Morphological variation in New Zealand brown teal *(Anas chlorotis)*

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Abstract

Detailed examination of brown teal skins shows that there is substantial geographic variation in plumage characters within the species.

The two surviving populations are distinct from each other. Extinct populations from the southern North Island were very similar to extant populations in the north of the North Island. However, minimal information on extinct populations from the northern South Island makes it difficult to reach formal taxonomic conclusions at present. There are insufficient specimens available from this area for us to distinguish between clinal and discrete population variation.

Males from the southern South Island have significantly smaller bills than those from the northern North Island, despite not being detectably different in four other standard measurements. Statistical comparison of morphological measurements of mainland populations is hampered by small sample sizes.

A three-month difference in seasonal cycles between North Island birds and those from the southern South Island supports indications of taxonomic distinction from the plumage and bill size differences.

A by-product of this work has been the discovery that the brown teal that once inhabited Chatham Islands were a distinct taxon.

1. Introduction

Brown teal were once common and widely distributed in New Zealand. Currently there are relatively well known natural populations in Northland and on Great Barrier Island and perhaps elsewhere in the northern North Island. There is also a far flung remnant in Fiordland. Field observations in Fiordland show the males there to be much brighter in colour than those in the north, and they seem to have smaller bills and a rounder head. The females appear to be a paler brown and the eye ring is less contrasting (I.S. pers. obs.). Museum skins were examined to investigate the possibility that these two populations are taxonomically distinct.

2. Methods

2.1 PLUMAGE CHARACTERS

Brown teal skins in New Zealand museums were examined for definable characters that varied within the species (Appendix 1), and these were scored for

each bird. Such characters were found only in males in breeding plumage. Differences in the intensity of colour between females from northern and southern populations apparent in the field could not be defined discretely in skins. Only those skins with clear locality data on the labels were used in the analysis. These locations were grouped into broad geographic localities for analysis. These characters were also scored in some related dabbling ducks which were used as outgroups. Particular attention was paid to the two species of flightless teal, as recent studies have shown some differences in the details of their relationships to each other and to brown teal (Kennedy & Spencer 2000).

2.2 ANALYSIS OF PLUMAGE VARIATION

Male breeding plumage variation at the population level in the above characters was analysed cladistically using the PAUP*4.0b4a package. Bootstrap support for the tree structure was assessed using 1000 bootstrap replicates and heuristic maximum parsimony searches. Distribution of individual variation was also assessed using a bootstrapped (1000 replicates) neighbour-joining analysis of all individuals.

2.3 MEASUREMENTS

Standard measurements (bill-culmen, tarsus, mid-toe and claw, wing cord, and tail lengths), were taken from the museum skins where possible. From the bill, only length was taken as there was often obvious distortion in width and depth.

2.4 ANALYSIS OF MORPHOLOGICAL MEASUREMENTS

There were too few females with full sets of data for statistical analysis. Male measurements were analysed using the SYSTAT 8.0 package. Multivariate analysis of variance (MANOVA), canonical discriminant analysis, principle components analysis, and cluster analysis were carried out on the male measurements. Differences in bill length between the extant populations were tested using a paired sample t-test.

3. Results and discussion

3.1 PLUMAGE

Parsimony analyses of plumage characters (Appendices 1, 2, 3) produced a tree with only low bootstrap support values for major groups (Appendix 4). This is because the number of variable characters is low, and polymorphism

of these characters within populations is high. This has the effect that even populations with very similar character states, such as the two North Island populations (see below) are grouped together with surprisingly low bootstrap support.

The two populations of teal from the North Island have male breeding plumage character-states which differ only in the presence/absence of extreme states of characters which vary within both populations (Appendix 2). This similarity is reflected in a lack of branch length between them in the phylogram (Appendix 4) generated from the bootstrapped parsimony analysis. Small sample sizes do not allow the significance of this frequency variation to be formally assessed. Birds from the south do appear to be brighter in colour.

