

## TWO NEW LIZARD SPECIES FROM THE GENUS *LEIOLOPISMA* (SCINCIDAE: LYGOSOMINAE) IN SOUTHEASTERN AUSTRALIA AND TASMANIA

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### Summary

Two new species from the genus *Leiopisma* Dumeril and Bibron 1839 are described (*L. coventryi* and *L. greeni*) and earlier literature records of the species are listed. The ecology, distribution and relationships of each species are discussed.

### Introduction

Lizards belonging to the genus *Leiopisma* (*sensu* Clarke 1965 and Greer 1970) dominate the cool and cold temperate reptile faunas of Australia. A revision of the genus has almost been completed as part of a survey of temperate Australian reptiles. This survey has involved extensive field collecting and examination of museum collections in Australia and Europe. As a result of the work in museums, all extant type specimens of species which properly belong in the genus *Leiopisma* have been located and examined, thus all described species are known. Recent field collections revealed two new species of *Leiopisma* which were not represented in any European museums and were only poorly represented in Australian museums. Both of the new species are relatively abundant in their rather specialized habitats, one is restricted to montane wet sclerophyll forests in the high rainfall areas of Victoria, the Australian Capital Territory and SE. New South Wales, and the other is restricted to rocky alpine streams and swamps in N. Tasmania. The paucity of museum material can be explained by the fact that these habitats are normally regarded as unsuitable for reptiles and hence collectors have avoided them.

Specimens have been examined from the collections of the Australian Museum, Sydney (AM); the National Museum of Victoria, Melbourne (NMV); Queen Victoria Museum, Launceston (QUM); and the South Australian Museum, Adelaide (SAM). Specimens referred to elsewhere (e.g. Rawlinson 1969 and 1971 as *L. weekesae*) from the collection assembled

while the author was working in the Melbourne University Zoology Department (MUZD) are now all registered in the collection of the NMV.

### Genus *LEIOLOPISMA* Dumeril and Bibron 1839

*Leiopisma* Dumeril, A. M. C., and G. Bibron, 1839, *Erpetologie Generale*, 5: 742-744. Roret, Paris.  
Type species (monotypy): *Leiopisma telfairii* Desjardin, J., 1831, *Ann. Scient. Nat.* 22: 292.

The last generic revision was by Mittleman (1952) and his definition of the genus is basically accepted. However, following Clarke (1965) and Greer (1970) the possession of a divided frontoparietal is not regarded as a generic character and consequently the species which Mittleman separated off in the genus *Lampropholis* are included in *Leiopisma*.

There is no doubt that *Leiopisma* as defined here is polyphyletic. Variations in the palatal bone structures of the various species enable the genus to be broken up into two major groups which Greer and Parker (1968) and Greer (1970) have designated as "alpha" and "beta" *Leiopisma*. These morphological groupings correspond to major biological divisions (Rawlinson unpublished), for example all "alpha" *Leiopisma* species are viviparous heliotherms; all "beta" *Leiopisma* species are oviparous and most are also communal nesting thigmotherms. No meaningful attempt can be made to split the genus up at present for details of the morphology and biology of all the present *Leiopisma* species must precede a generic revision, however it can be recorded that the two new species described below are true "alpha" *Leiopismas*.

*Diagnosis:* Small to moderately large skinks. Limbs pentadactyl, digits not elongate, sub-

digital lamellae undivided. Lower eyelid moveable with a well developed transparent palpebral disc bordered above by the lower ciliaries, otherwise surrounded by small granular scales. External ear opening obvious and tympanum visible. Supranasal and postnasal scales lacking. Prefrontals enlarged but fail to contact on midline. Frontoparietals divided or fused but always separate from the interparietal. Parietals large and contact on the midline. One or more pairs of enlarged nuchals. Preanals only slightly enlarged.

***Leiolopisma coventryi* sp. nov.**

Pl. 1., fig. 1.; Fig. 1.; Pl. 2., fig. 3(a).

*Lygosoma (Leiopisma) weekesae* (? part) Weekes, H. C., 1928, *Proc. Linn. Soc. N.S.W.* 54: 34-60. Weekes H. C., 1935, *Proc. Zool. Soc. Lond.* 3: 625-645.

*Leiolopisma metallica* Brazenor, C. W., 1947, *Mem. natn. Mus. Vict.* 15: 156-158.

*Leiolopisma weekesae* (?) Rawlinson, P. A., 1967, *Proc. Roy. Soc. Vict.* 80: 211-224. Rawlinson, P. A., 1969, *ibid.* 82: 113-128. Rawlinson, P. A., 1971, *ibid.* 84: 37-52. Rawlinson, P. A., 1971, *Vict. Yearbook* 85: 11-36. Spellerberg, I. F., 1972, *Oecologia* 9: 23-46. Rawlinson, P. A., 1974, *Pap. Proc. Roy. Soc. Tas.* 107: 153-170. Rawlinson, P. A., 1974, Ch. 11, *Biogeography and Ecology in Tasmania. Monographie Biologicae* 26. The Hague, Junk: 230-269.

*Leiolopisma* sp. nov. Rawlinson, P. A., 1974, *Mem. natn. Mus. Vict.* 35: 87-96.

*Holotype*: NMV D 40080, adult male, National Museum of Victoria, Melbourne.

*Locality*: 2 km N. of Mt. St. Leonard, Victoria, 37°33'S., 145°32'E.

*Collectors*: A. J. Coventry, P. A. Rawlinson and W. R. Rawlinson.

*Date of collection*: June 21, 1974.

*Description*: Snout-vent length 43.5 mm. Length of tail (intact) 66 mm, 151% of S-V length. Total length 109.5 mm. Snout-axilla length 16 mm. Axilla-groin length 24 mm. Length of forelimb 10.5 mm, 24% of S-V length. Length of hindlimb 16 mm, 36% of S-V length. No supranasal or postnasal scales. Rostral and frontonasal in broad contact. Frontal and frontonasal in narrow contact. Prefrontals large, fail to meet; contact the frontonasal, anterior and posterior loreals, first supraeyliary, first supraocular and frontal. Anterior and posterior loreals large, subequal. Frontoparietals divided. Interparietal separate,

large, about half the size of the frontoparietals. Parietals large, contact along midline. One very enlarged pair of nuchals followed by a series of smaller pairs. A series of enlarged temporal scales. Four supraoculars, the second the largest (on the right hand side the third has an abnormal division). Six supraciliaries. Seven upper ciliaries, the third, fourth and fifth enlarged and project outwards. Nine lower ciliaries. Lower eyelid moveable with a large transparent palpebral disc bordered above by the lower ciliaries but otherwise surrounded by small granular scales. Length of palpebral disc 0.8 mm. Length of eye 1.7 mm. Seven upper labials, the fifth subocular (on the right hand side abnormal, six upper labials, the fourth subocular). Six lower labials. Ear opening obvious, tympanum visible but partially enclosed as external scales overlap opening. Diameter of external ear opening 0.8 mm. No ear lobules. Ten preanal scales, central pair slightly enlarged. Subdigital lamellae black, undivided and rough, 21 under the fourth toe. Palmar tubercles black, flattened asymmetrically with apical point directed distally. Midbody scales in 26 rows. Dorsal scales with 4 very faint keels. Lateral scales with 3 very faint keels. Ventral scales smooth and highly polished.

Colour in life drab, pattern resembles that of *L. delicata* (unrelated, a "beta" *Leiolopisma*). Dorsal surface of head dark brown with black flecks. Dorsal surface of neck, trunk and tail dark brown, each scale with 3-4 fine black lines which sometimes fuse to give a black patch, many scales with light olive flecks between the black lines. Dorsolateral scales on neck, trunk and anterior section of tail with a light yellow upper half and black lower half giving the impression of a light dorsolateral stripe bordered below by black. This "stripe" extends from the eye onto the tail where it is broken up. Upper lateral scales from eye to anterior section of tail black with scattered brown flecks. Lower lateral scales light grey with scattered black, brown and even yellow flecks. Ventral surface light grey with some scattered black flecks especially under the chin. Palms and subdigital lamellae black.

