

**Reference Type:** Journal Article

**Record Number:** 41

**Author:** Abourachid, Anick; Green, David M.

**Year:** 1999

**Title:** Origins of the frog-kick? Alternate-leg swimming in primitive frogs, families Leiopelmatidae and Ascaphidae

**Journal:** Journal of Herpetology

**Volume:** 33

**Issue:** 4

**Pages:** 657-663

**Label:** 41

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; frog swimming

**Abstract:** This paper describes *Leiopelma* species alternating leg movements when swimming. Frogs typically kick synchronously and symmetrically with both hind legs when swimming, as when jumping. This is an evolutionarily derived, drag-based mechanism employing the feet as paddles and the hind limbs as thrusters. But morphologically archaic frogs of the genera *Leiopelma* and *Ascaphus*, although they jump when on land, obligately swim using alternating leg movements. Observations of five *L. hochstetteri* and three *L. archeyi* from video-recordings showed that *Leiopelma* spp. and *Ascaphus* always swam with alternating movements of their hind limbs, holding their forelimbs forward and outstretched. One leg always trailed the body acting as a rudder reducing yaw. The frogs swam with near constant velocity and, like swimming tadpole, the body swung from side to side, pivoting at the level of the otic region. The locomotor behaviour of *Leiopelma* and *Ascaphus* demonstrates that frog jumping and frog swimming are independent locomotor modes with separate evolutionary derivations and neural controls.

**Reference Type:** Journal Article

**Record Number:** 14

**Author:** Aitken, A. Wander

**Year:** 1870

**Title:** On the New Zealand frog (*Leiopelma hochstetteri*), with an account of a remarkable feature in the history of some species of Australian frogs.

**Journal:** Transactions and Proceedings of the New Zealand Institute

**Volume:** 2

**Pages:** 87-88

**Label:** 14

**Keywords:** Thames; *Leiopelma hochstetteri*

**Abstract:** Whilst at a Thames gold field the author was shown frogs previously unknown to him. A specimen (*Leiopelma hochstetteri*) from Puriri, about 500' above the level of the Thames River, was subsequently forward to the New Zealand Institute. The rest of the paper discusses Australian frogs.

**Reference Type:** Journal Article

**Record Number:** 29

**Author:** Allison, Bertha; Blair, David

**Year:** 1987

**Title:** The genus *Dolichosaccus* (Platyhelminthes: Digenea) from amphibians and reptiles in New Zealand, with a description of *Dolichosaccus (Lecithopyge) leiopismae* n.sp.

**Journal:** New Zealand Journal of Zoology

**Volume:** 14

**Issue:** 3

**Pages:** 367-374

**Label:** 29

**Keywords:** helminth; parasites; *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma pakeka*

**Abstract:** This paper describes helminth parasites of *Leiopelma*. Two species of *Dolichosaccus* occur in New Zealand. *Dolichosaccus (Lecithopyge) novaezealandiae* Prudhoe, 1970 was described from *L. archeyi* and *L. hochstetteri*. An additional six specimens were obtained from preserved frogs in the collections of the British Museum (Natural History), London. Several specimens examined contained no worms, including *L. hochstetteri* from Coromandel and the East Cape, and two *L. hamiltoni* from Maud Island (therefore referring to *L. pakeka*).

**Reference Type:** Magazine Article

**Record Number:** 160

**Author:** Anon.

**Year:** 1978

**Title:** Rare N.Z. frog bred in captivity

**Magazine:** Victoria University Graduate

**Volume:** 1978

**Pages:** 16

**Label:** 160

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; reproduction; captivity;

**Abstract:** This brief article reports on the success of breeding *Leiopelma hamiltoni* in captivity by Ben Bell. This is more than likely referring to *L. pakeka* as Bell reports elsewhere (cf. ref. # 148) that the first breeding of *L. hamiltoni* from Stephens Island occurred over the 1978/79 summer.

**Notes:** This article was reprinted from News Vuw, Vol. 2, No. 1, 18 February 1977.

**Reference Type:** Magazine Article

**Record Number:** 148

**Author:** Anon.

**Year:** 1979

**Title:** Rare Stephens Island frog breeds in captivity

**Magazine:** News Vuw

**Volume:** 4

**Issue Number:** 10

**Pages:** 20-21

**Label:** 148

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; reproduction; development

**Abstract:** This article refers to the first reported breeding in captivity of

*Leiopelma hamiltoni* by Ben Bell. Ten adults had been collected from Stephens Island the previous winter. Two clusters of fertile eggs were laid in an enclosure over the summer and the young have successfully developed to the small frog stage. The captive population therefore increased from 10 to 13-17 individuals. Concern is also expressed over loss of habitat from afforestation schemes for *L. hochstetteri* in the northern North Island.

**Reference Type:** Magazine Article

**Record Number:** 161

**Author:** Anon.

**Year:** 1984

**Title:** Intriguing frog behaviour discovered

**Magazine:** Victoria University Graduate

**Volume:** 1984

**Pages:** 18-19

**Label:** 161

**Keywords:** reproduction; development; parental care; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; *Leiopelma hochstetteri*

**Abstract:** This brief article reports on the studies of Ben Bell of *Leiopelma* in captivity including reproduction and development. The ecology and reproduction of all *Leiopelma* species is briefly discussed, including parental care by males of *L. archeyi* and *L. hamiltoni*/*L. pakeka*.

**Reference Type:** Magazine Article

**Record Number:** 91

**Author:** Anon.

**Year:** 1985

**Title:** Famous frogs

**Magazine:** Forest & Bird

**Volume:** 16

**Issue Number:** 4

**Pages:** 34-35

**Label:** 91

**Keywords:** *Leiopelma hamiltoni*; habitat; ecology

**Abstract:** This article describes the habitat and ecology of *Leiopelma*, specifically *Leiopelma hamiltoni* (described as being on both Stephens and Maud Islands), in commemoration of a Post Office issue of a stamp featuring *L. hamiltoni*.

**Reference Type:** Generic

**Record Number:** 259

**Author:** Anon.

**Year:** 1991-2001

**Title:** SRARNZ Notes

**Publisher:** SRARNZ

**Custom 1:** Paulette Dewhurst 2002

**Custom 2:** Frog recovery group leader, Waikato Conservancy Office, Department of Conservation, Hamilton

**Label:** 259

**Keywords:** *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*

**Abstract:** This is the newsletter of the Society for Research on Amphibians and Reptiles in New Zealand. The newsletter covers recent work carried out by SRARNZ members, news items and reports on conferences held by the Society. A NZ herpetological record list is also included. The leading article in the March 2002 issue covers concerns over the chytrid crisis.

**Notes:** Hardcopies includes pages relevant to *Leiopelma* only.

**Reference Type:** Magazine Article

**Record Number:** 254

**Author:** Anon.

**Year:** 1995

**Title:** Frog tunnel

**Magazine:** Forest & Bird

**Volume:** 277

**Pages:** 6

**Label:** 254

**Keywords:** *Leiopelma hochstetteri*; conservation

**Abstract:** This brief article appears in the 'Conservation briefs' section of the magazine. A 15 metre concrete pipe was installed as a 'frog tunnel' on a section of road in West Auckland. This was a result of reports from local residents that frogs were regularly killed on the road by cars at night.

**Reference Type:** Magazine Article

**Record Number:** 141

**Author:** Anon.

**Year:** 1998

**Title:** New, rare, old, odd frogs

**Magazine:** NZ Science Monthly

**Volume:** September 1998

**Pages:** 10

**Label:** 141

**Keywords:** *Leiopelma pakeka*; *Leiopelma hamiltoni*; genetics; subfossil

**Abstract:** This article reports on the description of *Leiopelma pakeka* as a separate species from *L. hamiltoni* after genetic studies. Ben Bell is quoted. General information is given on all four species of *Leiopelma*.

The population of *L. pakeka* on Maud Island is given as around 10,000. The categorisation of some of the subfossils found as *L. hamiltoni* is questioned.

**Reference Type:** Generic

**Record Number:** 196

**Author:** Anon.

**Year:** 2001

**Title:** New Zealand's native frogs - pepeketua

**Publisher:** Auckland Conservancy, Department of Conservation

**Pages:** 2

**Type of Work:** Fact Sheet

**Custom 1:** Paulette Dewhurst 2002

**Custom 2:** Frog recovery group leader, Waikato Conservancy Office, Department of Conservation, Hamilton

**Label:** 196

**Keywords:** identification; advocacy

**Abstract:** This is a DoC Fact sheet and provides details about *Leiopelma* and describes each of the four species. Interesting facts on native frogs are also provided. This is for advocacy purposes.

**Reference Type:** Magazine Article

**Record Number:** 224

**Author:** Anon.

**Year:** 2001

**Title:** Every frog has its day

**Magazine:** New Zealand Wilderness

**Volume:** November 2001

**Pages:** 20

**Label:** 224

**Keywords:** agents of decline; chytrid fungus; *Leiopelma archeyi*

**Abstract:** This brief article describes concerns over the first discovery of the chytrid fungus in *Leiopelma archeyi* in the Coromandel. Andrew Harrison, Department of Conservation, and Ben Bell, Victoria University of Wellington, are quoted.

**Reference Type:** Journal Article

**Record Number:** 65

**Author:** Anon.

**Year:** 2002

**Title:** NZ's native frogs face extinction

**Journal:** Moko

**Volume:** June 2002

**Pages:** 24-25

**Label:** 65

**Keywords:** disease; chytrid fungus

**Abstract:** This article is from the NZPA The Daily News 18-4-02 and quotes Bruce Waldman, University of Canterbury, on concerns relating to the chytrid fungus *Batrachochytrium dendrobatidis*. Don Newman, Science Manager, Department of Conservation is also quoted on how the fungus affects frogs.

**Reference Type:** Conference Proceedings

**Record Number:** 290

**Author:** Anon.

**Year of Conference:** 2002

**Title:** Australian Amphibian Declines

**Editor:** Waldman, Bruce

**Conference Name:** Ecology2002

**Conference Location:** Cairns

**Publisher:** Bruce Waldman

**Label:** 290

**Keywords:** Amphibian decline, Australia, New Zealand

**Abstract:** Abstracts of papers presented at the Ecological Society of Australia / New Zealand Ecological Society joint conference, both at the main conference symposium and the satellite conference held during one day. The full abstracts are available on: <http://www.zool.canterbury.ac.nz/cairns-abstracts-271102.pdf>

Abstracts from:

- Alford, Ross A.: Amphibian declines in Australia: their history and possible causes
- Anstis, Marion: Tadpole keys: a tool for monitoring frog populations?
- Bradfield, Kay S. & Ross A. Alford: Using the measurement of asymmetry to identify amphibian populations at increased risk of decline: what do we need to know to interpret estimates correctly?
- Burgin, Shelley, Chris Schell & Candida Briggs: The dynamics of a chytridiomycosis epidemic in *Limnodynastes tasmaniensis*
- Burns, Emma L. & Bronwyn A. Houlden: Genetic diversity and differentiation assessed among Green and Golden Bell Frog populations
- Davis, Robert A.: Impacts of habitat fragmentation on the metapopulation dynamics of a West Australian frog, *Heleioporus albopunctatus*
- Hazell, Donna L.: Characterising landscape patterns for conservation: what about the frogs?
- Holzapfel, Avi, Tertia Thurley & Nadia Webster: Variation in detectability of Archey's frog in Whareorino Forest, New Zealand - working towards a robust monitoring technique
- Hyatt, Alex, Donna Boyle & Veronica Olsen: Diagnostic assays for the detection of *Batrachochytrium dendrobatidis*
- Johnson, Megan L., Lee Berger & Richard Speare: In vitro evaluation of chemical disinfectants and physical techniques to kill the amphibian chytrid, *Batrachochytrium dendrobatidis*, and its survival in water from different sources
- Lemckert, Frank: A review of frog movements and habitat use and its implications for conservation
- Marshall, Leigh J.: The response of the New Zealand Department of Conservation (DOC) to managing amphibian chytrid fungus in New Zealand
- McDonald, K.R., R. Speare, D. Mendez & A.B. Freeman: Declining frog populations in the wet tropics: chytrid presence and patterns
- Parris, Kirsten M.: Conservation management of frog metapopulations in urban habitats
- Parris, Kirsten M.: Decline and persistence of pond-breeding frogs in urban and suburban Melbourne - a metapopulation study
- Pergolotti, Deborah: Diseases in Far North Queensland frogs received by the Cairns Frog Hospital
- Retallick, Richard W: Experimental translocations - shedding new light on frog population declines
- Scroggie, Michael P., Charles R. Todd & Graeme R. Gillespie: Long data-series, mark-recapture analysis, population models and adaptive management of Spotted Tree Frogs
- Speare, Rick: Hypotheses on chytridiomycosis: how are we going?
- Waldman, Bruce: Chytridiomycosis and New Zealand frog population declines

- Wassens, Skye, Alistar Robertson & Robyn Watts: Spatial and temporal dynamics of Southern Bell Frog (*Litoria raniformis*) populations in agricultural landscapes

- Woodhams, Douglas C., Ross A. Alford, Gerry Marantelli & Louise A. Rollins-Smith: Temperature and chytridiomycosis in rainforest frog  
Weldon, Ché, Louis H. du Preez & Rick Speare: Occurrence of the amphibian chytrid in South Africa

**Reference Type:** Journal Article

**Record Number:** 77

**Author:** Archey, Gilbert

**Year:** 1922

**Title:** The habitat and life history of *Leiopelma hochstetteri*

**Journal:** Records of the Canterbury Museum

**Volume:** 2

**Issue:** 2

**Pages:** 59-71 + plates

**Label:** 77

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; development; habitat; parental care; evolution

**Abstract:** This paper describes the terrestrial habitat and breeding habits of a frog described as *Leiopelma hochstetteri* (as *Leiopelma*), later to be formally named *L. archeyi* by E.G. Turbott in 1942 (ref # 43).

Green and brown specimens were found under logs on the western face of Tokatea Ridge, 'far-removed from surface water'. This is the first report of a frog being found sitting over a cluster of eggs, observed in November 1921, some in advanced stages of development. A detailed description of the eggs and their development is given. Archey reported that several of the hatchlings were killed by a fungus that 'appeared very quickly' after hatching.

Possible origins and the evolution of independence of water for *Leiopelma* are examined. Mention is made of a letter received from Mr G. K. Noble, of the American Museum of Natural History who examined the musculature of *Leiopelma* and stated 'it agrees with *Ascaphus*, and differs from all other discoglossids in possessing two 'tail-wagging' muscles, homologous to those in the salamander.' The alternative spelling of *Leiopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 184

**Author:** Archey, Gilbert

**Year:** 1935

**Title:** Frogs in New Zealand

**Journal:** Bulletin of The Auckland Zoological Society

**Volume:** 2

**Pages:** 5-8

**Label:** 184

**Keywords:** history; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma*

*archeyi*; development; parental care; Coromandel

**Abstract:** This paper describes frogs in New Zealand, both native and introduced. A brief history of liberations of Australian frogs is given (referred to at this time as the genus *Hyla*). The discoveries of *Leiopelma* (as *Liopelma*) are also discussed, although at this time *L. archeyi* had not been officially described or named. Therefore this publication refers only to *L. hochstetteri* and *L. hamiltoni* (from Stephens Island).

