Diagnostic morphometrics of the skink species, *Oligosoma maccanni* and *O. nigriplantare polychroma,* from South Island, New Zealand

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ABSTRACT

We examined 124 specimens of the partially cryptic species, *Oligosoma maccanni* and *Oligosoma nigriplantare polychroma* (Reptilia: Squamata: Lacertilia: Scincidae) from Otago/Southland and Canterbury/Marlborough and considered 34 morphological characters. In south Otago/Southland the two species are clearly distinguishable from each other by three mutually exclusive morphological characters, namely, presence or absence of dorsal stripe to end of tail, number of subdigital lamellae scales on hind foot 4th toe, and number of rows of mid-body scales. However, species-distinguishing characters are less evident in the north of their range. In the vicinity of Alexandra, the presence of chin speckling in *O. maccanni* and its absence in *O. n. polychroma* clearly define the species. In addition, extremes of some character trait ranges remain exclusive to each species. These traits may be considered with chin speckling to strengthen confidence of species identification. No mutually exclusive ranges in morphological traits exist between *O. maccanni* and *O. n. polychroma* from the Canterbury/Marlborough region. To identify either species there, it is necessary to collect a small sample of skinks (5–10) on which the ranges of several character traits not shared by both species are measured.

Keywords: diagnostic morphometrics, cryptic species, *Oligosoma maccanni, Oligosoma nigriplantare polychroma*.

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1. Introduction

1.1 TAXONOMIC HISTORY OF *Oligosoma maccanni* AND *O. nigriplantare polychroma*

Owing to their often cryptic nature, the 'common skinks' of the South Island of New Zealand have been misrepresented and their classification has been confused over the past 50 years. To make use of historical data and publications it is important to be aware of the various pseudonyms to which these species have previously been referred, although the nature of the confusion negates the usefulness of much of this work at the species level.

The two skink species *Oligosoma maccanni* (Patterson & Daugherty 1990) and *Oligosoma nigriplantare polychroma* (Patterson & Daugherty 1990), formerly *Leiolopisma,* were previously considered within the species *Leiolopisma nigriplantare maccanni* (Hardy 1977), which emanated from *Leiolopisma zelandica* in the classification of McCann (1955). McCann's (1955) classification was first criticised by Gill (1976).

Patterson & Daugherty (1990) conducted an allozyme and morphometric analysis of *L. n. maccanni* and defined four new species and one new subspecies: *L. inconspicuum* (species*), L. maccanni* (species), *L. microlepis* (species), *L. notosaurus* (species) and *L. nigriplantare polychroma* (subspecies). The genus *Leiolopisma* was later reclassified by the resurrection of the genus *Oligosoma* by Patterson & Daugherty (1995).

1.2 PROBLEMS OF IDENTIFICATION FROM A KEY

The fact that these four species and one subspecies had been regarded as a single species, albeit highly variable morphologically, for over 50 years gives some indication of the general similarity and occasional crypsis between them. Patterson & Daugherty (1990) provide systematic descriptions for each species, including counts of scales—the most useful criterion for differentiating Squamates—consisting of mean, averages, and range. These morphometric data sets can differentiate species when statistically analysed using canonical variates analysis (CVA), which enables the position of individual skinks to be plotted along axes of morphological characters. These axes represent the greatest difference between species. When skink morphometric data sets are then entered into the analysis, data for individuals cluster together in species clusters. Patterson & Daugherty (1990) provide equations by which skink specimens may be plotted against their established species clusters to verify species identity. This is an excellent tool for researchers skilled in discriminant function analysis but is of limited use to the field worker without this knowledge.

In the present study, a CVA analysis was carried out to verify the species identity of skinks sampled (see Section 2.1).

However, a dichotomous key was also provided in Patterson & Daugherty (1990), who attempted to provide a workable field key. Unfortunately, this key is confused by individuals of *O. n. polychroma* and *O. maccanni* possessing intra-specific variation in dorsal stripe and variability of dorsal 'speckling' over certain areas of their range.

Indeed, Freeman (1997) conducted a study on the comparative ecology of *O. maccanni* and *O. n. polychroma* specimens from central Otago and Birdlings Flat, Canterbury, where both niche habitat selection and gross marking patterns appeared to be interchangeable between the two species. In central Otago, *O. maccanni* possessed spotted or reticulated makings and *O. n. polychroma* was clearly identified by its strong posterior-anterior stripes, dominated by a dark brown dorsal stripe to the end of the tail, and cream dorso-lateral stripes. However, Freeman's (1997) study concentrated on the populations of Birdlings Flat, where *O. maccanni* markings were dominated by stripes and *O. n. polychroma* had much reduced striping, with the dark dorsal stripe rarely extending to the end of the tail and the stripes often breaking up into spots.

