Zootaxa 5437 (4): 480–494
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5437.4.2
http://zoobank.org/urn:lsid:zoobank.org:pub:19D2B6C7-28E3-44BF-BFAA-E426E11C6389

Oligosoma eludens sp. nov. (Reptilia: Scincidae) from the Hawkdun, Ida, and Saint Bathans Ranges of North Otago, Aotearoa/New Zealand

CAREY KNOX[1], DAVID G. CHAPPLE[2] & TRENT BELL[3]
[1] *57 Bute Street, Ranfurly, New Zealand.*
southernscales@outlook.co.nz; https://orcid.org/0000-0001-8293-5122
[2] *School of Biological Sciences, Monash University, Clayton, Victoria 3800, Australia.*
David.Chapple@monash.edu; https://orcid.org/0000-0002-7720-6280
[3] *46 Sunrise Boulevard, Tawa, Wellington, New Zealand.*
trent.ecogecko@gmail.com; https://orcid.org/0000-0002-6064-6968

Abstract

A species of diurnal skink from the Hawkdun, Ida, and Saint Bathans Ranges of North Otago, Aotearoa/New Zealand is described as *Oligosoma eludens* **sp. nov.** It is a small species, coloured mid- to dark brown with especially fine, smooth longitudinal stripes, and lives along the edges of greywacke screes in alpine grasslands. This skink is cryptic, fast moving, and displays erratic emergence, generally only being easily detectable in the early morning or evening.

Key words: *Oligosoma eludens* **sp. nov.**, rockhopper skink, Scincidae, Reptilia, lizard, alpine, Hawkdun, Ida, Otago, New Zealand

INTRODUCTION

The scincid lizards of Aotearoa/New Zealand include 55 described species, and another ~20 further putative species awaiting formal description (van Winkel *et al.* 2018; Hitchmough *et al*. 2021). These include the world's southern-most occurring skinks, reaching up to latitude 44°20" S. These skink species are cold-adapted with many ranging into alpine environments, some up to one kilometre above the local tree limit (Whitaker 1984; Whitaker *et al*. 1999). New Zealand's mountainous environments support unique flora and fauna adapted to the extreme cold and harsh conditions of the alpine zone. However, many of the alpine skink species in New Zealand may be under threat due to predation from introduced mammals and climate change, the latter resulting in more predators entering the alpine zone (note that New Zealand's lizard fauna evolved for millions of years in the absence of terrestrial mammals; O'Donnell *et al*. 2017; Chapple *et al*. 2021). Much of the New Zealand high country remains poorly explored for lizards; hence, the fuller diversity of this fauna is still being discovered and described (van Winkel *et al*. 2018; Jewell 2019; Knox & Jewell 2020; Knox *et al*. 2021a,b).

In New Zealand, alpine areas are a substantial component of the landscape covering c. 11% of the land area (O'Donnell *et al*. 2017). Following geologically-recent tectonic activity and glaciations, phylogenetic radiations of plants, invertebrates, birds and lizards have been significant in the alpine zone (Wallis & Trewick 2009; Chapple *et al*. 2016). New Zealand has a diverse alpine lizard fauna, with at least 27 gecko and 32 skink species extending into alpine areas (out of 125 described and undescribed lizard taxa listed by Hitchmough *et al.* 2021 or scientifically described since). The true number of lizard species living in the alpine zone of New Zealand is likely to be greater than these numbers suggest, as evidenced by recent new discoveries and taxonomic work (for example, the recent discovery of hura te ao gecko; Knox *et al*. 2021a, as well as the subject of this paper). Some of these species may represent alpine restricted relicts of former, more widespread, distributions due to anthropogenic factors, such as habitat modification and predation by introduced mammals (Worthy 1987; Jewell 2006; Bell & Patterson 2008; Knox *et al*. 2019, 2021a).

In this paper, we describe a new skink species from the alpine zone of the Hawkdun, Saint Bathans, and Ida Ranges. Herpetologist Tony Jewell (TJ) initially encountered the species in the southern Hawkdun Range in 2011 and, after noting an especially agile saxicolous behaviour, suggested the name 'rockhopper skink'. In January 2019, a number of individuals were photographed *in situ*, and three were captured and released again, providing detailed information about the species, and enabling the collection of a DNA sample (via tail-tip tissue). Following this work, and reflecting a seemingly rare status, the New Zealand Department of Conservation authorized the collection of a single voucher specimen to serve as a holotype, with the collection being undertaken by TJ and one of the authors (CK) in January 2020.

METHODS

Voucher collection. The holotype specimen was 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.

Variation. A further four specimens were photographed and measured in detail before release, and another three photographed *in situ* to contribute to the description of variation in the dorsal colour pattern.

Scale counts and morphometric measurements. For consistency with taxonomic work on New Zealand skinks, scale counts and morphometric measurement methodology follow that of Hardy (1977) and Patterson & Daugherty (1990). The upper preocular in Hardy (1977) is sometimes considered the first supraciliary, the lower preocular as either preocular or upper preocular, and postoculars as pretemporals by others (Taylor 1935, Grismer *et al.* 2019). Midbody scale rows were counted at the midpoint between the fore- and hind legs. Ventral scales were counted in a line from the mental scale to the vent (including the mental and one preanal scale). Head and chin scales were counted and/or described as outlined in Patterson & Daugherty (1990): rostral, frontonasal, prefrontal, frontal, frontoparietals, interparietal, parietal, nuchals, supraciliaries, upper and lower ciliaries, anterior and posterior suboculars, supralabials, infralabials, supraoculars; mental, postmental and chinshields. It was noted whether prefrontals were in contact and which supralabials were in contact with the first and second loreal. Lamellae count start from the first wider scale.

Measurements were taken to the nearest millimetre. Body measurements were taken with limbs at right angles to body. Morphometric measurements were made for snout-vent length (SVL), snout-axilla, axilla-groin; snout to ear; ear to axilla; head length from the posterior part of the interparietal to the tip of the snout; head width between the lateral edges of the parietals; intact tail length; fourth hind toe length from toe base to nail tip; hindlimb length from inguinal crease to tip of fourth toe including nail tip; ear width—greatest dimension across ear opening (Patterson & Daugherty 1990; 1994; Chapple *et al.* 2008a). The following body measurement ratios were calculated: snout-ear/ear forelimb, snout-axilla/SVL; snout-axilla/axilla-groin; hind limb length/SVL; front limb length/SVL; hind toe length/SVL; head length/head width; head length/SVL; head width/SVL.

It is noted that measurements of voucher and live animals in the field will differ, because preservation is known to shrink voucher animals. There are practical limitations involved in undertaking scale counts on live specimens under field conditions, particularly when counting midbody scale rows.

Genetic analyses. To help confirm the distinctiveness of the rockhopper 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). 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).

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 rockhopper 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 (Table 1). Two skink species from New Caledonia (*Nannoscincus mariei* Bavay, *Marmorosphax tricolor* Bavay) were included as outgroups (Table 1). The rockhopper 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 based on the

Bayesian Information Criterion (BIC). This model was then implemented in MEGA X to generate a Maximum Likelihood (ML) tree. The node support was estimated using 1000 bootstrap replicates. Model-corrected genetic distances among the rockhopper skink and closely related *Oligosoma* species, were calculated in MEGAX.

TABLE 1. Locality information and GenBank accession numbers for the *Oligosoma inconspicuum* group samples used in the phylogenetic analyses. Samples with CD or FT codes were obtained from the National Frozen Tissue Collection (NFTC) housed at Victoria University of Wellington, New Zealand. Samples with RE codes were obtained from ethanol preserved specimens housed at Te Papa Tongarewa, National Museum of New Zealand, Wellington. Samples with NR codes were obtained from the Australian Museum, Sydney.