A description of the development of the eggs and hatchlings of *L. hochstetteri* (later discovered to be *L. archeyi*) from Tokatea Ridge, Coromandel, is given. Frogs were observed under logs sitting over clusters of eggs.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 154

**Author:** Baker, Michael R.; Green, David M.

**Year:** 1988

**Title:** Helminth parasites of native frogs (Leiopelmatidae) from New Zealand

**Journal:** Canadian Journal of Zoology

**Volume:** 66

**Pages:** 707-713

**Label:** 154

**Keywords:** parasites; helminth

**Abstract:** The three native frogs species were examined for gastrointestinal helminth parasites. *Leiopelma hamiltoni* (from Maud Island, therefore referring to *L. pakeka*) was uninfected. *L. hochstetteri* was parasitised by the nematodes *Aplectana novaezealandiae* n.sp. and *Cosmocerca australis* n.sp. (both Cosmocercidae: Cosmocercinae), and the digenean *Dolichosaccus (Lecithopyge) novaezealandiae* Prudhoe, 1972 (Telorchidae: Opisthoglyphinae). *L. archeyi* was infected with *Cosmocerca archeyi* n.sp. The three new cosmocercid species are differentiated readily from congeners in other parts of the world by caudal features of the males and the shape of the female tail. *Cosmocerca archeyi* differs from *C. australis* in the shape of the tail in males and females, the lack of rosette caudal papillae in males, and the possession of an unusually robust ventral somatic musculature in females. Since the native frogs are believed to have been isolated since the Mesozoic, the presence in them of cosmocercids that fall readily into well-established genera confirms the antiquity of the subfamily Cosmocercinae.

Examinations for parasites were on specimens of *Leiopelma* that were collected for other studies. At necropsy, digeneans and nematodes were collected from six *L. hochstetteri* and nematodes from one *L. archeyi*. None of the three *L. hamiltoni* from Maud Island (therefore *L. pakeka*) were found to be infected.

**Reference Type:** Magazine Article

**Record Number:** 143

**Author:** Barnett, Shaun

**Year:** 2000



**Title:** New Zealand's native amphibians: the frog without a croak

**Magazine:** New Zealand Wilderness

**Volume:** February 2000

**Pages:** 40-41

**Label:** 143

**Keywords:** ecology; identification; translocation

**Abstract:** This article is a general introduction to all four species of *Leiopelma* as well as mentioning introduced species.

Concerns over declines in *L. archeyi* in the Coromandel are referred to as well as the translocation of 300 *L. pakeka* from Maud Island to Motuara Island in 1997 by the Department of Conservation (DoC).

A call is made for trappers to report any frogs they see (but not to disturb or actively search for them) to DoC. Basic points for identification are given. Information on distribution of introduced species is requested to be sent to Bruce Waldman and Phil Bishop.

General concerns over global amphibian declines are also mentioned.

**Reference Type:** Magazine Article

**Record Number:** 255

**Author:** Barnett, Shaun

**Year:** 2000

**Title:** The trouble with frogs

**Magazine:** Forest & Bird

**Volume:** 295

**Pages:** 14-17

**Label:** 255

**Keywords:** *Leiopelma archeyi*; Coromandel; agents of decline

**Abstract:** This article deals with concerns over the possible decline of *Leiopelma archeyi* in the Coromandel as reported by Ben Bell. DoC's responses included a three-year research grant to Ben Bell of \$25,000 to investigate the factors influencing the status and decline of *L. archeyi* in the Coromandel Ranges.

Declines in Australian species are also discussed. Bruce Waldman and Phil Bishop are also both quoted. At this time, the chytrid fungus has not been found in any species of frogs in New Zealand. General ecology of *Leiopelma* is also briefly discussed.

**Reference Type:** Journal Article

**Record Number:** 54

**Author:** Barwick, R.E.

**Year:** 1961

**Title:** Illustrations of the New Zealand frog fauna

**Journal:** Tuatara

**Volume:** 8

**Issue:** 3

**Pages:** 95-98

**Label:** 54

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma pakeka*; identification

**Abstract:** Full-colour plates are provided for all currently known frog species in New Zealand, including *Leiopelma hochstetteri*, *L. archeyi* and *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*).

Colour variations in *Leiopelma* are noted. One marked change in colour was noted on the Maud Island frog, which showed small patches of light green amongst the overall golden brown of the flanks that occurred after exposure to bright sunlight for about two hours. The green patches on the body and legs of *L. archeyi* were seen to become more intense and sharply defined in intense light. Also refers to tonic immobility in *Leiopelma*.

**Reference Type:** Journal Article

**Record Number:** 32

**Author:** Beauchamp, A.J.

**Year:** 1995

**Title:** Weka and native frogs - a feeding experiment

**Journal:** New Zealand Journal of Zoology

**Volume:** 22

**Pages:** 404

**Label:** 32

**Keywords:** weka; *Leiopelma archeyi*; *Leiopelma hochstetteri*; antipredator behaviour

**Abstract:** This is an abstract of a paper presented at the 6th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at Manaia, Whangarei, 10-12 February 1995. This presentation covers a study on captive North Island weka (*Gallirallus australis greyi*) that was presented with *Leiopelma archeyi* and *L. hochstetteri*. The frog antipredator behaviours and gland secretions were sufficient to prevent weka eating or damaging the frogs. Objects under which frogs were found were heavier than those generally moved by weka while foraging. The leaf litter in the habitats where frogs occur in Coromandel are less likely to be favoured by weka. A full article on this research is presented in Beauchamp 1996 (ref # 96).

**Reference Type:** Journal Article

**Record Number:** 96

**Author:** Beauchamp, A.J.

**Year:** 1996

**Title:** Weka (*Gallirallus australis*) and *Leiopelma* frogs - a risk assessment

**Journal:** Notornis

**Volume:** 43

**Issue:** 2

**Pages:** 59-65

**Label:** 96

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; weka; antipredator behaviour; predation; Coromandel; vocalisations

**Abstract:** This paper describes a risk assessment where captive weka (*Gallirallus australis*) were offered *Leiopelma hochstetteri* and *L. archeyi* as prey. The antipredator behaviour and/or gland secretions of the frogs were sufficient to avoid damage and allow them to escape. The leaf litter habitats where frogs

occur in the Coromandel Ranges are least likely to be favoured by weka. Objects under which frogs were found were heavier than those generally moved by weka while foraging. Weka seem to constitute less of a risk to frogs than earlier believed.

Weka co-existed with *L. hochstetteri* and *L. archeyi* in the Coromandel Ranges until 1928. Recent releases of weka in the southern Coromandel at Karangahake could bring weka back into contact with both species.

Six adult *L. hochstetteri* were collected from two areas in 20-60 year old forest and eight adult *L. archeyi* were collected from the bush-covered ridgeline up to 300 m north of the summit of the Tapu to Coroglen Road. All specimens collected for the feeding trials were returned to their exact point of capture within 24 hours.

Both *L. hochstetteri* and *L. archeyi* were picked up and tasted by the weka, at which point the frogs emitted a series of high-pitched squeaks and were consequently dropped by the weka. *L. archeyi* also assumed the arched head butt position after being released by the weka. All frogs were undamaged. The weka consumed food that had been rubbed against the frogs to obtain glandular secretions. There was no obvious difference in weka behaviour when eating food with secretions or the control.

**Reference Type:** Report

**Record Number:** 249

**Author:** Bell, Brian D.

**Year:** 1963

**Title:** List of New Zealand off-shore islands and their wildlife status

**Institution:** Wildlife Branch, Department of Internal Affairs

**Pages:** 29

**Label:** 249

**Keywords:** Stephens Island; Maud Island; status; survey

**Abstract:** This report lists the offshore islands surveyed to date by the Wildlife Branch in relation to wildlife conservation. Approximately 500 islands or island groups were classified according to their wildlife values into four groups, A, B, C, and D (in order of values). Islands with *Leiopelma* are Stephens Island, which is listed as A: of major importance.

Maud Island is listed as B: secondary importance (land ownership at this time was 'freehold').

Frogs had not been discovered on Great Barrier Island at the time of publication, which was listed as A due to its other wildlife values.

**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 51

**Author:** Bell, Ben D.

**Year:** 1971

**Title:** Frogs are worth looking for

**Journal:** Pepeke

**Volume:** 17

**Pages:** 1-5

**Label:** 51

**Keywords:** survey; *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*

**Abstract:** This article calls for a national survey of amphibians in New Zealand, including introduced species. A description and sketch of each known species is provided (*Litoria ewingi*, *L. aurea*, *L. caerulea*, *Leiopelma hochstetteri*, *L. archeyi* and *L. hamiltoni* (for both Stephens and Maud Islands, therefore also referring to *L. pakeka*)).

Followed by a talk given by Ben Bell on the history of discoveries of *Leiopelma* and liberations of *Litoria*.

**Reference Type:** Journal Article

**Record Number:** 52

**Author:** Bell, Ben D.

**Year:** 1972

**Title:** Progress report on the frog distribution survey

**Journal:** Pepeke

**Volume:** 23

**Pages:** 1-4

**Label:** 52

**Keywords:** survey; subfossil

**Abstract:** A progress report on the national survey of frogs called for the previous year in the same journal. Refers to *Leiopelma* subfossils collected by Stephen Markham in Wairarapa and in Hawkes Bay, and similar finds through Tony Whitaker in northwest Nelson.

Record Form - New Zealand Frog Distribution Survey included.

**Reference Type:** Magazine Article

**Record Number:** 93

**Author:** Bell, Ben D.

**Year:** 1977

**Title:** Research uncovers more facts about rare native frogs

**Magazine:** Forest & Bird

**Issue Number:** 204

**Pages:** 12-17

**Label:** 93

**Keywords:** *Leiopelma pakeka*; *Leiopelma hamiltoni*; *Leiopelma archeyi*; *Leiopelma hochstetteri*; captivity; development; reproduction; husbandry

**Abstract:** This article briefly describes the habits of and differences between the species of *Leiopelma*. Studies in captivity are described, including reproduction and development. *L. archeyi* and *L. hochstetteri* from the Coromandel were first taken into captivity by Dr Ben Bell in 1972. *L. hochstetteri* were fed on a diet of noctuid moths, supplemented with other insects and invertebrates. *L. archeyi* were mostly maintained on laboratory-bred houseflies, also supplemented with other invertebrates. Most survived after five years in captivity (as at the time of publishing). Successful breeding in captivity of *L. archeyi* (1973) led to attempts with *L. hamiltoni* (collected in 1974 and 1975 from Maud Island, therefore referring to *L. pakeka*). The incident of 20 December 1976 is

described, when the *L. pakeka* outdoor pen was flooded due to record rainfalls in Wellington. The rescue and clean-up operations led to the discovery of egg clusters. The surviving fertile eggs were then placed on damp filter papers in petri dishes and their subsequent development studied.

**Reference Type:** Journal Article

**Record Number:** 168

**Author:** Bell, Ben D.

**Year:** 1978

**Title:** Observations on the ecology and reproduction of the New Zealand leiopelmid frogs

**Journal:** Herpetologica

**Volume:** 34

**Issue:** 4

**Pages:** 340-354

**Label:** 168

**Keywords:** reproduction; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*; morphology; vocalisations

**Abstract:** Field surveys of leiopelmid frogs show ecological separation of the sympatric *Leiopelma archeyi* and *L. hochstetteri*, but habitats of the allopatric *L. archeyi* and *L. hamiltoni* (from both Stephens and Maud Island, therefore also referring to *L. pakeka*). Differences in colouration, size, and body proportions are described. Snout-vent lengths of frogs are 7-37 mm in *L. archeyi*, 10-44 mm in *L. hochstetteri*, and 10-49 mm in *L. hamiltoni*, while an undescribed sub-fossil species probably attained 100 mm. *L. archeyi* and *L. hamiltoni* are similar in body proportions, but *L. hochstetteri* is more robust, with broader limbs and body but shorter snout and digits. Sexual dimorphism of the forelimbs occurs in *L. hochstetteri*, but not in the other two species. Amplexus (inguinal) and breeding of *Leiopelma* in captivity are detailed, including the development of *L. hamiltoni* which was previously unknown (these would probably have been *L. pakeka*). The frogs appear to be mostly nocturnal, although some captive *L. archeyi* emerged from cover by day. *L. hamiltoni* on Maud Island (therefore referring to *L. pakeka*) emerged in greater numbers and tended to climb higher up in vegetation on wet nights. This study further emphasizes the dichotomy between *L. hochstetteri* and the other closely related species. A revised identification key to the three species and their larvae is presented. Vocalisations in *Leiopelma* are also briefly discussed.

**Reference Type:** Magazine Article

**Record Number:** 169

**Author:** Bell, Ben D.

**Year:** 1978

**Title:** Breeding New Zealand's archaic frogs

**Magazine:** Wildlife

**Volume:** November 1978

**Pages:** 512-514

**Label:** 169

**Keywords:** reproduction; *Leiopelma archeyi*; *Leiopelma pakeka*; *Leiopelma*

*hamiltoni*; *Leiopelma hochstetteri*; captivity; Coromandel; Maud Island

**Abstract:** This article gives a brief introduction to *Leiopelma* with a description of breeding in captivity of *L. archeyi* and *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*).

Collections of *L. hochstetteri* and *L. archeyi* were made from the Coromandel in 1972, and *L. pakeka* from Maud Island in 1974. *L. archeyi* first bred in captivity in 1973, *L. pakeka* in 1976. As a result of breeding the Maud Island frog, 10 *L. hamiltoni* were collected from Stephens Island in 1978.

**Reference Type:** Magazine Article

**Record Number:** 147

**Author:** Bell, Ben D.

**Year:** 1981

**Title:** The native frogs - rare and ancient endemics threatened by mining?

**Magazine:** N.Z. Environment

**Volume:** 29

**Pages:** 30-31

**Label:** 147

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; habitat; conservation; Coromandel; forestry; priority rankings

**Abstract:** This article gives a brief introduction to each species of *Leiopelma*. Concerns are highlighted in relation to the effects on *L. hochstetteri* of exotic afforestation developments near Warkworth and the Brynderwyn Range near Waipu. Large-scale mining activities in the Coromandel Peninsula could be detrimental to both *L. archeyi* and *L. hochstetteri* from erosion, silting, chemical pollution and changed water-flow patterns. Conservation priorities for the Coromandel frogs are suggested.

**Reference Type:** Book Section

**Record Number:** 2

**Author:** Bell, Ben D.

**Year:** 1982

**Title:** The amphibian fauna of New Zealand

**Editor:** Newman, Donald G.

**Book Title:** New Zealand Herpetology: Proceedings of a symposium held at Victoria University of Wellington, January 1980

**City:** Wellington

**Publisher:** New Zealand Wildlife Service

**Volume:** Occasional Publication No. 2

**Pages:** 23-89

**Label:** 2

**Keywords:** history; reproduction; development; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*

**Abstract:** Existing knowledge of the amphibian fauna of New Zealand is reviewed. This fauna currently comprises six species of frogs: three endemic species (*Leiopelma archeyi*, *L. hamiltoni*, *L. hochstetteri*) and three introduced species from Australia (*Litoria aurea*, *L. ewingi*, *L. raniformis*). The historical record of discovering the endemic species is summarised and updated. The

origin of *Leiopelma*, its relationship with other frogs, and affinities within the genus are considered. Aspects of reproduction and development are compared. Significant contributions to frog research in New Zealand are highlighted, and the management and conservation of the frog fauna is discussed.

Includes notes on general discussion after presentation of the amphibian session.

**Notes:** Pages relating only to *Litoria* omitted from hardcopy

**Reference Type:** Journal Article

**Record Number:** 155

**Author:** Bell, Ben D.

**Year:** 1982

**Title:** New Zealand frogs

**Journal:** Herpetofauna

**Volume:** 14

**Issue:** 1

**Pages:** 1-21

**Label:** 155

**Keywords:** identification; distribution; habitat; reproduction; development; taxonomy

**Abstract:** This paper provides a comprehensive description of the existing frog fauna of New Zealand, covering such aspects as identification, distribution, habitat, reproduction, development and systematics. Both endemic and introduced species are considered.

