Article

Oligosoma aureocola sp. nov. (Reptilia: Scincidae) from the northern Southland high country of Aotearoa/New Zealand

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Abstract

A species of diurnal skink from the Mataura Range and Mid Dome in central northern Southland, Aotearoa/New Zealand is described as *Oligosoma aureocola* **sp. nov.** It is a small species, coloured mid- to dark brown with smooth longitudinal stripes, and lives along rocky alpine ridges, low-stature shrublands, and tussock grasslands. This skink is a conspicuous species, easily sighted basking and foraging in talus or alpine plants such as golden spear grass (*Aciphylla aurea*).

Key words: *Oligosoma aureocola* **sp. nov.**, Mataura skink; Scincidae, Reptilia, lizard, alpine, Southland, Murihiku, New Zealand

Introduction

Aotearoa/New Zealand holds the world's most southerly occurring skinks, down to latitude 44°20" S (Patterson & Daugherty, 1990; Patterson & Daugherty, 1994). This includes 52 described species, and a further 23 or more awaiting formal description (van Winkel *et al.,* 2018; Hitchmough *et al.*, 2021). Incorporating smaller surrounding islands, the cooler South Island holds a greater diversity of skinks (51 taxa) than the warmer North Island (26 taxa), with only three taxa occurring on both of New Zealand's main islands (Hitchmough *et al.*, 2021). This may be due to a greater array of habitats in the South Island, more extensive historical mountain building, and glaciation, resulting in niche separation and extensive radiation of the skink fauna of southern New Zealand (Wallis & Trewick, 2009; Chapple *et al.*, 2016; Jewell, 2017).

These skink species are highly cold-adapted with many ranging into alpine environments, some over 500 metres above the tree line (Bell & Patterson, 2008; Chapple *et al.*, 2011; Jewell, 2017; Patterson & Bell, 2009; Patterson & Hitchmough, 2021). Much of New Zealand's remote high country remains poorly explored for skinks and the full diversity of this fauna is still being explored and described (van Winkel *et al.*, 2018; Jewell, 2019), thus several new discoveries have occurred in recent years (e.g. Jewell, 2017; Knox *et al.*, 2021; Patterson & Hitchmough, 2021). This discovery also follows a trend of cryptic New Zealand skink species being revealed through a combination of improved genetic techniques and new observations in the wild—recent examples include *O. kahurangi* Patterson & Hitchmough (2021) from the upper South Island, and *O. kak*erak*au Barr e*t. *al.* (2021) from the Auckland area.

In this paper, we describe a new skink species from the sub-alpine and alpine zone of central northern Southland. One of the authors (CK) originally encountered this skink in April 2017 at ~1,000 metres ASL on the Mataura Range (Figure 1). This skink was originally misidentified as the superficially similar Eyres skink (*Oligosoma repens* Chapple *et al.*, 2011); however, because the location was about 30 km further southeast of the closest known population of *O. repens*, and outside of their known distributional range, a DNA sample (via tail-tip tissue) was taken for confirmation of species identity. This DNA sample then spent about four years in storage before eventually being examined, and to the great surprise of Aotearoa's herpetological community, the results strongly indicated a new species had been found.

Following genetic analyses, the New Zealand Department of Conservation authorised the collection of three voucher specimens to serve as a holotype and two paratypes, with the collection being undertaken by one of the authors (CK) in March 2022.
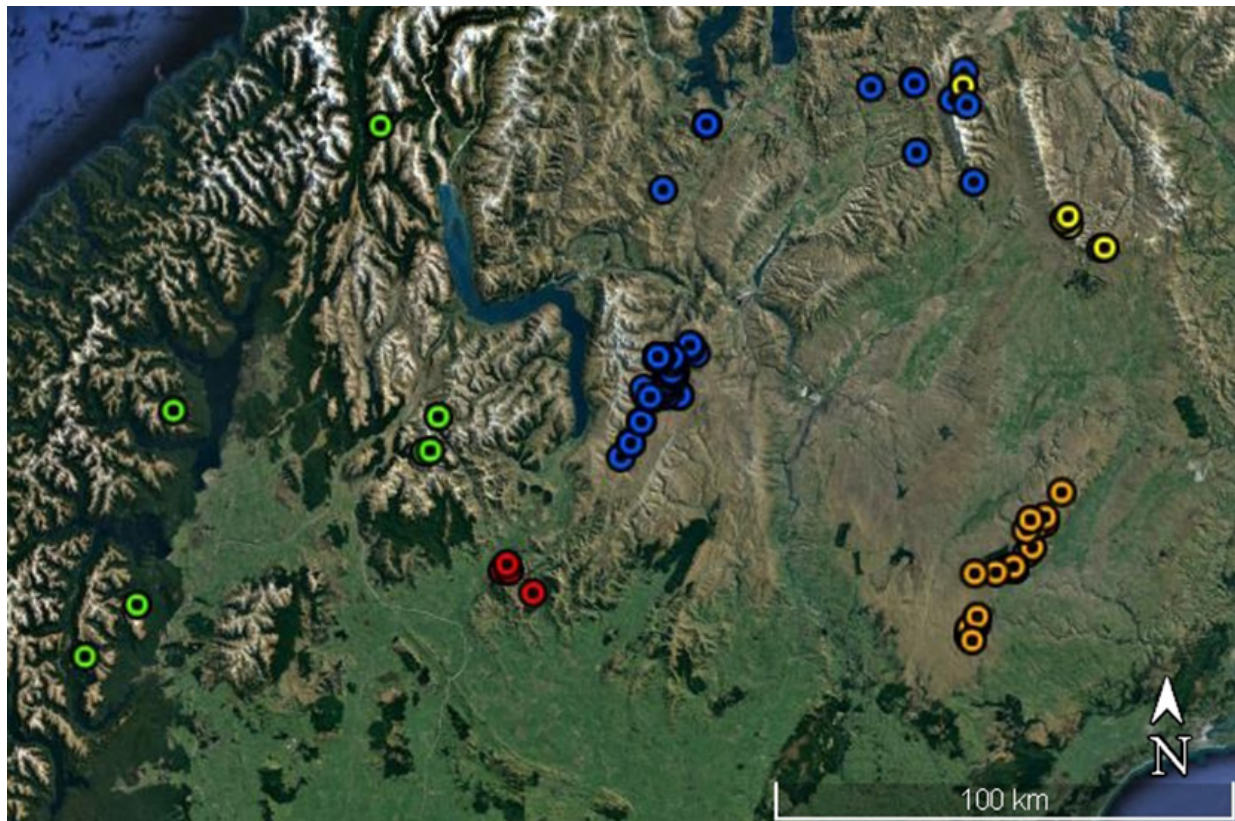

FIGURE 1. Map showing distribution and divergence sequence of five related *Oligosoma* species, including the established species *O. burganae* (orange), *O. repens* (green), *O. toka* (blue), and *O.* "Rockhopper" (yellow). The new species *O. aureocola* **sp. nov** is in red.