Species	Sample code	Museum Code	Locality	GenBank Accession No.
Oligosoma inconspicuum	BBS1; BBS3–4; **BBS13**–16	FT3783; FT3784–85; **FT3031**–34	Awarua Point, Big Bay, Westland	EU567705; **EU728596**–97; EU728604–07
Oligosoma inconspicuum	BBS2; BBS5–6	FT3786; **FT3787**–88	Mouth of Mackenzie River, Big Bay, Westland	EU567706; **EU728598**–99
Oligosoma inconspicuum	BBS7; BBS9	FT3789; FT3791	Mid-point Mackenzie River, Big Bay, Westland	EU728600–01
Oligosoma inconspicuum	BBS10–11	FT3792–93	Big Bay, Westland	EU728602–03
Oligosoma inconspicuum	BBS17	FT3813	Barn Bay, Westland	EU567707
Oligosoma inconspicuum	BBS18–20	FT7652–54	Cascade Plateau, Westland	EU728608–10
Oligosoma inconspicuum	LSS1	FT7739	Sinbad Gully, Llawrenny Peaks, Fiordland	EU728611
Oligosoma inconspicuum	RAH698	NA	Mt Buster, Hawkdun Range	MZ747616
Oligosoma inconspicuum	S1022_04	NA	Mt Cardrona	MZ747618
Oligosoma inconspicuum	OIN42-43	RE004878 (S1241); RE004879 (S1242)	Centre Island, Foveaux Strait	EU728647–48
Oligosoma inconspicuum	OIN1; OIN25–30	CD1101; CD1100–05; CD1124	Gorge Burn, Eyre Mountains, Southland	EU567708; EU728632–37
Oligosoma inconspicuum	OIN31-36	CD1905–08, FT2063–64	Tree Island, Lake Wakatipu, Otago	EU728638–43
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; EU728612–14
Oligosoma notosaurus	ONT1	FT575	Magog, Stewart Island	EU567710
Oligosoma notosaurus	ONT2, ONT4–5	CD1089–91	Arena Ridge, Stewart Island	EU567711; EU728651– 52
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

......*Continued on the next page*

TABLE 1. (continued)

Species	Sample code	Museum Code	Locality	GenBank Accession No.
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	HQ113371–72
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	CD935–41, field collected	Nevis Range, Central Otago	EU728625–31; HQ113373
Oligosoma toka	RAH686	Field collected	Lindis Pass	MZ747615
Oligosoma burganae	OIN7–9; OIN11–17	CD766–68; CD770–76	Rock & Pillar Range, Burgan Stream Hut, Otago	EU728615–17; EU728618–24
Oligosoma eludens **sp. nov.**	S1022_10	Field collected	Hawkdun Range	MZ747619
Nannoscincus mariei	EUG1	NR9808	New Caledonia	EU423132
Marmorosphax tricolor	EUG2	NR9800	New Caledonia	EU423133

DESCRIPTION

Family SCINCIDAE

Genus *Oligosoma* Girard

Oligosoma eludens sp. nov.

Figures 1 (distribution), 2 (morphological variation) and 3 (habitat).

Holotype: NMNZ RE.008616, western slope of Peak 1658, south-eastern end of Hawkdun Range, Otago, New Zealand (-44.892481, 170.059696; 1,500 m ASL), 16 January 2020, coll: Tony Jewell.

Other material examined: Four live specimens captured (three adults, one juvenile) and three adults photographed only, at the type locality; one adult photographed in the Hawkdun Range two kilometres NW of the type locality (-44.878603˚S, 170.031174˚E; 1,300 m ASL); one live adult captured in the Ida Range near the head of Blue Duck Creek (-44.942777˚S, 170.172221˚E; 1,450 m ASL). Further individuals (est. nine in total) were observed at each site and their similarity in size, habitat, behaviour and colour pattern noted, but eluded attempts at capture or photography. In addition, several individuals were observed in January 2020 near the type locality, at -44.884581˚S, 170.059807˚E. In November 2020, another population was discovered in the northern Saint Bathans Range in scattered boulderfield and talus at 1,600 m ASL. Three individuals were captured, examined, and photographed on site (Knox *et al.* 2021b).

Etymology. L. *eludens* = eluding, i.e. elusive; as the species is difficult to capture. Vernacular name 'rockhopper skink' refers to the species habit of hopping between rocks when foraging or disturbed.

Diagnosis. A small *Oligosoma* (SVL 60–65 mm) with a smooth tail of moderate length (1.1–1.2 x SVL). Iris pale grey to light brown. Ear opening small (1.5 x diameter of nostril) with two small scales protruding from anterior margin. Four supraocular scales in each series. Fourth (longest) toe of hind foot with 24–27 subdigital lamellae. Coloured mid- to dark brown above with thin, smooth longitudinal stripes along back and sides, and lacking any prominent spots, flecks, or mottling. Mid-dorsal stripe is wide and present on the body of adults but often dull or indistinct and absent from the tail, and absent or indistinct on neonates. Throat pale grey or pale yellow with sparse dark specks, merging gradually into a uniform bright yellow belly. Soles of feet dark yellow-brown. The species can be separated from the below related species of which *O. toka* (Chapple *et al*. 2011*)* and *O. maccanni* (Hardy 1977) are in sympatry:

- *Oligosoma stenotis* (Patterson & Daugherty 1994): distinguished from *O. eludens* **sp. nov** species by the presence of a keeled tail, smaller ear-opening, and a prominent mid-dorsal stripe *versus* a dull, indistinct, and wide mid-dorsal stripe in *O. eludens* **sp. nov.**
- *Oligosoma burganae* (Chapple *et al*. 2011): usually three, but sometimes four supraocular scales; body stocky; eye dark brown *versus* pale grey to light brown in *O. eludens* **sp. nov.**; ventral pale brown; 18–23 lamellae *versus* always four subraoculars; eye grey or light brown; ventral yellow; 22–27 subdigital lamellae in *O. eludens* **sp. nov.** *Oligsoma eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides compared with *O. burganae*.
- *Oligosoma repens* (Chapple *et al*. 2011): three supraocular scales; lamellae 19–23 *versus* four supraoculars, 22–27 lamellae in *O. eludens* **sp. nov.** *Oligosoma eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides compared with *O. repens*.
- *Oligosoma toka*: three supraoculars; 17–23 lamellae *versus* 22–27; soles cream or brown *versus* four supraocular scales; soles black in *O. eludens* **sp. nov.** *Oligosoma eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides compared with *O. toka*.
- *Oligosoma grande* (Gray 1845): much larger size <115 mm SVL *versus* <65 mm SVL in *O. eludens* **sp. nov.**; dorsal black or dark brown with cream of yellow flecks or striations; *O. eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides compared with *O. grande*.
- *Oligosoma maccanni*: dorsal grey or grey-brown; if dorsal stripes present, mid-dorsal stripe bright and not usually smooth; ventral grey or muddy yellow; soles white or cream *versus* dorsal brown base colour*;* dull, indistinct, and wide mid-dorsal stripe in *O. eludens* **sp. nov.** *Oligosoma eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides compared with *O. maccanni*.

The species can also be separated from the following sympatric species as follows:

- *Oligosoma* aff. *waimatense* "alpine rock": larger size up to at least 90 mm SVL *versus* <65 mm SVL; intact tail 1.4 x SVL; eyes black *versus* pale grey to light brown eye colour in *O. eludens* **sp. nov.**; dorsal black, with pale yellow-green flecking, never striped *versus* dorsal brown, striped; ventral grey, uniform *versus* ventral yellow in *O. eludens* **sp. nov.**
- *Oligosoma* aff. *chloronoton* "eastern Otago": large size <110 mm SVL *versus* <65 mm SVL in *O. eludens* **sp. nov.**; dorsal green, olive or brown with prominent ocelli or black flecks; uniform grey ventral; eye colour dark brown; <22 lamellae *versus* 22–27 lamellae; dorsal brown, striped; chin grey with yellow ventral *O. eludens* **sp. nov.**
- *Oligosoma* aff. *polychroma*; Clade 5: chin light brown or grey, uniform; ventral uniform grey, brown, cream white or dull yellow; soles brown, grey or black, sometimes flushed with yellow; lamellae 16–24 *versus* dull, indistinct, and wide mid-dorsal stripe, all other details as described above in *O. eludens* **sp. nov.** *Oligosoma eludens* **sp. nov.** has thinner, smoother, and brighter (or whiter) dorso-lateral and mid-lateral stripes along the sides and a smaller ear-opening compared with *O.* aff *polychroma* Clade 5.
- *Oligosoma* aff. *inconspicuum* "North Otago": throat mid-grey with prominent black flecking; prominent black-flecking on side of throat and on the lateral and dorsal surfaces, such that the majority of scales have a black outline *versus* throat pale grey or pale yellow with sparse dark specks; lacking any prominent spots, flecks or mottling on the body in *O. eludens* **sp. nov.** In addition, the mid-dorsal stripe is absent or indistinct in *O.* aff. *inconspicuum* "North Otago" versus a dull, indistinct, and wide mid-dorsal stripe in *O. eludens* **sp. nov.**
- *Oligosoma waimatense* (McCann 1955): large size up to 110 mm SVL *versus* <65 mm SVL in *O. eludens* **sp. nov.**; dorsal grey, brown or creamy yellow, with black transverse markings, not striped; ventral uniform whitish-grey, sometimes flushed with pink or orange; eyes black; midbody scale rows 50–68; 30–34 lamellae *versus* smaller size; striped; midbody scale rows 32 in *O. eludens* **sp. nov**. Also much greater TL/SVL ratio in *O. waimatense*.