**Reference Type:** Magazine Article

**Record Number:** 95

**Author:** Bell, Brian D.

**Year:** 1983

**Title:** The challenge of the 'stoat invasion' on Maud Island

**Magazine:** Forest & Bird

**Volume:** 14

**Issue Number:** 5

**Pages:** 12-14

**Label:** 95

**Keywords:** Maud Island; *Leiopelma pakeka*

**Abstract:** This article discusses the conservation activities on Maud Island to date and various species management programmes. A recent sighting of a stoat on the Island put some of the activities in doubt. *Leiopelma pakeka* persisted in a remnant forest patch and was described as 'a strong colony'.

**Reference Type:** Book Section

**Record Number:** 107

**Author:** Bell, Ben D.

**Year:** 1983

**Title:** Breeding and parental care in the endemic New Zealand frogs

**Book Title:** Proceedings 18 International Ethological Conference Abstracts, Brisbane 29th August to 6th September 1983

**City:** Brisbane

**Publisher:** International Ethological Committee

**Pages:** 25

**Label:** 107

**Keywords:** development; reproduction; parental care; vocalisations

**Abstract:** This is an abstract from a paper presented at the 18th International Ethological Conference held at the University of Queensland, Brisbane, Australia 29 August to 6 September 1983. The presentation reviewed breeding and parental behaviour in *Leiopelma*. Breeding sites, when egg-laying occurs, differences in the morphology and behaviour of larvae and adults are discussed briefly. During mating, all species have been observed to give calls; the context and function of such calls are poorly understood. Amplexus is in the inguinal position.

**Reference Type:** Book Section

**Record Number:** 97

**Author:** Bell, Ben D.

**Year:** 1985

**Title:** Conservation status of the endemic New Zealand frogs

**Editor:** Grigg, Gordon; Shine, Richard; Ehmann, Harry

**Book Title:** Biology of Australasian frogs and reptiles

**City:** New South Wales

**Publisher:** Royal Zoological Society of New South Wales

**Pages:** 449-458

**Label:** 97

**Keywords:** conservation; agents of decline; antipredator behaviour; status; history; distribution; translocation

**Abstract:** This paper reviews the conservation status of *Leiopelma*. All extant species are described as having restricted distributions, especially *L. hamiltoni*, confined to two islands (therefore also referring to *L. pakeka*) and *L. archeyi*, confined to the Coromandel area. No one species was considered to be immediately endangered. Potential threats include fragmentation of habitat, the impact of introduced fauna and possibly reduced genetic variation in remnant populations. Conservation-oriented research and management programmes are outlined and the antipredator mechanisms of *Leiopelma* reviewed.

Status, history, current and past distribution, reasons for decline and existing population size are addressed for each species (*L. hamiltoni*, *L. archeyi* and *L. hochstetteri*). Translocations are discussed briefly, including 15, possibly *L. archeyi* though reported by A. S. Wilkinson at the time as *L. hochstetteri*, that were transferred to Kapiti Island in December 1924 (13) and March (2). The liberations, in the Kahikatea catchment behind Rangatira Point, were apparently unsuccessful (cf. Wilkinson 1925, ref. # 289).

Recommendations are made for future research and management activities.

**Reference Type:** Book Section

**Record Number:** 98

**Author:** Bell, Ben D.

**Year:** 1985

**Title:** Development and parental-care in the endemic New Zealand frogs

**Editor:** Grigg, Gordon; Shine, Richard; Ehmann, Harry



**Book Title:** Biology of Australasian Frogs and Reptiles

**City:** New South Wales

**Publisher:** Royal Zoological Society of New South Wales

**Pages:** 269-278

**Label:** 98

**Keywords:** development; parental care; *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma pakeka*

**Abstract:** This paper describes recent observations on *Leiopelma* that have shown differences in development and parental care. In the semi-aquatic *L. hochstetteri* hatchlings emerge as relatively active, aquatic larvae that do not closely associate with the adult. In the terrestrial *L. archeyi* and *L. hamiltoni* the male remains closely associated with the eggs and hatchlings up to metamorphosis; eggs hatch at a later stage and hatchlings climb onto the male. Factors influencing these differences are considered and the development of *Leiopelma* and *Ascaphus* is compared.

For *L. hochstetteri*, the breeding season is given as at least from August to February, with recorded clutch sizes of 10-22 eggs. For *L. archeyi*, the breeding season is given as September to November with clutch sizes of 1-13 eggs. For *L. hamiltoni*/*L. pakeka*, the breeding season is given as October to December with clutch sizes of 2-19 eggs.

Most observations for both *L. hamiltoni*/*L. pakeka* were made on specimens in captivity. Field observations have shown that *L. archeyi* and *L. hamiltoni* hatchlings usually remain on the wet fluids and jelly of the ruptured egg capsules (which may contain anti-fungal and anti-bacterial properties) for some days before climbing onto the male.

All species of *Leiopelma* have relatively large yolky eggs. Larvae of all species hatch with a large abdominal yolk sac, which provides nourishment up until metamorphosis.

**Reference Type:** Book

**Record Number:** 12

**Author:** Bell, Brian D.

**Year:** 1986

**Title:** The Conservation status of New Zealand wildlife

**City:** Wellington

**Publisher:** New Zealand Wildlife Service

**Volume:** Occasional Publication No. 12

**Number of Pages:** 103

**ISBN:** '(no number)'

**Label:** 12

**Keywords:** conservation; IUCN; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; status

**Abstract:** This paper updates the conservation status of NZ wildlife (as defined in the Wildlife Act 1953 and amendments) including *Leiopelma*. The bulk of this publication involves a master list of wildlife species and subspecies, which are given classification under three categories. In addition, there is a list of comments relating to the conservation status. The first listing follows the con-

servation categories of the IUCN Red Data Books, with minor amendments. The second listing deals with the species' distribution classification and the final listing relates to distribution status.

*Leiopelma hamiltoni* is listed as 'threatened' (= IUCN 'vulnerable'), *L. archeyi* and *L. hochstetteri* as 'threatened - regionally only' and *L. archeyi* also as 'restricted distribution - but numerically strong'.

**Reference Type:** Book Section

**Record Number:** 178

**Author:** Bell, Ben D.

**Year:** 1989

**Title:** Demographic studies of *Leiopelma archeyi* and *L. hamiltoni* in New Zealand with an account of an experimental transfer of *L. hamiltoni* on Maud Island

**Editor:** Halliday, Tim; Baker, John; Hosie, Lottie

**Book Title:** Abstracts of the First World Congress on Herpetology

**City:** Milton Keynes

**Publisher:** Open University

**Label:** 178

**Keywords:** *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; demography; translocation

**Abstract:** This is an abstract from a presentation given to the First World Congress of Herpetology held at the University of Kent at Canterbury, UK on 11-19 September 1989.

Recent demographic studies of *Leiopelma archeyi* in the Coromandel Ranges and of *L. hamiltoni* on Maud Island (therefore referring to *L. pakeka*) have provided new information on population densities, growth rates, survival rates and movements. These two terrestrial *Leiopelma* species are k-strategists, with comparatively slow growth rates to sexual maturity, low fecundity, and intensive parental care. Though rare and of restricted distribution, both species can attain relatively high densities in suitable habitats. The two species are morphologically similar, though differing in body-size and evidently in vulnerability to introduced mammalian predators.

As a conservation measure there have been many successful transfers of rare and endangered birds to new locations in New Zealand, but to date there have been few experimental transfers of the rarer herpetofauna. However, 100 *L. pakeka* were locally transferred to restored habitat on Maud Island over 1984-85 and the preliminary results of this trial experiment are presented.

**Reference Type:** Journal Article

**Record Number:** 84

**Author:** Bell, Ben D.

**Year:** 1993

**Title:** The status of endemic *Leiopelma* frogs recently discovered in the western Maniapoto Ranges, near Te Kuiti

**Journal:** New Zealand Journal of Zoology

**Volume:** 20

**Pages:** 130

**Label:** 84

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; Te Kuiti; survey; subfossil

**Abstract:** Abstracts of the Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at the Southland Museum, Invercargill, 27-29 November 1992.

This paper reports on a survey in June 1991 resulting from a discovery by Conservation Corps of a population of native frogs in the northern King Country. Thirty-three terrestrial frogs resembling *Leiopelma archeyi* were examined. In addition, the first records of *L. hochstetteri* for the district were obtained (two examined), sympatric with *L. archeyi*.

Worthy (1987, ref # 18) identified two extant species - *L. hochstetteri* and *L. hamiltoni* - among subfossils from the nearby Waitomo caves complex. The 1991 survey confirmed the survival of *L. hochstetteri* in the area, while Te Kuiti '*L. archeyi*' may be the taxon described by Worthy as *L. hamiltoni*. Ten Waitomo subfossils identified by Worthy as *L. hamiltoni* had estimated snout-vent lengths of 35-43 mm. This exceeds the Te Kuiti '*L. archeyi*' size range (18-38 mm), though is less than *L. hamiltoni* from Maud (therefore also referring to *L. pakeka*) and Stephens Islands (where maximum recorded snout-vent lengths are 49 mm and 45 mm, respectively).

Further biochemical and ecological studies are needed to clarify the taxonomy and conservation status of the Te Kuiti frogs resembling *L. archeyi*.

**Reference Type:** Journal Article

**Record Number:** 59

**Author:** Bell, Ben D.

**Year:** 1994

**Title:** A review of the status of New Zealand *Leiopelma* species (Anura: Leiopelmatidae), including a summary of demographic studies in Coromandel and on Maud Island

**Journal:** New Zealand Journal of Zoology Special issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 341-349

**Label:** 59

**Keywords:** conservation; taxonomy; translocation; population studies

**Abstract:** This paper updates earlier reviews on taxonomy, external morphology, distribution and decline, and population studies.

Field surveys have extended the known contemporary ranges of *Leiopelma archeyi* and *L. hochstetteri*, though subfossils reveal that both *L. hochstetteri* and *L. archeyi/hamiltoni* were formerly more widespread in New Zealand than they are now. Introduced predators and food competitors, especially *Rattus*, have probably had a major detrimental impact on *Leiopelma*. No extant species is immediately at risk of extinction, but *L. hamiltoni/pakeka* on Stephens and Maud Islands is very restricted in range and/or numbers.

*Leiopelma* reaches high densities (up to eight frogs/m<sup>2</sup>) in suitable rock-strewn

habitats and can be relatively long-lived (*L. archeyi* 17+ years, *L. pakeka* 23+ years). Populations levels of *L. archeyi* have fluctuated in a Coromandel study plot sampled approximately annually over 1982-93. Experimental translocations of *L. hamiltoni* were made on Maud Island (therefore referring to *L. pakeka*) in 1984-85 and on Stephens Island in 1992. The new colony on Maud Island had bred successfully, and locally bred young have been recruited into the population.

**Reference Type:** Book Section

**Record Number:** 173

**Author:** Bell, Ben D.

**Year:** 1994

**Title:** The systematics, ecology and distribution of New Zealand *Leiopelma* species (Anura: Leiopelmatidae) with a reappraisal of their conservation needs

**Editor:** Davies, Margaret; Norris, Rachel M.

**Book Title:** Abstracts of the Second World Congress of Herpetology

**City:** Adelaide

**Publisher:** University of Adelaide

**Pages:** 20-21

**Label:** 173

**Keywords:** conservation; taxonomy; reproduction; demography; translocation; parental care; subfossil; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*

**Abstract:** This is an abstract of a paper presented at the Second World Congress of Herpetology held at the University of Adelaide, South Australia, December 29, 1993 to January 6, 1994.

Much new information on the biology of the *Leiopelma* has been reported over the past 10-15 years. Three extinct subfossil species of *Leiopelma* are now recognised (*L. auroraensis*, *L. markhami*, *L. waitomoensis*) in addition to the three extant species already known (*L. archeyi*, *L. hamiltoni*, *L. hochstetteri*). The taxonomy of frogs from Maud Island (morphologically resembling *L. hamiltoni*) and from near Te Kuiti (morphologically resembling *L. archeyi*) is under investigation and may reveal further species. Osteological, biochemical and genetic evidence suggests *Leiopelma* should be retained in its own family Leiopelmatidae (rather than being placed with *Ascaphus*). Such studies confirm the broad dichotomy in *Leiopelma* between semi-terrestrial species (eg *L. hochstetteri*) and terrestrial species (eg *L. archeyi*) and generic distinction between the two groups should be considered. *Leiopelma* locally reaches high densities (> 4 frogs/m<sup>2</sup>) in suitable habitats and may be relatively long-lived (some Maud Island frogs surviving 20+ years). Experimental translocations of frogs have been attempted on Maud Island (1984/85) and on Stephens Island (1992), with young being successfully recruited into the new colony on Maud Island. Male parental care occurs in all four populations of terrestrial *Leiopelma*, though such parental care is absent in *L. hochstetteri*. New locality records of extant species have extended their known distribution, though research on subfossil bones reveals that both *L. hochstetteri* and *L. archeyi/hamiltoni* were formerly more widespread in New Zealand. No surviving populations of *Leiopelma* are known from mainland areas

of the South Island, despite four species being formerly present there, while *L. hochstetteri* and *L. archeyi* have declined in the North Island. Introduced mammalian predators and/or competitors probably had a major and detrimental impact on the survival of *Leiopelma* species in New Zealand, with habitat destruction also being a problem in many areas. The conservation status of surviving taxa needs to be reappraised given recent research on their systematics and distribution. No species is immediately at risk of extinction, but *L. hamiltoni* is now very restricted in range and numbers. *L. archeyi* is local in distribution and *L. hochstetteri* remains relatively widespread in suitable habitats in the northern North Island.

**Reference Type:** Journal Article

**Record Number:** 101

**Author:** Bell, Ben D.

**Year:** 1996

**Title:** Aspects of the ecological management of New Zealand frogs: conservation status, location, identification, examination and survey techniques

**Journal:** Ecological Management

**Volume:** 4

**Issue:** Department of Conservation

**Pages:** 91-111

**Label:** 101

**Keywords:** conservation; survey; status; identification; management

**Abstract:** Techniques for identifying, locating, examining and sampling frogs are described, and the impact of fieldwork on *Leiopelma* discussed. All four *Leiopelma* species have been bred in captivity, providing new knowledge on reproduction and on captive propagation techniques. Translocation of native frogs should follow accepted protocols and should be based on knowledge of the species' demography and habitat requirements. Most appropriate techniques for long-term monitoring should be decided upon in the near future.

A summary of methods used to study *Leiopelma* populations is included, showing both day and night searches.

**Reference Type:** Journal Article

**Record Number:** 37

**Author:** Bell, Ben D.

**Year:** 1997

**Title:** Demographic profiles of terrestrial *Leiopelma* (Anura: Leiopelmatidae) on Maud Island and in Coromandel: growth, home-range, longevity, population trends, survivorship, and translocation

**Journal:** New Zealand Journal of Zoology

**Volume:** 24

**Pages:** 323-324

**Label:** 37

**Keywords:** *Leiopelma pakeka*; Maud Island; *Leiopelma archeyi*; *Leiopelma hochstetteri*; Coromandel; survivorship; translocation; population studies; recruitment

**Abstract:** This is an abstract of a paper presented at the Proceedings of the

Society for Research on Amphibians and Reptiles in New Zealand, their 7th conference, held at Kaikoura, 31 January-2 February 1997.