Methods

Voucher collection. The holotype and two paratypes were collected by hand, photographed in detail to record colouration, then preserved in ethanol and lodged in the reptile collection at Te Papa Tongarewa/ Museum of New Zealand, Wellington, New Zealand.

The type specimens were collected under Wildlife Act Authority 72460-FAU and AEC (animal ethics) Approval 410 from the Department of Conservation. Sampling strategy was to simply locate three individuals that incorporated as much of the known variation in pattern, colour, and morphology within the species as was possible within the timeframe available for collection (a two day survey). The three animals were collected within a three hour period and safely stored in cool, ventilated containers awaiting euthanasia. Collection of pregnant females was avoided in order to minimise impacts on fecundity of the wider population.

Variation. A further 12 specimens were photographed and measured in detail before their release in the field, and over 100 individuals sighted or photographed *in situ* contributed to the description of variation in dorsal colour pattern (Knox *et al.*, 2022). It is unlikely that any individuals were double counted, as each patch of habitat was surveyed only once. Generally surveys would follow a ridgeline for several kilometres identifying, counting, and photographing skinks as we progressed. On subsequent days, different ridgelines would be surveyed. Measurements in the field were merely life history stage (adult, subadult, juvenile, or neonate), sex, snout-vent length (SVL), and vent-tail length (VTL). Photographs covered other features like belly and dorsal colour, markings, and scales (Table 4, Figure 2).

Species	Sample code	Museum Code	Locality	GenBank Accession No.
Oligosoma inconspicuum	BBS1; BBS3–4; BBS13–16	FT3783; FT3784-FT3785; FT3031-FT3034	Awarua Point, Big Bay, Westland	EU567705; EU728596-EU728597; EU728604-EU728607
Oligosoma inconspicuum	BBS2; BBS5–6	FT3786; FT3787-FT3788	Mouth of Mackenzie River, Big Bay, Westland	EU567706; EU728598-EU728599
Oligosoma inconspicuum	BBS7; BBS9	FT3789, FT3791	Mid-point Mackenzie River, Big Bay, Westland	EU728600-EU728601
Oligosoma inconspicuum	BBS10–11	FT3792-FT3793	Big Bay, Westland	EU728602-EU728603
Oligosoma inconspicuum	BBS17	FT3813	Barn Bay, Westland	EU567707
Oligosoma inconspicuum	BBS18–20	FT7652-FT7654	Cascade Plateau, Westland	EU728608- EU728610
Oligosoma inconspicuum	LSS1	FT7739	Sinbad Gully, Llawrenny Peaks, Fiordland	EU728611
Oligosoma inconspicuum	RAH698	NA	Mt Buster, Ida Range	MZ747616
Oligosoma inconspicuum	S1022_04	NA	Mt Cardrona	MZ747618
Oligosoma inconspicuum	OIN42–43	RE004878 (S1241), RE004879 (S1242)	Centre Island, Foveaux Strait	EU728647-EU728648
Oligosoma inconspicuum	OIN1; OIN25–30	CD1101; CD1100- CD1105, CD1124	Gorge Burn, Eyre Mountains, Southland	EU567708; EU728632-EU728637
Oligosoma inconspicuum	OIN31–36	CD1905-CD1908, FT2063-FT2064	Tree Island, Lake Wakatipu, Otago	EU728638-EU728643
Oligosoma inconspicuum	OIN39	RE002122	Eyre Mountains, Southland	EU728646
Oligosoma inconspicuum	ONP56	FT2924	Tower Peak, Takitimu Range, Southland	EU728649
Oligosoma inconspicuum	EyInc	—	Eyre Mountains, Southland	MZ747614
Oligosoma inconspicuum	OIN37	FT3633	Catlins, Department of Conservation Red Tussock Reserve, Southland	EU728644
Oligosoma inconspicuum	OIN38	RE001889	Dipton, Southland	EU728645
Oligosoma inconspicuum	OIN2–5	CD421, 2 field collected, CD423	Macraes Flat, Otago	EU567709, EU728612-EU728614
Oligosoma notosaurus	ONT1	FT575	Magog, Stewart Island	EU567710

TABLE 1. (Continued)

Species	Sample code	Museum Code	Locality	GenBank Accession No.
Oligosoma notosaurus	ONT2, ONT4-5	CD1089-CD1091	Arena Ridge, Stewart Island	EU567711, EU728651-EU728652
Oligosoma notosaurus	ONT3	CD500	Mason Bay, Stewart Island	EU728650
Oligosoma notosaurus	ONT6	CD1125	Kakapo Study Site, Stewart Island	EU728653
Oligosoma notosaurus	ONT7	RE001888	Jacksons River, Stewart Island	EU728654
Oligosoma tekakahu	TEK1	FT7650	'Blowout', Chalky Island, Fiordland	EU728655
Oligosoma maccanni	OMA1	CD930	Nevis Range, central Otago	EF081195
Oligosoma maccanni	OMA4	FT3039	Garston, Southland/Westland	EF447117
Oligosoma repens	Eyres1, Eyres2	Field collected	Eyre Mountains, Southland	HQ113371-HQ113372
Oligosoma repens	RAH710	Field collected	Takahe Valley	MZ747617
Oligosoma grande	OGR1	CD1055	Central Otago	EU567720
Oligosoma grande	OGR2	FT3017	Lindis Pass	EU567721
Oligosoma stenotis	OST1	FT2	Mt Anglem, Stewart Island	EU567718
Oligosoma stenotis	OST2	FT289	Table Hill, Stewart Island	EU567719
Oligosoma toka	OIN18-24, Nevis	CD935-941, field collected	Nevis Range, Central Otago	EU728625-EU728631, HQ113373
Oligosoma toka	RAH686	Field collected	Lindis Pass	MZ747615
Oligosoma burganae	OIN7-9; OIN11-17	CD766-CD768; CD770-CD776	Rock & Pillar Range, Burgan Stream Hut, Otago	EU728615-EU728617; EU728618-EU728624
Oligosoma "Rockhopper"	S1022_10	Field collected	Hawkdun Range	MZ747619
Oligosoma aureocola sp. nov.	S1226_136	Field collected	Mataura Range	ON911506
Nannoscincus mariei	EUG1	NR9808	New Caledonia	EU423132
Marmorosphax tricolor	EUG2	NR9800	New Caledonia	EU423133

