The Distribution of the Genus *Leiopelma* in New Zealand with a Description of a New Species.

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*Leiopelma** Fitzinger (1861, 218) is a member of the family Leiopelmidae*, instituted by Noble in 1924 for the reception of *Leiopelma* of New Zealand and *Ascaphus* of western North America. Morphological and developmental studies by Noble (1922, 1924, 1925, 1926, 1927), Archey (1922) and Wagner (1934) have established the primitive nature of the *Leiopelmidae*. De Villiers (1929, 67, fig. 17), slightly altering Noble's table (1924) of anuran phylogeny, derives the Leiopelmidae, Discoglossidae, Pelobatidae and Aglossa from an extinct leiopelmid-like group.

Nearly all work on *Leiopelma* has been applied to the general relationship of the genus. McCulloch (1919) alone has contributed directly to the taxonomy of the species of *Leiopelma* in separating *L. hamiltoni* McCulloch of Stephen Island from *L. hochstetteri* Fitzinger of the mainland.

The type locality of *L. hochstetteri* is Coromandel. Specimens had been taken in 1852 (Thomson, 1853, 66) from under rocks on the banks of a mountain stream near Coromandel, but were not named. The types of Fitzinger's species were brought to Hochstetter (1867, 163) by Maoris. Hochstetter describes the habitat of the frogs as " the small creeks rising in the Cape Colville range; also in swamps, but always as a great rarity." It may be presumed that the types came from a creek or swamp, but this is not stated definitely.

Specimens of native frogs in the Auckland Museum collection are from several localities other than Coromandel (see text-figure): Warkworth, Huia (Waitakere Hills), Thames, Waitekauri, Te Araroa (East Cape). All these specimens have come from stream-beds or swampy areas and agree with the description of *L. hochstetteri*. Reports of frogs have also come from Opotiki (Hutton and Drummond, 1923, 384) and the Kaweka Range, in water just below the bush-line (*fide* Mr. K. M. Sorby), the habitats in both localities suggesting the occurrence of *L. hochstetteri*.

In the Coromandel district, however, specimens are found not only in the streams and swamps, but also on the hill-tops (Archey, 1922), and the latter now prove to be of a new species, differing from the stream inhabitants chiefly in lacking the webbing of the toes.

* Fitzinger's original spelling, although incorrectly transliterated, should be retained, and extended to the family name. The spelling *Liopelma* was apparently first used by Günther (1868, 478).

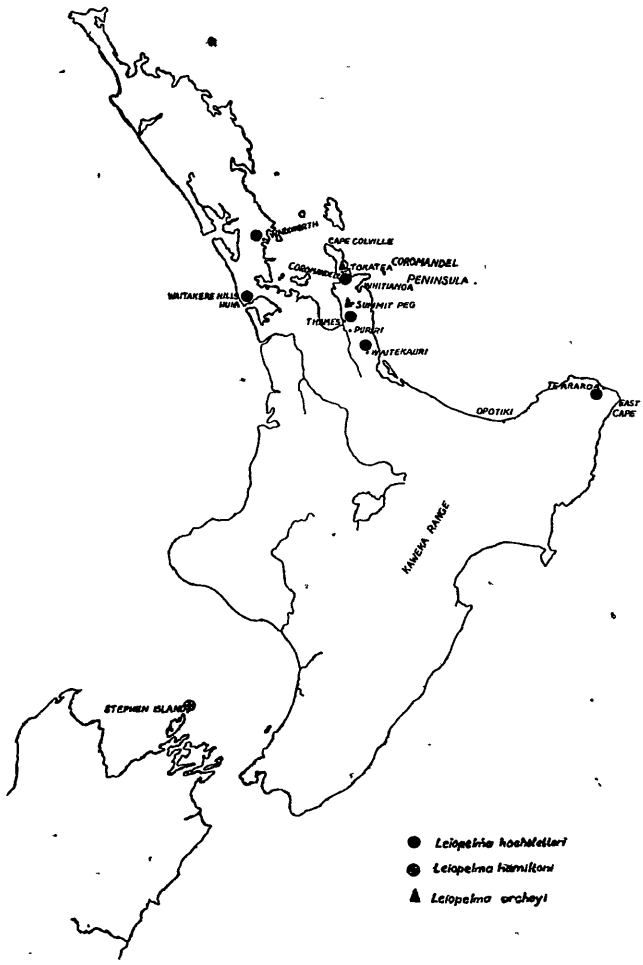
Leiopelma archeyi n.sp.