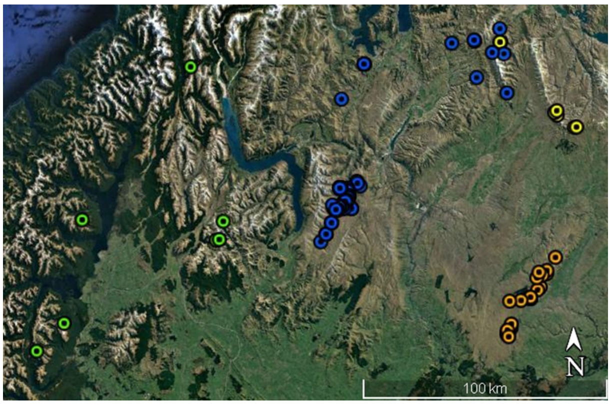

FIGURE 1. Map showing distribution of four related *Oligosoma* species, including *O. burganae* (orange), *O. repens* (green) and *O. toka* (blue) and *O. eludens* **sp. nov.** (yellow).

Description of holotype. Body oval in cross-section; limbs well-developed, pentadactyl; head of moderate proportion, ocular bulge slight but angle of forward descent noticeably steeper than that of snout. Lower eyelid with a transparent palpebral disc, bordered on sides and below by small, oblong granules. Nostril centred just below middle of nasal, pointing up and back, not touching bottom edge of nasal. Nasals widely separated. Supranasals absent. Rostral broader than deep. Frontonasal broader than long, touching frontal and separating prefrontals. Frontal longer than broad, shorter than frontoparietal and interparietal together, in contact with two anteriormost supraoculars. Supraoculars four, the second is the largest. Frontoparietals distinct, each slightly larger than interparietal. One pair of parietals, meeting behind interparietal and each bordered posteriorly by one nuchal and one temporal, also in contact with interparietal, frontoparietal, fourth supraocular and two postoculars. Loreals two, anterior one the larger; anterior loreal in contact with 1st and 2nd supralabials, posterior loreal, prefrontal, frontonasal and nasal; posterior loreal in contact with second and third supralabials, first subocular, upper and lower preoculars, prefrontal and anterior loreal. Supralabials 7, the 6th largest and 5th below pupil of eye. Infralabials seven, 2nd–4th largest. Suboculars six, 3rd and 4th separated by fifth supralabial. Upper ciliaries seven, lower ciliaries eight, supraciliaries five; nuchals two right and three left; one primary temporal, two secondary temporals, two tertiary temporals; one scale row between tertiary temporals and ear opening. Mental broader but shallower than rostral. Postmental narrower but deeper than mental. Chinshields three pairs., in contact with infralabials, first pair in median contact with each other, second pair separated by a single scale, and third pair by three scales. Dorsal scales largest, each with three extremely feeble longitudinal striations, striations present from posterior margin of parietal back onto tail; striations becoming weaker on sides, and absent from venter; dorsal tail scales two x wider than long, striations feeble, not forming longitudinal keels. Ear opening round, moderately small (height 1.5 x diameter of nostril) with one small and one tiny pale domed lobule projecting from the anterior margin. Forelimbs shorter than hindlimbs. Digits moderately long, cylindrical; third front digit shorter than fourth; fourth (longest) toe of hind foot with 16 smooth dorsal scales and 26 smooth (but rugose in preservation) subdigital lamellae. Plantar scales granular, smooth. Snout-vent length (SVL) 61 mm, intact tail 66 mm (1.08 x SVL); midbody scale rows 32; ventral scale rows 73. Snout-eye 4.6 mm, eye-ear 4.6 mm, snout-ear 10.5 mm (1.07 x ear-forelimb), ear-forelimb 9.8 mm, snout-axilla 23 mm (0.37 x SVL, 0.67 x axilla-groin), ear-axilla 11.3 mm, axilla-groin 34 mm; hind limb length 21 mm (0.34 x SVL), front limb length 14.5 mm (0.23 x SVL), hind toe length 7.5 mm (0.12 x SVL), head length 10 mm (0.16 x SVL, 1.38 x head width), head width 7.2 mm (0.11 x SVL).

Variation among other specimens. Snout-vent length of adults 60–65 mm; second loreal either narrowly touches or is narrowly excluded from contact with third supralabial; subdigital lamellae of fourth hind toe 22–27; scale rows on top of fourth hind toe 14–16; fourth toe of front foot slightly to distinctly longer than third; hind limb 0.32–0.34 x SVL; fourth toe of hind foot 0.11–0.12 x SVL.

Colour pattern. Dorsum mid- to dark brown. Top of head uniform or with fine dark flecks, back sometimes with very fine indistinct dark longitudinal flecks within the scale striations. All stripes on the body are smooth-edged, as follows: a prominent black-brown mid-dorsal stripe (spanning two half-scales in width) runs uninterrupted from the level of the ear onto the upper half of the tail, fading out well before the tip, often bordered on each side by a narrow, indistinct light brown stripe; a similar dark lateral-dorsal stripe extends from just behind the level of the ear to at least the base of the tail; a thin cream to white dorso-lateral stripe from eye onto tail, becoming broader, slightly wavy and sometimes browner on the tail; a broad (up to three scales wide) dark brown upper lateral stripe from nostril, through eye, above ear and onto tail where it narrows abruptly, usually with outer borders darkened to form indistinct thin black stripes, and lower margin becoming indistinct on tail; a thin white subocular stripe from just in front of the level of the eye to the ear, and continues (usually having been interrupted by the ear or rarely passing over top of it) as a thin white mid-lateral stripe that passes above the forelimb without dipping to meet it, to the top of the hind limb insertion where it abruptly ends. The region between the mid-lateral stripe and the belly varies from light brown to light grey with few blemishes, to having these colours obscured by extremely fine and dense white/grey speckling. The throat is pale cream to grey, sometimes suffused all over with yellow and with sparse to numerous, very fine blackish specks, merging gradually into a uniform mid-yellow belly; the undersurface of the tail is a darker shade of grey, with the yellow of the belly fading out anywhere from one eighth to halfway along. The limbs are almost uniform brown above, but the forelimb often exhibits the indistinct rudiments of a pale anterior stripe, becoming light grey below and dark yellow-brown on the palms and soles; toes are uniform brown or with indistinct thin dark banding above, and jet black below. Iris is coloured pale grey to light brown, darkening to near-black behind the pupil. A melanistic individual was recorded (A. Davies & C. Knox, unpub. data).