On-going mark-recapture studies of terrestrial *Leiopelma* on Maud Island and in the Coromandel have revealed new information on body growth, population trends, survivorship, longevity and home ranges. On Maud Island (where the frog was still designated as *L. hamiltoni* at the time of publication) there were 3,791 frog captures comprising 913 individuals. In Coromandel 884 frogs were captured, comprising 590 individual *L. archeyi* and six individual *L. hochstetteri*. The estimated population levels remained relatively stable on the two Maud Island plots over 1983-96: mean Jolly-Seber population estimates were 104 and 334 frogs, representing mean densities of 0.72 and 2.32 frogs/m<sup>2</sup>, respectively. On the Coromandel plot, *L. archeyi* also remained relatively stable over 1983-93, the mean Jolly-Seber population estimate being 470 frogs (4.70 frogs/m<sup>2</sup>). The mean Jolly-Seber annual survival estimate was 82-83% on Maud Island, and 75% for Coromandel *L. archeyi*. The maximum recorded age is 29+ years for a female *L. hamiltoni* on Maud Island (therefore referring to *L. pakeka*). After an experimental translocation of 100 frogs on Maud Island over 1984-84, 12 locally bred frogs are known to have been recruited into the new population at Boat Bay.

**Reference Type:** Book Section

**Record Number:** 122

**Author:** Bell, Ben D.

**Year:** 1997

**Title:** Demographic profiles of terrestrial *Leiopelma* (Anura: Leiopelmatidae) in New Zealand

**Editor:** Rocek, Zbynek; Hart, Scott

**Book Title:** Herpetology '97: abstracts of the Third World Congress of Herpetology 2-10 August 1997 Prague, Czech Republic

**Pages:** 17

**Label:** 122

**Keywords:** conservation; ecology; population studies; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; *Leiopelma hochstetteri*; Coromandel; Maud Island

**Abstract:** This is an abstract from a presentation made at the Third World Herpetology Congress held in Prague, Czech Republic in 1997. Mark-recapture studies of *Leiopelma archeyi* in the Coromandel Ranges and *L. hamiltoni* on Maud Island (therefore referring to *L. pakeka*) have revealed new information on home ranges, population trends, survival rates, body growth and longevity of these species. *L. archeyi* was sampled by day on a 10x10 m plot and *L. hamiltoni* at night on two 12x12 m plots. 590 individual *L. archeyi* and six *L. hochstetteri* were caught in Coromandel over 1982-96, while 913 individual *L. hamiltoni* were caught on Maud Island over 1976-97. Both terrestrial species tend to occupy discrete home ranges and their estimated population levels remained relatively stable. Over 1983-94 the mean Jolly-Seber population estimate for the *L. archeyi* plot was 483 frogs (uncorrected mean density 4.8 m<sup>2</sup>). Over 1983-96 mean population estimates on the two *L. hamiltoni* plots were 104 and 334 frogs (0.7 and 2.3 frogs/m<sup>2</sup> respectively). The mean annual

survival rate was 80% for *L. archeyi* and 91-92% for *L. hamiltoni*. Both species grow throughout much of their life, the growth rate being more rapid in earlier years. The maximum known age is at least 29 years for a female Maud Island frog. These demographic profiles are related to the conservation management of these rare frogs.

**Reference Type:** Book Section

**Record Number:** 123

**Author:** Bell, Ben D.

**Year:** 1997

**Title:** Predation, body-size and survival of New Zealand endemic frogs (Anura: Leiopelmatidae)

**Editor:** Rocek, Zbynek; Hart, Scott

**Book Title:** Herpetology '97: abstracts of the Third World Congress of Herpetology 2-10 August 1997 Prague, Czech Republic.

**Label:** 123

**Keywords:** conservation; morphology; predation; subfossil; distribution

**Abstract:** This is an abstract from a presentation made at the Third World Herpetology Congress held in Prague, Czech Republic in 1997. The seven archaic *Leiopelma* frog species have been subject to major declines or extinctions since humans and introduced predators arrived in the country. Distribution changes of the frogs following human settlement are reviewed and explanations are sought for the absence of surviving *Leiopelma* on most of the New Zealand mainland. The relationship between predation pressure, body-size and survival is examined within and between *Leiopelma* taxa, using subfossil and contemporary data. Spatial and temporal changes in body-size over present and former distributions are assessed, and the impact of different types of predator considered, including rats *Rattus* sp. and introduced frogs *Litoria* sp. Morphology, colour pattern and defence mechanisms of extant *Leiopelma* species are related to predation risk, habitat and sex. A model summarising these relationships is presented and implications for the conservation management of surviving *Leiopelma* populations are explored.

**Reference Type:** Journal Article

**Record Number:** 142

**Author:** Bell, Ben D.

**Year:** 1997

**Title:** A comparison of 1996 IUCN Red List categories and Department of Conservation priority rankings for the New Zealand herpetofauna

**Journal:** Ecological Management

**Volume:** 5

**Issue:** Department of Conservation

**Pages:** 65-71

**Label:** 142

**Keywords:** IUCN; conservation; priority rankings

**Abstract:** For the New Zealand herpetofauna, categories in the 1996 IUCN Red List of Threatened Animals are compared with the Department of Conservation's (DoC) 1994 priority rankings for the conservation of New Zealand's

threatened plants and animals. Differences in the ranking of species are discussed in relation to the different approaches adopted by the two systems.

The categories assigned to *Leiopelma* are as follows:

*L. archeyi* - IUCN category = 'Lower Risk, near threatened', DoC category = 'B' (second priority).

*L. hochstetteri* - IUCN category = 'Lower Risk, least concern', DoC category = 'B' (second priority).

*L. hamiltoni*/*L. pakeka* - IUCN category = 'Vulnerable, D2', DoC categories are 'A' (highest priority for *L. hamiltoni*) and 'B' (second priority for *L. pakeka*).

**Reference Type:** Journal Article

**Record Number:** 34

**Author:** Bell, Ben D.

**Year:** 1999

**Title:** Recent population declines of Archey's frog (*Leiopelma archeyi*) in the central Coromandel Range

**Journal:** New Zealand Journal of Zoology

**Volume:** 26

**Pages:** 255

**Label:** 34

**Keywords:** *Leiopelma archeyi*; Coromandel; *Leiopelma hochstetteri*; IUCN; agents of decline; chytrid fungus

**Abstract:** This is an abstract of a paper presented at the Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand, their 8th conference held at Great Barrier Island, 5-7 February 1999.

Systematic field surveys carried out since the 1970s indicate that there was a marked decline in *Leiopelma archeyi* in the central Coromandel Range over 1996-98. On Tapu Ridge *L. archeyi* was formerly abundant but had become scarce by December 1996. At Tokatea Saddle, 30 km north, no equivalent decline was apparent in February 1997, but *L. archeyi* was very scarce by November 1998, and 29 dead specimens were collected there in January 1995 during a drought. Surviving *L. archeyi* tended to be larger individuals. No corresponding decline was evident among *L. hochstetteri* at Tapu, nor along ridges at Tokatea.

There are no reports of equivalent declines of *L. archeyi* elsewhere in New Zealand, nor of other *Leiopelma* species, although further surveys are needed to better assess the situation.

Possible causes for these declines are listed as climate change; amphibian disease (such as chytrid fungus); research disturbance of sites; illegal collection of frogs; impact of biocides; impact of introduced predators; and other factors not yet identified. Of these, climatic change and/or amphibian disease were considered to be of most concern. A revision of the IUCN Red List status of *L. archeyi* is suggested (currently Low Risk (Near Threatened)). The importance of hygiene protocols in light of the concern over chytrid is emphasized.

This abstract also appears as Froglog 35, Newsletter of the Declining Amphibian Populations Task Force, October 1999.

**Reference Type:** Report

**Record Number:** 227



**Author:** Bell, Ben D.

**Year:** 2001

**Title:** Recent population declines of Archey's frog *Leiopelma archeyi* in the central Coromandel Ranges

**Pages:** 16

**Type:** Unpublished report for the Native Frog Recovery Group, Department of Conservation

**Label:** 227

**Keywords:** agents of decline; *Leiopelma archeyi*; Coromandel; monitoring; *Leiopelma hochstetteri*; population studies

**Abstract:** This paper summarises population studies and monitoring of *Leiopelma archeyi* in the Coromandel, which extends back to 1973. Surveys have revealed that a marked decline of the species occurred there over 1996-98, most data coming from the regions of the Tapu-Coroglen and Tokatea saddles (some 30 km apart). At Tapu, proportionately more mature frogs (>24 mm snout-vent length) were caught over 1996-2000 than before the decline (Mann-Whitney U test,  $z = 5.5609$ ,  $p < 0.0001$ ). The decline in *L. archeyi* was not confined to the mark-recapture plot, for in February 1997 numbers were low along the 1080-sample transects in both the 1080-treated and untreated (control) areas. Prior to the major decline at Tapu, DoC collected 29 dead *L. archeyi* on a 50 m stretch of the summit track at Tokatea in January 1995, after a report from the public. This mortality event occurred following a thunderstorm after a drought. These frogs were measured after desiccation but fell mainly in the adult size range. A report of an incidence of suspected human disturbance in a mark-recapture plot in early 1997 (where numerous rocks had been upturned and rolled) is included. Demographic and morphometric data are presented, while possible causes for the decline are then discussed. These include: climate change, human disturbance, disease, toxins, predation, decline in invertebrate food supply, changes in local distribution and other unidentified causes.

Population information for *L. hochstetteri* is also presented. There are no reports of equivalent declines of *L. archeyi* in Whareorino, nor elsewhere in Coromandel (eg Te Moehau), nor of other *Leiopelma* species.

**Reference Type:** Report

**Record Number:** 222

**Author:** Bell, Ben D.

**Year:** 2002

**Title:** Experience of captive breeding the four extant *Leiopelma* species

**Pages:** 17

**Type:** Unpublished report for the Department of Conservation

**Label:** 222

**Keywords:** captivity; reproduction; development; husbandry

**Abstract:** This report summarises the previous experience of Dr Ben Bell, Victoria University of Wellington, on captive maintenance and breeding of *Leiopelma*. Studies of reproduction have involved captive breeding of all extant species, plus observations of development of *L. archeyi* and *L. hochstetteri* egg clusters collected in the wild. The reports covers breeding patterns of

*Leiopelma*, the history of breeding success and rearing of captive-bred progeny and maintenance regimes. A captive reared *L. hamiltoni* has survived to 17 years and a captive reared *L. pakeka* for at least 14 years. Breeding of captive bred and reared progeny has not been known to occur as yet. Only *L. archeyi* has successfully bred in an indoor facility, whilst all four species have successfully bred in outdoor facilities. Overall fertility rates in captivity are given as: *L. archeyi* - 0.50; *L. pakeka* - 0.73; *L. hamiltoni* - 0.17; *L. hochstetteri* - limited data available. Mortality factors in captivity are also discussed.

**Reference Type:** Journal Article

**Record Number:** 23

**Author:** Bell, Ben D.; Daugherty, Charles H.; Hay, Jennifer M.

**Year:** 1998

**Title:** *Leiopelma pakeka*, n.sp. (Anura: Leiopelmatidae), a cryptic species of frog from Maud Island, New Zealand, and a reassessment of the conservation status of *L. hamiltoni* from Stephens Island.

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 28

**Issue:** 1

**Pages:** 39-54

**Label:** 23

**Keywords:** *Leiopelma pakeka*; *Leiopelma hamiltoni*; *Leiopelma archeyi*; *Leiopelma hochstetteri*; allozyme; taxonomy; conservation; Maud Island; Stephens Island

**Abstract:** This paper gives a formal description of *L. pakeka*. Patterns of allozyme variation reveal that frogs from Maud Island, here designated *Leiopelma pakeka*, n.sp. are specifically distinct from *L. hamiltoni* from Stephens Island. Previously, the two populations had been thought to be conspecific. *L. pakeka* shows limited morphological differentiation from *L. hamiltoni*, but is highly distinct genetically. Among 12 allozyme loci resolved from toe tissue, the two taxa showed fixed differences at two loci and one significant frequency difference. *L. hamiltoni* was genetically more similar to *L. archeyi* (Nei's D = 0.18) than to *L. pakeka* (D = 0.24). The discovery that Maud Island and Stephens Island frogs are distinct species increases the conservation significance of both as the single known population of each species. *L. hamiltoni* is one of the world's rarest frogs and warrants the highest level of conservation protection.

The population estimate for *L. pakeka* on Maud Island is given as 19,000 on a 16 -hectare remnant patch of habitat. The population of *L. hamiltoni* on Stephens Island is stated as fewer than 300 individuals in habitat less than 1 hectare. The toe tissue of the 11 *L. hamiltoni* used for analysis were all from captive individuals. Samples of *L. archeyi* were taken from Tapu and Tokatea in the Coromandel and Tapu for *L. hochstetteri*.

The designation of *L. pakeka* as a new species has been questioned by Holyoake, Waldman & Gemmell (#'s 35 and 115)

**Reference Type:** Journal Article

**Record Number:** 31

**Author:** Bell, Ben D.; Daugherty, Charles H.; Hitchmough, Rodney A.

**Year:** 1995

**Title:** An electrophoretic comparison of the allozymes of Archey's frog (*Leiopelma archeyi*) and a terrestrial frog from Whareorino forest, northern King Country.

**Journal:** New Zealand Journal of Zoology

**Volume:** 22

**Pages:** 401

**Label:** 31

**Keywords:** *Leiopelma archeyi*; Whareorino

**Abstract:** This is an abstract of paper presented at the 6th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at Man-aia, Whangarei, 10-12 February 1995. This presentation discusses the discovery of a native frog resembling *Leiopelma archeyi* in Whareorino forest in 1991. To clarify its taxonomic status, allozyme electrophoresis was used to compare the Whareorino frog with *L. archeyi* from Coromandel. No electrophoretic evidence was found to taxonomically differentiate the populations from the Coromandel from the slightly larger frog from Whareorino. Refer Bell *et al.* 1998 (ref # 5) for a full journal article on this work.

**Reference Type:** Journal Article

**Record Number:** 5

**Author:** Bell, Ben D.; Daugherty, Charles H.; Hitchmough, Rodney A.

**Year:** 1998

**Title:** The taxonomic identity of a population of terrestrial *Leiopelma* (Anura: Leiopelmatidae) recently discovered in the northern King Country, New Zealand.

**Journal:** New Zealand Journal of Zoology

**Volume:** 25

**Pages:** 139-146

**Label:** 5

**Keywords:** *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; allozyme; taxonomy; conservation; morphology

**Abstract:** This paper addresses the discovery of a terrestrial endemic frog resembling *Leiopelma archeyi* in the Whareorino Forest in 1991. To clarify its taxonomic status, allozyme electrophoresis of toe tissue was used to compare it genetically with four other populations of terrestrial *Leiopelma* (*L. archeyi* from Tapu and Tokatea, Coromandel; *L. hamiltoni* from Stephens Island; *L. pakeka* from Maud Island). Thirteen presumed genetic (allozyme) loci could be consistently scored for the five populations. At 11 loci, no genetic differences were found between the Whareorino frog and the two Coromandel *L. archeyi* populations. Allelic frequencies differed slightly at two loci. The authors therefore concluded that the terrestrial Whareorino frog represents a western population of *L. archeyi*. *L. hamiltoni* is genetically closer to *L. archeyi* than is *L. pakeka*. The Whareorino *L. archeyi* population is morphologically similar to Coromandel *L. archeyi* populations, although multivariate analysis suggests subtle morphological differences, including the relative position of the nostril. Size comparisons between Whareorino and three Coromandel sites (Moehau, Tapu, Tokatea) show there were more larger frogs (35-38 mm snout-vent lengths (SVL)) at Whareorino and Tokatea compared with Moehau and Tapu, where maximum SVL lengths were 34 and 36 mm, respectively.