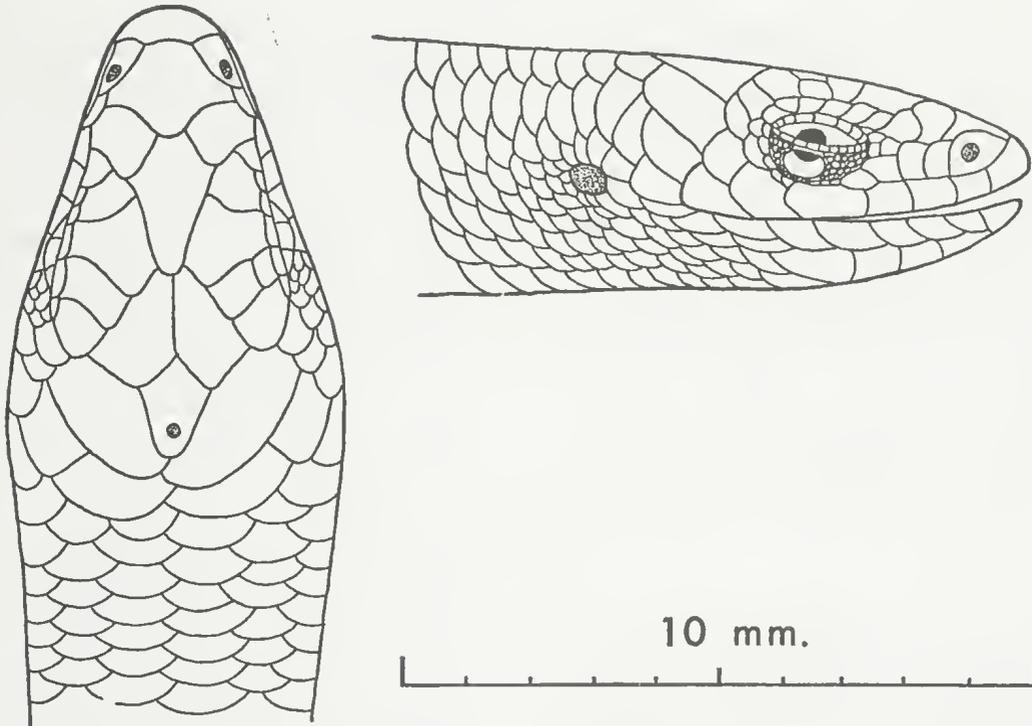


Fig. 1—Headshields of *Leiolopisma coventryi* sp. nov. NMV D40080.

*Paratypes*: Thirty-five specimens; 28 adult females, NMV D 40081-97, D 40102-112, and 7 adult males, NMV D 40098-101, D 40113-115, National Museum of Victoria, Melbourne.

*Locality*: 2 km N. of Mt. St. Leonard, Victoria, 37°33'S., 145°32'E.

*Collectors*: A. J. Coventry, P. A. Rawlinson and W. R. Rawlinson.

*Date of collection*: June 21, 1974.

*Description of the 35 paratypes*: As for holotype except as follows: Snout-vent length 35.5-51.0 mm, mean 43.3 mm. Intact tail 124-151% (mean 138%) of S-V length (8 specimens). Total length of adults with intact tails 87.5-109.5 mm, mean 98.2 mm (8 specimens). Length of forelimb 8.5-12.0 mm, mean 10.8 mm; 22-27% (mean 24.7%) of S-V length. Length of hindlimb 12.0-17.0 mm, mean 15.3 mm; 31-39% (mean 34.9%) of S-V length. One very enlarged pair of nuchal scales in 34 of the paratypes, NMV D 40110 has two very enlarged pairs. Six supraciliaries in 33 of the paratypes, NMV D 40086 and NMV D 40100 each have seven. Seven upper labials with the fifth subocular in 34 of the paratypes, NMV D 40114 has six upper labials with the fourth subocular. Lamellae under the fourth toe 19-23,

mean 20.5, mode 20. Midbody scales in 25-27 rows, mean 25.9, mode 26.

Colour of all paratypes as for holotype.

*Sexual Dimorphism in the Type Series*: There is some evidence of sexual dimorphism, adult males tend to be smaller and longer limbed as the following figures illustrate. As only one male (the holotype) has a complete tail it is not known if there is any relative difference in tail length.

*Snout-vent length*:

Females 35.5-51.0 mm, mean 44.3 mm  
(28 specimens).

Males 36.0-43.5 mm, mean 40.0 mm  
(8 specimens).

*Length of forelimb*:

Females 8.5-12.0 mm, mean 10.9 mm,  
22-27% (mean 24.3%) of S-V length  
(28 specimens).

Males 9.5-12.0 mm, mean 10.6 mm,  
24-27% (mean 26.1%) of S-V length  
(8 specimens).

*Length of hindlimb*:

Females 12.0-18.0 mm, mean 15.4 mm,  
31-38% (mean 34.3%) of S-V length  
(28 specimens).

Males 13.5-17.0 mm, mean 15.0 mm,  
35-39% (mean 36.9%) of S-V length  
(8 specimens).

*L. coventryi* can be easily separated from its closest relatives *L. metallica* and *L. entrecasteauxii* as follows:

1. Frontoparietals undivided . . . . . *L. metallica*  
Frontoparietals divided . . . . . 2
2. Length of palpebral disc more than half  
length of eye, midbody scales in 29-33  
rows, light dorsolateral and midlateral  
stripes . . . . . *L. entrecasteauxii*  
Length of palpebral disc less than half  
length of eye, midbody scales in 25-29  
rows, no trace of light dorsolateral or mid-  
lateral stripes . . . . . *L. coventryi*

#### COMMENT

Three species of skinks, *Leiolopisma coventryi*, *Anotis maccoyi* and *Pseudemoia spenceri*, are virtually restricted to SE. Australian montane wet sclerophyll forests. These species are relatively common in their rather specialized habitats, yet they were completely overlooked by the early European collectors who probably avoided densely forested areas. Two of the species, *A. maccoyi* and *P. spenceri*, were described by Lucas and Frost (1894) in "The Lizards Indigenous to Victoria". *L. coventryi* however remained unknown, no specimens were held in the major European museums (Rawlinson unpublished) and by 1894 when Lucas and Frost published their work, only one specimen was preserved in any of the museum collections in Australia (AM R 560). Between 1894 and 1947 one more specimen was added to the AM collection and seven specimens were catalogued into the NMV collection. Thus there was little chance of taxonomists picking up the species prior to 1947. Since 1947 10 specimens have been added to the AM, 193 to the NMV, and 10 to the SAM. These figures help to explain why *L. coventryi* has only been discovered recently. *L. coventryi* is sympatric with its closest relatives, *L. entrecasteauxii* and *L. metallica* in several localities, e.g. the type locality, without hybridizing, thus they are good biological species (*sensu* Mayr 1963).