Genetic analyses. To confirm the distinctiveness of the Mataura skink taxon, and determine its phylogenetic position, we sequenced the mitochondrial DNA gene (mtDNA), ND2. Previous studies have found this mtDNA region to be phylogenetically informative for taxonomic and phylogeographic studies of New Zealand skinks (Chapple & Patterson, 2007; Chapple *et al.*, 2008a,b,c, 2009, 2011, 2012; Greaves *et al.*, 2007, 2008; Hare *et al.*, 2008; Liggins *et al.*, 2008a,b; Melzer *et al.*, 2019; Miller *et al.*, 2009; O'Neill *et al.*, 2008; Patterson *et al.*, 2013; Whitaker *et al.*, 2018; Barr *et al.*, 2021). A ND2 sequence from one of the specimens that was captured, measured and released, was produced by EcoGene Ltd, following the protocols of Greaves *et al.* (2008). Sequencing of all three type specimens was not required for the purposes of the species description, given the morphological data we obtained.

Sequences were edited and aligned (using default parameters of Clustal W; Larkin *et al.*, 2007) in Geneious 7.1.5 (Kearse *et al.*, 2012). We translated all coding region sequences in MEGA X (Kumar *et al.*, 2018) to ensure none contained premature stop codons. Based on preliminary analysis of the Mataura skink sequence, it was found to group within the *Oligosoma inconspicuum* species group, within Clade 1 of *Oligosoma* (Chapple *et al.,* 2009, 2011), therefore we included samples from members of this group as well (Table 1). Two skink species from New Caledonia (*Nannoscincus mariei* Bavay, *Marmorosphax tricolor* Bavay) were included as outgroups (Table 1), based on the phylogeny of Chapple *et al.*, 2009). The Mataura skink sequence data were deposited in GenBank under the accession number listed in Table 1. We used jModelTest 2.1.10 (Darriba *et al.,* 2012) to identify the most appropriate model of sequence evolution using the Bayesian Information Criterion (BIC). This model was then implemented in MEGA X to generate a Maximum Likelihood (ML) tree. The branch support was estimated using 1000 bootstrap replicates. Model-corrected genetic distances among the Mataura skink and closely related *Oligosoma* species, were calculated in MEGA X. For MEGA X a value of 70 is considered to be strongly supported.

Phylogeny. The edited alignment comprised 458bp of ND2, with 205 (45%) variable and 167 (36%) parsimony-informative sites. For the ingroup, the alignment comprised 186 (41%) variable characters and 158 (34%) parsimony informative sites. The BIC from jModelTest supported the TrN+G substitution model for our data set.

We present the optimal ML tree (-ln L = -2997.17), with ML bootstraps indicating branch support (Figure 3). The phylogenetic tree indicates that *O. aureocola* **sp. nov**. is a genetically distinct species within th*e O. inconspicuum* species group and is most closely related to several species in Otago and Southland, including *O. stenotis* (11.77% genetic divergence), *O. repens* (7.19%), *O. grande* (11.96%), *O. toka* (9.47%), and *O. burganae* (10.44%) (Figure 3, Table 2). Based on the evolutionary rate for ND2 calculated in O'Neill *et al.*, (2008) (1.3% per million years), *O. aureocola* **sp. nov**. appears to have diverged from its most closely related sister taxon approximately 5.5 mya.

Description

Family SCINCIDAE

Genus *Oligosoma* Girard

Oligosoma aureocola sp. nov.

Holotype. Mataura Range (45º 39'S, 168º 35'E), 950m ASL, NMNZ RE008659 (female) (coll. C. Knox, 16 Mar 2022).

Paratypes. Mataura Range (45º 39'S, 168º 35'E), NMNZ RE008661 (female) (coll. C. Knox, 16 Mar 2022); Mataura Range (45º 39'S, 168º 35'E), NMNZ RE008660 (female) (coll. C. Knox, 16 Mar 2022).

Etymology. *Oligosoma aureocola* in reference to the skinks' frequent use of golden speargrass (*Aciphylla aurea*). Epithets ending in -cola stand for "inhabitant of". These epithets can be in the masculine or feminine gender and are used as a nominative in apposition. Accordingly, their gender does not reflect the gender of the genus name (which is neuter). *A. aurea* is found throughout the South Island of New Zealand, usually in mountainous areas. Individual plants of *A. aurea* may be up to 100 cm tall and consist of sharp spiky yellowish-green leaves which make a good shelter for lizards. Vernacular name 'Mataura skink' refers to the Mataura Range where the species was first found, as well as the Mataura River, which abuts to the north of the prominent peak Mid Dome, where the species was subsequently found in February 2022.

TABLE 2. Model-corrected (TrN) genetic distances among members of the *Oligosoma inconspicuum* species group.