1922. *Liopelma hochstetteri;* Archey, *Rec. Canterbury Mus.*, vol. 2, no. 2, p. 59; (not of Fitz.).

Holotype. Adult female; Auckland Museum No. AMPH. 2·1; Tokatea, near Coromandel.

Paratypes. Auckland Museum Nos. AMPH. 2·2–2·15, all topotypes.

Diagnosis. A terrestrial frog having much the appearance of *L. hamiltoni* but smaller; the snout shorter, the nostrils nearer to the eye; the subarticular tubercles of the fingers and toes less distinct; and the toes with no trace of a web. More slender than *L. hochstetteri*; the fingers and toes slightly longer; the femur shorter, causing the heels to overlap slightly when the femurs are placed at right angles to the body; and the toes not webbed.



Map showing the distribution of the species of *Leiopelma.*

Description of Holotype. General form slender; snout short, rounded, flattened above; canthus rostralis moderately distinct; nostrils visible from above, nearer to the eye than the tip of the snout; internostril space greater than distance between nostril and eye, slightly less than the interorbital space, equal to width of the upper eyelid; eye shorter than the snout, distance from the nostril about two-thirds the diameter of its opening; narrowest interorbital space equal to the width of the upper eyelid; no tympanum; mandible pointed at the symphysis; width of tongue half that of the mouth, almost completely united with the floor of the mouth, slightly free posteriorly; vomerine teeth as in *L. hochstetteri* and *L. hamiltoni;* foreleg not muscular, its length measured from axilla contained slightly more than one and one-half times in the head and body length; fingers long, slender, the first shorter than the second and fourth and much shorter than the third; a large inner and a small outer metacarpal tubercle; subarticular tubercles indistinct; fingers not webbed; hind limb moderately muscular; distance between vent and tibiotarsal joint slightly more than the distance between vent and angle of jaw; tibia contained two and one-third times in the head and body length, slightly longer than the distance from the base of the inner metatarsal tubercle to the tip of the longest toe; femur short, heels overlapping slightly when the femurs are placed at right angles to the body; toes long, the fourth longer than the third and fifth, and considerably longer than the first and second; toes not webbed; subarticular tubercles indistinct; a small, flat inner metatarsal tubercle; no outer tubercle; a strongly-marked dorso-lateral ridge extends backwards from behind the eye to above the abdomen, being interrupted above the insertion of the arm; a broken ridge on each side dorsal to the dorso-lateral ridge; remainder of upper surface covered with scattered tubercles; dorsal surfaces of appendages covered with similar tubercles, those on the leg in the form of oblique ridges; under side smooth.

Colour in life light brown above, with irregular darker and lighter marbling and green patches; a black band extending from the tip of the snout to the nostril and eye, continuing backwards as a broken line into marbling posterior to and below the dorso-lateral ridge; a black band between the eyes posterior to a light brown area which extends forward as far as the base of the snout; leg marked above with oblique black cross bands parallel to the ridges, most prominently on the thighs; pale greyish-brown below, mottled with brown, most prominently on the appendages. Colour in alcohol as in life but above lighter, the pattern less distinct, without green; below light yellowish-brown mottled with dark brown.

Measurements (mm.). Tip of snout to vent, 32; tip of snout to angle of mouth, 11; tip of snout to nostril, 4; snout, 6·5; diameter of eye, 3·5; width of head, 12; width of interorbital space, 4; forelimb from axilla, 21; hind-limb from vent, 48; femur from vent, 12·5; tibia, 15; foot from base of inner metatarsal tubercle to tip of longest toe, 13.

Notes on Variation. The width and degree of attachment of the tongue vary in the paratypes. These characters are also variable

in *L. hochstetteri* and *L. hamiltoni*, and are thus not reliable diagnostic characters as interpreted by McCulloch (1919).

The amount of green varies considerably in the field. In the paratypes in alcohol the relative amounts of dark and light colour above and below vary.

The holotype reaches the known maximum size, 32 mm. The measurements of an adult male and an adult female paratype (length 25 mm.) are almost identical. (Nos. 2·2–2·3).

Localities. Tokatea (type locality) and summit peg on the Thames-Whitianga road (both on the Cape Colville Range); Mount Moehau, near Cape Colville (*fide* L. M. Cranwell, L. B. Moore and A. W. B. Powell, specimens not seen).

KEY TO SPECIES OF *Leiopelma*.