Distribution. Currently known from alpine areas between 1,300 and 1,650 m in three mountain ranges (northern Saint Bathans Range, eastern Ida Range, and southern Hawkdun Range) in Oteake Conservation Park, North Otago. The Saint Bathans, Hawkdun, Ida, and Kakanui Ranges, of the lower-mid South Island of New Zealand, form part of a near-contiguous mountain system that runs south-west across four-fifths of the island's width, from the Southern Alps to the eastern coast (Figure 1). The section of this range that forms the Hawkdun and Ida rises abruptly from intermontane plains at 700 m ASL in the Clutha and Taieri River catchments to the south, peaking at between 1,350–1,850 m ASL, before tapering more gradually into the Waitaki River catchment at 250 m ASL in the north. The Saint Bathans Range occurs further to the northwest towards Lindis Pass and ascends to an altitude of 2,098 m ASL at its highest point and contains many peaks over 1,700 m ASL. Between the Hawkdun Range and the Saint Bathans Range lies the east and west branches of the Manuherikia River, with a small unnamed mountain range between the two branches. The Hawkdun Range contains the largest known population with *O. eludens* being found over an estimated area of 60 ha. In the Ida Range the species has been found over a 15 ha area. In the northern Saint Bathans Range, only three have been found to date. The species is cryptic and difficult to detect outside of optimal conditions for emergence or basking, and so is likely to be more widespread in these mountain ranges than currently recognised. Nonetheless, the species appears to be of patchy occurrence, even within seemingly suitable areas of habitat, and may not be in high abundances. The species may also potentially occur in other mountain ranges in North Otago, the Mackenzie Basin, and South Canterbury, such as the Saint Marys Range, Wether Range, Ewe Range, Dunstan Range, St Cuthbert Range, and Kakanui Mountains.

Environment. The climate across both the 64.03 Hawkdun and 64.04 Saint Bathans Ecological Districts is semi-arid with hot, dry summers with frequent strong warm northwest winds and cold winters with less frequent southerly storms (McEwen 1987). LENZ Level IV data indicate the land environment at the type locality is particularly harsh, with an annual average temperature of 4.2 °C, a mean minimum temperature of -4.1 °C during the coldest month of the austral winter (July), average annual solar radiation of 13.2 MJ/m2/day and winter solar radiation of 3.8 MJ/m2 /day (Leathwick *et al.* 2002). Annual rainfall is approximately 500–600 mm at low altitudes, but increasing towards the ridge tops where snow may fall at any time of the year and may lie on the ground for several months during winter (Department of Conservation 2005).

Habitat. The ranges are primarily composed of greywacke rock which forms numerous crumbling outcrops, bluffs, boulderfield, talus, and fellfield on the ridge crests and expansive, active scree slopes on the mountain sides. Vegetation in the ranges is snow tussock (*Chionochloa* spp.) grassland, giving way to open fellfield or talus environments on the most exposed ridge crests. The vegetation becomes increasingly modified (i.e. signs of historical fire damage, fewer woody species and more exotic species) with lowering altitude. *Oligosoma eludens* has been observed on three adjacent slopes (within two km distance) of one gully system in the south-eastern Hawkdun Range, and on two slopes (within 500 m distance) of one gully system in the eastern Ida Range. All of these populations are between 1,100–1,550 m ASL, and have north, south-east, west or south-west aspects. In each case, the skinks were found along the scree-grassland ecotone where low-stature woody subshrubs, and in particular *Dracophyllum pronum*, grow among and over large, chunky and stable rocks located at scree-edges. The site at 1,600 m in the Saint Bathans Range contains patches of boulderfield and talus interspersed with snow tussock and low-stature woody subshrubs, particularly *Dracophyllum pronum* (Knox *et al*. 2021b).

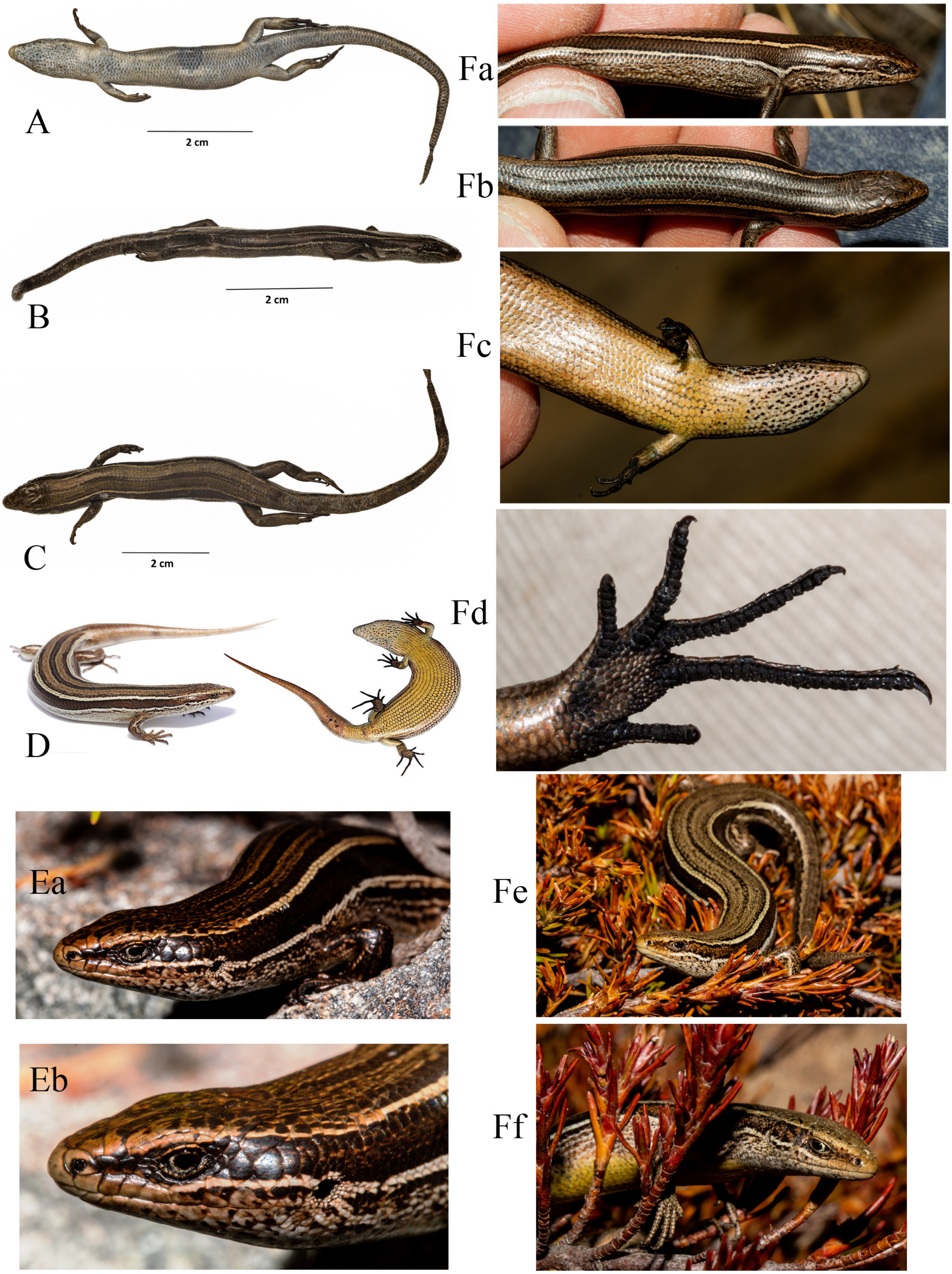

FIGURE 2. *Oligosoma eludens* **sp. nov.**: The holotype specimen after preservation (a–c) and live specimens photographed in the field (d–f).