The aim of the present study was to provide a workable field key to distinguish between *O. maccanni* and *O. n. polychroma,* focusing on the north Otago and Canterbury/Marlborough regions, where most of confusion arises. This report assumes that the field worker is equipped with Patterson & Daugherty's key (1990), and either a copy of Gill & Whitaker (1996), or a similar field key. Descriptions of other possibly similar species are not included in this study; species which might be confused with these include *O. inconspicuum, O. lineoocellatum* and *O. chloronoton*.

2. Methods

Unfortunately it was not possible to obtain the original specimens examined by Patterson & Daugherty (1990) for allozyme analysis to confirm species categorisation.

2.1 SPECIES CONFIRMATION

Specimens examined were from collections at DOC Otago Conservancy and Te Papa, and from collection specifically for this study. These are listed in Appendix 1, which also gives the geographic origins of these specimens, which are shown in Fig. 1.

Specimens were confirmed as either *O. maccanni* or *O. n. polychroma* by CVA using the character sets described by Patterson & Daugherty (1990). From the equations provided by Patterson & Daugherty (1990), the first two canonical variables were calculated for representatives of each 'skink collection event' at each geographic site. These canonical variates were then plotted against the allozyme-confirmed species clusters illustrated in Patterson & Daugherty

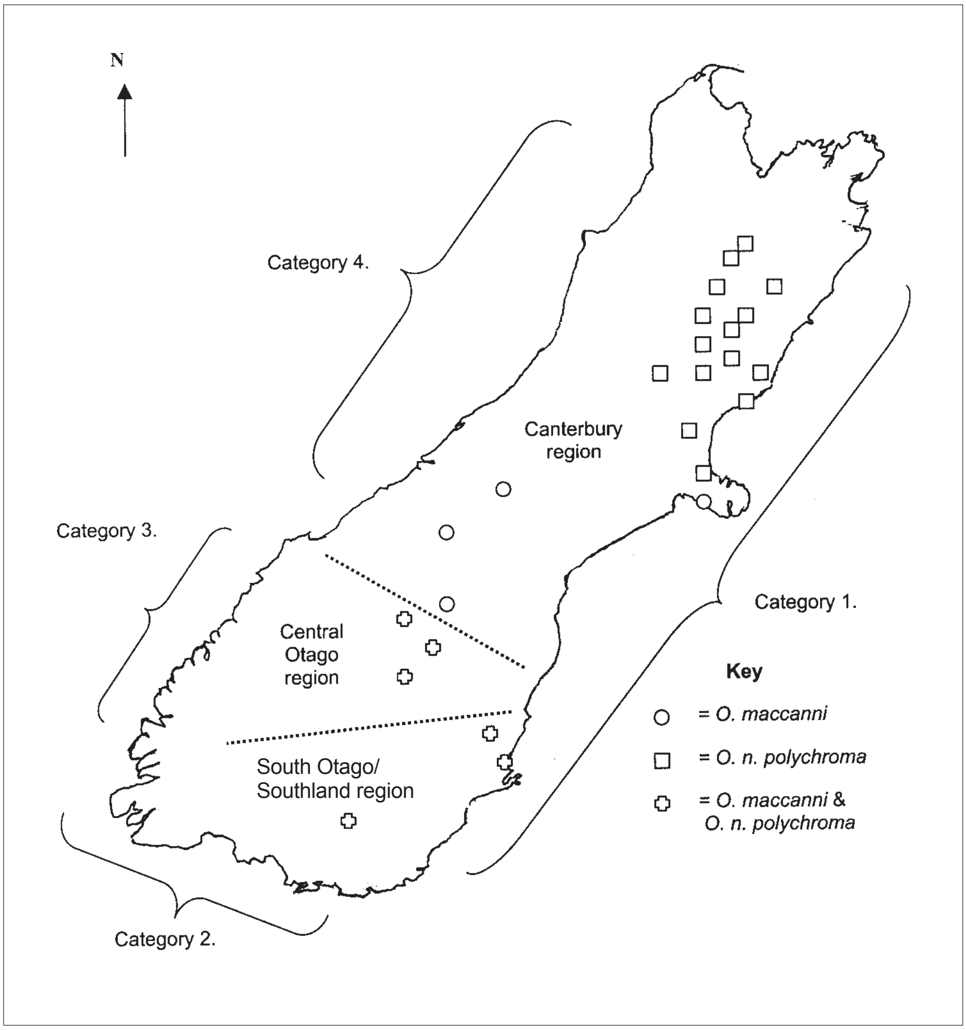

Figure 1. Map of collection sites for *Oligosoma maccanni* and *O. nigriplantare polychroma* in Otago/Southland and Canterbury/Marlborough. Categories 1–4 refer to the arbitrary division of sites used in the present study.