**Reference Type:** Report

**Record Number:** 53

**Author:** Bell, Ben D.; Newman, Donald G.; Crawley, M.C.; Hardy, G.S.; Thomas, B.R.

**Year:** 1983

**Title:** Research on amphibians and reptiles in New Zealand

**City:** Wellington

**Institution:** Wildlife Research Liaison Group Research Review 2

**Pages:** 15

**Label:** 53

**Keywords:** research priorities

**Abstract:** A review of existing knowledge is given for both native and introduced frogs. Current projects are outlined. Priority ratings are given to suggested projects: 'High' - population ecology of all *Leiopelma* spp. excluding *L. hamiltoni*; 'Medium' - niche separation in the Coromandel region for *L. hochstetteri* and *L. archeyi*.

**Reference Type:** Book Section

**Record Number:** 99

**Author:** Bell, Ben D.; Newman, Donald G.; Daugherty, Charles H.

**Year:** 1985

**Title:** The ecological biogeography of the archaic New Zealand herpetofauna (Leiopelmatidae, Sphenodontidae)

**Editor:** Grigg, Gordon; Shine, Richard; Ehmann, Harry

**Book Title:** Biology of Australasian Frogs and Reptiles

**City:** New South Wales

**Publisher:** Royal Zoological Society of New South Wales

**Pages:** 99-106

**Label:** 99

**Keywords:** biogeography; morphology; ecology; genetics

**Abstract:** This paper describes the morphological, ecological and genetic divergence between the semi-aquatic *Leiopelma hochstetteri* and the more terrestrial *L. archeyi* and *L. hamiltoni*. *Leiopelma* has probably been in New Zealand since the Mesozoic. Some factors affecting the present day distribution and abundance of *Leiopelma* are reviewed.

The extant species of *Leiopelma* result from two divergence events: a Miocene divergence (perhaps 13-15 million years ago) which separated the *L. hochstetteri* lineage from the *L. archeyi*/*L. hamiltoni* lineage, and a Pliocene divergence (3-5 million years ago) which led to the present *L. archeyi* and *L. hamiltoni* (and presumably also *L. pakeka* which was not recognised as a separate species at the time of writing). Recent subfossil evidence indicates that *Leiopelma* was more widespread and diverse before human settlement than was previously believed.

**Reference Type:** Journal Article

**Record Number:** 33

**Author:** Bell, Ben D.; Pledger, Shirley

**Year:** 2001

**Title:** Estimating population trends in the terrestrial and partly subterranean

Maud Island frog *Leiopelma pakeka*

**Journal:** New Zealand Journal of Zoology

**Volume:** 28

**Pages:** 361-362

**Label:** 33

**Keywords:** *Leiopelma pakeka*; Maud Island; population studies

**Abstract:** This is an abstract of paper presented at the 9th conference of the Society for Research on Amphibians and Reptiles in New Zealand Conference, held at St Arnaud, Nelson Lakes, 2-4 February 2001. Data was presented from one of the most substantial population databases of any anuran, *Leiopelma pakeka* from Maud Island, which has been studied using mark-recapture techniques since 1976.

Over 1983-2000, frogs were sampled at least annually on two 12 x 12 m sampling plots in the main forest habitat on Maud Island. A further 100 frogs translocated within Maud in 1984-85 to Boat Bay were also monitored. To assess population trends and survival rates at three Maud Island sites, a range of closed and open mark-recapture models were applied to the capture data. Population trends, annual survival rates and longevity are described.

**Reference Type:** Book Section

**Record Number:** 288

**Author:** Bell, B. D.; Pledger, S. A.

**Year:** 2001

**Title:** An experimental island translocation of the endemic New Zealand frog *Leiopelma pakeka* - how did the colonists fare in their new environment?

**Book Title:** The ecology of insular biotas

**City:** Wellington

**Publisher:** Victoria University of Wellington

**Pages:** 14

**Keywords:** *Leiopelma pakeka*; Maud Island; translocation

**Abstract:** This is the abstract of a paper presented at The Ecology of Insular Biotas conference held at Victoria University of Wellington 11 -17 February 2001.

An experimental translocation of *Leiopelma pakeka* took place on Maud Island in 1984 and 1985. A total of 100 individually marked frogs were transferred from the species' remnant forest habitat on Maud Island to restored coastal forest 0.5 km SW in Boat Bay. All frogs were released at the same site in a rocky boulder scree under regenerating forest. An initial release of 43 occurred in May 1984. After confirming good survival, a further 57 were liberated in May 1985. Translocated frogs comprised a cross-section of age and size classes, though the sample was biased in favour of frogs in the adult size range (34-40 mm snout-vent). Subsequent searches for frogs were made at night over 1984-2000, twice each year until 1994, though annually thereafter to minimise habitat disturbance. Additional night searches were made in 1992-93 and in 2000. Most relocated frogs remained in the boulder area within 10 m of the liberation site, although one individual had moved ca. 25 m to an alternative boulder area. Individual frogs generally came to occupy discrete home ranges. After their move

to Boat Bay, most recaptures increased in weight and the maximum weights at Boat Bay were higher than those in the source population. By May 2000, half of the released frogs (50) had been recaptured and a further 23 young frogs were locally recruited into the population over 1984-2000. Using mark-recapture analysis, population trends at Boat Bay are described and compared with those of populations in the original habitat where densities are higher. Demographic and resource differences between Boat Bay frogs and the source population are compared in an attempt to explain growth, size and spatial differences between the two populations. The ultimate fate of the translocated population is assessed given these data for the first 16-17 years of study. This is the first major translocation of a native frog in New Zealand. As a result of this trial, the New Zealand Department of Conservation translocated a further 300 frogs from Maud Island (Pelorus Sound) to Motuara Island (Queen Charlotte Sound) in 1997.

**Reference Type:** Report

**Record Number:** 267

**Author:** Bell, Elizabeth A.

**Year:** 1987

**Title:** Hamilton's frog

**City:** Wellington

**Institution:** St Catherine's College

**Pages:** 31 + apps

**Type:** Unpublished report for 7th form project 'Mathematics with Statistics'.

**Label:** 267

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; habitat; distribution

**Abstract:** This report for a 7th form project at St Catherine's College looks at the habitat, distribution and classification of *Leiopelma hamiltoni* (on Maud Island, therefore referring to *L. pakeka*). A four-day intensive study included a survey of two quadrats in the lower bush region of frog habitat on Maud Island. A total of 139 frogs were captured and measured. The mean snout-vent lengths (SVL) of frogs over 30 mm (ie no juveniles included) were 41.9 mm for Quad 1 and 39.4 for Quad 2 (these correspond to Ben Bell's Grids 1 & 2). The mean weights were 6.8 g for Quad 1 and 5.9 g for Quad 2. Fatness, colour intensity and pattern were also recorded. A higher number of frogs were found in Quad 2 than Quad 1, including frogs in the juvenile size range (ie < 30 mm SVL).

**Reference Type:** Report

**Record Number:** 138

**Author:** Bell, Elizabeth A.

**Year:** 1995

**Title:** Investigation of the presence of *Leiopelma* frogs and availability of suitable frog habitats in the Marlborough Sounds area

**City:** Wellington

**Institution:** Wildlife Management International Limited

**Pages:** 22

**Type:** Unpublished report for Nelson/Marlborough Conservancy, Department of Conservation

**Label:** 138

**Keywords:** habitat; *Leiopelma pakeka*; *Leiopelma hamiltoni*; survey; Nukuwaiata Island; Motuara Island; Maud Island; Stephens Island; translocation

**Abstract:** Various locations in the Marlborough Sounds were visited in 1995 to search for relictual populations of *Leiopelma* frogs and assess the availability of suitable habitat for the transfer of frogs from the known populations on Maud and Stephens Islands. These sites were: Arapawa Island, Motuara Island; Nukuwaiata Island, Tawa Bay, Tawhitinui Island, Tarakaipa Island, Kauauroa Scenic Reserve and Mt Shewell Scenic Reserve.

No frogs were found at any of the eight locations, but several had suitable habitat similar to that on Maud Island. Each location had canopy cover which would maintain humidity and reduce temperature extremes, and could be modified to maintain a frog population, by increasing the depth of available rock piles. However, Kauauroa Scenic Reserve and Motuara Island would require very little, if any, modification. These two sites had large areas of deep rock substrate and moderate to dense canopy cover. Motuara Island was the best location overall due to the predator free status of the island, whereas Kauauroa Scenic Reserve has weka, goats and pigs.

A transfer of at least 100 *L. pakeka* to Motuara Island is recommended. This transfer will increase the number of populations, enhancing the survival of *L. pakeka* and long-distance transfer techniques could be developed and used as a guide in further transfers.

Mainland transfers would be premature at present, unless incorporated with a strict monitoring programme (or university project) to determine the predation and habitat effects by introduced mammals. Kauauroa Scenic Reserve could support a frog population as is. However, although extensive work would be required at the Tennyson Islands, they may be a better choice for preliminary transfers, to monitor the effects of native predators, such as morepork and weka, before testing survival with introduced mammals.

Several of the other areas could be modified to enable transfers at a later date, however some areas would require more extensive work than others. Nukuwaiata Island would be an excellent site for the Stephens Island frog in the future. Further mainland transfers of both *L. pakeka* and *L. hamiltoni* could also continue once several populations on other islands were secure and other sites had been prepared.

**Notes:** The hardcopy has some annotations by someone on it.

**Reference Type:** Thesis

**Record Number:** 177

**Author:** Bell, Elizabeth A.

**Year:** 1995

**Title:** Habitat use, distribution and population dynamics of the Maud Island frog *Leiopelma hamiltoni*

**Academic Department:** Zoology

**University:** Victoria University of Wellington

**Number of Pages:** 168

**Thesis Type:** MSc. (hons)

**Label:** 177

**Keywords:** *Leiopelma pakeka*; *Leiopelma hamiltoni*; habitat; distribution; population studies; Maud Island

**Abstract:** *Leiopelma hamiltoni* on Maud Island (therefore referring to *L. pakeka*) is generally restricted to a 16-hectare remnant forest stand. Systematic surveys of the forest habitat showed the frogs were not uniformly distributed throughout the forest. Higher densities occurred in the lower section of forest where the canopy was higher and rocks more abundant. Other habitat variables had less effect on frog distribution. The minimum population estimate based on frogs seen at night was approximately 6,400, though the actual number present in the forest remnant was estimated to be approximately 19,000.

The minimum adult snout-vent length was 35.1 mm (range: 35-50.5 mm), while sub-adults ranged from 12-35 mm. Adult weights varied from 4.5-10.9 g and sub-adults from 0.3-4.4 g. Most adult frogs were medium brown, with uniform or mottled patterns. Sub-adults were predominately uniform, light or medium brown. Five adult and 16 sub-adult frogs had speckled green markings.

The Maud Island frog is nocturnal and its activity (as measured by the number of frogs caught per night) was influenced by the amount of available moisture, with greater numbers of frogs emerging on nights with rain, or rain over the previous 24 hours. Frogs also climbed higher into the foliage on wet nights. On the two study grid sites, frog capture sites were correlated with rock substrate and the density of frogs was higher on the grid with the most extensive rock substrate (30-78 frogs/100m<sup>2</sup> on Grid One and 82-185 frogs/100m<sup>2</sup> on Grid Two).

The population translocated within Maud Island to Boat Bay in 1984/5 was also surveyed.

**Notes:** Hardcopy includes: title page, abstract, table of contents, lists of tables and figures.

**Reference Type:** Journal Article

**Record Number:** 63

**Author:** Bell, Elizabeth A.; Bell, Ben D.

**Year:** 1994

**Title:** Local distribution, habitat, and numbers of the endemic terrestrial frog *Leiopelma hamiltoni* on Maud Island, New Zealand

**Journal:** New Zealand Journal of Zoology Special Issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 437-442

**Label:** 63

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Maud Island; conservation; distribution; survey

**Abstract:** This paper is on *Leiopelma hamiltoni* on Maud Island, therefore referring to *L. pakeka*. Systematic surveys in the 16 ha forest habitat of the Maud Island frog show that frogs are not uniformly distributed throughout the forest. They live at higher densities in the lower section of forest where the



forest canopy is higher and rocks more abundant. Other habitat variables have less effect on frog distribution. The minimum population estimate, based on frogs seen out at night on two surveys, is c. 6500, though the actual number present in the forest remnant is estimated to be c. 19,000.

**Reference Type:** Book Section

**Record Number:** 174

**Author:** Bell, Elizabeth A.; Bell, Ben D.

**Year:** 1994

**Title:** Local distribution of the rare endemic frog *Leiopelma hamiltoni* on Maud Island, New Zealand

**Editor:** Davies, Margaret; Norris, Rachel M.

**Book Title:** Abstracts of the Second World Congress of Herpetology

**City:** Adelaide

**Publisher:** University of Adelaide

**Pages:** 21-22

**Label:** 174

**Keywords:** *Leiopelma pakeka*; *Leiopelma hamiltoni*; Maud Island; distribution

**Abstract:** This is an abstract of a paper presented at the Second World Congress of Herpetology held at the University of Adelaide, South Australia, December 29, 1993 to January 6, 1994.

Systematics surveys in the remnant 16-hectare forest habitat of *Leiopelma hamiltoni* on Maud Island (therefore referring to *L. pakeka*), have clarified its local distribution pattern. The frog's distribution in relation to altitude, vegetation and substrate is described and spatial variation in density, size and colour patterns is examined.

**Reference Type:** Magazine Article

**Record Number:** 103

**Author:** Bishop, Phil

**Year:** 1997

**Title:** Declining amphibians

**Magazine:** Forest & Bird

**Volume:** 284

**Pages:** 7

**Label:** 103

**Keywords:** agents of decline

**Abstract:** This brief article discusses some of the possible causes of global amphibian declines, including habitat destruction and fragmentation, herbicides and pesticides, acid rain from pollution and ultra-violet radiation. Introduced *Litoria* species are considered to be unlikely predators or competitors of *Leiopelma* as they utilise different habitats. A call is made for assistance in the The New Zealand Frog Survey (mainly for locating introduced frogs).

**Reference Type:** Magazine Article

**Record Number:** 127

**Author:** Bishop, Phil

**Year:** 2000

**Title:** Chytrid fungi identified from dying frogs in New Zealand

**Magazine:** Froglog

**Volume:** 39

**Pages:** 2

**Date:** June 2000

**Label:** 127

**Keywords:** agents of decline; chytrid fungus

**Abstract:** Froglog is the magazine of the Declining Amphibian Populations Task Force (DAPTF) and is available online. This article refers to recent discoveries of chytrid fungi in the introduced frog *Litoria raniformis* in Canterbury. Concerns relating to the susceptibility of *Leiopelma* are briefly discussed.

**URL:** <http://www2.open.ac.uk/biology/froglog/FROGLOG-39-2.html>

**Reference Type:** Report

**Record Number:** 252

**Author:** Bishop, Phil

**Year:** 2002

**Title:** Frog research at the University of Otago, P. Bishop report for Native Frog Recovery Group, Hamilton, 20 May 2002

**Pages:** 4

**Type:** Unpublished report for the Department of Conservation

**Label:** 252

**Keywords:** *Leiopelma pakeka*; Maud Island; survey; sex determination; captivity; husbandry

**Abstract:** This report appears as Appendix 3 in the Native frog Recover Group Annual Report 2002 (ref # 250).

Research carried out by the University of Otago over the past year is outlined.