The sister group to the North Island birds is the extinct population from the Chatham Islands. There are three plumage characters, only one of which (character A3) is included in this analysis, that are found on Chatham Island birds but not on any from teal from the main islands. Character A3 is breast feathers of breeding males with the subterminal spot completely or partially connected to the greyish base. These markings are clearly separated in all other teal if apparent at all (some flightless teal). The second diagnostic character is the width of the white bar on the posterior edge of the speculum: extent of white on the inner vane of the tips of feathers one half to about equal that on the outer vane (on mainland birds it is 1/3 to absent). It is apparent on all birds regardless of moult or sex. The third character is the flank feathers of males in breeding plumage with mid brown centres and paler tips with a blackish subterminal bar. Some northern North Island birds have these feathers as in eclipse plumage without the subterminal bar, and most have fine wavy bars, alternately chestnut and blackish (vermiculated). Chatham Island teal resemble teal from the northern North Island, in particular in having spotted not barred shoulders and blackish brown crowns without any trace of the warmer brown tone found on South Island, Auckland Island and some Campbell Island teal. The extinct Chatham Islands population is therefore readily diagnosable as a separate taxon.

There was only one labelled skin in breeding plumage from the northern two-thirds of the South Island, from Lake Ellesmere (CM 2996). This bird is an interesting combination of characters. It is superficially like birds from further south but in detail has two characters (D1, H1) more typical of North Island birds and is intermediate for another (E1). It is impossible to know if this bird is typical of the area, or how much individual and geographic variation formerly existed in the northern South Island. Because only a single specimen was included, this population could not display the polymorphism recorded for many characters in other populations, and this created potential problems with the parsimony analysis; the phylogenetic position of this specimen should be accepted with caution.

There is a better sample of skins from the southern South Island and, especially when the Canterbury bird is excluded from the analysis, they are quite distinct from other mainland birds. They are diagnostically different from northern North Island birds in characters C (chin pattern), H (collar marking), and K(thigh patch). The characters that set them apart from other populations of brown teal are also generally found in the flightless teal, suggesting

that they are ancestral in origin. This is reflected in their position near the branching point between subantarctic and other mainland populations in the phylogram (Appendix 4).

3.2 MEASUREMENTS

Measurements of teal used in these analyses are presented in Appendix 5. The analysis of these measurements was hampered by small sample sizes, even of the extant populations. Only the males had a large enough sample for meaningful comparisons, and the results of these analyses refer only to them. The multivariate comparisons revealed no significant differences between the mainland populations but indicated that there was more variation in bill length than in the other measurements. A t-test of bill lengths of birds from the northern North Island and southern South Island (Appendix 5) showed that southern birds had smaller bills than those from the northern North Island, and the difference was almost significant ($p=0.06$). One of these North Island birds has a bill length substantially shorter than the others and should be checked in case of measurement error. Excluding this bird, the difference becomes highly significant ($p<0.01$). The enigmatic bird from Lake Ellesmere, and another in eclipse plumage from Marlborough (MNZ 2175) have a larger bill more like North Island birds.

3.3 SEASONAL CYCLES

The breeding cycle of brown teal in the northern North Island is fairly well known. While eggs can be found at almost any time of year there is a definite late winter laying season with a peak in July and August (Marchant & Higgins 1990). In Fiordland nests with eggs have been found on 4 Dec90 and 10 Dec 99 U.S. pers. obs.) and a clutch was collected at Lake Ada in December 1903 (MNZ 7439a-b). Reports of birds with chicks also suggest a spring breeding season (brown teal database, Department of Conservation,Te Anau).

Post-breeding moult in brown teal from northern New Zealand mostly occurs in October with a few as late as January or February. The pre-breeding moult occurs from January to February (Marchant & Higgins 1990). In Fiordland, males in breeding plumage have been observed from July to November. All males seen in December (n=5) and some in January have been in some stage of moult ranging from a small patch of brown feathers to fully flightless. The post-breeding moult seems to take place in December and probably January. Males in eclipse have been seen as late as February (I.S. pers. obs.). There is a dated skin in breeding plumage in April (AMNH 731927), which suggests a pre-breeding moult occurs about March.

There is a little historic information on the extinct populations from the southern North Island. At Hawera a collector mentioned seeing a teal with five young on 27 Jul 1912 and "half grown young" a month earlier (Drummond 1912). Guthrie-Smith (1910) records a flock "in mature plumage" on Lake Tutira "on January 1st and weeks after that date." Presumably this refers to males in

breeding plumage. These dates are consistent with northern North Island birds but not with the Fiordland population.

The information available on the timing of both laying and moult suggests a difference of two or three months in the seasonal cycles of birds from the North Island compared with those in Fiordland.