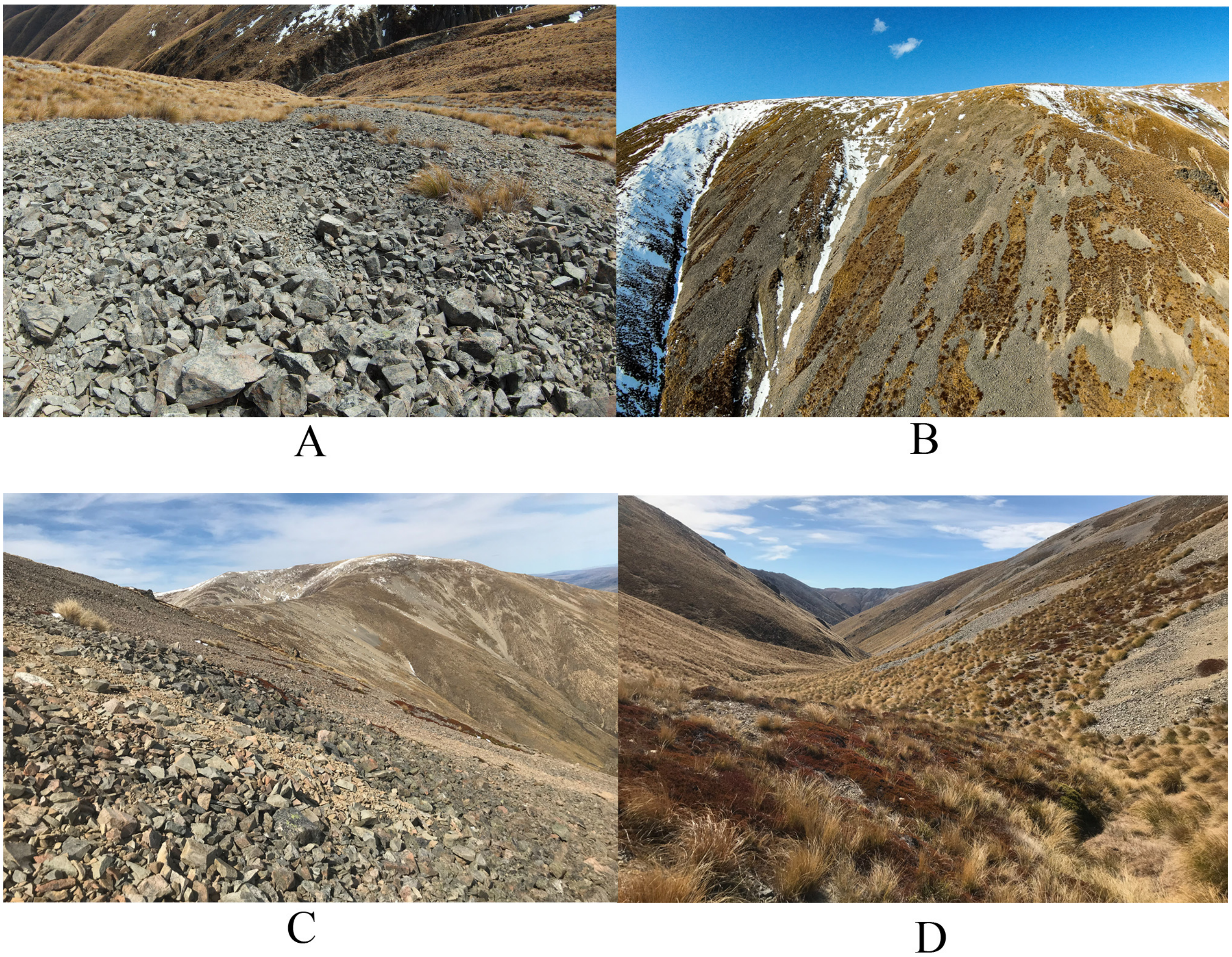

FIGURE 3. Typical habitats of *Oligosoma eludens* **sp. nov.**: Hawkdun Range (upper), Ida Range (lower). Skinks are predominantly found around vegetated edges of scree slopes.

Natural history. Diurnal, heliothermic. Numerous specimens were observed emerging to sunbask at the type locality, as or just before the morning fog cleared; specimens basked conspicuously for the first hour or so after the sun emerged but became increasingly difficult to detect or elusive once air and rock temperatures warmed (TJ, pers. obs. 15 January 2019). Several specimens were observed in activity by TJ in 2021, at a site two km NW of the type locality. These were basking in the afternoon sun but would rapidly disappear beneath the rocks whenever a light but cool breeze picked up. When basking, the skinks would initially allow TJ to approach within about 1.5 m then on closer approach, would leap between rocks to distance themselves, or disappear beneath the rocks, re-emerging 1–2 m away within 20–40 seconds. Similar rapid agile behaviour, involving leaping between rocks, was observed by TJ at the type locality on 16 January 2020. Such rock-hopping behaviour has not been observed in any other New Zealand skink species.

Two non-pregnant females and one pregnant female was captured during the mid-January months of the year (data pooled from 2019, 2020 surveys; TJ pers. comm.). The pregnant female contained two large embryos. Two possible neonates (each bright chestnut-brown, but uncaptured) were also observed in mid-January 2020. These insights would suggest that the species may have a low fecundity, and birth of young occurs in or by mid-January (during the austral summer).

Sympatric species. Six lizard species, or proposed species, have been observed in direct sympatry with *O. eludens* **sp. nov.:** *O. maccanni* (Hardy), *O.* aff. *waimatense* 'alpine rock', *O.* aff. *chloronoton* 'eastern Otago', *O.* aff. *polychroma* Clade 5 and the gecko *Woodworthia* 'Southern Alps' (Hitchmough *et al*. 2021).

Based on lizard surveys to date, *O. eludens* **sp. nov.** appear to exclude the similar *O. maccanni* from favoured microsites along the scree-grassland ecotone, although they can remain in close proximity, and in turn *O. eludens*

sp. nov. may be excluded from some sections of this environment by the much larger (i.e. SVL 90–110 mm) *O.* aff. *chloronoton* 'eastern Otago' (Knox & Jewell 2020). *Oligosoma* aff. *polychroma* Clade 5 (grassland) and *O.* aff. *waimatense* 'alpine rock' (open scree) may interact less frequently with *O. eludens* **sp. nov.** due to different habitat preferences, while the gecko is syntopic but is segregated temporally by foraging at night.

Other species detected within several kilometres of *O. eludens* **sp. nov.** are the skinks *O.* aff. *inconspicuum* 'North Otago' (Mt Kyeburn) and *O. waimatense* (Ida Range), and the geckos *Mokopirirakau galaxias* (Knox *et al*. 2021a), *Mokopirirakau* 'Roy's Peak', *Naultinus gemmeus* (McCann 1955), *W*. 'Otago large' – Danseys Pass lineage (Mt Buster), and *W*. 'Raggedy' (Ida Range foothills) (Hitchmough *et al*. 2021; Knox & Jewell 2019, 2020; Knox *et al*. 2021a).

Conservation. The conservation status of *O. eludens* **sp. nov.** was assessed by the Department of Conservation in 2020 (Hitchmough *et al.* 2021). Following the criteria of Townsend *et al.* (2008), a conservation threat status of 'At Risk – Declining' based on "its potential restriction to just three mountain ranges, and because of probable predation by introduced predators". 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). Fire and grazing animals, such as feral deer, may pose a significant threat to their shrubland habitats around the edges of scree and talus slopes. The species 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.

Phylogeny. The edited alignment comprised 483bp of ND2, with 217 (45%) variable and 179 (37%) parsimony-informative sites. For the ingroup, the alignment comprised 197 (41%) variable characters and 170 (35%) parsimony informative sites. The BIC from jModelTest supported the TrN+I+G substitution model for our data set. Parameters estimated under this model were: relative substitution rates (A↔C = 1.8113, A↔G = 33.8067, A↔T = 1.8113, C↔G = 1.000 C↔T = 19.6684 relative to G↔T = 1.000), and gamma distribution shape parameter (0.890) and proportion of invariant sites (0.2013).

We present the optimal ML tree (-ln L = -3193.00), with ML bootstraps indicating branch support (Figure 4). The phylogenetic tree indicates that *O. eludens* **sp. nov.** is a genetic distinct species with the *O. inconspicuum* species group, and is most closely related to several species in Otago and Southland, including *O. stenotis* (11.75% genetic divergence), *O. repens* (11.39%), *O. grande* (12.56%), *O. toka* (11.69%), and *O. burganae* (14.06%) (Figure 4, Table 2). Based on the evolutionary rate for ND2 calculated by O'Neill *et al.* (2008) (1.3% per million years), *O. eludens* **sp. nov.** appears to have diverged from its most closely related species approximately 8.8 mya.

Recognition. *Oligosoma eludens* **sp. nov.** is a taxon readily diagnosable by scale and colour traits (see 'Diagnosis', above), exhibits unique behavioural traits (see 'Natural History', above), and has a deep, distinct lineage (see 'Phylogeny', above). The taxon is appropriately treated here as a new species.