1. An investigation into sex determination in the field and age/size of females at first egg production of *L. pakeka* on Maud Island. Three plots (10 x 15 m) were divided into 6m<sup>2</sup> quadrants. Measurements were taken pre and post breeding season. 12 separate measurements were taken three times. A total of 106 frogs were processed, resulting in 4,134 measurements being taken and 41 urine samples being collected. A preliminary analysis has been unable to reveal any change in condition from the cohort measured in November 2001 compared to the cohort processed in January and February 2002. Morphological data failed to differentiate the population of frogs into two different size classes. Urine immunoassays are still in progress.

2. In November 2001, 12 *L. pakeka* were taken from the main forest remnant for a captive colony to be maintained in Otago. Rocks from Maud Island were also collected to be used in the vivarium, which was sterilised, along with any material placed inside that was not of Maud Island origin. Frogs were individually marked with a fluorescent elastomer implant injected sub-cutaneously under the ventral skin of the thigh. The vivarium was maintained at ambient temperature, which ranged from 13-21°C. The relative humidity was kept above 85% by frequent sprayings of MilliQ-sterilised water. The blue light used to observe the fluorescent markers was visible to the frogs, which are also sensitive to red light. Frogs were fed twice a week on black crickets and occasionally supplemented with vestigial winged *Drosophila*. After three months nine of the

frogs died. The dead frogs were analysed by Bruce Waldman at Canterbury University and found to have fungal growths in the skin, however tests were negative for chytrid. Hence the exact cause of death is unknown. The New Zealand Frog Survey and International Amphibian Day are also discussed.

**Reference Type:** Report

**Record Number:** 171

**Author:** Blacken, Robyn A.

**Year:** 2000

**Title:** Habitat use and population dynamics of the Maud Island frog, *Leiopelma pakeka*, at Boat Bay, Maud Island, New Zealand

**City:** Hamilton

**Institution:** School for International Training

**Pages:** 52

**Type:** Unpublished independent study project

**Label:** 171

**Keywords:** *Leiopelma pakeka*; habitat; Maud Island; survey; translocation

**Abstract:** This is a report prepared as a result of a research project for The School of International Training New Zealand.

A survey of the translocated population of *Leiopelma pakeka* located in the Boat Bay forest remnant on Maud Island, Marlborough Sounds was conducted over 19 April to 6 May 2000. During this population survey, a grid of 10 m<sup>2</sup> centred on the release point of the translocation was searched. The scree extending above and below the grid was also searched for *L. pakeka*. A zigzag approach was used. This survey was carried out using capture and release strategies. Forty-four captures were made of 29 different individuals including 15 recaptures. Eight of the individuals were 'new' (not previously captured/marked) individuals. Ten of the individuals had not been captured since their initial release (in 1984/85). There was some difficulty with identifying marked individuals in this study (seven individuals were identified as being the same number). Of the eight new captures, two were considered to have hatched in the previous breeding season. Captures were concentrated on the rock scree and ground litter.

**Reference Type:** Report

**Record Number:** 228

**Author:** Blanchard, Barbara

**Year:** 1999

**Title:** A display of Archey's frogs (*Leiopelma archeyi*) at Wellington Zoo

**Institution:** Wellington Zoo

**Pages:** 7

**Type:** Unpublished report

**Label:** 228

**Keywords:** *Leiopelma archeyi*; captivity; husbandry; Coromandel

**Abstract:** Two wild-caught *Leiopelma archeyi* were kept at Wellington Zoo in a glass aquarium, reversed light cycle, indoor exhibit for 100 days from December 1998 to April 1999. Their husbandry and observed behaviour is described. The frogs were collected from the Coromandel. The aquarium was 84 x 23 x

26 cm high with a glass lid. The frogs were fed cultured house flies (8%) and cultured crickets (72%), small moths (8%) and midges (4%). 8% of the feeds were unspecified. Both animals gained weight during the display period. The frogs were retained in captivity by Ben Bell, Victoria University of Wellington, after the display period.

**Reference Type:** Book

**Record Number:** 219

**Author:** Boulenger, George Albert

**Year:** 1882

**Title:** Catalogue of the Batrachia Salientia S. Ecaudata in the collection of the British Museum

**City:** London

**Publisher:** British Museum, printed by order of the Trustees

**Number of Pages:** 503 + plates

**Edition:** Second

**ISBN:** '(no number)'

**Label:** 219

**Keywords:** reference; history; *Leiopelma hochstetteri*

**Abstract:** The object of this catalogue is to give a description of the species of 'Tailless Batrachians' in the British Museum, with an indication of the history and origin of all the specimens in that collection. The collection contained 522 species, represented by 4,692 specimens. *Leiopelma* (as *Liopelma*) is placed in the family Discoglossidae. Only *Leiopelma hochstetteri* had been identified and named at this time. A physical description is provided. The collection contained one male specimen received from Sir A Smith (Percy).

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Thesis

**Record Number:** 131

**Author:** Bowsher, Julia Hadfield

**Year:** 2000

**Title:** Intraspecific genetic variation in New Zealand's endemic frog, *Leiopelma hochstetteri*

**University:** University of Canterbury

**Number of Pages:** 65

**Thesis Type:** MSc.

**Label:** 131

**Keywords:** *Leiopelma hochstetteri*; genetics; chromosome; cytochrome *b*; phylogeny

**Abstract:** This study looks at *Leiopelma hochstetteri* as a model for studying the effects of population fragmentation on patterns of genetic diversity. *L. hochstetteri* inhabits streambeds that are becoming increasingly isolated due to urban and agricultural development. The potential for autosomal divergence between populations of *L. hochstetteri* is already apparent from the great extent of cytogenetic diversity within the species. Different populations exhibit

variable numbers of B-chromosomes, ranging from none in some populations to as many as fifteen. Past studies on B-chromosomes in other taxa have indicated these karyological elements can affect gene flow between populations, resulting in genetic isolation and differentiation.

This study investigated sequence variation in 600 bp of the mtDNA gene cytochrome *b* to determine the phylogenetic relationships among 17 populations of *L. hochstetteri*. The phylogeny and population structure was investigated using different methods: phylogenetic reconstruction, a minimum spanning network, and analysis of molecular variance. The sequence variation between *L. hochstetteri* and the outgroup *L. archeyi*, was exceptionally high (20%) for a sister species. *L. hochstetteri* was found to be highly structured at the population level (64%, Phi = 0.740, p = 0.001) suggesting little or no gene flow among geographically close populations. Phylogenetic relationships above the population level were ambiguous.

The presence or absence of B-chromosomes appears to have no effect on population structure in *L. hochstetteri*. The molecular phylogeny indicates that B-chromosomes arose multiple times in *L. hochstetteri*, and evolved earlier than previously thought. In consideration of this new evidence on the phylogeny and karyology of *L. hochstetteri*, recommendations are made concerning the prioritisation of populations for conservation.

**Notes:** Hardcopy includes title page, abstract and list of tables (there was no table of contents in this thesis).

**Reference Type:** Journal Article

**Record Number:** 61

**Author:** Brown, Derek

**Year:** 1994

**Title:** Transfer of Hamilton's frog, *Leiopelma hamiltoni*, to a newly created habitat on Stephens Island, New Zealand

**Journal:** New Zealand Journal of Zoology Special issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 425-430

**Label:** 61

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; translocation; conservation

**Abstract:** This paper describes the creation of a new habitat (the 'frog pit') on Stephens Island for *Leiopelma hamiltoni*. *L. hamiltoni* was previously confined to one small, severely modified habitat (the 'frog bank' a 600 m<sup>2</sup> rock-tumble). This habitat has become susceptible to climatic extremes through loss of vegetation cover. To enhance the population, estimated to be around 170 frogs, a new habitat was created between May and October 1991 in a nearby forest remnant 40 m from the rock-tumble, by excavation of pits and backfilling these with rocks. A predator-proof fence was built around the new habitat to exclude tuatara, *Sphenodon punctatus*, and the area was 'seeded' with invertebrate prey. Twelve adult frogs were transferred to the site in May 1992. Twenty-seven recaptures of seven of the transferred frogs have been recorded to June 1993.

Recaptured frogs showed variable changes of weight since transfer, with a mean increase of 23% (range = 12% loss to 55% gain); only one showed a detectable increase in snout-vent length. Breeding at the new site has yet to be confirmed.

**Reference Type:** Report

**Record Number:** 187

**Author:** Bruland, Greg; Perkins, Sarah

**Year:** 1997

**Title:** An analysis of the current status of native frog management in New Zealand

**Institution:** Principia College, USA

**Pages:** 18

**Type:** Unpublished report

**Label:** 187

**Keywords:** management; ecology; morphology

**Abstract:** This is a paper written for Greg Bruland's Natural History of New Zealand class at Principia College in the US. An account of the first discovery of *Leiopelma* in NZ is given and their ecology is briefly discussed. A table summarises the physical characteristics and behaviour of *L. hamiltoni*, *L. archeyi* and *L. hochstetteri*. *L. pakeka* is recognised as a separate species from *L. hamiltoni* in this paper, but is as yet unnamed. The characteristics of amphibians that may make them sensitive to environmental change is also discussed. The recovery plan for *Leiopelma* (ref # 90 - referred to as the 'Native Frog (*Leiopelma* spp.) Management plan') and the Frog Recovery Group are discussed. A table lists the number of frogs held in captivity as follows: *L. hamiltoni* -1; *L. pakeka* - 13; *L. archeyi* - 12; *L. hochstetteri* - 12. Concern over the status of *L. hamiltoni* is discussed in particular. Recommendations for future management are briefly discussed.

**Reference Type:** Book Section

**Record Number:** 120

**Author:** Bull, P. C.; Whitaker, A.H.

**Year:** 1975

**Title:** The amphibians, reptiles, birds and mammals

**Editor:** Kuschel, G.

**Book Title:** Biogeography and Ecology in New Zealand

**City:** The Hague

**Publisher:** Dr. W. Junk B.V. Publishers

**Pages:** 231-276

**Label:** 120

**Keywords:** biogeography; ecology

**Abstract:** This chapter looks at the amphibians, reptiles, birds and mammals of New Zealand, both native and introduced. The section on amphibians briefly discusses the ecology and biogeography of *Leiopelma* (giving the distribution for *L. hamiltoni* as both Stephens and Maud Islands).

**Notes:** A. H. Whitaker also publishes under Tony Whitaker.

**Reference Type:** Thesis

**Record Number:** 104

**Author:** Cameron, Murray Colin

**Year:** 1974

**Title:** Aspects of the osmotic and water balance of the New Zealand native frog *Leiopelma hochstetteri* Fitzinger, and the Australian whistling frog *Litoria ewingi* Dumeril and Bibron

**Academic Department:** Zoology

**University:** Massey University

**Number of Pages:** 105

**Thesis Type:** MSc.

**Label:** 104

**Keywords:** *Leiopelma hochstetteri*; *Litoria ewingi*; water balance; physiology; husbandry

**Abstract:** Rates of dehydration and rates of water uptake when hydrated or dehydrated are described for two species of frog of similar size from different habitats (*Leiopelma hochstetteri* and *Litoria ewingi*). No detectable differences in rates of water loss in frogs of both species of comparable size were noted. Considerable differences were seen in rates of water uptake. These uptake rates were lower in hydrated and dehydrated *L. hochstetteri* than in hydrated *L. ewingi*. Differences in rates of water uptake were reflected in measurements of skin permeability and blood plasma osmolality. Rates of water uptake in *L. ewingi* were dramatically increased after dehydration, and it was proposed that this was due to hormonal mediation. The osmotic permeability of different skin regions in frogs of different species may vary in the presence or absence of oxytocin or vasopressin. This was not observed in *L. hochstetteri* where the skin exhibited relatively uniform permeability, but was seen in *L. ewingi* and *L. aurea*. In these two species, the abdominal skin was more permeable and more readily stimulated by oxytocin or vasopressin than the dorsal skin. Oxytocin and vasopressin also increased the short circuit current (inward Na<sup>+</sup> transport) through both dorsal and ventral skin in *L. hochstetteri*, but most noticeably through the ventral skin in *L. ewingi* and *L. aurea*. The skin was observed to be thinner in *L. ewingi* than in *L. hochstetteri* or *L. aurea*. Thin areas in the ventral pelvic integument of *L. ewingi* and *L. aurea* and the presence of epidermal capillaries in these two species are thought to be of importance in water uptake. It has been suggested that water uptake mechanisms are a major factor determining the distribution of the three frog species.

Twenty *L. hochstetteri* were collected from three sites in the Coromandel - Tokatea Ridge, near the Saddle and Tapu. The frogs were kept in a variety of aquaria and round plastic food containers, with at least a small pile of rocks, providing retreat sites, and water. Initially frogs were fed on a mixed diet of fruit flies, blowflies and houseflies, and occasionally supplemented with moths caught in a light trap. However, later the frogs were fed mainly houseflies.

**Notes:** Hardcopy includes title page, table of contents, lists of figures, tables, plates and appendices, abstract and bibliography

**Reference Type:** Journal Article

**Record Number:** 67

**Author:** Carman, J.B.

**Year:** 1955

**Title:** The carotid labyrinth in a *Hyla aurea*, with a note on that in *Leiopelma hochstetteri*

**Journal:** Journal of Anatomy

**Volume:** 89

**Issue:** 4

**Pages:** 503-524

**Label:** 67

**Keywords:** physiology; *Leiopelma hochstetteri*; *Hyla aurea*

**Abstract:** This paper suggests that the carotid labyrinth in the Amphibia develops at metamorphosis to ensure that the external carotid artery receives an adequate supply of blood at a reasonable pressure. Comparisons between *Hyla aurea* and *Leiopelma hochstetteri* are made. The four specimens used were collected by Mr S.G. Gittos of Warkworth.

**Reference Type:** Report

**Record Number:** 198

**Author:** Carter Holt Harvey

**Year:** 1997

**Title:** Management strategy for *Leiopelma hochstetteri* in the Mahurangi Forest

**Pages:** 19

**Type:** Unpublished report for the Auckland Regional Council

**Label:** 198

**Keywords:** management; monitoring; conservation; *Leiopelma hochstetteri*; forestry

**Abstract:** Carter Holt Harvey currently holds several resource consents allowing forestry activities to be undertaken within specified parts of the Mahurangi Forest. However, special conditions are attached to these consents with regards to the populations of *Leiopelma hochstetteri* which inhabit these areas, which require Carter Holt Harvey to: implement a biological monitoring programme; develop an appropriate management strategy for *L. hochstetteri* within the exotic forest; and implement the aforementioned management strategy.

Potential effects of forestry operations are considered. The habitat of *L. hochstetteri* within the forest is described. The management strategy required by Carter Holt Harvey is described as a three-tier integrated approach. These are: employing Best Management Practices to mitigate environmental effects; retain, and as far as practicable, enhance, in terms of frog habitat, the existing 'enclaves'; a monitoring programme for *L. hochstetteri* that utilise a 'before and after' approach. It is anticipated that a Progress Report and Working Report will be made to the Review Group annually.

**Reference Type:** Journal Article

**Record Number:** 3

**Author:** Chandler, Mark; Green, David M.; Taylor, Alison; Zeyl, Clifford W.

**Year:** 1993

**Title:** Chiasma frequency in frogs of the genus *Leiopelma* (Amphibia; Anura) and a test of the hypothesis of inducible recombination.