The present author was responsible for the

name *Leiolopisma weekesae* being applied to *L. coventryi*, and this mistake arose as follows. In 1929 Kinghorn described a new species, *Lygosoma (Lioplepisma) weekesae*, which was named after Dr H. C. Weekes. Dr Weekes (1929) described the placentation of a species she ascribed to *L. (L.) weekesae* in an article immediately following Kinghorn's description of that species. After Rawlinson (1974c) *L. (L.) weekesae* is now known to be a junior subjective synonym of *Pseudemoia spenceri*, this was not discovered earlier as Kinghorn stated and illustrated that supranasal scales (diagnostic for *P. spenceri*) were absent in *L. (L.) weekesae*, where in fact they were present and obvious in all his type specimens. However, Weekes' specimens ascribed to *L. (L.) weekesae* could not have all been *P. spenceri*, for the recorded litter sizes (3-7) are much too large for the latter species where litters average 1.9 and range from 1-3. When *L. coventryi* was discovered it was realized that it did not fit any of the early descriptions of *Leiolopisma* species. However, it did fit Kinghorn's description of *L. (L.) weekesae* in all respects except midbody scale counts and the litter size (1-7, mean 3.0) agreed with Weekes' account of the species. In an attempt to identify *L. (L.) weekesae*, collections were made from the localities mentioned by Kinghorn and Weekes, these yielded specimens of *P. spenceri* and *L. coventryi*. Mislead by Kinghorn's inaccurate description, and the litter sizes recorded by Weekes, the author in 1967 tentatively applied the name *Leiolopisma weekesae* to specimens now properly identified as *L. coventryi*. Although dubious about the identification the author has continued to apply the name for the sake of consistency. During work on a revision of the genus *Pseudemoia* (Rawlinson 1974e) the author located all the specimens mentioned in the description of *L. (L.) weekesae* and all proved to be conspecific with *P. spenceri*. Thus the name *L. weekesae* cannot now be associated with *L. coventryi* except for the specimens used in Weekes' work and specimens misidentified by the author (see synonymy above) including the specimens worked on by Spellerberg (1972).

The species is named in honour of John Coventry, Field Officer in the National Museum of Victoria, in recognition of his help in gathering the material presented here and also for his many outstanding contributions to Australian herpetology. He has worked on the NMV amphibian and reptile collections since 1953 and has been responsible for them since 1957. During this period he has completely revised and greatly extended the herpetological collections so that they now rank as one of the best repositories of Australian material and they include the best collections of SE. Australian, Bass Strait and Tasmanian material.

#### OTHER SPECIMENS EXAMINED

In order to determine the intraspecific variation in some important taxonomic characters, a further 107 specimens including juveniles were examined in detail.

*Size:* Mature adults: Snout-vent length 35.0-57.0 mm, mean 44.2 mm (76 specimens). Intact tail 118-146% (mean 136%) of S-V length (16 specimens). Total length of adults with intact tails 81.0-113.0 mm, mean 99.1 mm (16 specimens). Juveniles at birth: Snout-vent length 17.0-19.0 mm, mean 18.0 mm (8 specimens). Intact tail 110-127% (mean 114.9%) of S-V length (8 specimens). Total length of juveniles with intact tails 37.0-41.0 mm, mean 38.8 mm (8 specimens).

*Scalation:* Supranasals and postnasals absent in all specimens examined. Midbody scales in 25-29 rows, mean 27.2 (97 specimens). Lamellae under the fourth toe 16-23, mean 19.2 (97 specimens).

*Colour:* Remarkably uniform, as for holotype and paratypes above.

The localities and registered numbers of all other specimens of *Leiopisma coventryi* examined are listed below.

*New South Wales:* (AM) Blue Mountains: South Bowenfels district, R 27022. Black Range: 8 km N. of Jenolan Caves, R 39106; 3 km N. of Jenolan Caves, R 39103-5; Mt. Edwards, Boyd Plateau via Jenolan, R 31595. Snowy Mountains: Island Bend, Mt. Kosciusko National Park, R 15934; Mt. Kosciusko, 1080-1800 m, R 560. (NMV) Black Range: 4 km

WSW. of Jenolan Caves, D 38180-1; 8 km WSW. of Jenolan Caves, D 39189. Snowy Mountains: 5 km ESE. of Laurel Hill, D 32968; Hansens Mill, 23 km S. of Batlow, D 32951; 4 km N. of Cabramurra, D 32969; 6.5 km SW. of Eucumbene, D 32940-5; Sawpit Creek, Mt. Kosciusko Road, D 16728; 8 km ENE. of Thredbo, D 32922; Cascade Creek, 16 km N. of Tin Mine Huts, D 32996. Coast Range: Brown Mountain, D 16729-31, D 32988; 3 km ESE. of Brown Mountain, D 16727.

*Australian Capital Territory:* (AM) Brindabella Ranges: Brindabella Ra., R 15304, R 15306, R 15343. (NMV) Brindabella Ranges: Picadilly Circus, D 32999; 1.5 km S. of Bulls Head, D 16726.

*Victoria:* (AM) Victoria, R 4893. (NMV) Burrowa Massif: 1.5 km SE. of Mt. Burrowa, D 17523. Strathbogie Ranges: S. slopes of Mt. Buggarec, Warrenbayne Plantation area, D 17247; Police Track, Warrenbayne Plantation area, D 17167; Albert Track, Warrenbayne Plantation area, D 17229-33, D 17132, D 17741; 1 km WNW. of Junction Police and Albert Tracks, Warrenbayne Plantation area, D 17254-6; Mt. Albert, Warrenbayne Plantation area, D 17733; Chapmans Lane, Warrenbayne Plantation area, D 18027. Blue Range: Whiskey Creek, 13 km SSE. of Tatong, D 18111; The Bird Reserve, D 17393-4; Engelkes Track, between Holland Creek and Spring Creek Road, D 17435; Engelkes Track, between Holland Creek and Old Tolmie Road, D 17432-3. Australian Alps: 4 km SSW. of Cowombat Plain, D 32995; 1.5 km NW. of Mt. Cobberas, D 32981; Limestone Creek, 13 km W. of Mt. Cobberas, D 32997-8; Native Dog Plain, 7 km SW. of Mt. Cobberas, D 32979, D 33397; 3 km N. of Wulgulmerang, D 32946-50; Honeysuckle Track, Currie Creek, 6 km NW. of Gelantipy, D 7728. Coast Range: 21 km ENE. of Mt. Ellery, 790 m, D 14107; 13 km ENE. of Mt. Ellery, 1200 m, D 14151; 9.5 km NE. of Mt. Ellery, D 14162-7; 3 km NE. of Mt. Ellery, D 14173; Yalmy Road, 8 km W. of Goongerah, D 32973. Grampians Range: 3 km SE. of Mt. Victory, D 38184-5; Strachans Camp, D 32926. Western Highlands, Midlands Range: Mt. Cole Forest, 14.5 km S.

of Elmhurst, D 32928; 9.5 km WSW. of Trentham, D 32982; Mt. Blackwood area, D 32952-4. Eastern Highlands including the Victorian Alps: King Parrot Creek, 16 km N. of Kinglake West, D 32955-6; No. 1 Camp, Mt. Disappointment Forest, D 32974, D 33299; 3 km E. of No. 1 Camp, Mt. Disappointment Forest, D 32978; Kilmore Reservoir, 4 km WNW. of Mt. Disappointment, D 32983-90; Mt. Disappointment, D 13970-1, D 32966, D 32991-3, D 40130; 9 km NNE. of Kinglake, D 32957; 15 km N. of Big River Camp, D 32972; 9 km SE. of Marysville, D 32927; 8 km SW. of Lake Mountain, D 38456; 3 km NE. of Mt. St. Leonard, D 32934-5; Mt. St. Leonard, D 32929-33; Blacks Spur, 13 km ENE. of Healesville, D 1737-8; Acheron Gap, Acheron Way, 13 km SSE. of Narbethong, D 33646; Pantons Gap, 11 km SE. of Healesville, D 32920-1; Don Gap, 16 km ESE. of Healesville, D 32936-7; 6 km S. of Kel Junction, D 32925; Mt. Baw Baw, D 11245; 4 km SW. of Mt. Baw Baw, D 13583-4, D 13600; Neulynes Mill, 5 km SW. of Mt. Baw Baw, D 13585; Waterloo, Gippsland, D 1054-5. Dandenong Ranges: Kalorama, D 32967, D 32970-1, D 32975-7, D 33000-6, D 38183; Sassafras, D 1288; Belgrave, D 32939; Emerald, D 2170. Otway Ranges: Kawarren, D 13636; Gellibrand River, Gellibrand, D 12274, D 18022; 5 km S. of Forrest, D 32963; Mt. Sabine, D 13631-5, D 32994; 3 km S. of Wylangta, D 12242; 3 km N. of Cape Horn, D 32962; 3 km SW. of Cape Horn, D 32923-4; 5 km SW. of Cape Horn, D 32938; 5 km ENE. of Hordern Vale, D 32958-61; Apollo Bay, D 32964-5; 1.5 km NNW. of Blanket Bay, D 38182. Victoria, D 1728. (SAM) Grampians Range: 9 km SE. of Glenisla, 37°17'S., 142°16.5'E., R 13671; 10 km SE. of Glenisla, 37°17'S., 142°17.5'E., R 13672 a-c (3 ex.); 11 km E. of Mooralla, 37°23.5'S., 142°15'E., R 13795 a-c (3 ex.). Otway Ranges: Otway Ra., R 12377; Erskine Falls, 8 km NW. of Lorne, R 12376. South Melbourne (?), R 6197.