| Species	1	2	3	4	5	6	7	8	9	10	11
1. *O. aureocola* **sp. nov.**	—										
2. *O. burganae*	0.1044	—									
3. *O. repens*	0.0719	0.1164	—								
4. *O. toka*	0.0947	0.1125	0.0974	—							
5. *O. grande*	0.1196	0.1375	0.0974	0.1114	—						
6. *O. stenotis*	0.1177	0.1272	0.1330	0.1183	0.1323	—					
7. *O. maccanni*	0.1398	0.1489	0.1343	0.1386	0.1387	0.1187	—				
8. *O. tekakahu*	0.1455	0.1647	0.1741	0.1611	0.1808	0.1591	0.1541	—			
9. *O. notosaurus*	0.1374	0.1685	0.1472	0.1552	0.1545	0.1532	0.1558	0.0588	—		
10. *O. inconspicuum*	0.1511	0.1760	0.1599	0.1621	0.1671	0.1703	0.1770	0.0815	0.0428	—	
11. *O.* "Rockhopper"	0.1166	0.1406	0.1125	0.1104	0.1224	0.1178	0.1486	0.1791	0.1646	0.1858	—
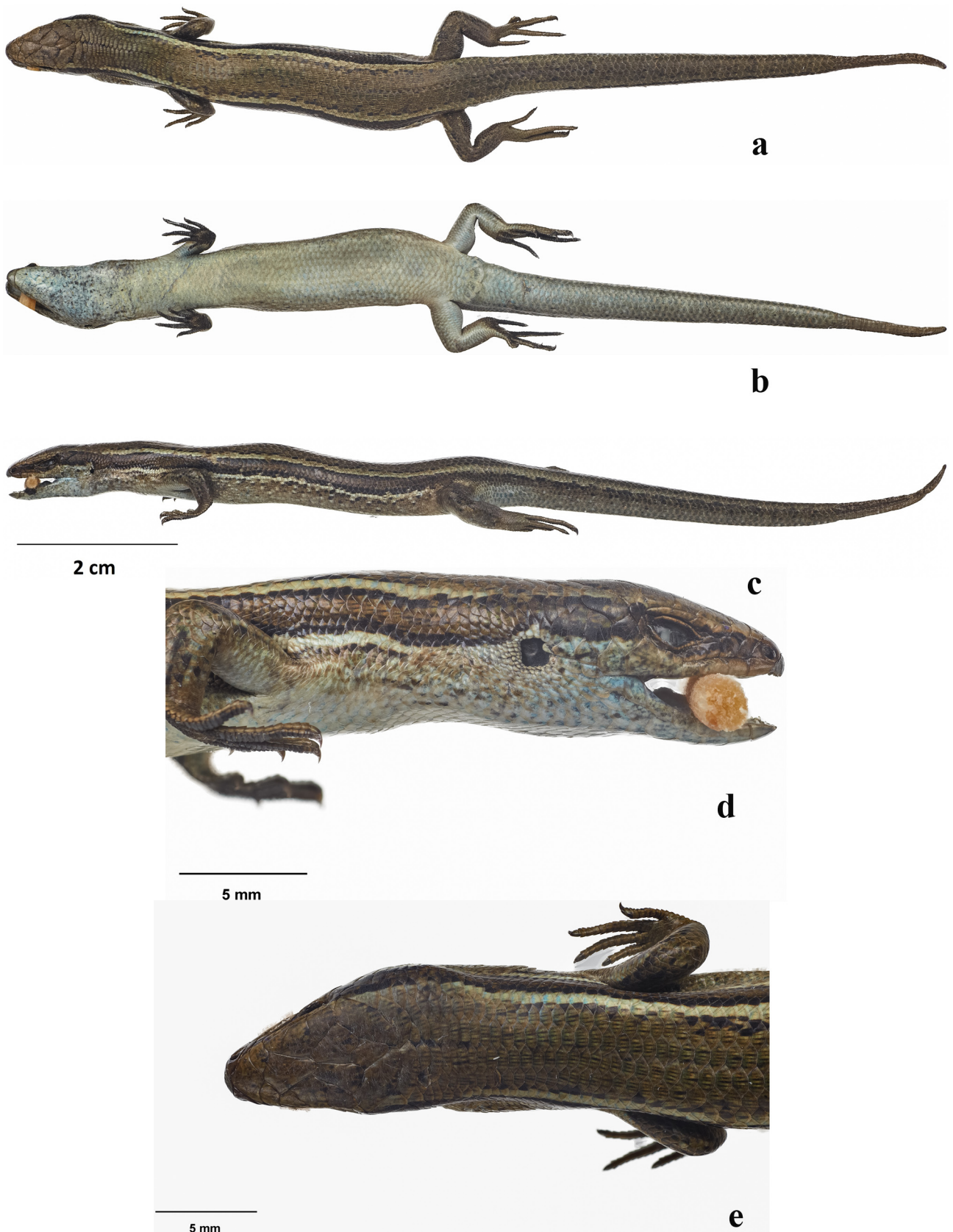
FIGURE 2. *Oligosoma aureocola* **sp. nov**.: The holotype specimen after preservation (a–e) and holotype as a live specimen in the field (f) and the two paratypes live in the field (g and h).
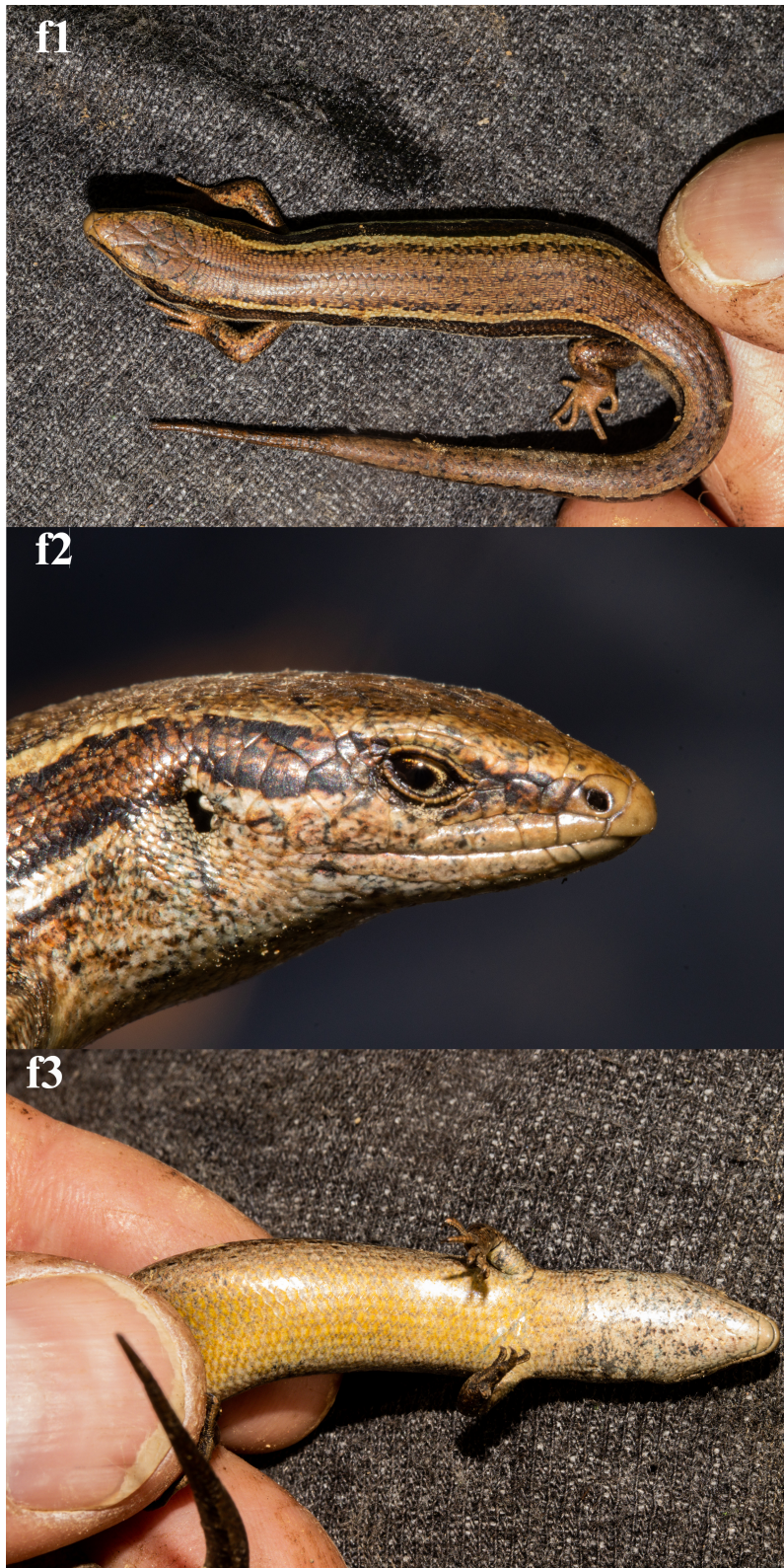
FIGURE 2. (Continued)