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
1. *O. eludens* **sp. nov.**	-									
2. *O. burganae*	0.1406	-								
3. *O. repens*	0.1139	0.1200	-							
4. *O. toka*	0.1169	0.1154	0.1016	-						
5. *O. grande*	0.1256	0.1321	0.1042	0.1135	-					
6. *O. stenotis*	0.1175	0.1238	0.1347	0.1218	0.1310	-				
7. *O. maccanni*	0.1559	0.1535	0.1394	0.1465	0.1460	0.1258	-			
8. *O. tekakahu*	0.1877	0.1766	0.1858	0.1827	0.1949	0.1727	0.1640	-		
9. *O. notosaurus*	0.1770	0.1827	0.1619	0.1793	0.1696	0.1694	0.1680	0.0603	-	
10. *O. inconspicuum*	0.1919	0.1852	0.1745	0.1801	0.1769	0.1810	0.1836	0.0840	0.0453	-

DISCUSSION

Oligosoma eludens **sp. nov.** is a well-defined taxon for which confinement to the alpine zone, in a region which has historically received little attention from herpetologists, has helped conceal it from western science. Whitaker (1985) likely encountered examples of the species, but at that time it would have agreed with the description of the highly variable taxa *Leiolopisma nigriplantare maccanni* McCann (*fide* Hardy 1977). Other herpetologists, naturalists and conservation workers may also have encountered specimens at various times, but again the significance of these skinks would have been obscured by ineffective taxonomies, or they were incorrectly identified as more common taxa such as *Oligosoma maccanni* or *O.* aff. *polychroma* Clade 5. It was not until Patterson & Daugherty (1990) revised *L. n. maccanni*, and then Chapple *et al*. (2011) revised the resulting *L. inconspicuum*, that it became possible to recognise *O. eludens* in its current context.

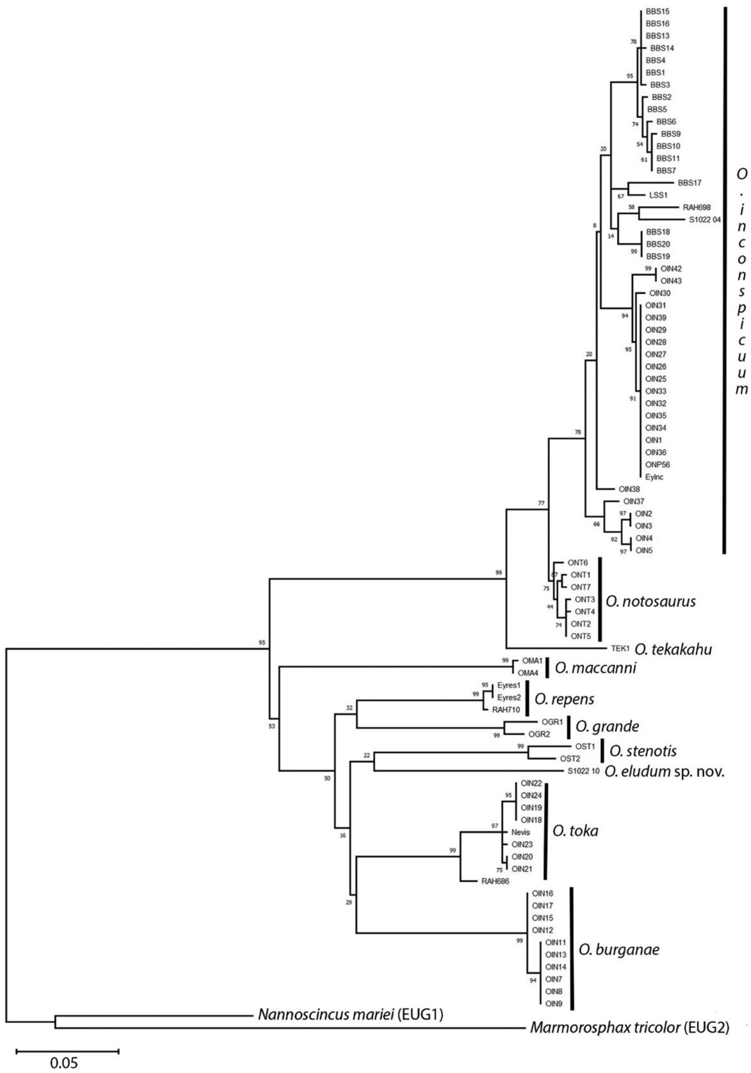

FIGURE 4. Maximum likelihood (ML) phylogenetic tree, with 1,000 bootstraps, for the *Oligosoma inconspicuum* species group, indicating the phylogenetic affinities of *Oligosoma eludens* **sp. nov.**

Now that *Oligosoma eludens* **sp. nov.** is named and defined, the species' current conservation status, existential threats, and management requirements can be identified. Research into the species' ecology (abundance, distribution, habitat, altitude range) and biology (particuarly fecundity) would be invaluable in assessing existing and potential emerging threats, such as impacts from climate change (see 'Natural History', above). The species should be relatively easy to study because several of its known localities are relatively accessible, it can often be observed while active, and live traps can easily be placed in its habitat to facilitate systematic sampling.

This new species helps highlight the wider issue of conservation among the lizard fauna of the North Otago mountains. These mountains contain several threatened species, including hura te ao gecko (*Mokopirirakau galaxias*), scree skink (*Oligosoma waimatense*), alpine rock skink (*Oligosoma* aff. *waimatense* "alpine rock"), lakes skink (*Oligosoma* aff. *chloronoton* "western Otago"), and Oteake skink (*Oligosoma* aff. *inconspicuum* 'North Otago')

(Hitchmough *et al*. 2021). There is almost no information available on historical and current trends in changes to habitat across these mountain ranges, nor on trends in lizard distribution and abundance. Additionally, there is no management of exotic predators such as mustelids (*Mustela* sp.), rats (*Rattus* sp.), mice (*Mus musculus*), hedgehogs (*Erinaceus europaeus*) and cats (*Felis catus*) at within these mountain ranges, leaving all of these poorly understood lizard species vulnerable to predation, and consequently, population decline. The impact of exotic predators on the lizards of North Otago's mountain 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). This is compounded by threats by exotic herbivore pests (deer *Cervus*, hares *Lepus* and rabbits *Oryctolagus*) and wildfire that reduce habitat complexity and quality.

ACKNOWLEDGEMENTS

We thank Tony Jewell for providing key information and data that greatly helped with this manuscript. Advances in our knowledge of this species was made in the course of three lizard research expeditions into the mountains of North Otago, between 2018−2021, funded by Auckland Zoo (AZ) and Department of Conservation (DOC), and implemented by Wildlands Consultants Ltd (WC). The authors thank Tony Jewell (private herpetologist), Seth Garden (AZ), Dave Hansford (volunteer, reporter), Rod Morris (volunteer, photographer), Shaun Murphy (volunteer), Nick Reynolds (AZ), Jenny Spencer (AZ), Ruth Smith (AZ), Cameron Thorp (WC) and Jacqui Wairepo (WC) for their respective contributions to the field work. We thank Jo Monks (DOC) for securing government funding and acquiring legal permission to collect the voucher specimen for the taxonomic description. Colin Miskelly (Te Papa Tongarewa Museum of New Zealand) provided access to the holotype for taxonomic description. We also thank EcoGene Limited for generating the genetic data used herein, which DC analysed and constructed the phylogenetic tree. The type specimen was collected under Wildlife Act Authority 72460-FAU and AEC (animal ethics) Approval 334 from the Department of Conservation.