#### DISTRIBUTION

Highlands of SE. New South Wales, Australian Capital Territory and Victoria from the Bowenfels area, Blue Mountains (N.S.W.), to

the Victoria Range in The Grampians (Vic.). The species occurs disjunctly in a number of isolates within this area.

#### HABITAT

Found only in regions of high rainfall (more than 75 cm per year). Populations within these regions are restricted to large decaying fallen trees, logs or tree stumps in clearings in montane wet sclerophyll forests. The exposed surfaces of the decaying wood are used for basking and foraging sites during activity, while crevices in the wood are used for shelters when inactive.

#### ECOLOGY

The distribution of *L. coventryi* parallels that of *Pseudemoia spenceri* to a remarkable extent (see map in Rawlinson, 1974e), this is because both species are limited to true montane wet sclerophyll forests. *L. coventryi* also resembles *P. spenceri* in that it is an insectivorous skink with a thermoregulatory behaviour pattern during activity which classifies it as a shuttling heliotherm (see discussions in Rawlinson 1974a, b, c). However, *P. spenceri*, a very agile lizard, is mainly arboreal and most activity is carried out on elevated surfaces, whereas *L. coventryi* is restricted in its activity to logs and litter at or close to ground level (within 1-2 m).

The densest *L. coventryi* populations are found in naturally burnt regenerating montane forests or regenerating montane forests where limited selective cutting for timber has been carried out. In these areas are found the clearings and large decaying fallen trees, logs and tree stumps which provide the essential habitat requirements for basking, foraging and shelter. Some of the densest populations occur in areas where limited selective cutting has been carried out, however the modern forestry management practice in montane forests (Ashton 1956; Butler 1971; Cunningham 1960; Grose 1957), where large areas are clear cut and the slash is later burnt to establish a seed-bed for dense regeneration, destroys the species habitat (sunlit clearings, fallen logs and litter) and eliminates the species from such areas.

Details of hibernation are reasonably well known, in fact the type series collected on June 21, 1974 were all taken from hibernation

sites. When inactive the lizards utilize crevices inside large decaying logs usually only 5-20 cm beneath the surface and within 2 m of ground level. The lizards may hibernate singly, but are more commonly found in dens which may contain up to 8 individuals. This denning probably results from a number of individuals locating the same favourable site rather than from a social factor for other species of skinks are also found in the dens. During the collection of the 36 type specimens, 3 *Leiolopisma entrecasteauxii*, 5 *L. metallica* and 4 *Sphenomorphus tympanum* specimens were also taken from *L. coventryi* dens. The winter hibernation sites of *L. coventryi* make the species very vulnerable to another modern forestry practice, the deliberate lighting of so-called controlled fires in winter for fuel reduction (see for example Hodgson 1969). These fires burn slowly and intensely at ground level setting fire to the logs and litter. Thus the hibernation sites of this species are actually the target of such winter forestry management practices.

Laboratory measurements of the thermal preferences and "Normal Activity Range" of *L. coventryi* have been made from continuous recordings of body temperature in a photo-thermal gradient (15-50°C.) using the methods outlined by Rawlinson (1974c) for *P. spenceri*. These results are summarized in Table 1. As with *P. spenceri*, the specimens in the gradient mirrored their thermoregulatory behaviour in the field, i.e. shuttled continuously from under the radiant heat lamp to shaded cool areas and back. From body temperature measurements made at one-minute intervals on 7 specimens (1136 observations) it was determined that the "Mean Preferred" body temperature was 30.1°C., while the "Voluntary Minimum" and "Voluntary Maximum" body temperatures were 22.7°C. and 37.5°C. respectively (Table 1). The histogram of frequency of body temperature maintained during activity (1°C. class intervals, range 20°-37°C.) is slightly skewed towards the high temperature end of the scale. The mode is the 28°C. class interval, but it is not pronounced and contains only 10% of the observations, while each of the class intervals from 27°-34°C. contain more than 8% of the observations. This result reflects the shuttling

method of thermoregulation with the consequent rapid fluctuations in body temperature as the lizard moves to and from the basking site. The method of thermoregulation also explains the wide range of body temperatures tolerated during normal activity.

Spellerberg (1972) determined the physiological thermal tolerances of the species (as *L. weekesae*, see above) by measuring the "Critical Maximum" and "Critical Minimum" body temperatures. These are the temperatures at which locomotory ability is lost as measured by the loss of the righting reflex. The "Critical Maximum" is 41.9°C. and the "Critical Minimum" is 3.5°C. Thus *L. coventryi* has wide thermal tolerances; it tolerates large fluctuations in body temperature during voluntary activity, the mean normal activity range for the specimens tested was 14.8°C. (22.7°-37.5°C.), the absolute range was 17.6°C. (20.2°-37.8°C.); and specimens are capable of co-ordinated movements over a very wide range of body temperatures, a mean range of 38.4°C. (3.5°-41.9°C.) and an absolute range of 38.9°C. (3.0°-41.9°C.). *Pseudemoia spenceri* which occupies the same major habitat as *L. coventryi* also has very wide thermal tolerances (Rawlinson 1974c).

#### REPRODUCTION

*L. coventryi* is a live-bearing skink. There is no trace of eggshells around developing embryos, so it is assumed the species is fully viviparous (i.e. placental). Pregnant females kept under observation in the laboratory produced litters between January 30 and February 13. In all, 15 pregnant females were examined, litter sizes ranged from 1-7 and the mean number of offspring was 3.0 (Table 1). Copulation and the insemination of females takes place in autumn (April). The females store the sperm over winter, ovulation occurs in spring (mid October) and the ova are then fertilized.

Weekes (1929, 1935) described in detail the placentation of a species which was ascribed to *Lygosoma (Liolepisma) weekesae* but was almost certainly *L. coventryi* (see above). Weekes recorded 3-7 embryos for the specimens she examined which were collected in

TABLE 1

Thermal tolerances and reproduction of *Leiolopisma coventryi* sp. nov.

Body Temperature Value/Litter Size	Number of Observations	Mean	Range
<i>Thermal tolerances:</i>			
Critical Minimum Temperature °C.	2	3.5	3.0- 4.0
Voluntary Minimum Temperature °C.	7	22.7	20.2-27.0
Mean Preferred Temperature °C.	1136	30.1	—
Voluntary Maximum Temperature °C.	7	37.5	37.3-37.8
Critical Maximum Temperature °C.	2	41.9	41.9-41.9
<i>Reproduction:</i>			
Litter Size	15	3.0	1-7

the Jenolan area where *L. coventryi* is reasonably common and so it is almost certain that her detailed account of placentation in the species ascribed to *L. (L.) weckesae* applies instead to *L. coventryi*.

#### RELATIONSHIPS OF *LEIOLOPISMA COVENTRYI*

The palatal bone structure shows that *L. coventryi* is an "alpha" *Leiolopisma* species. As was mentioned by Rawlinson (1974c), there are two groups in "alpha" *Leiolopisma*, viz. species with low midbody scale counts (20-32) which includes *L. entrecasteauxii* and *L. metallica* in Australia, and species with high midbody scale counts (38-66) which includes *L. greeni* sp. nov., *L. ocellata* and *L. pretiosa*. *L. coventryi* has 25-29 midbody scale rows and its closest relatives are undoubtedly *L. entrecasteauxii* and *L. metallica*. It is considered that *L. coventryi* is a sibling species of *L. metallica*.