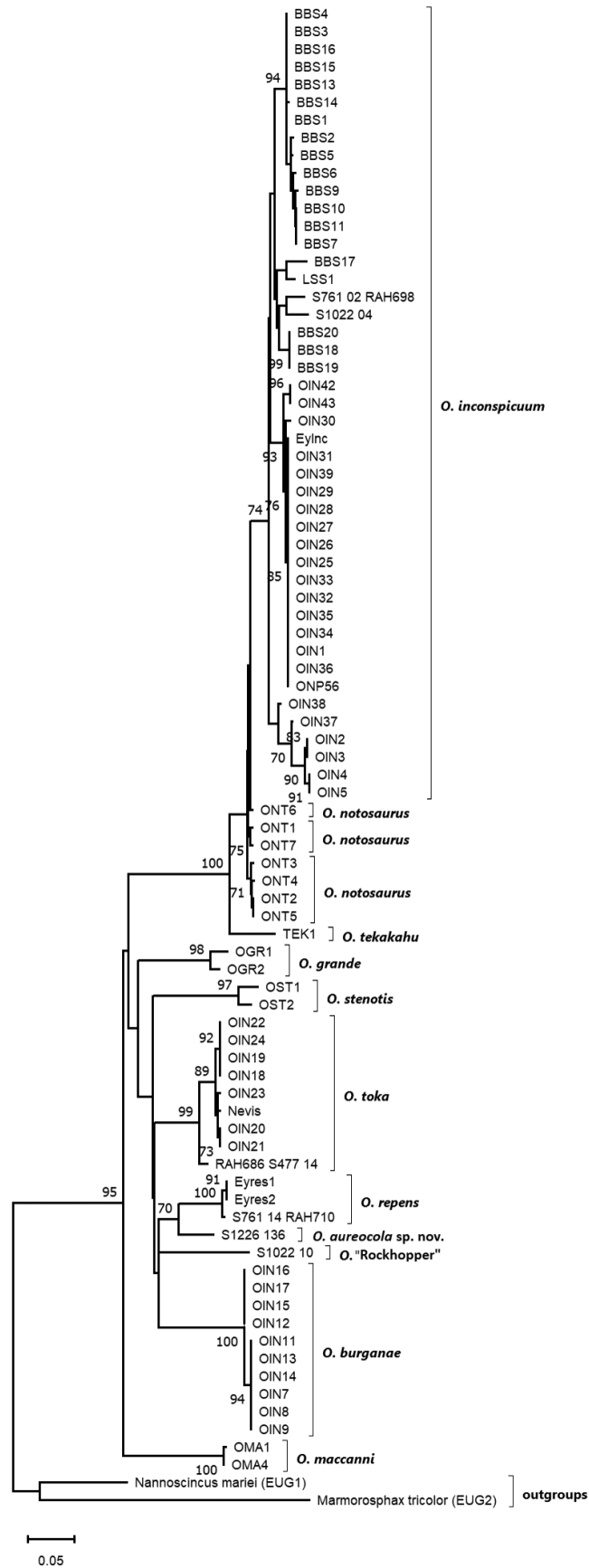**FIGURE 2.** (Continued)

FIGURE 2. (Continued)

FIGURE 3. Maximum likelihood (ML) phylogenetic tree, with 1,000 bootstraps, for the *Oligosoma inconspicuum* species group, indicating the phylogenetic affinities of *Oligosoma aureocola* **sp. nov**.

Morphological analyses. We examined three specimens of *Oligosoma aureocola* **sp. nov.** from the type locality. Specimens are held by Te Papa Tongarewa, National Museum of New Zealand (RE.008659 - holotype; RE.008660, RE.008661 - paratypes). In addition we examined nine specimens of *O.repens* (RE007279, RE007292, RE007282, RE007294, RE007285, RE007287, RE007295, RE007291, RE007296) from the same repository.

Morphological descriptions follow methods set out by Patterson *et al.* (2013). Briefly, midbody scale rows (MS) were counted at the midpoint between the fore- and hind legs. Ventral scales (VS) were counted in a line from the mental scale to the vent (including the mental and one preanal scale). The subdigital lamellae were counted on the fourth hind toe of the right foot. Nine categories of head scales were counted and described as outlined in Patterson & Daugherty (1990): supraciliaries, upper and lower ciliaries, anterior and posterior suboculars, supralabials, infralabials, supraoculars and nuchals.

Morphometric measurements were made on all specimens with calipers to the nearest 0.1 mm: 1) axilla to groin (AG), 2) snout to axilla (SF), 3) snout to ear (S-Ear), 4) ear to axilla (EF), 5) head length (HL) from the posterior part of the interparietal to the tip of the snout, 6) head width (HW) between the lateral edges of the left and right parietals, 7) fourth hind toe length from base of toe to tip excluding nail (FTL), 8) SVL, 9) hindlimb length (HLL), measured from groin to tip of fourth toe including nail, 10) ear width (D-Ear)—greatest dimension across ear opening; and 11) forelimb length (FLL) measured from axilla to tip of fourth toe including nail (Patterson & Daugherty 1990; 1994; Chapple *et al.* 2008a). None of the Mataura Range animals had intact tails. The following ratios were calculated for each specimen: AG/SF; S-Ear/EF; SVL/HLL; HL/HW; SVL/HW; SVL/HL; SVL/FTL. Further, it was noted whether the adpressed limbs touched or not, prefrontals were in contact and which supralabials were in contact with the first and second loreal.