(1990). In the present paper, the morphometric characters recorded to generate canonical variate scores have not been included in the description of the biometric characters tested unless they provided significant results when considered regionally, as Patterson & Daugherty (1990) have already tested their usefulness for dichotomous keys.

2.2 MORPHOMETRIC CHARACTER SETS

Initially, a search for novel characters was conducted to test for the presence of any previously overlooked variables that might be capable of distinguishing between *O. maccanni* and *O. n. polychroma* across their range. Morphometric (body dimension) characteristics and ratios were not used, as they require the use of accurate tools such as vernier callipers, and produce data which often require mathematical or statistical treatment before yielding useful information. Such characteristics are of limited use to field workers.

Therefore this study was limited to colour pattern characteristics and squamous (scale counts) character sets. An analysis of all characteristics of an un-anaesthetised specimen in field conditions would be logistically impossible, but it was anticipated that an abbreviated character set relevant to regional species identification could be developed. A binocular microscope or hand lens was used for recording all characters. For an explanation of head scales see Fig. 2. The following characters were recorded:

1–5 Front foot dorsal scales

Scales of the dorsal surface of each digit from the claw to the base of the digit where it joins the 'palm' (metatarsus) were counted. Digits were numbered 1-5, where digit 1 was the inner digit when the skink was viewed from above with the digits facing forwards and digit 5 was the one closest to the body.

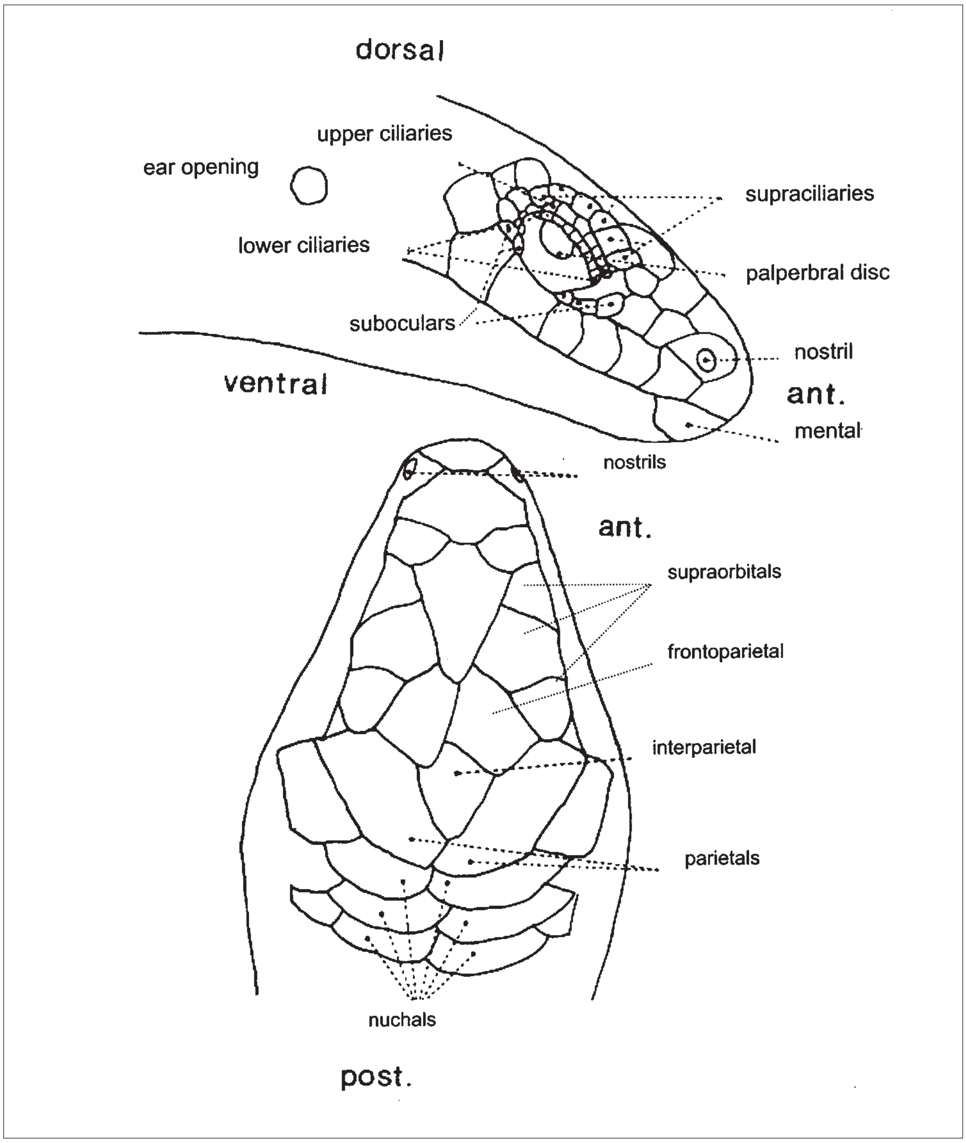

Figure 2. Diagram of head scales in *Oligosoma* spp. skinks used for taxonomic analysis. Redrawn from Patterson & Daugherty (1990).