3.4 TAXONOMIC STATUS OF MAINLAND POPULATIONS

Brown teal from the extreme ends of their range are easily distinguished in terms of the plumage characters examined here and, to a degree, by bill size. Also there is a three month difference in their seasonal cycles. On the basis of this there is a case to be made from taxonomic separation. In plumage characters, at least, they are more distinctive than the two taxa of flightless teal. The situation is complicated by the extinct populations. Birds from the southern North Island are indistinguishable from those in the extant populations in Northland and on Great Barrier, except that males in breeding plumage seem to have been brighter in colour. If there is taxonomic differentiation, the North Island birds should be regarded as a single taxon.

The taxonomically distinct population from the Chatham Islands is a sister group to the North Island birds, and the South Island birds lie outside of them in cladistic analyses of plumage variation (Appendix 4). The mainland teal (if regarded as a single taxon) are paraphyletic with respect to the Chatham island teal. To overcome this problem and define monophyletic taxa, the best resolution is by regarding the North Island and Chatham Islands populations as taxa of equal rank, most closely related to each other with the South Island populations consisting of one or more taxa.

The largest problem is the allocation of the populations that once inhabited the northern South Island. The single specimen examined is fairly distinctive but it is difficult to know if it is typical of the populations that lived there. It shows characters consistent with birds to the north and south and is difficult to place with the existing information. It may be part of either of the other populations showing further geographic variation but it could represent a distinct entity. Birds often show a taxonomic break at Cook Strait but not always. Recent work on brown kiwi *(Apteryx australis* complex), for instance, show that there is a more important divide in Westland than at the strait in at least some cases, and the white-flippered penguin *(Eudyptula minor albosignata)* is a Canterbury endemic.

4. Acknowledgements

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5. References

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Marchant, S.; Higgins, P.J. (eds) 1990. *Handbook of Australian, New Zealand and Antarctic birds*. Vol 1b. Oxford University Press, Melbourne.

Appendix 1: Plumage characters coded

A. Breast spots

The breast is chestnut in colour with dark spots, small and sometimes hard to see on the upper breast but becoming larger and more obvious lower down. On each feather there is usually a subterminal blackish spot separated from a greyish base. These spots tend to widen laterally towards the shoulders and belly; feathers within a few centimetres of the neck, near the midline are coded as follows:

0. Spots discrete, more or less round, width about equal to depth.
1. Spots larger, all or most with lateral extensions almost to the margins of the feather.
2. No obvious spots, feathers chestnut with indistinct grey freckling.
3. Spots with no lateral extension but completely or partially connected to the base to form a central stripe.
4. No spots

B. Pattern on shoulders

The breast is chestnut and the back dark brown with paler feather markings. The patterning on the chestnut feathers at the border of these two areas can be either of two character states:

0. A single broad subterminal dark bar, a finer chestnut bar and then a greyish base. The overall effect is of the dark spotted breast merging into the pattern on the back. The colour pattern on the back always continues to the base of the neck.
1. A fine subterminal dark bar, a slightly wider chestnut bar and up to five more fine dark bands alternating with chestnut bands of similar width. These feathers are an extension of the finely banded (vermiculated) sides, and this pattern often continues behind the neck to meet so that the pattern on the back does not meet the base of the neck.
2. Intermediate.

C. Chin pattern

The cheeks are a fairly even dark brownish grey and the chin may be either:

0. Dark grey in the New Zealand teal, or similar to the cheeks in these and other species, although pale feather bases may show through probably as an artefact of skin preparation. There may be a buff edge at the base of the bill.
1. Buffy with indistinct grey brown mottling, paler than the cheeks.
2. Intermediate.

D. Under tail coverts

The under tail coverts are basically black but with chestnut tips and outer edges, especially laterally.

0. Generally blackish, especially in the centre. Outer margins of the lateral feathers may be buff or chestnut, tips are chestnut.
1. Definitely browner, especially in the centre. All tips and margins of the feathers chestnut.

2. Intermediate between 0 and 1.
3. Totally black.

E. Belly pattern

The extent of the belly pattern may vary; the character coded here refers to the area between the legs on a study skin although it may be more extensive.
0. Appears barred.
1. Intermediate.
2. Appears spotted.
3. Finely freckled blackish and whitish.

F. Iridescence on the head

0. Extensive and bright green.
1. Usually bright, at least a trace on the nape.
2. No iridescence detectable on the nape.
3. No detectable iridescence.