Diagnosis. This species can be separated from *O. repens* by several features, summarised in Table 3. Relative ear size in particular is a reliable taxonomic character in other New Zealand skinks (eg Patterson *et al.*, 2013). Other similar species it may be sympatric with are *O. inconspicuum* (Patterson & Daugherty), *O.* aff. *polychroma* Clade 5 Liggins *et al.,* and *O. maccanni* (Patterson & Daugherty). It can be separated from both *O. maccanni* and *O. inconspicuum* by the presence of 3 supraoculars compared with 4 supraoculars in *O. maccanni* and *O. inconspicuum*. Furthermore, *O. maccani* has grey or grey-brown dorsal colouration versus brighter brown colouration and *O. aureocola* **sp. nov.** has smoother, and brighter dorso-lateral and mid-lateral stripes along the sides compared with *O. maccanni*. *O. inconspicuum* usually has prominent black flecking on its dorsal surface and head; versus no or little black-flecking in *O. aureocola* **sp. nov.** Liggins *et al.* (2008a) provided few characters that can be used to reliably separate *O.* aff. *polychroma* Clade 5 from *O. aureocola* **sp. nov.** in the field. Thus, for purposes of comparison 13 *O. polychroma* specimens in the Te Papa collection were examined for this study. There is no overlap between VS (64–74 in *O.* aff. *polychroma* Clade 5 compared with 80–84 in *O. aureocola* **sp. nov.**); 2nd loreal usually touches 2nd supralabial only in *O.* aff. *polychroma* Clade 5, compared with 1st and 2nd, or 2nd and 3rd in *O. aureocola* **sp. nov.**; HL/HW always >1.55 in *O.* aff. *polychroma* Clade 5, but always <1.55 in *O. aureocola* **sp. nov.** Many *O.* aff. *polychroma* Clade 5 specimens from the south of the South Island have 3 supraoculars and so this feature cannot be reliably used to separate the species, although *O.* aff. *polychroma* Clade 5 usually has 4 supraoculars, whereas O. *aureocola* **sp. nov** always has 3 supraoculars.

TABLE 3. Comparison of the morphological characters of *O. aureocola* **sp. nov.** (n = 3) and *O. repens* (n = 9). All measurements are presented in millimetres (mm).

Species	VS	MS	Subdigital lamellae	Ear opening	SVL	SVL/HL
O. aureocola **sp. nov.**	80–84	30–31	24–26	0.9–1.1	55.6–58.0	6.3–6.5
O. repens	68–81	30–34	19–23	0.5–0.6	47.6–61.8	6.5–7.2

Description of holotype. Habit lacertiform, body elongate, oval in cross-section; limbs well developed, pentadactyl. Lower eyelid with a transparent palpebral disc, bordered on sides and below by small, oblong granules. Nostril centred in lower middle of nasal, not touching bottom edge of nasal, pointing up and back. Iris gold colour.

Supranasals absent; rostral broader than deep; frontonasal wider than deep, contacts rostral, anterior loreals, prefrontals and frontal, narrow contact with frontal; frontal longer than broad, similar length to frontoparietal and interparietal together, in contact with 2 anteriormost supraoculars; supraoculars 3, 2nd largest; preoculars, 2, lower one larger; frontoparietals distinct, larger than the interparietal; a pair of parietals meeting behind interparietal

and bordered posteriorly by a pair of nuchals and temporals, also in contact with interparietal, frontoparietal, 3rd supraocular, 2 postoculars, 1 temporal and 1 nuchal scale; loreals 2, posterior the larger; anterior loreal in contact with 1st and 2nd supralabial, posterior loreal, prefrontal, frontonasal, and nasal; posterior loreal in contact with 2nd and 3rd supralabial, 1st subocular, lower preocular, prefrontal, anterior loreal and 1st supraciliary; supraciliaries 6, 1st largest; 7 upper ciliaries, 6th largest; 11 lower ciliaries; 6 suboculars, anterior largest, subocular row interrupted by 6th supralabial; 3 postoculars; 1 primary temporal, 2 secondary temporals; 2 tertiary temporals; supralabials 8, 7th largest, 6th supralabial under centre of eye; infralabials 7, several equally large.

Ear opening round, small, with several small projecting granules on anterior margin. Mental broader but shallower than rostral. Postmental larger than mental. Chinshields 3 pairs; anterior chinshields in broad contact, contact 2nd and 3rd infralabials; second chinshields separated by one scale, contact 3rd and 4th infralabials; posterior chinshields separated by 4 gular scales, contact 4th and 5th infralabials; one scale between 3 temporals and ear opening; ear with 2–3 prominent triangular lobules on anterior margin, uppermost the largest. Dorsal scales similar in size to ventral scales, weakly striate; top of front feet with series of 2 enlarged scales in line with toes, scales on top of hind feet small; ventral scales and subdigital lamellae smooth. Adpressed limbs meeting; digits moderately long, subcylindrical; third front digit shorter than 4th.

Measurements (in mm; holotype with the variation shown in the specimens examined in parentheses). SVL 58.0 (mean 56.8, range 55.6–58.0), HL 8.9 (mean 8.8, range 8.7–8.9), HW 5.9 (mean 5.9, range 5.9–6.0), AG 31.6 (mean 29.5, range 28.2–31.6), SF 21.2 (mean 21.5, range 21.2–21.8), S-Ear 10.9 (mean 10.7, range 10.6–10.9), EF 10.0 (mean 10.9, range 10.0–11.4), HLL 19.2 (mean 20.1, range 19.2–21.1); D-Ear 1.1 (mean 1.0, range 0.9–1.1); FLL 13.7 (mean 14.0, range 13.7–14.6).

TABLE 4. Field measurements of *Oligosoma aureocola* **sp. nov.** (n = 12).