**Journal:** Hereditas

**Volume:** 118

**Issue:** 3

**Pages:** 205-210

**Label:** 3

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma pakeka*; *Leiopelma hamiltoni*; chiasma frequency; Coromandel; Maud Island; autosome; chromosome; genetics

**Abstract:** This paper looks at the chiasma frequency in *Leiopelma*. The rate of recombination in three species of *Leiopelma* was estimated by measuring chiasma frequency in spermatocyte bivalents. Both the mean and intra-individual variance of excess chiasmata frequency differed among the three species (*L. hochstetteri* =  $13.17 \pm 2.96$  SD; *L. hamiltoni* =  $9.69 \pm 1.16$  SD; *L. archeyi* =  $10.71 \pm 1.11$  SD). *L. hochstetteri* has one of the highest rates of intra-individual variation in chiasma frequency found in frogs. The presence of supernumerary chromosomes in *L. hochstetteri* was used to test the theory of inducible recombination. If supernumeraries are parasites, then they will be associated with an increase in either chiasma frequency or an increase in within-individual variance. However, this was not found in *L. hochstetteri*. Nevertheless, the high variance in chiasma frequency associated with these putative genomic parasites in *L. hochstetteri* makes it impossible to rule out the Red Queen hypothesis as an explanation.

Collections of *L. hochstetteri* in 1987 and 1989 were from six populations. *L. archeyi* was collected in 1987 from the Coromandel peninsula and *L. hamiltoni* from Maud Island (therefore referring to *L. pakeka*). Frogs were exported live to Montreal, Canada.

*L. hochstetteri* differs karyotypically from *L. archeyi* and *L. hamiltoni* by having 22 autosomal chromosomes and no sex chromosomes in the male rather than the 16 autosomes and sex chromosome pair.

**Reference Type:** Report

**Record Number:** 108

**Author:** Clarkson, Bruce D.; Daniel, L. J.; Overmars, F.B.; Courtney, S. P.

**Year:** 1986

**Title:** Motu Ecological District: survey report for the Protected Natural Areas Programme

**City:** Wellington

**Institution:** Department of Lands and Survey

**Pages:** 153 + maps

**Label:** 108

**Keywords:** *Leiopelma hochstetteri*; survey

**Abstract:** This is a survey report on the flora and fauna of the Motu Ecological Area. *Leiopelma hochstetteri* is described as widely distributed in suitable habitats from near sea level to the high hills. *L. hochstetteri* is also listed as one of five rare and endangered species in the district listed in The Red Data Book of New Zealand. Some specific areas where *L. hochstetteri* have been found are also listed.

**Notes:** Only pages relating to *L. hochstetteri* copied for hardcopy

**Reference Type:** Magazine Article

**Record Number:** 102

**Author:** Collingwood, David G.

**Year:** 1984

**Title:** Hamilton's frog

**Magazine:** Forest & Bird

**Volume:** 15

**Issue Number:** 1

**Pages:** 16-17

**Label:** 102

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; ecology; biogeography

**Abstract:** This article briefly discusses the possible origins and describes the ecology of *Leiopelma hamiltoni* from both Stephens and Maud Islands (therefore also referring to *L. pakeka*).

**Reference Type:** Journal Article

**Record Number:** 9

**Author:** Craw, R.C.

**Year:** 1985

**Title:** Classic problems of southern hemisphere biogeography re-examined: panbiogeographic analysis of the New Zealand frog *Leiopelma*, the ratite birds and *Nothofagus*.

**Journal:** Zeitschrift für Zoologische Systematik und Evolutionsforschung

**Volume:** 23

**Pages:** 1-10

**Label:** 9

**Keywords:** biogeography; distribution; phylogeny;

**Abstract:** This paper uses Croizat's panbiogeographic method to re-examine the distribution patterns of *Leiopelma*, *Nothofagus* and ratite birds. These patterns are usually interpreted as due to the fragmentation of pan Austral biota distributed over the ancient southern supercontinent Gondwana. The biogeography of *Leiopelma* and its relatives are discussed in detail, which are shown to exhibit a trans-Pacific biogeographic pattern rather than a trans-Antarctic, Gondwanan or Pangaeon biogeographic pattern as claimed by vicariance theorists. Geographic distributions for *Nothofagus-Fagus* and the ratite birds are also discussed in detail. The geographic distribution of *Nothofagus-Fagus* is found to be biogeographically homologous with that of *Leiopelma* and its relatives because both groups of taxa display trans-Pacific tracks. The author suggests that the geographic sympatry of the ratite birds, *Nothofagus* and leiopelmatid frogs in eastern Australasia and southern South America is due to the composite geological nature of these areas.

Distribution of *Leiopelma*, extant and subfossil records, is related to tectonic features of NZ. This paper was written before Trevor Worthy's work on Leiopelmatidae subfossils.

**Reference Type:** Book Section

**Record Number:** 100

**Author:** Cree, Alison

**Year:** 1985

**Title:** Water balance of New Zealand's native frogs (Anura: Leiopelmatidae)

**Editor:** Grigg, Gordon; Shine, Richard; Ehmann, Harry

**Book Title:** Biology of Australasian Frogs and Reptiles

**City:** New South Wales

**Publisher:** Royal Zoological Society of New South Wales

**Pages:** 361-371

**Label:** 100

**Keywords:** physiology; *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; water balance; husbandry

**Abstract:** Rates of dehydration, rehydration, and water uptake in response to arginine vasotocin (AVT) were examined in the anatomically primitive *Leiopelma*. All three species have high rates of dehydration due to evaporative water loss (EWL) and urination. EWL varies inversely and linearly with relative humidity in the two species examined, *L. archeyi* and *L. hochstetteri*. The terrestrial species *L. archeyi* and *L. hamiltoni* rehydrate rapidly and ventral skin is the major site for water uptake. *L. hochstetteri* is semi-aquatic and rehydrates at only one-sixth the speed of the terrestrial species. Rehydration of *L. hochstetteri* is achieved by reducing urine output; there is no obvious change in cutaneous water uptake. These patterns of rehydration are paralleled by differences in response to AVT. *L. archeyi* and *L. hamiltoni* respond by rapidly absorbing water, reaching peak weight gains of 37% and 29% respectively, three to eight hours after injection. *L. hochstetteri* absorbs water only slowly, gaining 9% in weight over nine hours. These results are consistent with hypotheses about adaptations of water balance to terrestriality in the Anura, and demonstrate that responsiveness to AVT is not restricted to anatomically specialised genera. The data also agree with other studies suggesting a closer evolutionary relationship between *L. archeyi* and *L. hamiltoni* than between either species and *L. hochstetteri*.

Experiments with *L. archeyi* and *L. hochstetteri* were performed with 10 animals of each species collected from the Coromandel Peninsula. The frogs were maintained on a diet of houseflies, blowflies, nymphal locusts and mealworms. Later experiments were performed on *L. hamiltoni* on Maud Island (therefore referring to *L. pakeka*) in 1984 on 15 frogs that were returned to their natural habitat upon completion of the experiments.

**Reference Type:** Thesis

**Record Number:** 105

**Author:** Cree, Alison

**Year:** 1986

**Title:** Water relations of the endemic New Zealand frogs *Leiopelma archeyi*, *L. hamiltoni* and *L. hochstetteri*

**Academic Department:** Biological Sciences

**University:** University of Waikato

**Number of Pages:** 196

**Thesis Type:** PhD.

**Label:** 105

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; physiology; water balance; development; captivity; husbandry; artificial induction of egg-laying; Coromandel; Maud Island

**Abstract:** Aspects of habitat and water balance physiology were compared between the endemic and anatomically primitive New Zealand frogs *Leiopelma archeyi*, *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*) and *L. hochstetteri*. Field studies in an area of the Coromandel Range showed that the partially sympatric *L. archeyi* and *L. hochstetteri* had nearly disjunct distribution. *L. archeyi* occurred in terrestrial habitats on the forested ridge tops, whereas most *L. hochstetteri* were found in semi-aquatic habitats along the edges of streams. *L. archeyi* also showed less preference for water than *L. hochstetteri* in the laboratory. Climatic conditions in the ridge top habitat of *L. archeyi* were usually cool and humid, and resemble those previously reported for the allopatric and completely terrestrial *L. hamiltoni*.

In laboratory studies, all three species dehydrated rapidly in dry conditions. Resistance to evaporative water loss (EWL) was similar to that for a free water surface. *L. archeyi* and *L. hamiltoni* rehydrated rapidly (in one-two hours) when returned to shallow water after dehydration to 9-15% weight loss. Rapid rehydration was due to increased water uptake through ventral skin and to reduced bladder urine accumulation (cutaneous and antidiuretic water balance responses). *L. hochstetteri* rehydrated very slowly (rehydration incomplete within 16 hours) and showed only an antidiuretic response. *L. hochstetteri* also rehydrated more slowly from moist soil when compared with *L. archeyi*.

Treatment with arginine vasotocin (AVT,  $7 \times 10^{-11}$  mol g<sup>-1</sup>) produced water balance responses similar to those seen during rehydration. *L. archeyi* and *L. hamiltoni* placed in shallow water showed rapid water retention, reaching weight gains of 31% and 29% respectively four-five hours after treatment. *L. hochstetteri* gained weight at a slow and linear rate (9% over nine hours). Unlike *L. archeyi* and *L. hamiltoni*, *L. hochstetteri* showed no increase in cutaneous water uptake, and water retention was attributed solely to antidiuresis.

*In vitro* experiments confirmed that AVT ( $3 \times 10^{-8}$  mol l<sup>-1</sup>) caused increased osmotic water flow (OWF) through ventral pelvic skin of *L. archeyi* and *L. hamiltoni*. However, pelvic skin from *L. hochstetteri* and ventral pectoral and dorsal skin from all three species showed no hydroosmotic response. The bladders of the three species showed small increases in OWF in response to AVT. *In vitro*, glomerular filtration rate fell following AVT treatment in all species, although the effect on *L. hochstetteri* was not statistically significant.

Pelvic skin of *L. archeyi* showed no obvious structural specialisation for rapid water uptake, when examined using light and scanning electron microscopy. Pelvic skin was smooth, structurally similar to non-glandular areas of pectoral or dorsal skin, and less vascularised than pelvic skin of *L. hochstetteri*.

Adults of all three species were ureotelic. In the terrestrial eggs and larvae of *L. archeyi*, intracapsular larvae were ammonotelic, but most larvae became ureotelic within four days after hatching. The eggs had no resistance to EWL, but absorbed water rapidly from moist surfaces. Male parental care (egg brood-

ing, larval transport) led to reduced EWL from eggs and hatched larvae of *L. archeyi*.

The study demonstrates that the presence of a cutaneous hydrosmotic response varies between adults of the three species in an inverse manner with habitat water availability. It also supports previous studies indicating a closer ecological similarity and evolutionary relationship between *L. archeyi* and *L. hamiltoni*, than between either and *L. hochstetteri*.

Laboratory experiments were carried out on 20 *L. archeyi* and 20 *L. hochstetteri* and included immature females and mature adults of each sex. The first 10 of each were collected from the Tapu study area in 1983 and the remaining 10 in 1984/85.

*L. archeyi* were housed in vivarium containing damp forest soil, leaf litter, rocks and logs. *L. hochstetteri* were kept in a vivarium containing rocks and stones and with stream water trickling through. Stream water originated from the Waitakararu Stream, Waikato. Frogs were fed a varied diet of houseflies, blowflies, nymphal locusts and mealworms.

Experiments on the Maud Island frog (therefore *L. pakeka*) were carried out on Maud Island in May 1984 using 15 unsexed animals that were held overnight on damp paper towels and later returned to their natural habitat. Later experiments were performed on five mature females and three mature males collected from Maud Island by Dr Ben Bell in May 1985. These were housed in the laboratory at the University of Waikato in a vivarium containing three *L. archeyi*. Specimens were kept in captivity for up to 23 months and most remained apparently healthy.

Four egg clusters and one clutch of larvae from Tapu were collected for laboratory experiments.

Attempts were made to supplement the collected material by inducing breeding in captive animals. Mature females and presumed males were treated with various doses of human chorionic gonadotrophin or luteinising hormone-releasing hormone, however, only infertile eggs were produced.

Development in *L. archeyi* eggs and larvae is described.

**Notes:** Hardcopy includes title page, abstract, table of contents, lists of figures, tables, plates

**Reference Type:** Journal Article

**Record Number:** 237

**Author:** Cree, Alison

**Year:** 1988

**Title:** Effects of arginine vasotocin on water balance of three leiopelmatid frogs

**Journal:** General and Comparative Endocrinology

**Volume:** 72

**Pages:** 340-350

**Label:** 237

**Keywords:** physiology; water balance

**Abstract:** The effects of arginine vasotocin (AVT) on water movements in three *Leiopelma* were compared *in vivo* and *in vitro*. Treatment with AVT *in vivo* ( $7 \times 10^{-13}$  mol/g body weight) led to significant water retention in the ter-

restrial species *L. archeyi* and *L. hamiltoni*, but not in the semiaquatic species *L. hochstetteri*. All three species showed increasing water retention over some part of the dose range  $7 \times 10^{-15}$  -  $7 \times 10^{-11}$  mol/g. Isolated pelvic skin from *L. archeyi* and *L. hamiltoni* increased in osmotic water flow (OWF) in response to AVT, whereas that from *L. hochstetteri* did not. Dorsal skin from all three species, as well as pectoral skin from *L. archeyi* and *L. hochstetteri*, showed no hydroosmotic response to AVT. Isolated bladders of all species are small and showed small increases in OWF in response to AVT. Glomerular filtration rate *in vivo* was reduced significantly by AVT in *L. archeyi* and *L. hamiltoni*, but not in *L. hochstetteri*. These results show that water balance responses to AVT among the three species are correlated with habitat, and indicate that the absence of a cutaneous hydroosmotic response in *L. hochstetteri* is not a characteristic, primitive feature of the entire genus.

*L. archeyi* and *L. hochstetteri* were collected near Tapu, Coromandel. *L. hamiltoni* was collected from Maud Island (therefore referring to *L. pakeka*).

**Reference Type:** Journal Article

**Record Number:** 40

**Author:** Cree, Alison

**Year:** 1989

**Title:** Relationship between environmental conditions and nocturnal activity of the terrestrial frog, *Leiopelma archeyi*

**Journal:** Journal of Herpetology

**Volume:** 23

**Issue:** 1

**Pages:** 61-68

**Label:** 40

**Keywords:** *Leiopelma archeyi*; Coromandel; ecology; rehydration; physiology

**Abstract:** The number of frogs emerging at night in a field population (Tapu) of *Leiopelma archeyi* is examined in relation to environmental conditions. Frogs emerge at or about dusk from retreat sites on the forest floor, climbing up to 2 m high in the vegetation before returning to their retreats at dawn. Emergence is strongly and positively correlated ( $P < 0.005$ ) with the following moisture-related factors: relative humidity, rainfall, and wetness of vegetation, and negatively ( $P < 0.001$ ) with vapour pressure deficit. Air temperature showed a weaker and barely significant ( $P < 0.05$ ) correlation with emergence, and strength of wind gusts no significant correlation ( $P > 0.1$ ). Frogs that emerged on nights when the vegetation was dry probably suffered little water loss by evaporation, because of the high humidities and cool temperatures, which prevailed in the forest habitat. Experimentally dehydrated *L. archeyi* rehydrated rapidly from wet foliage, increasing from 92 to 99% of original body weight over four hours. These experiments were carried out in the field and frogs were rehydrated using stream water. Although emergence of most *L. archeyi* was limited to times of high moisture availability, rapid water uptake through ventral skin allowed this species to utilise sources of water which were only present ephemerally.