G. Collar

Some brown teal have a collar between the neck and breast extending around only the front half of the neck.
0. Collar obvious, white to pale rufous.
1. Collar darker, visible though care may be needed.
2. Not discernible.

H. Crown colour

The pattern on the crown is distinguishable from that on the face of the brown teal group by having a fine pale fringe on each feather and often a browner tone.
0. Crown may be blackish brown at the forehead, becoming a warmer brown especially toward the nape.
1. Blackish brown from forehead to nape.
2. Intermediate between 0 and 1.
3. No differentiation between the colour of the crown and the face and chin.

I. Green gloss on the rump, secondaries and wing coverts

0. Present
1. Absent

J. Whitish patch on belly

0. Obvious
1. Poorly defined
2. Absent

K. White thigh patch

0. Bright and obvious.
1. Discernible but dull.
2. Not discernible.

L. Eye ring

0. White eye ring absent.
1. White eye ring present.

M. Anterior bar of speculum

0. Narrow, chestnut in colour.
1. Broad, white in colour.

N. Speculum

1. Bright glossy green and black with a chestnut anterior bar and a white posterior bar.
2. Poorly defined, with reduced colour and barely visible anterior and posterior bars.

O. Inner margin of the primaries and secondaries with a paler brown border up to 1 mm wide

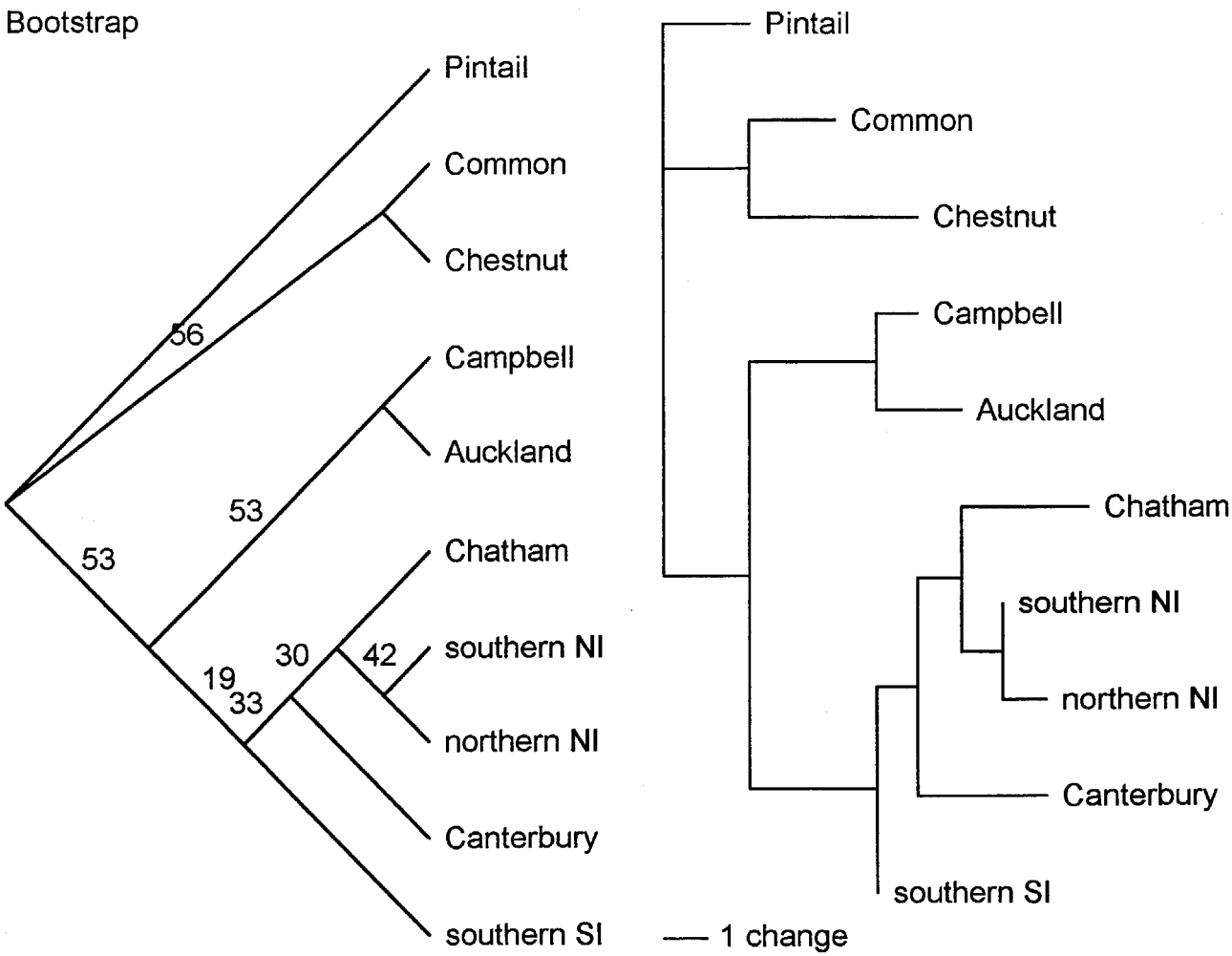
1. Absent
2. Present

Appendix 2: Individual character states for plumage characters (for character definitions see Appendix 1). Museum abbreviations: AIM, Auckland Institute and Museum; AMNH, American Museum of Natural History; BM, British Museum; CM, Canterbury Museum; MNZ, Museum of New Zealand; SD, Southland Museum (informal tag numbers).

Character	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Pintall															
AIM B 948.5	4	1	0	0	0	2	2	0	0	0	2	0	0	1	1
AIM B 948.9	4	1	0	0	0	2	2	0	0	0	2	0	0	1	1
Common teal															
AIM B 94591	0	1	0	3	0	1	2	3	0	0	1	0	1	1	1
Chestnut teal															