Life history stage	Sex	SVL	VTL (regeneration - if present in brackets, otherwise tail fully intact)
Adult	F	64	71
Adult	F	61	67
Adult	M	64	69
Subadult		51	55
Juvenile		42	45
Adult	M	57	33 (19)
Adult	F	56	65
Juvenile		36	43
Adult	F	57	67
Adult	F	58	67
Subadult		52	23 (18)
Adult	M	56	44 (39)

Variation (holotype with the variation shown in the paratypes/specimens examined in parentheses). Upper ciliaries 6 (mean 6, range 5–7); lower ciliaries 11 (mean 10, range 9–11); nuchals 1 pair (mean 2 pairs, range 1–3 pairs); midbody scale rows 31 (mean 30, range 30–31); ventral scale rows 84 (mean 82, range 80–84); subdigital lamellae 24 (mean 25, range 24–26); supraciliaries 6 (mean 6, range 5–6); suboculars 6 (mean 6, range 6–6). Frontonasal never separated from frontal by prefrontals meeting in midline. Anterior loreal usually in contact with first and second supralabial, posterior loreal usually in contact with second and third supralabial. Supralabials 8 (usual), or 7, the sixth or seventh largest. Infralabials 6 or 7. Projecting scales always present in ear opening. Maximum SVL 58.0 mm. None of the specimens examined had an intact tail. Ratios for morphological measurements (± SD): AG/SF 1.37 ± 0.10; S-Ear/EF 0.99 ± 0.09; HL/HW 1.48 ± 0.03 (N=3).

Colour pattern: Dorsal surface brown often with a median dorsal very dark brown longitudinal stripe, 2 half-scale rows wide, well or partially developed, commencing behind the head and passing back to the tip of the tail, outlines may become jagged after base of tail. A yellowish brown dorsal band 2 half-scale to 1.5 scale rows wide sometimes with light flecks. Sometimes another dark brown band a half-scale row wide. Another broken dark brown band, 1 half to 2 half-scale rows wide, shading on to a pale dorsolateral band 1 half- to 2 half-scale rows wide. This

pale dorsolateral band, extending from above and behind posterior margin of eye to base of tail. This stripe bordered laterally by a strong brown band 1–2 scale rows wide, originating behind nostril, passing through eye and ending past base of tail, bordered laterally by a dark brown band. Below this an indistinct pale stripe passes from beneath the posterior border of the eye through the ear, above the limbs to the groin. This stripe is irregularly defined below by brown scales which merge gradually with the ventral colouration. Ventral surface may be lightly speckled with black spots on chin and throat, which are cream. Ventral surface yellow. Outer surface of forelimbs is dark brown with black and white specks. Juvenile colouration similar to adult, but generally lighter. There do not appear to be sexually dimorphic colour patterns. Dorsal scales clearly marked with striations.

Distribution. Currently known only from sub-alpine to alpine areas between 950 and 1,480 m on Mid Dome and the Mataura Range (Figure 1), which occur in the same mountain system, near Lumsden in central northern Southland, South Island. Both areas appear to hold large populations of *O. aureocola* **sp. nov.** which are distributed over at least four kilometres of ridgeline at each site. A long ridgeline containing the peak named Cupola links these two sites, and Mataura skinks are likely to be present on at least parts of this ridgeline. To the west of this mountain system lies a low and narrow plain (1–3 km wide and 350–400 m ASL.) which soon rises into the Eyre Mountains—a large and expansive hill and mountain system located southwest of Lake Wakitipu with several peaks rising to 1,700–2,000 m ASL. Parts of the Eyre Mountain system appear to be occupied by Eyres skink, *O. repens*, and it is not known whether *O. aureocola* **sp. nov.** also occurs in this mountain system, or indeed whether the two species could occur sympatrically. Prospects for locating more populations of *O. aureocola* **sp. nov.** are probably greater to the east or northeast of the Mataura Range, across the other side of the Mataura River, where there are several low-alpine to alpine ranges including the southern Garvie Mountains, Black Umbrella Range, and Umbrella Mountains. These ranges have not been extensively surveyed for herpetofauna.

Environment. The Nokomai 74.01 Ecological District *c.* 116,000 hectares experiences a cool to cold temperate climate, transitional between the wetter Eyre District to the west and the drier Central Otago Region to the northeast (McEwen, 1987; Dickinson *et al.* 1998). There is a general south-north decrease in precipitation. Five stations along the region's western margin - Kingston, Garston, Eyre Creek, Athol, and Mid Dome (244–386 m altitude)—have long-term annual means of 767–995 mm, while in the south-west Lumsden (207 m) averages 891 mm, and in the central-southern part Waikaia (152 m) receives 866 mm annually (N.Z. Meteorological Service 1973 and undated). Much of the region's high country is under snow for about 4 months annually, while drifts may persist until early January. LENZ Level IV data indicate the land environment at both sites is reasonably harsh, with an annual average temperature of 6.8 °C, a mean minimum temperature of -2.5 °C during the coldest month of the austral winter (July), average annual solar radiation of 13.2 MJ/m^2/day and winter solar radiation of 3.6 MJ/m^2 /day (Leathwick *et al.,* 2002).

Habitat. With Polynesian settlement in southern New Zealand about A.D. 1100, burning became common, resulting in widespread depression of the treeline and extensive replacement of forest by various tussockland and shrubland communities (Molloy *et al.*, 1963). Following European colonisation, differential palatability among the tussock species to domestic stock, particularly sheep *Ovis aries Linnaeus*, allowed the upper limit of *Festuca novae-zelandiae* to extend, while *Chionochloa rigida* receded upslope (Dickinson *et al.*, 1998). Top-dressing, oversowing, and movement of domestic stock encouraged the spread of adventive species, particularly grasses, which at low to mid altitudes displaced a large component of the native flora (Dickinson *et al.*, 1998). Today small beech forest (*Fuscospora*) stands persist in many gullies, with large stands only on the eastern side of the Mataura Range and in the Waikaia Valley.

Mid Dome and the Mataura Range are primarily composed of schist rock which forms numerous crumbling outcrops, tors, bluffs, small talus fields, and fellfield on the ridge crests with expansive tussockland, and sub-alpine shrubland, on the mountainsides (McIntosh *et al.*, 1990; Mortimer, 1993). The vegetation becomes increasingly modified (i.e. signs of historical fire damage, historical or recent livestock grazing, fewer woody species and more exotic species) with lowering altitude (Dickinson *et al.*, 1998).