#### *Leiolopisma greeni* sp. nov.

Pl. 1., fig. 2.; Fig. 2.; Pl. 2., fig. 3(b).

*Leiolopisma pretiosum* (Form B) Rawlinson, P. A., 1971, *Proc. Roy. Soc. Vict.* 84: 37-52.

*Leiolopisma* sp. nov. Rawlinson, P. A., 1974, Ch. 11, *Biogeography and Ecology in Tasmania. Monographie Biologique* 26. The Hague, Junk: 230-269.

*Holotype*: NMV D 18243, adult female, National Museum of Victoria, Melbourne.

*Locality*: Mt. Barrow summit, 1413 m, Tasmania, 41°23'S., 147°25'E.

*Collectors*: M. O. Rawlinson and P. A. Rawlinson.  
*Date of collection*: January 31, 1967.

*Description*: Snout-vent length 50.0 mm. Length of tail (regrown) 49.0 mm. Total length 99.0 mm. Snout-axilla length 19 mm. Axilla-groin length 29 mm. Length of forelimb 15.0 mm, 30% of S-V length. Length of hindlimb 21.0 mm, 42% of S-V length. Supranasals partially separated off on both sides. No postnasal scales. Rostral and frontonasal in narrow contact. Frontal and frontonasal just in contact. Prefrontals large, narrowly separated; contact the frontonasal, anterior and posterior loreals, first supraciliary, first supraocular and frontal. Anterior and posterior loreals large, subequal. Frontoparietals fused. Interparietal separate, large, about one quarter the size of the frontoparietals. Parietals large, contact on the midline. One enlarged pair of nuchal scales, all other neck scales small. A series of enlarged temporal scales. Four supraoculars, the second the largest. Seven supraciliaries. Six upper ciliaries, the third, fourth and fifth enlarged and project down and outwards. Ten lower ciliaries. Lower eyelid moveable with a large transparent palpebral disc bordered above by the lower ciliaries, but otherwise surrounded by small granular scales. Length of palpebral disc 1.0 mm. Length of eye 2.6 mm. Eight upper labials, the sixth subocular. Eight lower labials. Ear opening obvious, tympanum visible. Diameter of external ear opening 1.1 mm.

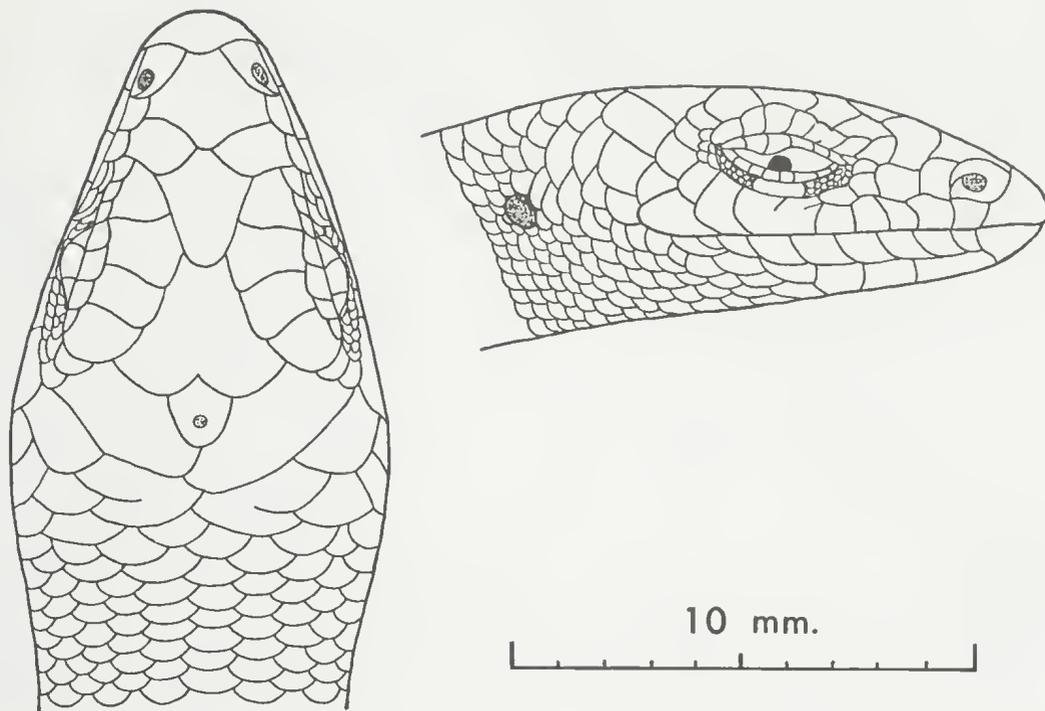


Fig. 2—Headshields of *Leiolopisma greenii*, sp. nov. NMV D18243.

Three small anterior ear lobules. Eleven pre-anal scales, central scale slightly enlarged. Subdigital lamellae undivided, smooth, 24 under the fourth toe. Palmar tubercles flattened asymmetrically with apical point directed distally. Midbody scales in 42 rows. Dorsal scales with 3 very faint keels. Lateral scales with 2 very faint keels. Ventral scales smooth.

Colour in life, dorsal surface of head, trunk and tail black, most scales with a grey-green central patch. No dorsolateral stripe. Upper and lower lateral surfaces the same as dorsal surface except grey-green patches enlarge towards the ventral surface. Ventral surfaces grey-green, some black patches along the sides. Palms and subdigital lamellae dark grey.

**Paratypes:** Sixteen specimens in the collections of the National Museum of Victoria, Melbourne (NMV), the Queen Victoria Museum, Launceston (QVM), and the South Australian Museum, Adelaide (SAM).

NMV D 18240, adult female.

Locality: Mt. Rufus, 1417 m, Tasmania, 42°08'S., 146°06'E.

Collector: J. A. Owen.

Date of collection: February, 1962.

NMV D 18241, D 18244-5, 3 adult females; NMV D 18246-8, 3 adult males; NMV D 18249, juvenile. Locality: Pine Lake, 1150 m, 5 km NNE. of Berona, Tasmania, 41°35'S., 146°43'E.

Collectors: M. O. Rawlinson and P. A. Rawlinson. Date of collection: January 30, 1967.

NMV D 18242, adult female.

Locality: Mt. Barrow summit, 1413 m, Tasmania, 41°23'S., 147°25'E.

Collectors: M. O. Rawlinson and P. A. Rawlinson. Date of collection: January 31, 1967.

QVM 1947.3.4 a-e, three adults and two half-grown specimens, sex not determined.

Locality: Ben Lomond Central Plateau, 1500 m, Tasmania, 41°35'S., 147°39'E.

Collector: M. Merrilees.

Date of collection: January, 1947.

QVM 1972.3.201, half grown, sex not determined.

Locality: Ben Lomond summit, 1573 m, Tasmania, 41°32'S., 147°39'E.

Collector: R. Upson.

Date of collection: March, 1971.

SAM R 11136, adult, sex not determined.

Locality: Barn Bluff, 1559 m, Tasmania, 41°44'S., 145°55'E.

Collector: F. J. Mitchell.

Date of collection: January 16, 1963.