REFERENCES

Bell, T.P. & Patterson, G.B. (2008) A rare alpine skink *Oligosoma pikitanga* sp. nov. (Reptilia: Scincidae) from Llawrenny Peaks, Fiordland, New Zealand. *Zootaxa*, 1882 (1), 57–68.
https://doi.org/10.11646/zootaxa.1882.1.3

Chapple, D.G. & Patterson, G.B. (2007) A new skink species (*Oligosoma taumakae* sp. nov.; Reptilia: Scincidae) from the Open Bay Islands, New Zealand. *New Zealand Journal of Zoology*, 34 (4), 347–357
https://doi.org/10.1080/03014220709510094

Chapple, D.G., Patterson, G.B., Gleeson, D.M., Daugherty, C.H. & Ritchie, P.A. (2008a) Taxonomic revision of the marbled skink (*Cyclodina oliveri*, Reptilia: Scincidae) species complex, with a description of a new species. *New Zealand Journal of Zoology*, 35 (2), 129–146.
https://doi.org/10.1080/03014220809510110

Chapple, D.G., Patterson, G.B., Bell, T. & Daugherty, C.H. (2008b) Taxonomic revision of the New Zealand copper skink (*Cyclodina aenea*: Squamata: Scincidae) species complex, with descriptions of two new species. *Journal of Herpetology*, 42 (3), 437–452.
https://doi.org/10.1670/07-110.1

Chapple, D.G., Daugherty, C.H. & Ritchie, P.A. (2008c) Comparative phylogeography reveals pre-decline population structure of New Zealand *Cyclodina* (Reptilia: Scincidae) species. *Biological Journal of the Linnean Society*, 95 (2), 388–408.
https://doi.org/10.1111/j.1095-8312.2008.01062.x

Chapple, D.G., Ritchie, P.A. & Daugherty, C.H. (2009) Origin, diversification and systematics of the New Zealand skink fauna (Reptilia: Scincidae). *Molecular Phylogenetics and Evolution*, 52 (2), 470–487.
https://doi.org/10.1016/j.ympev.2009.03.021

Chapple, D.G., Bell, T.P., Chapple, S.N.J., Miller, K.A., Daugherty, C.H. & Patterson, G.B. (2011) Phylogeography and taxonomic revision of the New Zealand cryptic skink (*Oligosoma inconspicuum*; Reptilia: Scincidae) species complex. *Zootaxa*, 2782 (1), 1–33.
https://doi.org/10.11646/zootaxa.2782.1.1

Chapple, D.G., Birkett, A., Miller, K.A., Daugherty, C.H. & Gleeson, D.M. (2012) Phylogeography of the endangered Otago Skink, *Oligosoma otagense*: Population structure, hybridisation and genetic diversity in captive populations. *PLoS ONE*, 7 (4), e34599.
https://doi.org/10.1371/journal.pone.0034599

Chapple, D.G. & Hitchmough, R.A. (2016) Biogeography of New Zealand lizards. *In*: Chapple, D.G. (Ed.), *New Zealand lizards*. Springer, Cham, pp. 109–131.
https://doi.org/10.1007/978-3-319-41674-8_5

Chapple, D.G., Roll, U., Böhm, M., Aguilar, R., Amey, A.P., Austin, C.C., Baling, M., Barley, A.J., Bates, M.F., Bauer, A.M., Blackburn, D.G., Bowles, P., Brown, R.M., Chandramouli, S.R., Chirio, L., Cogger, H., Colli, G.R., Conradie, W., Couper, P.J., Cowan, M.A., Craig, M.D., Das, I., Datta-Roy, A., Dickman, C.R., Ellis, R.J., Fenner, A.L., Ford, S., Ganesh, S.R., Gardner, M.G., Geissler, P., Gillespie, G.R., Glaw, F., Greenlees, M.J., Griffith, O.W., Grismer, L.L., Haines, M.L., Harris, D.J., Hedges, S.B., Hitchmough, R.A., Hoskin, C.J., Hutchinson, M.N., Ineich, I., Janssen, J., Johnston, G.R., Karin, B.R., Keogh, J.S., Kraus, F., LeBreton, M., Lymberakis, P., Masroor, R., McDonald, P.J., Mecke, S., Melville, J., Melzer, S., Michael, D.R., Miralles, A., Mitchell, N.J., Nelson, N.J., Nguyen, T.Q., Nogueira, C.D.C., Ota, H., Pafilis, P., Pauwels, O.S.G., Perera, A., Pincheira-Donoso, D., Reed, R.N., Ribeiro-Junior, M.A., Riley, J.L., Rocha, S., Rutherford, P.L., Sadlier, R.A., Shacham, B., Shea, G.M., Shine, R., Slavenko, A., Stow, A., Sumner, J., Tallowin, O.J.S., Teale, R., Torres-Carvajal, O., Trape, J.F., Uetz, P., Ukuwela, K.D.B., Valentine, L., Van Dyke, J.U., van Winkel, D., Vasconcelos, R., Vences, M., Wagner, P., Wapstra, E., While, G.M., Whiting, M.J., Whittington, C.M., Wilson, S., Ziegler, T., Tingley, R. & Meiri, S. (2021) Conservation status of the world's skinks (Scincidae): taxonomic and geographic patterns in extinction risk. *Biological Conservation*, 257, 109101.
https://doi.org/10.1016/j.biocon.2021.109101

Clark, K., Karsch-Mizrachi, I., Lipman, D.J., Ostell, J. & Sayers, E.W. (2016) GenBank. *Nucleic Acids Research*, 44 (D1), D67–D72.
https://doi.org/10.1093/nar/gkv1276

Department of Conservation. (2005) *Omarama Pastoral Lease: conservation resources report*. Department of Conservation, Wellington, 39 pp.

Greaves, S.N.J., Chapple, D.G., Gleeson, D.M., Daugherty, C.H. & Ritchie, P.A. (2007) Phylogeography of the spotted skink (*Oligosoma lineoocellatum*) and green skink (*O. chloronoton*) species complex (Lacertilia: Scincidae) in New Zealand reveals pre-Pleistocene divergence. *Molecular Phylogenetics and Evolution*, 45 (2), 729–739.
https://doi.org/10.1016/j.ympev.2007.06.008

Greaves, S.N.J., Chapple, D.G., Daugherty, C.H., Gleeson, D.M. & Ritchie, P.A. (2008) Genetic divergences pre-date Pleistocene glacial cycles in the New Zealand speckled skink, *Oligosoma infrapunctatum*. *Journal of Biogeography*, 35 (5), 853–864.
https://doi.org/10.1111/j.1365-2699.2007.01848.x

Grismer, L.L., Wood, P.L., Quah, E.S., Anuar, S., Poyarkov, N.A., Thy, N., Orlov, N.L., Thammachoti, P. and Seiha, H. (2019) Integrative taxonomy of the Asian skinks *Sphenomorphus stellatus* (Boulenger, 1900) and *S. praesignis* (Boulenger, 1900) with the resurrection of *S. annamiticus* (Boettger, 1901) and the description of a new species from Cambodia. *Zootaxa*, 4683 (3), 381–411.
https://doi.org/10.11646/zootaxa.4683.3.4

Hardy, G.S. (1977) The New Zealand Scincidae (Reptilia : Lacertilia); a taxonomic and zoogeographic study. *New Zealand Journal of Zoology*, 4 (3), 221–325.
https://doi.org/10.1080/03014223.1977.9517956

Hare, K.M., Daugherty, C.H. & Chapple, D.G. (2008) Comparative phylogeography of three skink species (*Oligosoma moco*, *O. smithi*, *O. suteri*; Reptilia: Scincidae) in northeastern New Zealand. *Molecular Phylogenetics and Evolution*, 46 (1), 303–315.
https://doi.org/10.1016/j.ympev.2007.08.012

Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D. & Rolfe, J. (2016) *Conservation status of New Zealand reptiles, 2015*. New Zealand Threat Classification Series 17. Department of Conservation, Wellington, 14 pp.

Hitchmough, R., Barr, B., Knox, C., Lettink, M., Monks, J.M., Patterson, G.B., Reardon, J., van Winkel, D., Rolfe, J. & Michel, P. (2021) *Conservation status of New Zealand reptiles. 2021*. New Zealand Threat Classification Series 35, Department of Conservation, Wellington, 15 pp.

Jewell, T. (2006) *Central Otago lizards.* Jewell Publications, Cromwell, Central Otago, 125 pp. [CD book]

Jewell, T. (2019) *Skinks of southern New Zealand—a field guide. 4th Edition*. Jewell Publications, Cromwell, Central Otago, 102 pp.