6–10 Front foot subdigital lamellae

Rough scales known as lamellae exist on the ventral surface of each digit. These were counted, for all five digits identified and numbered as above, from the claw to the base of the digit where it joins the 'palm' (metatarsus).

11–15 Hind foot dorsal scales

Scales of the dorsal surface of each digit from the claw to the base of the digit where it joins the 'palm' (metatarsus) were counted. Digits were numbered 1–5, where digit 1 was the outer digit when the skink was viewed from above with the digits facing backwards towards the tail and digit 5 was the one closest to the body.

16–20 Hind foot subdigital lamellae

The lamellae scales were counted, for all five digits identified and numbered as above, from the claw to the base of the digit where it joins the 'palm' (metatarsus).

21, 22 Rows of dorsal scales on front (21) and hind (22) foot

The number of rows of scales across the foot immediately behind the intercept of the digits with the palm of the foot was counted.

23 Black lamellae

Presence or absence of black coloration of subdigital lamellae.

24 Black palm

Presence or absence of black coloration of scales on palm.

25 Forelimb stripe

Presence or absence of clearly defined pale stripe along the length of the forelimb on the anterior surface.

26 Dorsal stripe to end of tail

Presence or absence of dark dorsal stripe to the end of the tail.

27 Chin speckling

Presence or absence of defined dark speckles on the ventral chin and throat scales.

28 Supraorbital scales touching the frontoparietal scales

The number of scales of the supraorbital arc that touched the frontoparietal scale on either side of the head were counted.

29 Rows of mid-body scales

The number of rows of scales was counted at the mid-point between fore and hind limbs around the circumference of the body.

30 Ear to arm scales

The number of scales from the posterior edge of the ear opening to the axia of the forelimb, where it joins the torso, was counted.

31 Precloacal scales

The number of scales bordering the anterior margin of the cloacal opening (vent) was counted. Because of sexual dimorphism, this characteristic was considered separately for the sexes.

32 Neck collar scales

The number of scales was counted around the circumference of the neck immediately posterior to the ear opening.

33 Forelimb girdle scales

The number of scales was counted around the circumference of the torso immediately posterior to the forelimbs.

34 Hindlimb girdle scales

The number of scales was counted around the circumference of the torso immediately anterior to the hindlimbs.

2.3 ANALYSIS

Data sets were constructed in four categories. Firstly, experimental individuals identified to species by CVA were considered together, regardless of origin (Category 1, see Fig. 1). Category 1 skinks were used in an attempt to identify a species-defining characteristic across the entire range of 82 specimens of *O. maccanni* and 70 of *O. n. polychroma.*

Category 2 skinks included *O. maccanni* and *O. n. polychroma* from Macraes Flat, Long Beach (near Dunedin), and Croydon Bush near Gore in Southland. Category 3 skinks included individuals from Earnscleugh, Greys Hill, and Bendigo from the Alexandra region of central Otago. Category 4 skinks included experimental individuals from the Canterbury/Marlborough region, the area of most confusion in the field between the two species. Species-defining characteristics were searched for in all four categories.

3. Results

The analysis of category 1, in which all collection locations of *O. maccanni* and *O. n. polychroma* were grouped together, provided no mutually exclusive ranges of characteristics between the species (Table 1). However, species-exclusive characteristics were found for categories 2–4, and ranges and percentages of these are given in Tables 2–4, respectively.

The five characteristics that provided the greatest separation between species were:

- Chin speckling
- Number of subdigital lamellae on fourth (longest) digit of hind foot

- Dorsal stripe to end of tail
- Number of supraorbital scales touching the frontoparietal scales
- Number of rows of mid-body scales

With *O. maccanni* and *O. n. polychroma* from Macraes Flat, Long Beach, and Croydon Bush, the following morphometric characteristics were mutually exclusive to each species (Table 5):

- Dorsal stripe to end of tail
- Number of rows of mid-body scales
- Number of subdigital lamellae on fourth (longest) digit of hind foot

Similarly, with individuals from Earnscleugh, Greys Hill, and Bendigo, central Otago, a mutually exclusive character range was identified. However, in this

TABLE 1. COMPARISON OF CHARACTERISTICS OF *Oligosoma maccanni* AND *O. n. polychroma* OVER ENTIRE STUDY RANGE (CATEGORY 1).