**Description:** As for holotype except as follows. Mature adults: Snout-vent length 50.0-67.0 mm, mean 58.8 (13 specimens); Intact tail 120-132% (mean 126.7%) of S-V length (3 specimens); Total length of adults with intact tails 114.0-128.0 mm, mean 119.3 mm (3

specimens); Length of forelimb 15-22 mm, mean 17.4 mm, 25-38% (mean 29.3%) of S-V length (13 specimens); Length of hindlimb 20-25 mm, mean 22.4 mm, 35-46% (mean 37.8%) of S-V length (13 specimens). Half-grown specimens: Snout-vent length 40.0 and 32.0 mm; Intact tail 117 and 118% of S-V length; Total length 87.0 and 70.0 mm; Length of forelimb 12 and 11 mm, 30 and 34% of S-V length; Length of hindlimb 16 and 14 mm, 40 and 43% of S-V length (half-grown specimens QVM 1947.3.4. d-e respectively). Juvenile at birth: Snout-vent length 25.0 mm; Intact tail 32 mm, 128% of S-V length; Total length 57.0 mm; Length of forelimb 9 mm, 36% of S-V length; Length of hindlimb 12 mm, 48% of S-V length (NMV D 18249). Supranasals absent in all paratypes. Postnasals partially separated off in QVM 1947.3.4. e. Frontoparietals fused in all the paratypes. Interparietal separate, large, varies from about one third to one fifth the size of the frontoparietals. One very enlarged pair of nuchal scales in 15 of the paratypes, QVM 1947.3.4. a has no enlarged nuchals. Seven supraciliaries in 14 of the paratypes, NMV D 18248 and QVM 1947.3.4. c each have eight supraciliaries. Eight upper labials with sixth subocular in 13 of the paratypes, NMV D 18242, NMV D 18246 and QVM 1947.3.4. d have seven upper labials with the fifth subocular. Lamellae under the fourth toe 20-25, mean 22.7, mode 23. Midbody scales in 40-44 rows, mean 41.6, mode 42.

Colour of all sixteen paratypes as for holotype.

*L. greeni* can be easily separated from its closest relatives *L. pretiosa* and *L. ocellata* as follows:

1. Midbody scales in 30-39 rows, dorsal surface brown with scattered light and dark patches, black upper lateral surfaces with scattered light patches . . . . . *L. pretiosa*  
Midbody scales in 40 or more rows, colour not as above . . . . . 2
2. Midbody scales in 45-58 rows, light grey to olive-grey dorsal surface with black mottling, brown upper lateral surface with large ocellations—light grey patches surrounded by black . . . . . *L. ocellata*

Midbody scales in 40-44 rows, black dorsal and lateral surfaces—most scales with a small grey-green central patch . . . *L. greeni*

#### COMMENT

*L. greeni* is the only reptile species restricted to the Tasmanian mainland. It was originally thought to be closely related to *L. pretiosa*, but more critical examination has indicated that *L. ocellata* is its closest relative. *L. greeni* and *L. ocellata* are sympatric on the summit of Mt. Barrow and there is no trace of hybridization thus they are good biological species (*sensu* Mayr 1963).

The species is named in honour of Bob Green, Zoologist in the Queen Victoria Museum, Launceston, in recognition of his help in gathering the material presented here and also for his extensive work on the vertebrate fauna of N. and W. Tasmania and the Bass Strait area. His collections in the Queen Victoria Museum have helped many zoologists complete projects which required material from the more inaccessible parts of Tasmania and Bass Strait.

#### DISTRIBUTION

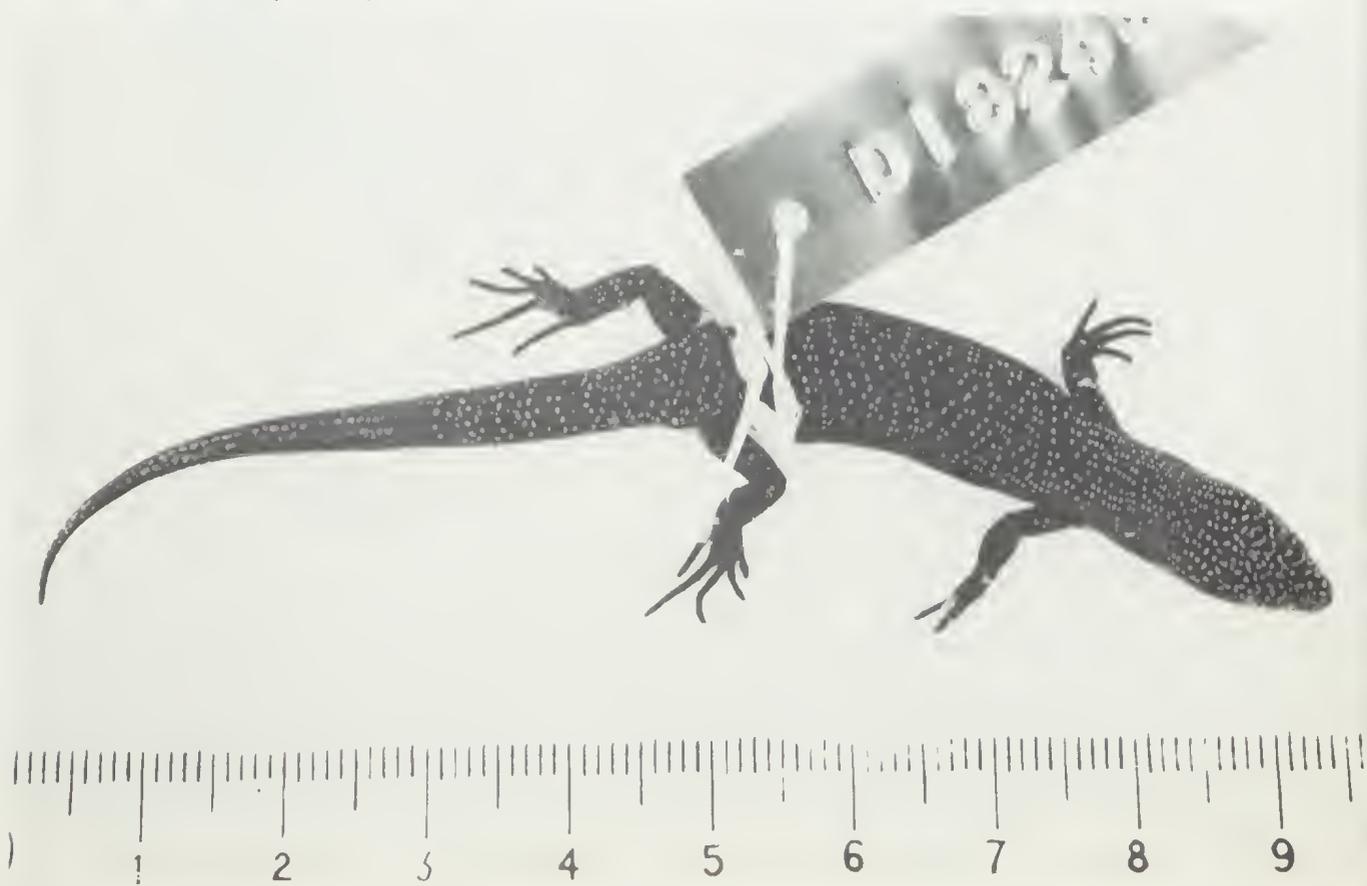
Found only on the Tasmanian mainland where it is restricted to alpine areas. Known from the Mount Barrow and Ben Lomond Massifs in the NE., and the Great Lake, Cradle Mountain and Lake St. Clair areas in the centre and NW. The species occurs disjunctly in a number of isolates within these areas.

#### HABITAT

All the known localities for this species are at altitudes over 1000 m in true alpine areas, i.e. above the tree line (Rawlinson 1974a,b). Precipitation in all the localities is high (more than 127 cm per year) and much of this falls as snow. Populations are restricted to the rocky banks of streams and swamps. The bare surfaces of rocks projecting from the stream or swamp banks are used for basking sites during activity and burrows under rocks in waterlogged soil along the banks are utilized for microenvironments during periods of inactivity. This is the only species of reptile in Australia which is restricted to alpine areas.



Fig. 1—Holotype of *Leiolopisma coventryi* sp. nov.  
NMV D40080 photographed in life.