MNZ 22359	0	0	0	3	2	0	2	3	0	2	2	0	1	1	1
MNZ 22090	0	0	0	3	2	0	2	3	0	2	2	0	1	1	1
Campbell 1															
MNZ 14752	2	1	0	1	0	0	2	2	1	2	0	1	0	2	2
MNZ 25584	2	1	0	1	0	0	2	1	1	0	1	1	0	2	2
MNZ 24051	2	1	0	1	0	1	2	1	1	1	0	1	0	2	2
Auckland 1															
MNZ 1305	2	1	0	1	0	1	2	0	1	1	0	1	0	2	2
MNZ 2196	2	1	0	0	0	1	2	0	1	1	0	1	0	2	2
MNZ 2203	2	1	0	1	0	1	2	0	1	0	0	1	0	2	2
MNZ 13056	2	1	1	1	0	1	2	0	1	0	0	1	0	2	2
MNZ 12778	2	1	0	1	1	1	2	0	1	1	0	1	0	2	2
MNZ 2201	0	1	0	.	0	1	2	0	1	1	0	1	0	2	2
MNZ 2195	2	1	0	0	0	1	2	0	1	0	0	1	0	2	2
AIM B 03479	2	1	0	2	0	1	2	0	1	0	0	1	0	2	2
BM 1901.10.21.55	2	1	0	2	0	1	2	0	1	1	0	1	0	2	2
BM 1949.64.129	2	1	0	0	0	1	2	0	1	0	0	1	0	2	2
BM 94.10.23.5	0	1	0	1	0	1	2	0	1	0	0	1	0	2	2
Chatham Is															
AIM B 3467	3	0	0	1	2	1	0	1	0	0	2	1	0	1	1
AMNH 731937	3	0	0	1	2	1	0	1	0	1	2	1	0	1	1
AMNH 731940	3	0	0	1	2	1	0	1	0	0	2	1	0	1	1
AMNH 731938	3	0	0	1	2	2	0	1	0	2	2	1	0	1	1
southern SI															
AIM B1341.1	0	1	0	0	0	0	0	0	0	2	2	1	0	1	1
CM Av 1571	0	1	0	1	0	1	0	0	0	2	.	1	0	1	1
SD 5	0	1	0	0	0	0	2	0	0	2	2	1	0	1	1
MNZ 23243	0	1	0	1	0	1	1	0	0	2	.	1	0	1	1
MNZ 2168	0	1	0	0	1	1	0	2	0	2	.	1	0	1	1
BM 52.1.17.29	0	1	0	0	0	0	0	0	0	2	2	1	0	1	1
AMNH 731927	0	1	0	0	1	0	0	0	0	2	2	1	0	1	1
AMNH 424078	0	1	2	1	1	0	1	2	0	2	2	1	0	1	1
AMNH 731925	0	1	0	0	0	0	0	0	0	2	2	1	0	1	1
AMNH 731928	0	1	2	0	3	1	0	0	0	2	2	1	0	1	1
Canterbury															
CM Av 2996	0	1	2	1	1	0	0	1	0	2	2	1	0	1	1
southern NI															
CM Av 2994	0	0	1	0	0	0	0	1	0	2	.	1	0	1	1
MNZ 2166	1	0	1	1	2	1	0	1	0	2	.	1	0	1	1
MNZ 11396	0	0	1	0	2	3	0	1	0	2	.	1	0	1	1
AMNH 734617	1	2	1	1	1			1	0	2	2	1	0	1	1
northern NI															
MNZ 18730	1	0	1	1	2	2	2	1	0	2	0	1	0	1	1
MNZ 18728	1	0	1	1	2	2	2	1	0	2	0	1	0	1	1
MNZ 21491	0	1	1	0	2	1	0	1	0	2	0	1	0	1	1
AIM B 116.5 03468	1	0	1	1	2	3	2	1	0	2	0	1	0	1	1
AIM B 01559	0	0	1	0	2	1	1	1	0	2	0	1	0	1	1
AIM B 03469	1	0	1	1	2	2	2	1	0	2	0	1	0	1	1
AIM B154.1	1	0	1	1	2	1	2	1	0	2	0	1	0	1	1
CM Av 143	0	0	1	0	2	2	2	1	0	2	0	1	0	1	1
AIM B 3472	1	0	1	1	1	2	1	1	0	2	0	1	0	1	1
AIM B 03465	1	0	1	1	2	2	2	1	0	2	1	1	0	1	1