Presence or absence data were recorded as 1 = present, 0 = absent.

		DORSAL STRIPE TO TAIL END	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Max.	1	35	29	3	1
(*n* = 80)	Mean ave.	0.11	31.67	23.83	3	0.94
	Min.	0	29	19	3	0
	SD	0.32	1.59	1.97	0	0.22
O. n. polychroma	Max.	1	32	25	3	0
(*n* = 72)	Mean ave.	0.64	28.56	21.16	2.56	0
	Min.	0	25	17	2	0
	SD	0.48	1.33	1.69	0.49	0

TABLE 2. COMPARISON OF CHARACTERISTICS OF *Oligosoma maccanni* AND *O. n. polychroma* IN SOUTH OTAGO/SOUTHLAND (CATEGORY 2).

Presence or absence data were recorded as 1 = present, 0 = absent.

		DORSAL STRIPE TO TAIL END	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Max.	0 *	35 *	28 *	3	1
(*n* = 17)	Mean ave.	0 *	32.83 *	25.85 *	3	0.75
	Min.	0 *	31 *	24 *	3	0
	SD	0 *	1.72 *	1.21 *	0	0.46
O. n. polychroma	Max.	1 *	30 *	22 *	2.5	0
(*n* = 16)	Mean ave.	1 *	27.91 *	20.28 *	2.07	0
	Min.	1 *	25 *	18 *	2	0
	SD	0 *	1.37 *	0.99 *	0.18	0

* Exclusive characteristics between species.

TABLE 3. COMPARISON OF CHARACTERISTICS OF *Oligosoma maccanni* AND *O. n. polychroma* IN CENTRAL OTAGO (CATEGORY 3).

Presence or absence data were recorded as 1 = present, 0 = absent.

		DORSAL STRIPE TO TAIL END	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Max.	1	33	25	3	1 *
(*n* = 12)	Mean ave.	0.08	31.58	22.91	3	1 *
	Min.	0	29	22	3	1 *
	SD	0.28	1.44	1.08	0	0 *
O. n. polychroma	Max.	1	29	24	3	0 *
(*n* = 14)	Mean ave.	0.78	27.71	21.35	2.07	0 *
	Min.	0	26	19	2	0 *
	SD	0.42	0.91	1.44	0.26	0 *

* Exclusive characteristics between species.

TABLE 4. COMPARISON OF CHARACTERISTICS OF *Oligosoma maccanni* AND *O. n. polychroma* IN CANTERBURY/MARLBOROUGH (CATEGORY 4).

Presence or absence data were recorded as 1 = present, 0 = absent.

		DORSAL STRIPE TO TAIL END	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Max.	1	35	29	3	1
(*n* = 34)	Mean ave.	0.15	31.51	23.74	3	0.97
	Min.	0	29	19	3	0
	SD	0.36	1.57	2.07	0	0.16
O. n. polychroma	Max.	1	32	25	3	0
(*n* = 31)	Mean ave.	0.39	29.19	21.48	3	0
	Min.	0	26	17	3	0
	SD	0.49	1.16	1.92	0	0

TABLE 5. EXCLUSIVE CHARACTERISTICS, RANGE AND PERCENTAGE REPRESENTATION IN *O. maccanni* AND *O. n. polychroma* IN SOUTH OTAGO/SOUTHLAND (CATEGORY 2).

		ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Exclusive range	> 31	> 24	3	present
(*n* = 17)	Percentage of sample	100	100	100	75
O. n. polychroma	Exclusive range	< 30	< 22	2	absent
(*n* = 16)	Percentage of sample	100	100	84.6	100

region, only the presence of chin speckling in *O. maccanni* and absence in *O. n. polychroma* clearly distinguish between the species (Table 6).

Finally, with individuals from the Canterbury/Marlborough area, no clear mutually exclusive characteristics were observed (Table 7). However, the degree of overlap of characteristics between species was variable.

TABLE 6. EXCLUSIVE CHARACTERISTICS, RANGE AND PERCENTAGE REPRESENTATION IN *O. maccanni* AND *O. n. polychroma* IN CENTRAL OTAGO (CATEGORY 3).

		ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Exclusive range	> 29	> 24	3	present
(*n* = 12)	Percentage sample	83	8.3	100	100
O. n. polychroma	Exclusive range	< 29	< 22	2	absent
(*n* = 14)	Percentage sample	86	50	93	93

TABLE 7. EXCLUSIVE CHARACTERISTICS, RANGE AND PERCENTAGE REPRESENTATION IN *O. maccanni* AND *O. n. polychroma* IN CANTERBURY/MARLBOROUGH (CATEGORY 4).

		ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE	SUPRAORBITALS TOUCHING F/PARIETALS	CHIN SPECKLES
O. maccanni	Exclusive range	> 33	> 25	- *	Present
(*n* = 35)	Percentage sample	23	20	- *	97
O. n. polychroma	Exclusive range	< 29	< 19	- *	Absent
(*n* = 31)	Percentage sample	13	3	- *	100

* Character trait is identical in both *O. maccanni* and *O. n. polychroma.*

4. Discussion

When considered as a whole, the morphometric data recorded from all specimens of *O. maccanni* and *O. n. polychroma* used could not be relied on to distinguish between species (i.e. analysis of Category 1 data).

4.1 SOUTH OTAGO/SOUTHLAND REGION

When the morphometric data were regionally subdivided, some distinctions could be made. The clearest results come from the south Otago/Southland populations sampled (Tables 2, 5). Here, the dichotomous key of Patterson &

Daugherty (1990) was fully effective in determining species identification between *O. maccanni* and *O. n. polychroma.* This was primarily due to the presence of a clear dorsal stripe to the end of the tail in all specimens of *O. n. polychroma* sampled, and its absence in all specimens of *O. maccanni* sampled. In this region, additional morphometric characters were also useful for species verification. Numbers of subdigital lamellae on the hind foot, 4th toe were within the range 18–22 for *O. n. polychroma* and 24–28 for *O. maccanni*, but this is an awkward character to record in an un-anaesthetised lizard. Therefore, in south Otago/Southland it may be preferable to verify species identification by numbers of rows of mid-body scales, which are 31–35 for *O. maccanni* and 25–30 for *O. n. polychroma*. The use of this character is especially useful in specimens with incomplete tails.

4.2 CENTRAL OTAGO REGION

Species identification becomes far less robust when considering the data set from the central Otago (Tables 3, 6). The only mutually exclusive morphometric character was the presence of chin speckling in *O. maccanni* and its absence in *O. n. polychroma*. This is a challenging character to quantify, as subtle 'mottling' and scars are often present in both species, but, when objectively recorded as a well defined black or very dark mark within the scale, it may be used to separate *O. maccanni* from *O. n. polychroma*.

Although no other characters recorded showed mutually exclusive states or ranges, some degree of species-specific separation occurred with other characteristics, which could be used to increase the confidence in separation by chin speckling, e.g. number of supraorbital scales touching the frontoparietals. *O. maccanni* uniformly has three supraorbital scales touching the frontoparietal scales, whereas in all but one specimen out of 15, *O. n. polychroma* had only two supraorbital scales touching the frontoparietal scale. This provides 93.3% confidence within the *O. n. polychroma* data set and 96.3% confidence amongst all specimens from that region.

Confidence in species identification may be further increased if specimens likely to be *O. maccanni* (based on chin speckling and number of supraorbital scales touching frontoparietals) also have other species-exclusive characteristics such as rows of mid-body scales of 30 and above (83.3% of sample). For specimens considered to be *O. n. polychroma*, rows of mid-body scales of 28 or less (85.7% of sample) increase confidence in species identification.

4.3 CANTERBURY/MARLBOROUGH REGION

No clearly mutually exclusive characteristics have been identified in *O. maccanni* and *O. n. polychroma* from Canterbury/Marlborough. However, some characters showed a high degree of divergence between species, and if these were considered cumulatively, they could provide a degree of confidence in ascribing species identification.

All *O. n. polychroma* showed no chin speckling in 31 individuals sampled, whereas all except one (out of 34) *O. maccanni* showed chin speckling, so this characteristic is capable of distinguishing species in 97.1% of cases considering only the *O. maccanni* sample and in 98.5% of cases considering both species samples. As no chin speckling has been observed in *O. n. polychroma* in the Canterbury/Marlborough region, any individuals with prominent chin speckling may be considered to be *O. maccanni*.

However, because of the varying degree of overlap in characteristics between species in this region, to establish any degree of confidence in identifying species there, it would be essential to obtain measurements from more than one individual from any given site. This would also increase the likelihood that individuals exhibiting traits in the exclusive range for respective species would be encountered.

The data showed that 22.8% of *O. maccanni* had more than 33 rows of mid-body scales, and 20% had more than 25 subdigital lamellae on the hind foot 4th toe; counts on *O. n. polychroma* were lower. Therefore, if 10 skinks captured from a site within the region showed no chin speckling and had no counts of mid-body scales above 33 or subdigital lamellae on the hind foot 4th toe above 25, they could be assumed to be *O. n. polychroma* with some confidence. The converse assumption could be applied to *O. maccanni*.