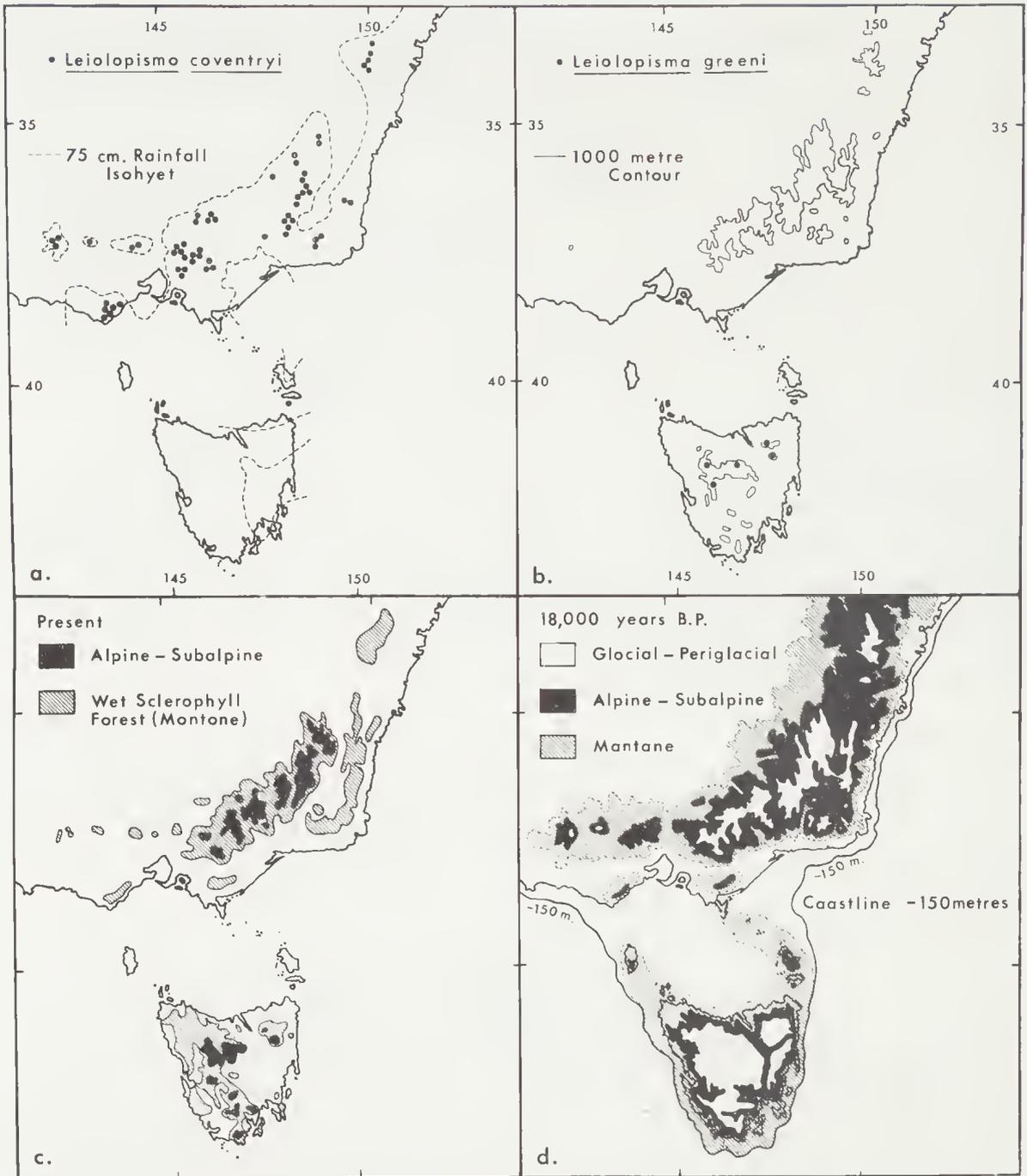


Fig. 3(a)—Distribution of *Leiolopisma coventryi* sp. nov. in SE. Australia and position of the 75 cm rainfall isohyet.

Fig. 3(b)—Distribution of *Leiolopisma greeni* sp. nov. in Tasmania and position of the 1,000 m contour.

Fig. 3(c)—Map of SE. Australia showing present

extent of the alpine and sub-alpine zones and the montane wet sclerophyll forest.  
 Fig. 3(d)—Map of SE. Australia showing approximate extent of the glacial and periglacial zones; the alpine and sub-alpine zones; the montane zone; and coastline (-150 m contour) 18,000 y. B.P. during the Late Wisconsin glacial phase.

## ECOLOGY

*L. greeni* is an insectivorous skink with a thermoregulatory pattern during activity that classifies it as a shuttling heliotherm (Rawlinson 1974 a,b,c). The exposed rock surfaces are used for basking sites and foraging takes place on the rock surfaces and through the low alpine vegetation. When inactive, burrows under rocks in waterlogged soil along the stream or swamp banks are used and it is assumed these form the hibernation sites also. If pursued, *L. greeni* will not hesitate to escape by diving under submerged rocks in streams, even though the water temperature may be as low as 5°C.

Laboratory measurements of the thermal preferences and "Normal Activity Range" of *L. greeni* have been made from continuous recordings of body temperature in a photo-thermal gradient (see above). The results are summarized in Table 2. As with *L. coventryi*, specimens in the gradient mirrored their "shuttling" method of thermoregulation in the field. From measurements of body temperature made at one minute intervals on 6 specimens (1009 observations) it was determined that the "Mean Preferred" body temperature was 28.9°C., while the "Voluntary Minimum" and "Voluntary Maximum" body temperatures were 21.5°C. and 37.3°C. respectively (Table 2). The histogram of frequency of body temperatures maintained during activity (1°C. class intervals, range 19°-37°C.) is skewed slightly towards the high temperature end of the scale. The mode is the 29°C. class interval which contains only 13% of the observations. This result reflects the shuttling method of thermoregulation as discussed above for *L. coventryi*.

The physiological thermal tolerances of the species are unknown as no values have yet been obtained for the "Critical Maximum" or "Critical Minimum" body temperatures. *L. greeni* tolerates relatively wide fluctuations in body temperature during normal activity, the mean activity range for specimens was 15.8°C. (21.5°-37.3°C.) and the absolute range was 18.6°C. (19.0°-37.6°C.). These ranges are close to those of *L. coventryi* (see above) and *P. spenceri* (Rawlinson 1974c), both of which

also occupy low temperature habitats, thus wide voluntary thermal tolerances are probably an essential requirement for cold temperate reptiles.

## REPRODUCTION

*L. greeni* is a live-bearing skink. There is no trace of eggshells around developing embryos, so it is assumed the species is fully viviparous (i.e. placental). Pregnant females kept under observation in the laboratory produced litters on March 10. Only three pregnant females were examined, litter size in each was 3, thus the mean number of offspring was also 3.0 (Table 2).

RELATIONSHIPS OF *LEIOLOPISMA GREENI*

The palatal bone structure shows that *L. greeni* (like *L. coventryi* sp. nov.) is an "alpha" *Leiopisma* species. *L. greeni* has 40-44 mid-body scale rows, thus unlike *L. coventryi*, it belongs in the second group of "alpha" *Leiopisma* species, viz. species with high midbody scale counts (see above) and its closest relatives are undoubtedly *L. ocellata* and *L. pretiosa*. It is considered that *L. greeni* is a sibling species of *L. ocellata*. The partially separated supranasals in the holotype and partially separated postnasals in one of the paratypes suggest that this species may have closer affinities with the genus *Pseudemoia* than was realized in the past (see also Rawlinson 1974c).

## Biogeography

*L. coventryi* and *L. greeni* belong to the "alpha" *Leiopisma* group of skinks which has radiated widely in the S. Pacific cool temperate area during the Quaternary. Both species have unusual distribution patterns and the explanations of these lie in the climatic and sealevel changes of the Late Wisconsin glacial phase and the post-glacial phase (Rawlinson 1974a, b,c). The Late Wisconsin lasted from 40,000-10,000 y. B.P. and it was either the most intense or one of the most intense Quaternary glaciations in SE. Australia (Galloway *et al.* 1973). A full account of the environmental changes has been given elsewhere (Rawlinson 1974a,b), but a summary of the main points plus some further information is given below

TABLE 2  
Thermal tolerances and reproduction of *Leiolopisma greeni* sp. nov.