Toes half webbed and digits slightly shorter; femur longer. Robust	*L. hochstetteri*
Toes not webbed or with much reduced webs and digits slightly longer; femur shorter. Slender.	
Smaller, maximum length 32 mm. The snout shorter and the nostrils nearer to the eye than to the tip of the snout. Webs absent	*L. archeyi*
Larger, maximum length 42 mm. The snout longer and the nostrils midway between tip of snout and eye. Webs much reduced	*L. hamiltoni*

NOTES ON HABITAT.

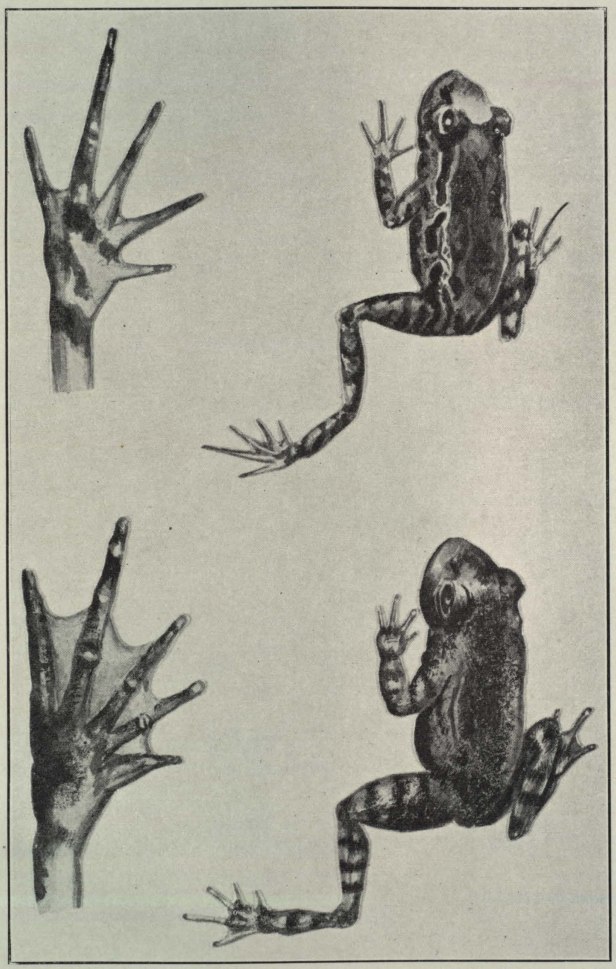
Archey (1922, 70) has described the habitat of *L. archeyi*: it lives and breeds on "damp, mist-swept hill tops moist enough all the year round for frogs to live there in comfort" without access to surface water. Mr. A. Richardson states (*in litt.*) that at the summit peg on the Thames-Tapu-Whitianga road it is active at night and may be seen climbing trees. The eggs (Archey *ibid.*) develop directly on land, the larva being intracapsular and at no time passing through a tadpole stage.

The absence of webs from the toes in the adult and the direct development may be regarded as adaptations to the absence of surface water in the habitat.

Turning to *L. hochstetteri*, one finds it, throughout its range, living in water at the edge of streams or in swampy areas. The adult is normally found sitting immersed in water except for the eyes and nostrils, and swims feebly with alternate leg strokes. It has been found only in streams surrounded by forest, or in swampy ground with plenty of protecting swamp-plants, possibly because, as in *Ascaphus* (Noble and Putnam, 1931, 97) the high temperatures of exposed lowland stream beds are not tolerated. It does not appear in streams lacking half-submerged stones, or moss and liverworts, providing recesses in which the adults may find concealment.

The half-webbing of the toes in the adult may be regarded as being related to this close dependence on surface water.

Although *L. hochstetteri* has not been observed at night in the field, it almost certainly feeds nocturnally away from the stream-beds. Partly-digested food, including the shell of a small, flat-spired gasteropod and portion of an arthropod appendage, probably of the terrestrial genus *Parorchestia*, comprised the stomach-contents of a



Upper figures, dorsal surface of left foot and adult of *Leiopelma archeyi*, new species; holotype; Auckland Museum No. AMPH. 2.1, from Tokatea, New Zealand. Lower figures, *Leiopelma hochstetteri* Fitzinger, from Warkworth, New Zealand.

—Drawn by E. Reekie.

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freshly-killed specimen, both food organisms inhabiting leaf-mould bordering on the stream-bed. This specimen was collected at 2.30 p.m., at which time the stomach contents were at a fairly advanced stage of digestion, as if the food had been taken during the previous night. Vivarium specimens will feed only at dusk, when living crane-flies (Tipulidae) and blue-bottles (*Calliphora quadrimaculata*) proffered by hand are accepted.