Appendix 3: Population character states for male breeding plumage characters, used in parsimony analysis. Characters are explained in detail in Appendix 1. Population ranges were generated by combining the values from all individuals in each population regardless of frequency. Outgroup character states (common teal and pintail) were added.

Character:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Pintail	4	1	0	0	0	2	2	0	0	0	2	0	0	1	1
Common	0	1	0	3	0	1	2	3	0	0	1	0	1	1	1
Chestnut	0	0	0	3	2	0	2	3	0	2	2	0	1	1	1
Campbell Is	2	1	0	1	0	{0,1}	2	{1,2}	1	{0,1,2}	{0,1}	1	0	2	2
Auckland Is	{0,2}	1	{0,1}	{0,1,2}	{0,1}	1	2	0	1	{0,1}	0	1	0	2	2
Chatham	3	0	0	1	2	{1,2}	0	1	0	{0,1,2}	2	1	0	1	1
southern SI	0	1	{0,2}	{0,1}	{0,1,3}	{0,1}	{0,1,2}	{0,2}	0	2	2	1	0	1	1
Canterbury	0	1	2	1	1	0	0	1	0	2	2	1	0	1	1
southern NI	{0,1}	{0,2}	1	{0,1}	{0,1,2}	{0,1,3}	0	1	0	2	2	1	0	1	1
northern NI	{0,1}	{0,1}	1	{0,1}	{1,2}	{1,2,3}	{0,1,2}	1	0	2	{0,1}	1	0	1	1



Appendix 4. Bootstrapped (1000 replicates) maximum parsimony (left) cladogram, with bootstrap support shown, and phylogram generated from data in appendix 3.

Appendix 5: Morphological data for male teal. Only male specimens with complete data were included in the statistical analysis. Museum abbreviations as in Appendix 2.