Body Temperature Value/Litter Size	Number of Observations	Mean	Range
<i>Thermal tolerances:</i>			
Critical Minimum Temperature °C.	—	—	—
Voluntary Minimum Temperature °C.	6	21.5	19.0-25.0
Mean Preferred Temperature °C.	1009	28.9	—
Voluntary Maximum Temperature °C.	6	37.3	36.9-37.6
Critical Maximum Temperature °C.	—	—	—
<i>Reproduction:</i>			
Litter Size	3	3.0	3-3

in order to discuss the distribution patterns of *L. coventryi* and *L. greeni* more fully.

Sealevel started to fall as water was locked up in glacial ice about 35,000 y. B.P., and it reached minus 80 m about 22,500 y. B.P. connecting Tasmania to Australia by a landbridge, the "Bassian Isthmus". Sealevel continued to fall until about 20,000-18,000 y. B.P. when the sea lay at minus 132-150 m. After 18,000 y. B.P., a rapid rise in sealevel commenced (the "Flandrian Transgression") as the glacial ice started to melt and by 12,750 y. B.P. it had reached minus 80 m breaking the Bassian Isthmus and isolating Tasmania (and the Bass Strait islands) from Australia. This rapid rise continued until 6,000 y. B.P. and the present coastline was attained at about 5,000 y. B.P. Thus Tasmania was connected to Australia for about 9,750 years (22,500-12,750 y. B.P.) while S. Australia was being subjected to the full glacial climate.

During the glacial phase mean air temperatures were lowered by about 5°C. at sealevel and up to 11°C. at the higher altitudes (above 2,000 m). The westerly wind system continued to influence SE. Australia, but there apparently was an increase in the south-westerly (snow bearing) winds and a decrease in the north-westerly (rain bearing) winds. Precipitation changed drastically during and after the glacial phase; after Bowler (1970) and Bowler and

Hamada (1971) the sequence seems to be as follows:

- Pre 30,000 y. B.P., low effective precipitation.
- 30,000-18,000 y. B.P., medium effective precipitation.
- 18,000-10,000 y. B.P., very low effective precipitation, arid period.
- 10,000-5,500 y. B.P., very high effective precipitation, pluvial period.
- 5,500-Present, medium effective precipitation.

Thus at the time the Bassian Isthmus broke up 12,750 y. B.P., SE. Australia was experiencing a very cold and very dry climate.

The altitudinal stratification of mountain zones was also severely depressed during the glacial phase. It is possible to recognize five mountain zones in SE. Australia:

1. Glacial zone: above the permanent snow-line, ice covers the ground all year, no vegetation.
2. Periglacial zone: ground freezes in winter and thaws in summer, no permanent vegetation.
3. Alpine zone: above the tree-line, ground continuously covered with snow for more than four months each year, vegetation low and stunted.

4. Sub-alpine zone: above the permanent winter snow-line and below the tree-line, ground continuously covered with snow for 1-4 months each year, vegetation woodland dominated by cold tolerant trees such as *Eucalyptus pauciflora* or *E. coccifera*.
5. Montane zone: below the permanent winter snow-line, snow lies on ground for short periods only, vegetation variable, if precipitation is high enough wet sclerophyll forest (dominated by large eucalypts such as *E. delegatensis*, *E. nitens* or *E. regnans*) or temperate rainforest (dominated by *Nothofagus cunninghami*) develops.
4. Subalpine zone: (depends only on temperature) =  $X - 300$  m.
5. Montane zone: (depends on temperature and rainfall) =  $X - 900$  m.

Estimates are available for the altitudes of these zones in SE. Australia and Tasmania at present and during the Late Wisconsin glacial phase 20,000-18,000 y. B.P. (see Rawlinson 1974a,b; plus authors listed above). These estimates are summarized in Table 3 and Pl. 2., figs. 3c and 3d. As *L. coventryi* is restricted to montane wet sclerophyll forest and *L. greeni* is restricted to the alpine zone, the present distribution patterns need to be explained in the light of the changes outlined above.

After studies published by several workers (Costin 1954, 1957, 1959, 1971; Davies 1967; Derbyshire 1972; Galloway 1965; Galloway *et al.* 1973; Jackson 1965; Peterson 1971) it is possible to estimate the lower limits of each of these zones once the altitude of an easily recognized marker such as the tree-line has been established. If the tree-line lies at X metres, then the lower limits of the various zones can be calculated as follows:

1. Glacial zone: (depends on temperature and snowfall) =  $X + (200-1,000)$  m.
2. Periglacial zone: (depends only on temperature) =  $X + 100$  m.
3. Alpine zone: (depends only on temperature) =  $X$  m.

*L. coventryi* has previously been designated as a post-glacial intrusive into S. Victoria (Rawlinson 1971, 1974a,b, as *L. weekesae*?). The species has a disjunct distribution in the montane wet sclerophyll forests of SE. Australia, but is absent from this vegetation form in Tasmania although wet sclerophyll forest is extensive there. These forests grow in areas of high rainfall (greater than 75 cm per year) in the montane zone. During the Late Wisconsin, the montane zone descended to sealevel (i.e. the low glacial sealevel of minus 132-150 m) in the Bass Strait area and Tasmania, thus there was a much more extensive montane area available which would be expected to

TABLE 3  
Mountain zones in SE. Australia.

Area and Period	Altitude of lower limit in metres relative to present sea level				
	Glacial Zone	Periglacial Zone	Alpine Zone	Sub-alpine Zone	Montane Zone
<i>Tasmania:</i>					
Present 0 y. B.P.	—	1300	1200	900	300
Late Wisconsin, 18,000 y. B.P.	600-1350	450	350	50	-550*
<i>S. Victoria:</i>					
Present 0 y. B.P.	—	1850	1750	1450	850
Late Wisconsin, 18,000 y. B.P.	—	900	800	500	-100*
<i>SE. N.S.W. and A.C.T.:</i>					
Present 0 y. B.P.	—	1950	1850	1550	950
Late Wisconsin, 18,000 y. B.P.	1850-2050	1000	900	600	0

\* Sea level lay at minus 132-150 m 18,000 y. B.P.

facilitate the movement of *L. coventryi* southward. However, the species did not reach Tasmania (or any Bass Strait islands) so it is reasonable to conclude that the vegetation form inhabited (wet sclerophyll forests) was very restricted and this is consistent with the theory that precipitation was greatly reduced during the glacial phase. The species probably expanded its range into S. Victoria as wet sclerophyll forests expanded during the post-glacial period 10,000-5,500 y. B.P. after the Bassian Isthmus was broken up (12,750 y. B.P.). Subsequently the climate has become more arid (after 5,500 y. B.P.) resulting in the present disjunction of the species. Thus the distribution of this species supports the theory that the Late Wisconsin glacial phase was a period of aridity and there was a post-glacial pluvial period.

*L. greeni* has previously been designated as a Tasmanian glacial relict (Rawlinson 1971 as *L. pretiosum* Form B and Rawlinson 1974b,c, as *Leiopisma* sp. nov.). The species has a disjunct distribution in the alpine areas of the NE. and the Central Plateau. Alpine areas are now largely restricted to altitudes above 1,200 m, however during the Late Wisconsin the lower limit descended to 350 m (Table 3, Pl. 2., fig. 3d), thus the alpine area was much greater than at present and the distribution of *L. greeni* would have been much more extensive than at present. However, even if it had occupied all available alpine areas, the species would not have reached the Bass Strait islands or S. Victoria for the low elevation of the Bassian Isthmus would have prevented the formation of alpine vegetation in all but a few localities. As the glacial phase receded, the alpine zone retreated to its present level fragmenting the range of *L. greeni* and leaving the species in its present disjunct high altitude localities. Thus the distribution of this species supports the theory that the alpine zone was much more extensive in Tasmania during the Late Wisconsin glacial phase.

#### Acknowledgements

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