eurapteryx,** the very broad-billed **exilis** and **haasti,** have been placed in a new genus, **Zelornis.** This new genus may not really be necessary, as **haasti** cannot be separated from **gravis** except by mandibulary and pre-maxillary characters, but I consider Archey was wrong in suppressing **haasti,** which he regarded as synonymous with **gravis.** The Canterbury Museum collection contains, as well as the type of

haasti, a number of crania, premaxillae, and mandibles which leave no doubt as to the necessity of recognising the specific distinction, and one very old, massive skeleton from Central Otago (A.V. 8427) lacking only the mandible, tarso-metarsi and one set of phalanges. This skeleton has the tracheal rings largely fused, with a very pronounced loop, and confirms the 3-4-4 phalangeal formation suspected, but not hitherto known for this species.

Oliver regards **Pachyornis pygmaeus**, which Archey accepts, as synonymous with **Euryapteryx geranoides**. In **Pachyornis** the new species are **septentrionalis**, **murihiku**, and **australis**, and in this genus Oliver places the part femur from the Queensland Post-Tertiary, described in 1884 by De Vris as **Dinornis queenslandiae**. Dr. Oliver examined this bone and publishes five clear photographs of it.

In **Euryapteryx** there is one new species, **tane**, and as mentioned above, **exilis** and **haasti** are transferred to **Zelornis**. Because the leg sizes of **Anomalopteryx didiformis** and **A. parvus** were connected by intermediate measurements, Archey placed them both under **A. didiformis** and transferred **oweni** to **Pachyornis**. Oliver restores **oweni** to **Anomalopteryx** and recognises both **parvus** and **didiformis**, while acknowledging the overlapping in size between the two latter, mainly because the typical **parvus** is small and slender, while **didiformis** is stoutly built. In the Canterbury Museum material I have noticed differences in the crania and pelves as well as the legs, which incline me to believe that Oliver may be right.

On the other hand, Oliver also separates **Megalapteryx didinus** from **M. hectori**, which Archey had united, but on examining a series of leg-bones of this genus from Notornis Valley, Te Anau, I found a continuous range from below the smallest **hectori** measurements given by Archey or Oliver, up to the **didinus** size. The smallest and largest of the tarso-metatarsi, for example, when contrasted looked very different, but no significant break in size could be seen in the intermediate bones.

In **Dinornis**, **gazella** and **hercules**, are new species, **hercules** being founded on a tibia and a few other bones. Reviewing the history of the classification of the moa and having recently untangled in Canterbury Museum the confusion of the past which had resulted in specimens of the same species being labelled under three or four names and the same name being applied to more than one species, I am suspicious of new species founded on size differences alone. Dr. Oliver removes **Pachyornis** from the sub-family **Anomalopteryginae**, mainly because of the character of the pre-orbital plates, and transfers it to **Emeinae**. With this I can hardly agree. The general character and proportions of the skull, particularly those of the temporal fossae and ridges, pre-orbitals, squamosals and the structure of the pre-maxilla and mandible of **Pachyornis** are much closer to **Anomalopteryx** than to **Emeus** or **Euryapteryx**; also, although this point may not be so important, **Pachyornis** has the usual 3-4-5 phalangeal formula, whereas **Emeus**, **Euryapteryx** and **Zelornis** are distinguished by the 3-4-4 formula.

Another point of disagreement is fig. 22, a photograph of the first egg found at the Wairau Bar moa-hunter burial ground and now in the Dominion Museum. The caption reads "Egg of **Pachyornis elephantopus (?)**. . ." and it is listed as such in the text. As, however, nearly all the moa remains from Wairau Bar are of **Euryapteryx gravis** and as so far no **Pachyornis** has been found there, the egg is very probably that of **Euryapteryx gravis**, as are the other Wairau Bar eggs. It has the characteristic longitudinal pitting of **gravis**.

The book is remarkable for the numerous photographs and line-drawings which illustrate it, and which add greatly to its usefulness. The generic and specific descriptions are carefully worked out—a great deal of work has been devoted to the skull—the lists of measurements are in the main adequate, and it is indispensable for anyone working on the moa. It is also of considerable interest to ornithologists in general.—R. J. Scarlett.

Date of Publication.—July 1st, 1951.
The Masterton Printing Co., Ltd., Lincoln Road, Masterton.

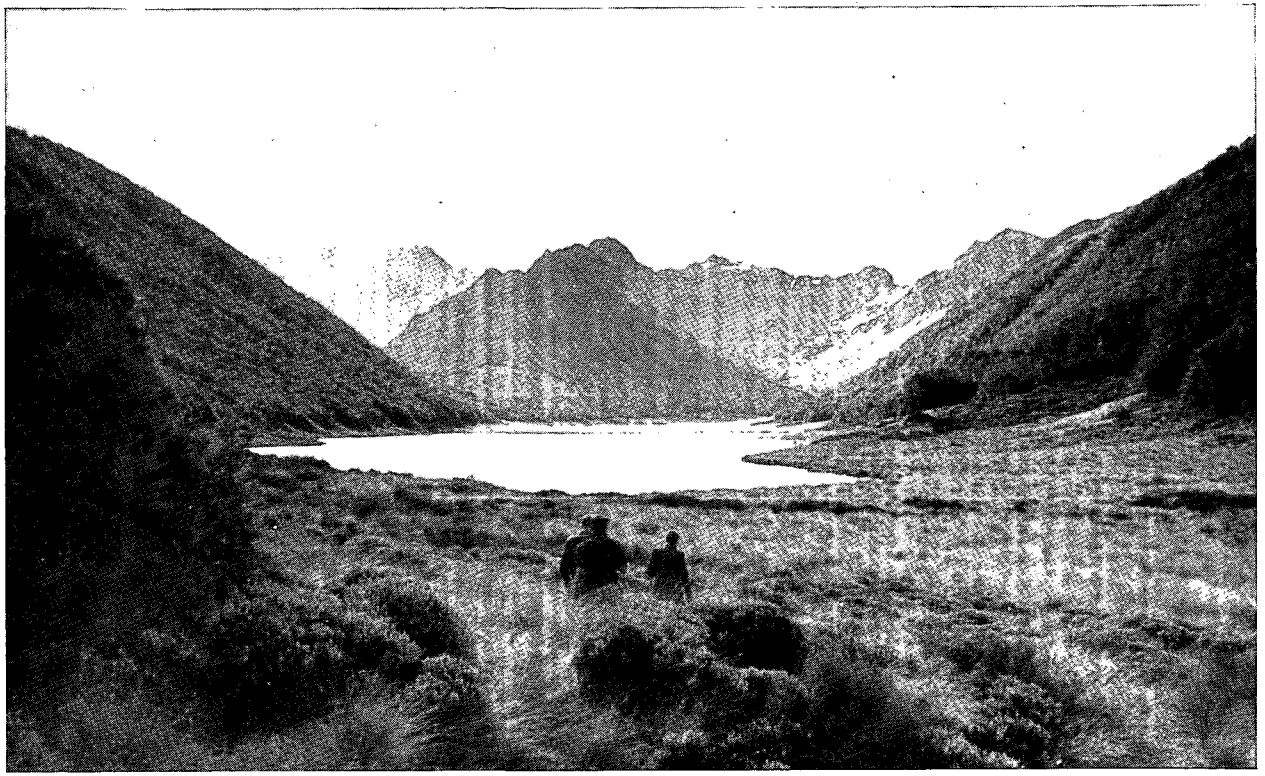


Photo: National Publicity Studios.

TAKAHE VALLEY.