Specimen	Locality	Bill	Tarsus	Mid-toe	Wine	Tail	Population
Males							
AIM B 3467	Chatham Is	42.5	36.9	51.6	201	86.6	3
AMNH 731938	Chatham Is	40.1	35.4		209	93	3
AMNH 731940	Chatham Is	39.9	36.9		192	91.3	3
AMNH 731937	Chatham Is	42.1	39		196	87	3
CM Av 143	Rangiriri	38.7	41	56.3	198	87.7	4
AIM B 3473	Gt Barrier I	41.6	39.9	52.7	205	85.8	4
MNZ 21491	Waipu R	42.6	36.6		202	82.5	4
AIM B 3472	Mangawhai	43	42.2	53.4	208	91.7	4
AIM B 3465	Clevedon	43.1	39.1	54.2	199	88.2	4
MNZ 18728	Gt Barrier I	44	42.1	52.7	209	86	4
AIM B 3469	Remuera	44	40.6	54.4	212	93.4	4
AIM B 3468	Lake Waikare	44.2	38.8	53.3	201	91.6	4
MNZ 18730	Gt Barrier I	44.4	39.5	55.2	207	82	4
AIM B 1559	Kaipara R	43	37	55.9	206	90.9	4
AIM B 154	S. Kaipara Har.	46.8	40	58	210	109.1	4
BM 1910.7.7.197	Taupo	42.4	42.2	57.5	208	84.3	4
CM Av 2994	Marton	42.9	37.2		202	89	5
MNZ 2166	Waitohu	44.6	38.5	51.2	207	87.3	5
MNZ 11396	Wellington	41.8	39.8	51	200	78	5
AMNH 734617	Manawatu	44.5	38.5	53.2	193	89.5	5
CM Av 2996	L. Ellesmere	43.7	41.3		190	92	6
MNZ 2175	Marlborough	44.7	40	56	202	92.3	6
AIMB 1341	Mossburn	41.6	38.2	53.2	211	96.8	7
MNZ 2168	Otago	41.7	36.5	50	205	92.5	7
MNZ 23243	Otago	42.8	38.4	54.4	203	84	7
CM Av 1571	Otago	41.6	40.1	53.2	212	86.7	7
CM Av 2.A	Codfish 1.	41.2	38.1	51.8	181	90.4	7
CM Av 2.13	Codfish 1.	41.5	38.7	51.2	182	92.3	7
CM Av 17	Codfish I.	41.1	41	55.8	205	91.9	7
SD 5	"Totara, Southland"	42.7	38.6		200	90.5	7
BM 99.10.17.1	Doubtful Sd.	41.8	42.2	57.5	208	84.3	7
BM 99.10.17.4	Doubtful Sd.	44.3	42.5		197	85.7	7
BM 52.1.17.29	Foveaux Straits	41.5	39.8		203	84.3	7
AMNH 424078	"Diamond Lake, Wakatipu"	44.8	39.9	54.3	195	92.4	7
AMNH 731928	"Dome Mts, Otago"	40.6	38.5	52.6	218	98.7	7
AMNH 731925	"Wallistown, Southland"	41.9	41.3	57.6	210	104.3	7
AMNH 731927	Gore	41.6	40.4	54.4	202	95.7	7
Females							
AIM B 3475	Kaeo	38.8	38.6	52.2	186	77.3	4
AIM B 3476	Bay of Islands	37.4	37.8	53	182	77.1	4
AIM B 3474	Little Barrier 1.	39.1	35.6		190	84	4
AIM B 1568	Little Barrier I.	40.9	34.7		184	66.5	4
AIM B 292	Gt Barrier 1.	39.9	37.9	53.5	191	81.8	4
AIM B 3477	Hikurangi	38.1	37.7		186	66.8	4
AIM B 3466	Clevedon	36.5	35	50.4	182	77.3	4
MNZ 18729	Gt Barrier I.	38.6	41	50.2	195	77	4
MNZ 2174	Napier		40		198	79.1	5
MNZ 2178	Wellington	41	37.2	44.9	195	81.9	5
MNZ 2179	Wellington	40	37	52.3	185	78.2	5
CM Av 2993	Wellington	41.9	40.4		191	82.2	5
MNZ 2167	Milford	40.2	36.3		198	79.1	7
CM Av 1562	Otago	38.6	32.3	50.1	195	92	7
BM 52.1.17.30	Foveaux Straits	41.3	38.3	53	192	86.1	7
BM 99.10.17.3	Doubtful Sd.	40.1	37		171	70.5	7
BM 99.10.17.5	Doubtful Sd.	40.5	36.3	49.2	193	82.3	7
BM 99.10.17.2	Doubtful Sd.	39	38.6		160	65.5	7
AMNH 731926	"Wallistown, Southland"		38.7	50	194		7
AMNH 424079	Hakataramea Valley	37.8	39.5	53.5	195	86.2	7
AMNH 731939	Chatham Is prob. female	39.3	36		187	85.5	3

Appendix 6: Comparison of bill lengths of southern South island and northern North Island brown teal.

Group	N	Mean	SD
northern North Island	11	43.200	2.05
southern South Island	12	41.850	1.66

Separate Variance t = 1.990 df = 14.9 Prob = 0.065
Difference in Means = 1.350 95.00% CI = -0.097 to 2.797

Pooled Variance t = 2.041 df = 21 Prob = 0.054
Difference in Means = 1.350 95.00% CI = -0.025 to 2.725