Should a similar sample contain individuals with and others without chin speckling, it is likely that both species are present. In such a case it would be desirable to obtain a larger sample, say 20 or more skinks (ideally equally representing the dominant trait, i.e. in this case, 10 with and 10 without chin speckling) to discriminate between species, using the additional characteristic of numbers of mid-body scales. Such a system of species identification is highly unsatisfactory but to date is the most accurate method for determining species in the field without the use of discriminant function analysis or a molecular investigation.

4.4 CONCLUSION

The present study illustrated the high degree of morphological variation shared by *O. maccanni* and *O. n. polychroma*, and highlighted the areas of crypsis between the two species. Although *O. maccanni* and *O. n. polychroma* exist as clear and defined species from allozyme studies (Patterson & Daugherty 1990), it would be fascinating to consider field observations and the present results in the light of a more precise molecular profile of the species such as is generated by microsatellite analysis. Studies outline the probable cause of New Zealand's high diversity of skink species from the *Oligosoma* and *Cyclodina* genera (Cooper & Cooper 1995; Hickson et al. 2000). However, they do not adequately explain the degree of morphological and ecological similarity between species given that island isolation leading to allopatric speciation of New Zealand skinks would have ended 35–25 million years ago. A decoupling of the way that evolution acts on the genetic characteristics (genotype) and their physical manifestation (phenotype) has been suggested by Bruna et al. (1996) in an attempt to explain the origin of cryptic species of Pacific Islands skinks, but the mechanism by which this has occurred has not been clearly identified or tested.

5. Keys for distinguishing *Oligosoma maccanni* and *O. nigriplantare polychroma*

For south Otago/Southland, the key below will give clear distinction between *Oligosoma maccanni* and *O. n. polychroma.* For the central Otago and Canterbury/Marlborough regions, no mutually exclusive character ranges exist between these species, although the presence or absence of chin speckling will account for an extremely high percentage of accurate species identification if a sample of 10 lizards is available from a site. Assumed species may then be checked by analysing the secondary characteristics given in the keys below.

KEY FOR SOUTH OTAGO/SOUTHLAND:

	DORSAL STRIPE TO TAIL END	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE
O. maccanni	No	> 31	> 24
O.n. polychroma	Yes	< 30	< 22

KEY FOR CENTRAL OTAGO:

	CHIN SPECKLING	ROWS OF MID-BODY SCALES	SUPRAORBITALS TOUCHING F/PARIETALS
O. maccanni	Yes	83% > 29	3
O.n. polychroma	93% no	85% < 29	92% 2

KEY FOR CANTERBURY/MARLBOROUGH:

	CHIN SPECKLING	ROWS OF MID-BODY SCALES	HIND FOOT SUBDIGITAL LAMELLAE
O. maccanni	97% yes	22% > 33	20% > 25
O.n. polychroma	No	12% < 29	3% < 19

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Appendix I

IDENTIFICATION AND LOCATION OF STUDY POPULATIONS OF *OLIGOSOMA MACCANNI* AND *O. NIGRIPLANTARE POLYCHROMA*

SPECIMEN ID	SPECIES	COLLECTION SITE	PRESENT LOCATION
JRP1	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP2	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP3	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP4	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP5	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP6	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP7	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP8	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP9	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP10	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP11	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP12	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP13	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP14	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP15	*O. n. polychroma*	Macraes Flat	M. Tocher DOC
JRP16	*O. n. polychroma*	Croydon Bush, Gore	In wild
B10.1	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B10.2	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B10.3	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B10.4	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B9.1	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B9.2	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B9.3	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B8.1	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B8.2	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
G1.1	*O. n. polychroma*	Greys Hill, Alexandra	M. Tocher DOC
E1.1	*O. n. polychroma*	Earnscleugh, Alexandra	M. Tocher DOC
B9.4	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B9.5	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
B9.6	*O. n. polychroma*	Bendigo, Alexandra	M. Tocher DOC
S1102	*O. n. polychroma*	Sumner, Christchurch	Te Papa
S781	*O. n. polychroma*	1 mile north of Cheviot, N Canterbury	Te Papa
S396	*O. n. polychroma*	1 mile above St James Station, Clarence River	Te Papa
S139	*O. n. polychroma*	Sedgemere bridge, upper Wairau River	Te Papa
RE1519	*O. n. polychroma*	Hope River, N Canterbury	Te Papa
RE2458	*O. n. polychroma*	Clarence River, S Timms Stream	Te Papa
S392	*O. n. polychroma*	1 mile N of Hawarden turnoff	Te Papa
S554	*O. n. polychroma*	1 mile N of Waikari, Canterbury	Te Papa
R1653.1	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa

SPECIMEN ID	SPECIES	COLLECTION SITE	PRESENT LOCATION
R1653.2	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.3	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.4	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.5	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.6	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.7	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.8	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1653.9	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
S214	*O. n. polychroma*	1/2 mile S of Tarndale turnoff, Acheron River	Te Papa
S140	*O. n. polychroma*	3 miles below lake Tennyson, Clarence River	Te Papa
S139	*O. n. polychroma*	Molesworth/St James boundary, Clarence River	Te Papa
S215	*O. n. polychroma*	5 mile stream, Acheron River	Te Papa
S201	*O. n. polychroma*	6 miles above Yarrow bridge, Acheron River	Te Papa
S142	*O. n. polychroma*	5 miles above St James Station	Te Papa
S141	*O. n. polychroma*	Timms Stream, Clarence River	Te Papa
R1652.1	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.2	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.3	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.4	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.5	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.6	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
R1652.7	*O. n. polychroma*	Motunau Island, Canterbury	Te Papa
JRM1	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM2	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM3	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM4	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM5	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM6	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM7	*O. maccanni*	Macraes Flat	M. Tocher DOC
JRM8	*O. maccanni*	Long Beach	In wild
JRM9	*O. maccanni*	Long Beach	In wild
JRM10	*O. maccanni*	Long Beach	In wild
JRM11	*O. maccanni*	Long Beach	In wild
JRM12	*O. maccanni*	Long Beach	In wild
JRM13	*O. maccanni*	Long Beach	In wild
JRM14	*O. maccanni*	Long Beach	In wild
JRM15	*O. maccanni*	Long Beach	In wild
JRM16	*O. maccanni*	Croydon Bush, Gore	In wild
JRM8	*O. maccanni*	Macraes Flat	M. Tocher DOC
G6.1	*O. maccanni*	Greys Hill, Alexandra	M. Tocher DOC
E4.1	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC
E2.1	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC
B7.1	*O. maccanni*	Bendigo, Alexandra	M. Tocher DOC
B7.2	*O. maccanni*	Bendigo, Alexandra	M. Tocher DOC
G3.1	*O. maccanni*	Greys Hill, Alexandra	M. Tocher DOC
G3.2	*O. maccanni*	Greys Hill, Alexandra	M. Tocher DOC
B6.1	*O. maccanni*	Bendigo, Alexandra	M. Tocher DOC
E7.1	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC
E7.2	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC

SPECIMEN ID	SPECIES	COLLECTION SITE	PRESENT LOCATION
E7.3	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC
E7.4	*O. maccanni*	Earnscleugh, Alexandra	M. Tocher DOC
R1671.141	*O. maccanni*	Tekapo	Te Papa
R1671.141	*O. maccanni*	Tekapo	Te Papa
R1671.138	*O. maccanni*	Tekapo	Te Papa
R1671.139	*O. maccanni*	Tekapo	Te Papa
S1341	*O. maccanni*	Lake Tekapo	Te Papa
S1353	*O. maccanni*	Lake Tekapo	Te Papa
S1338	*O. maccanni*	Lake Tekapo	Te Papa
R1675.167	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1675.166	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1675.169	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1675.165	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1675.168	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
S1340	*O. maccanni*	10 miles E of Omarama, Otago	Te Papa
R2400.1	*O. maccanni*	Lake Ohau, southern end	Te Papa
R2400.2	*O. maccanni*	Lake Ohau, southern end	Te Papa
R2400.3	*O. maccanni*	Lake Ohau, southern end	Te Papa
R2400.4	*O. maccanni*	Lake Ohau, southern end	Te Papa
R1674.162	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.164	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.159	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.157	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.163	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.158	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.161	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.160	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1674.156	*O. maccanni*	Birdlings Flat, Lake Ellesmere	Te Papa
R1670.129	*O. maccanni*	Lake Tekapo	Te Papa
R1670.133	*O. maccanni*	Lake Tekapo	Te Papa
R1670.135	*O. maccanni*	Lake Tekapo	Te Papa
R1670.137	*O. maccanni*	Lake Tekapo	Te Papa
R1670.136	*O. maccanni*	Lake Tekapo	Te Papa
R1670.130	*O. maccanni*	Lake Tekapo	Te Papa
R1670.128	*O. maccanni*	Lake Tekapo	Te Papa
R1670.131	*O. maccanni*	Lake Tekapo	Te Papa
R1670.132	*O. maccanni*	Lake Tekapo	Te Papa