Populations of Mataura skink occur only above 950 m ASL where vegetation is less modified, there is generally more consistent rock cover, and there are more native shrubs, tussocks, and grasses such as *Dracophyllum pronum*, *Coprosma dumosa*, *Gaultheria depressa*, *Muehlenbeckia complexa*, *Veronica odora*, *Celmisia haastii* var. *haastii*, and *A. aurea* (Figure 4)*.* Populations occur on a wide range of aspects, and often follow both sides of prominent ridgelines. Mid Dome is the highest point in this mountain system at 1,480 m ASL and thus may be a natural altitude limit for the species unless it also occurs further afield in the Garvie Mountains, for instance.

FIGURE 4. Typical habitats of *Oligosoma aureocola* **sp. nov**.: Mataura Range (images a–d), Mid Dome (images e–h). Skinks are found in a variety of habitats above 950 metres ASL. including spear grass (*Aciphylla aurea*).

FIGURE 4. (Continued)

FIGURE 4. (Continued)

FIGURE 4. (Continued)

Natural history. Diurnal, heliothermic. Numerous specimens observed sun-basking and foraging close to rock cover, amongst the protective spiny leaves of *A. aurea*, or amongst other dense prostrate vegetation (Knox *et al.*, 2022). Individuals also found resting under loose rock. Little is known of the reproductive cycle, but birth of 2–5

young annually is likely to occur each austral summer, similar to the ecology of related species such as *O. repens* (Chapple *et al.*, 2011).

Sympatric species. Up to five lizard species occur sympatrically with *O. aureocola* **sp. nov.** at both Mid Dome and in the Mataura Range. All of these species have been observed in direct sympatry with *O. aureocola* **sp. nov.** but all appear to be much less numerous, including *O. maccanni, O.* aff. *chloronoton* 'eastern Otago', *O.* aff. *polychroma* Clade 5, *O. inconspicuum*, and the gecko *Woodworthia* 'southern mini'.

Based on lizard surveys to date, *O. maccanni* occur in limited locations above 950 metres ASL throughout this area but are widespread in the lowlands below this elevation. *O.* aff. *polychroma* Clade 5 prefer damp areas, and only two individuals were found at the southern end of the Mataura Range across six days of survey between 2017 and 2022 (C. Knox, *pers. obs.*). *O.* aff. *polychroma* Clade 5 was not found from two days of survey on Mid Dome.

Oligosoma aureocola **sp. nov**. may be excluded from some sections of its environment by the much larger (i.e. SVL 90–110 mm) *O.* aff. *chloronoton* 'eastern Otago'; however, this species is only common in areas with large rocks for cover; whereas O. *aureocola* **sp. nov.** appears less dependent on rocks and extends more into vegetated areas away from rock cover. The gecko is syntopic, but only in rocky areas, and is segregated temporally by foraging at night.

Conservation. The conservation status of *O. aureocola* **sp. nov.** was not formally assessed by the Department of Conservation in 2020 (i.e. Hitchmough *et al.*, 2021), due to the species only being discovered following DNA results in August 2021 that revealed its existence to science.

Area of occupancy above 950 metres ASL in the Mid Dome and Mataura Range Scenic Reserves is approximately 1,000 ha. Applying this area of occupancy to Table 3 in Townsend *et al.*, 2008 and assuming a decline rate of 10–30% over the next 10 years or 3 generations the appropriate threat status for this species is 'At Risk-Declining'. Further survey work is planned for the southern Garvie Mountains and further east to better define its distributional limits. The species may have a heightened vulnerability and face an uncertain future in a warming climate and as introduced predators encroach on its habitat (O'Donnell *et al.*, 2017). Of most concern are stoats (*Mustela erminea* Linnaeus) (Reardon *et al.*, 2012), hedgehogs (*Erinaceus europaeus* Linnaeus) (Spitzen *et al.*, 2009) and feral cats (*Felis catus* Linnaeus) (Newman, 1994; King, 2005).

The species still remains poorly known and little studied. In the IUCN Red List system, in the absence of clear information on population trend, 'Data Deficient' seems the best recommendation for listing.

Recognition. *Oligosoma aureocola* **sp. nov.** is a taxon readily diagnosable by morphology (see 'Diagnosis', above), is geographically isolated from all close relatives, and has a distinct lineage (see 'Phylogeny', above). The degree of genetic divergence is at least as great, if not greater than for other N.Z. skink species, giving us confidence that this is actually a new species, using the phylogenetic species concept. The taxon is appropriately treated here as a new species.

Discussion

Oligosoma aureocola **sp. nov.** is a well-defined taxon for which confinement to the sub-alpine to alpine zone, in a region of Southland which has historically received little attention from herpetologists, has helped conceal its existence. Other herpetologists, naturalists, and conservation workers may have previously encountered specimens at various times, given their abundance on Mid Dome and the Mataura Range, but the significance of these skinks was overlooked, due to their outward superficial similarity to other species, such as *O. repens, O. inconspicuum* and *O.* aff. *polychroma* Clade 5. Indeed, they were originally misidentified as *O. repens* based on these similarities by one of the authors (CK) and another herpetologist familiar with the lizards from this area.

Now that *O. aureocola* **sp. nov.** is named and defined, future work can aim to better understand its distribution across the poorly explored mountain ranges of northern Southland. Although the species appears to be abundant within its limited range, this may change in future due to climate change (O'Donnell *et al.*, 2017), resulting fires, or predator encroachment. Wilding pines (*Pinus radiata*) are also a significant problem in this part of northern Southland and spread and growth of pines presents a significant risk to Mataura skinks by shading of preferred habitats and increased fire risk. A large program is being undertaken by the Mid Dome Wilding Trees Charitable Trust to eradicate or control the spread of these pines (https://www.middomewildingtreestrust.co.nz/).

More research is needed to better define the conservation status of, and threats to, *O. aureocola* **sp. nov.** The

species should be relatively easy to study because several of its known localities are accessible by 4WD tracks or short, but steep tramps, most of its known distribution is on conservation land administered by the Department of Conservation, they are easily observed while active, and live traps could easily be placed in its habitat to facilitate systematic sampling. Pitfall traps or g-minnow traps could be used. G-minnows are probably easier to use due to the rocky habitat.

There is no management of exotic predators such as mice *Mus musculus* Linnaeus, stoats, European hedgehogs, and cats within the mountain system, leaving this poorly understood lizard species vulnerable to predation, and consequently, population decline. The impact of exotic predators on the lizards of the northern Southland ranges may also worsen under climate change, as a warmer climate is likely to increase the abundance, species diversity, and frequency of visitation by introduced mammals at high elevation sites (O'Donnell *et al.*, 2017).

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