Kaiser, H., Crother, B.I., Kelly, C.M.R., Luiselli, L., O'Shea, M., Ota, H., Passos, P., Schleip, W.D. & Wüster, W. (2013) Best practices: in the 21st Century, taxonomic decisions in herpetology are acceptable only when supported by a body of evidence and published via peer-review. *Herpetological Review*, 44, 8–23.

Knox, C.D. & Jewell, T.R. (2019) *Field surveys and evaluation of four data deficient lizard taxa in Oteake Conservation Park, Otago*. Contract Report No. 4963a, Wildlands Consultants Ltd, Dunedin, 29 pp.

Knox, C.D., Jewell, T.R. & Monks, J.M. (2019) Ecology of orange-spotted geckos (*Mokopirirakau* "Roys Peak") in Central Otago and Queenstown-Lakes districts. *New Zealand Journal of Ecology*, 43 (2), 3365.
https://doi.org/10.20417/nzjecol.43.14

Knox, C.D. & Jewell, T.R. (2020) *Field surveys and assessment of four data deficient lizard taxa in Oteake Conservation Park, Otago*. Contract Report No. 5246, prepared for Auckland Zoo and the Department of Conservation. Wildland Consultants Ltd, Dunedin, 25 pp.

Knox, C.D., Hitchmough, R., Neilson, S.V., Jewell, T.R. & Bell, T. (2021a) A new, enigmatic species of black-eyed gecko (Reptilia: Diplodactylidae: *Mokopirirakau*) from North Otago, New Zealand. *Zootaxa*, 4964 (1), 140–156. https://doi.org/10.11646/zootaxa.4964.1.7

Knox, C.D., Sidaway, K., Bell, T. & Purdie, S. (2021b) *Field surveys and assessment of Data Deficient lizard taxa in the South Island's alpine zone*. *Contract Report No. 5565. Prepared for the Department of Conservation*. Wildland Consultants Ltd, Dunedin, 50 pp.

Leathwick, J., Morgan, F., Wilson, G., Rutledge, D., McLeod, M. & Johnston, K. (2002) *Land Environments of New Zealand: a technical guide.* Ministry for the Environment, Hamilton, 244 pp.

Liggins, L., Chapple, D.G., Daugherty, C.H. & Ritchie, P.A. (2008a) A SINE of restricted gene flow across the Alpine Fault: phylogeography of the New Zealand common skink *(Oligosoma nigriplantare polychroma*). *Molecular Ecology*, 17 (16), 3668–3683. https://doi.org/10.1111/j.1365-294X.2008.03864.x

Liggins, L., Chapple, D.G., Daugherty, C.H. & Ritchie, P.A. (2008b) Origin and post-colonization evolution of the Chatham Islands skink (*Oligosoma nigriplantare nigriplantare*). *Molecular Ecology*, 17 (14), 3290–3305. https://doi.org/10.1111/j.1365-294X.2008.03832.x

McEwen, W.M. (1987) *Ecological regions and Districts of New Zealand*. *4 Vols*. New Zealand Biological Resources Centre, Department of Conservation, Wellington. [unknown pagination]

Melzer, S., Hitchmough, R.A., Bell, T., Chapple, D.G. & Patterson, G.B. (2019) Lost and Found: taxonomic revision of the speckled skink (*Oligosoma infrapunctatum*; Reptilia: Scincidae) species complex from New Zealand reveals a potential cryptic extinction, resurrection of two species, and description of three new species. *Zootaxa*, 4623 (3), 441–484. https://doi.org/10.11646/zootaxa.4623.3.2

Miller, K.A., Chapple, D.G., Towns, D.R., Ritchie, P.A. & Nelson, N.J. (2009) Assessing genetic diversity for conservation management: a case study of a threatened reptile. *Animal Conservation*, 12 (2), 163–171. https://doi.org/10.1111/j.1469-1795.2009.00236.x

Miller, M.A., Pfeiffer, W. & Schwartz, T. (2010) Creating the CIPrES Science Gateway for inference of large phylogenetic trees. *In*: *Proceedings of the Gateway Computing Environments Workshop (GCE)*, 14 Nov. 2010, New Orleans, pp. 1–8. https://doi.org/10.1109/GCE.2010.5676129

O'Donnell, C.F.G, Weston, K.A. & Monks, J.M. (2017) Impacts of introduced mammalian predators on New Zealand's alpine fauna. New Zealand Journal of Ecology, 41 (1), 1–22. [https://www.jstor.org/stable/26198778] https://doi.org/10.20417/nzjecol.41.18

O'Neill, S.B., Chapple, D.G., Daugherty, C.H. & Ritchie, P.A. (2008) Phylogeography of two New Zealand lizards: McCann's skink (*Oligosoma maccanni*) and the brown skink (*O. zelandicum*). *Molecular Phylogenetics and Evolution*, 48 (3), 1168–1177. https://doi.org/10.1016/j.ympev.2008.05.008

Patterson, G.B. & Daugherty, C.H. (1990) Four new species and one new subspecies of skinks, genus *Leiolopisma* (Reptilia: Lacertilia: Scincidae) from New Zealand. *Journal of the Royal Society of New Zealand*, 20 (1), 65–84. https://doi.org/10.1080/03036758.1990.10426733

Patterson, G.B., Hitchmough, R.A. & Chapple, D.G. (2013) Taxonomic revision of the ornate skink (*Oligosoma ornatum*; Reptilia: Scincidae) species complex from northern New Zealand. *Zootaxa*, 3736 (1), 54–68. https://doi.org/10.11646/zootaxa.3736.1.2

Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013) MEGA6: molecular evolutionary genetics analysis version 6.0. *Molecular Biology and Evolution*, 30 (12), 2725–2729. https://doi.org/10.1093/molbev/mst197

Taylor, E.H. (1935) A taxonomic study of the cosmopolitan lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. *The University of Kansas Science Bulletin*, 23, 1–643. https://doi.org/10.2307/1436337

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M, Molloy, J. & Norton, D.A. (2008) *New Zealand Threat Classification System manual*. Department of Conservation, Wellington, 35 pp.

Wallis, G.P. & Trewick, S.A. (2009) New Zealand phylogeography: evolution on a small continent. Molecular Ecology, 18 (17), 3548–3580. https://doi.org/10.1111/j.1365-294X.2009.04294.x

Whitaker, A.H. (1984) *Hoplodactylus kahutarae* n. sp. (Reptilia; Gekkonidae) from the Seaward Kaikoura Range, Marlborough, New Zealand. *New Zealand Journal of Zoology*, 11 (3), 259–270. https://doi.org/10.1080/03014223.1984.10428239

Whitaker, A.H. (1985) *A survey of the lizards of the Mt. Ida area, Otago, 12–22 March 1985. Otago 'giant' skink survey NA. 2*. Unpublished report, New Zealand Wildlife Service, Wellington, 36 pp.

Whitaker, T.[A.H.], Shaw, T. & Hitchmough, R. (1999) *Black-eyed geckos* (Hoplodactylus kahutarae) *on Mt Arthur, Kahurangi National Park*. *Conservation Advisory Science Notes No. 230*. Department of Conservation, Wellington, 17 pp.

Whitaker, T. [A.H.], Chapple, D.G., Hitchmough, R.A., Lettink, M. & Patterson, G.B. (2018) A new species of scincid lizard in the genus *Oligosoma* (Reptilia: Scincidae) from the mid-Canterbury high country, New Zealand. *Zootaxa*, 4377 (2), 269–279. https://doi.org/10.11646/zootaxa.4377.2.7

Worthy, T. (1987) Osteological observations on the larger species of the skink *Cyclodina* and the subfossil occurrence of these and the gecko *Hoplodactylus duvaucelii* in the North Island, New Zealand. *New Zealand Journal of Zoology*, 14 (2), 219–229.
https://doi.org/10.1080/03014223.1987.10422992

Wüster, W., Thomson, S.A., O'Shea, M. & Kaiser, H. (2021) Confronting taxonomic vandalism in biology: conscientious community self-organization can preserve nomenclatural stability. *Biological Journal of the Linnean Society*, 133, 645–670.
https://doi.org/10.1093/biolinnean/blab009