HISTORICAL NOTES.

The recognition of *L. archeyi* as distinct from *L. hochstetteri* makes clear a number of references to these two species by earlier writers.

L. hochstetteri was apparently first discovered by gold-diggers who in the earliest stage of the industry on the Coromandel Peninsula washed the soil of forest streams. A. S. Thomson (1853, 66) describes this discovery in the first published account of a *Leiopelma*.

Fitzinger's description (1861) of *L. hochstetteri* was republished by Steindachner in the *Zoology of the Voyage of the Novara* (1869). The holotype is not at present available, being probably in an Austrian collection, but the probable habitat (see above) and the plate and description, including the character " toes connected by a web for about half their length " leave no doubt as to which species Fitzinger described.

W. A. Aitken (1870) records a frog from a characteristic habitat of *L. hochstetteri* in the neighbourhood of Puriri: a range-creek at an altitude of about 500 feet above a succession of water-falls, and very steep. A specimen was forwarded with Aitken's paper, read before the Auckland Institute, but it is apparently not in the Museum.

The first mention of a frog which, in view of the habitat, was probably *L. archeyi,* is that of S. Percy Smith (1921). He found several specimens on the Cape Colville Range in 1862 under " loose stones on the crest of the range, moss-covered and damp from the elevation."

In 1921 Archey (1922) found *L. archeyi* at Tokatea, describing its habitat and direct development, still the only development of a *Leiopelma* known. He also found one dark-coloured specimen under debris at the source of a stream, believing it to be a stray *L. archeyi* from the hilltops. This individual would now appear to have been *L. hochstetteri,* an identification which Mr. Archey has checked.

An isolated instance of Maori knowledge of a native frog was discovered in 1889 by Graham (1924, 210), who saw native frogs at this date on Mount Moehau near Cape Colville.

REMARKS AND CONCLUSION.

As has been suggested by Archey (1922, 70), the frog ancestral to *L. archeyi* may be envisaged as a more widely distributed, water-breeding *Leiopelma* (see also Noble, 1925 and 1927, 63). Archey points out that on the narrow Coromandel Peninsula there are at present in respect to surface water, three zones which become manifest in the summer: " They are, first, the low-lying valleys and narrow coastal plain, where, in the driest summer when fields are parched, streams of water are to be found, well suited at the present time to

support a frog fauna, as the hearty croakings of the introduced *Hyla aurea* testify; second, a zone from about 1,000 to 1,500 feet high, where, in summer, the upper courses of the streams are dry, as also are the hill-spurs, an area ill-suited to the well-being of frogs; and third, the damp mist-swept hill-tops moist enough all the year round for frogs to live there in comfort."

At Tokatea in December, 1938, I found *L. archeyi* restricted to the topmost zone, where it was breeding. At a lower altitude on the eastern side of the range, but still only several hundred yards from the ridge-top, *L. hochstetteri* was common in wet gold-mining drives and stream-beds. Thus here, although *L. archeyi* and *L. hochstetteri* live near each other, the narrow barren zone between the two species must be a material barrier if only during the dry period of the breeding season in November and December.

Archey assumes that the water-breeding ancestor of *L. archeyi* was widespread over the Coromandel Peninsula during a period of greater elevation with greater precipitation, and that the mist-swept, waterless topmost zone, which favoured the evolution of direct development and the loss of webs, was separated by a subsequent lowering of elevation.

It is yet to be discovered whether the larva of *L. hochstetteri* develops directly as in *L. archeyi* or passes through a more primitive aquatic stage comparable with that of *Ascaphus* (Noble, 1927, 63; Noble and Putnam, 1931).

The discovery of the former in *L. hochstetteri* would indicate that this species became distinct while the ancestral stock was still widespread, but at some time after the replacement of aquatic by direct development. The adult *L. hochstetteri* would in this case have reverted secondarily to the edges of streams, at some stage before the complete loss of webs. *L. hochstetteri* and *L. archeyi* (and probably *L. hamiltoni*) would then be closely related and equally close to the stage in leiopelmid evolution at which larval independence of surface water was first attained. This conclusion would also be in accordance with their general morphological resemblance when adult.

Should an aquatic larva be discovered in *L. hochstetteri*, this species would represent closely the adult and larval stages respectively of a widespread water-breeding *Leiopelma* ancestral to *L. archeyi* (and probably to *L. hamiltoni*). The association of the adult *L. hochstetteri* with surface water and its distribution far beyond the range of *L. archeyi*, which is known to have direct development, are two facts which would support this view.

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