**Reference Type:** Report

**Record Number:** 86

**Author:** Cree, Alison

**Year:** 1990

**Title:** Habitat restoration for Hamilton's frog

**Pages:** 15

**Type:** Unpublished report for Nelson/Marlborough Conservancy, Department of Conservation.

**Label:** 86

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; habitat; management

**Abstract:** This is a contract report, presumably for the Department of Conservation. A rock pit of 3 m<sup>2</sup> surface area and 0.5 m deep was created in the frog bank bush on Stephens Island as a trial to determine whether it would provide suitable microclimatic conditions for a new population of *Leiopelma hamiltoni*. Measurements of air temperature, relative humidity and soil water potential at the bottom of the pit during February-July 1990 suggest that it is suitably cool and moist for *L. hamiltoni* to survive in. It was recommended that: (i) monitoring continue for an entire year (ie until February 1991) before concluding that the habitat is suitable for the frog; (ii) the existing population of *L. hamiltoni* at the frog bank on Stephens Island should urgently be surveyed to estimate total population size; (iii) the frog bank should be fenced immediately to prevent tuatara predation on *L. hamiltoni*; (iv) a management group should be established to decide on future management activities for *L. hamiltoni*, including the identification of a source of additional rocks to extend the newly-created rock pit, and the most appropriate source of frogs for transfer.

**Reference Type:** Report

**Record Number:** 280

**Author:** Cree, Alison

**Year:** 1991

**Title:** Survey for Hamilton's frog on Stephens Island, November 15-23 1990

**Pages:** 21

**Type:** Unpublished report to the Nelson-Marlborough Conservancy, Department of Conservation

**Label:** 280

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; survey

**Abstract:** A survey for *Leiopelma hamiltoni* was carried out in November 1990 on the frog bank of Stephens Island. A total of 11 frogs were seen over seven nights of searching. Frogs ranged in size from 19.2 - 46.0 mm total length, and included newly metamorphosed frogs as well as large adult females carrying pre-ovulatory follicles. Despite encroachment of vegetation over the frog bank in recent years, the frog population has survived and reproduction is clearly occurring. All frogs were toe-clipped and the DoC officer and his wife resident on Stephens Island were trained to continue further surveys during 1991. By November 1991, sufficient sightings should have been made to estimate the probable population size. A recovery plan addressing methods for establishing new populations of this extremely rare frog is needed.

**Reference Type:** Journal Article

**Record Number:** 85

**Author:** Cree, Alison

**Year:** 1993

**Title:** A New Zealand monitoring programme for the Declining Amphibian Populations Task Force

**Journal:** New Zealand Journal of Zoology

**Volume:** 20

**Pages:** 130

**Label:** 85

**Keywords:** monitoring

**Abstract:** Abstracts of the Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at the Southland Museum, Invercargill, 27-29 November 1992.

This paper describes the formation of a New Zealand DAP Working Group to oversee the monitoring of frog populations in this country as part of the global organisation, the Declining Amphibian Populations Task Force.

**Reference Type:** Report

**Record Number:** 226

**Author:** Cree, Alison; Daugherty, Charles H.

**Year:** 1991

**Title:** Induction of egg-laying in terrestrial-breeding leiopelmatid frogs

**Institution:** School of Biological Science, Victoria University of Wellington

**Pages:** 18

**Type:** Unpublished report for the Department of Conservation

**Label:** 226

**Keywords:** reproduction; artificial induction of egg-laying; *Leiopelma archeyi*; *Leiopelma pakeka*; vocalisations; Coromandel; Maud Island

**Abstract:** Aspects of the breeding biology of the terrestrial-breeding endemic frogs *Leiopelma archeyi* and *L. pakeka* were examined. In addition, attempts were made to induce oviposition in wild frogs using hormonal injections. *L. archeyi* breeds during mid-late October at Tapu Summit on the Coromandel Peninsula. Calling (presumably by males) occurs from under rocks and pairs may remain in amplexus for at least 24 hours. The female then departs from the nest site and the male broods the eggs. Injections of the gonadotropin-releasing hormone (GnRH) agonist des-Gly<sup>10</sup>, D-Ala<sup>6</sup>-LHRH ethylamide into three pairs captured at the nest site prior to amplexus led to amplexus in all three pairs. Two pairs also oviposited, but the eggs did not develop.

The timing and breeding in *L. pakeka* is not known with certainty. Calling was heard in early November and females in pre-ovulatory condition were seen in early and late November. However, no pairs at the nest site or oviposited eggs were found, suggesting that breeding does not occur until early December. Injections of des-Gly<sup>10</sup>, D-Ala<sup>6</sup>-LHRH ethylamide or imBzl, D-His<sup>6</sup>-LHRH ethylamide into gravid females and presumed males in early and late November on Maud Island resulted in amplexus and oviposition in only one of ten treated pairs, and the eggs did not develop. The poorer response to GnRH treatment in *L. pakeka* than in *L. archeyi* may reflect the apparently earlier treatment relative to the time of natural oviposition. Although GnRH treatment may have some



potential for the induction of oviposition in leiopelmatid frogs, more detailed knowledge on the time of natural oviposition, the effects of GnRH at different times preceding natural oviposition, and the effects of GnRH on spermiation and fertilisation of induced eggs need further investigation.

**Reference Type:** Journal Article

**Record Number:** 146

**Author:** Crook, Ian G.

**Year:** 197?

**Title:** Stephens Island frog

**Journal:** Wildlife - A Review

**Volume:** 2

**Pages:** 13-16

**Label:** 146

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; habitat

**Abstract:** This paper discusses *Leiopelma hamiltoni* on Stephens Island (distribution is given as both Stephens and Maud Island), including the habitat and possible factors that attributed to the frogs' persistence after deforestation on the island. These include the depth of the rock pile in the frog bank, which is at least two to four feet, and that although rainfall on the island is only 34 inches per year, the summit and the frog bank are sometimes covered by cloud.

**Reference Type:** Magazine Article

**Record Number:** 186

**Author:** Crook, Ian G.

**Year:** 1973

**Title:** The frogs that link continents

**Magazine:** Animal Kingdom

**Volume:** 76

**Issue Number:** 4

**Pages:** 16-21

**Date:** August 1973

**Label:** 186

**Keywords:** biogeography; habitat; ecology

**Abstract:** This paper discusses the presence of *Leiopelma* in New Zealand, in that New Zealand is described as an oceanic island and no other appears to have endemic amphibians. The presence of *Leiopelma* provides support that New Zealand was once connected to a larger landmass. Comparisons between *Leiopelma* and *Ascaphus* are made. The life history and habitat of *L. hamiltoni* (Stephens and Maud Island, therefore also referring to *L. pakeka*), *L. hochstetteri* and *L. archeyi* are briefly described.

**Reference Type:** Magazine Article

**Record Number:** 164

**Author:** Crook, Ian G.

**Year:** 1974

**Title:** Native frogs

**Magazine:** New Zealand's Nature Heritage

**Volume:** 1

**Issue Number:** 10

**Pages:** 257-262

**Label:** 164

**Keywords:** ecology;

**Abstract:** This article provides general information on the possible origins, the ecology and life history of *Leiopelma*. Each species is described (with a distribution for *L. hamiltoni* given as both Stephens and Maud Islands). A brief description of introduced frogs is also included.

**Reference Type:** Journal Article

**Record Number:** 185

**Author:** Crook, Ian G.

**Year:** 1974

**Title:** The climate of a frog habitat

**Journal:** Wildlife - A Review

**Volume:** 5

**Pages:** 41-42

**Label:** 185

**Keywords:** Stephens Island; Maud Island; habitat

**Abstract:** This paper briefly reports on the climate comparison study between frog habitats on Stephens and Maud Islands. Figures (temperature and humidity) for March 1974 are given, but no conclusions were drawn at this time.

**Reference Type:** Magazine Article

**Record Number:** 145

**Author:** Crook, Ian G.

**Year:** 1976

**Title:** Archaic elements and a host of immigrants

**Magazine:** Australian Natural History

**Volume:** 18

**Issue Number:** 10

**Pages:** 362-365

**Label:** 145

**Keywords:** biogeography; *Leiopelma hamiltoni*; Stephens Island

**Abstract:** This article discusses the possible origins of amphibians and reptiles in New Zealand. *Leiopelma hamiltoni*'s persistence on Stephens Island is also discussed.

**Reference Type:** Journal Article

**Record Number:** 28

**Author:** Crook, Ian G.; Atkinson, I.A.E.; Bell, Brian D.

**Year:** 1971

**Title:** Habitats of the frog *Leiopelma hamiltoni* McCulloch on Stephens and Maud Islands, Cook Strait.

**Journal:** New Zealand Journal of Science

**Volume:** 14

**Pages:** 1082-1093

**Label:** 28

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Maud Island; Stephens

Island; habitat; history

**Abstract:** The two known habitats of *Leiopelma* on Stephens and Maud Islands are described briefly and compared. This paper refers to the Maud Island frog as *L. hamiltoni* (therefore referring to *L. pakeka*). Includes photos of Stephens Island 'frog bank' and gives history from 1894 to 1971. This paper also lists observations made of *L. hamiltoni* on Stephens since 1915.

**Reference Type:** Magazine Article

**Record Number:** 248

**Author:** Crook, Ian G.; Crook, Gillian

**Year:** 197?

**Title:** New Zealand's rarest frog

**Magazine:** Animals

**Volume:** 14

**Issue Number:** 4

**Pages:** 188-190

**Label:** 248

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; history

**Abstract:** This article gives an introduction to *Leiopelma hamiltoni* and provides a brief history of first years of observations made on Stephens Island. Specimens of *L. hamiltoni* were sent to Otago Museum and the Dominion Museum by R. G. Smith, son of the then lighthouse keeper, in 1915. The following year (1916) Harold Hamilton visited Stephens Island to make further collections. Frogs were found 30-60 cm below ground, between the rocks of a boulder bank (the frog bank). Several more frogs were observed between their discovery and 1927. After this they were believed to be extinct, but were 'rediscovered' by Dr W.H. Dawbin in 1950 and in 1951 the NZ Wildlife Service began revegetating the frog bank. In 1966, Stephens Island was declared a Wildlife Sanctuary. Finding *L. hamiltoni* at night, thereby reducing the need to disturb habitat, was assisted by the discovery by A.H. Whitaker that light reflected from the tapetum in their eyes. This article also refers to *L. hamiltoni* on Maud Island (therefore also referring to *L. pakeka*).

**Reference Type:** Book

**Record Number:** 190

**Author:** Crowe, Andrew; Campbell, Peter

**Year:** 1997

**Title:** Archey's frog - the discovery of New Zealand's tiniest native frog

**Series Editor:** Hodge, Judith

**Series Title:** Wild Stories

**City:** Auckland

**Publisher:** Heinemann Education

**Number of Pages:** 22

**ISBN:** 1869441699

**Label:** 190

**Keywords:** *Leiopelma archeyi*; history

**Abstract:** This is a children's book describing the discovery of *Leiopelma archeyi* in the Coromandel by Percy Smith in 1862. Further Information on

*L. archeyi* is also given at the back of the book.

**Notes:** Hardcopy only includes the title page, publishers information and last page.

**Reference Type:** Book

**Record Number:** 273

**Author:** Cusa, Noel W.; Lockley, Ronald M.

**Year:** 1980

**Title:** New Zealand endangered species: birds, bats, reptiles, freshwater fishes, snails and insects

**City:** Auckland

**Publisher:** Cassell New Zealand

**Number of Pages:** 150

**ISBN:** 0908572220

**Label:** 273

**Keywords:** ecology

**Abstract:** This book gives a general introduction to the ecology of *Leiopelma*.

**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 119

**Author:** Czopek, Juliusz

**Year:** 1955

**Title:** Vascularization of respiratory surfaces in *Leiopelma hochstetteri* Fitzinger and *Xenopus laevis* (Daudin)

**Journal:** Acta Anatomica

**Volume:** 25

**Pages:** 346-360

**Label:** 119

**Keywords:** *Leiopelma hochstetteri*; physiology; respiration

**Abstract:** This paper investigates the vascularisation of respiratory surfaces in *Leiopelma hochstetteri* and *Xenopus laevis*. The lengths of skin, lung and palate capillaries were measured. Relative to 1 g of body weight, the length of capillaries in *L. hochstetteri* is as follows: skin capillaries 6.95 m/g, lung capillaries 3.40 m/g and palate capillaries 0.316 m/g. Consequently most of the gas exchange of this species should be by the skin, the capillaries of which constitute 65.1% of the total length of capillaries of respiratory surfaces. The lung capillaries constitute 31.9%, the palate capillaries 3.0%.

The three specimens of *L. hochstetteri* used for the investigation were collected in 1947, injected with Indian ink through the truncus arteriosus, fixed, and sent by post to Prof. Szarski of Copernicus University, Poland. One of these had been injected insufficiently and could not be used (see ref # 236).

**Reference Type:** Journal Article

**Record Number:** 27

**Author:** Daugherty, Charles H.; Bell, Ben D.; Adams, Mark; Maxson, Linda R.

**Year:** 1981

**Title:** An electrophoretic study of genetic variation in the New Zealand frog

genus *Leiopelma*.

**Journal:** New Zealand Journal of Zoology

**Volume:** 8

**Pages:** 543-550

**Label:** 27

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma archeyi*; evolution; genetics; *Leiopelma pakeka*

**Abstract:** Genetic variation at 33 loci in three species of *Leiopelma* was examined by cellulose acetate electrophoresis of liver enzymes. Heterozygosity is apparently comparable to levels detected in other amphibians. Genetic differentiation between species is extensive. *L. hochstetteri* is greatly divergent from both *L. archeyi* and *L. hamiltoni* but these two are relatively similar genetically, in agreement with morphological, ecological, and developmental patterns. A tentative estimate is made that the divergence of *L. hochstetteri* from the other two species occurred during the Miocene, whereas that of *L. archeyi* and *L. hamiltoni* occurred during the Pliocene. Implications of the genetic data for conservation of *Leiopelma* are discussed.

Collections were made in 1980 as follows: five from Maud Island (therefore refers to *L. pakeka*); five *L. archeyi* from Tapu, Coromandel; 16 *L. hochstetteri* from five populations in four regions (Great Barrier Island, Warkworth, Tokatea, Tapu and Opotiki).

**Reference Type:** Journal Article

**Record Number:** 94

**Author:** Daugherty, Charles H.; Gibbs, George W.; Hitchmough, Rodney A.

**Year:** 1993

**Title:** Mega-island or micro-continent? New Zealand and its fauna

**Journal:** Trends in Ecology & Evolution

**Volume:** 8

**Issue:** 12

**Pages:** 437-442

**Label:** 94

**Keywords:** evolution; ecology; translocation

**Abstract:** This paper addresses the evolution of New Zealand's terrestrial fauna. Life history traits of many of NZ's faunal species are discussed in relation to the absence of mammalian predators. References are made to studies on *Leiopelma* by Worthy and Green (specifically sex determination in *Leiopelma*). The reference to the translocated population of *L. pakeka* within Maud Island is for 1984 only (stating 43 frogs), which does not take into account the 1985 translocation (being 100 frogs in total over the two years).

**Reference Type:** Journal Article

**Record Number:** 83

**Author:** Daugherty, Charles H.; Hitchmough, Rodney A.; Patterson, Geoff B.

**Year:** 1993

**Title:** A taxonomic review of New Zealand herpetofauna - new data challenge some old ideas

**Journal:** New Zealand Journal of Zoology

**Volume:** 20

**Pages:** 128

**Label:** 83

**Keywords:** taxonomy; Oligocene; evolution

**Abstract:** Abstracts of the Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at the Southland Museum, Invercargill, 27-29 November 1992.

This paper reviewed the taxonomy of NZ herpetofauna. Estimates of divergence dates within all indigenous herpetological genera are consistent with a model of restricted land area during an 'Oligocene drowning', recently proposed to explain avian evolution.

**Reference Type:** Journal Article

**Record Number:** 26

**Author:** Daugherty, Charles H.; Maxson, Linda R.; Bell, Ben D.

**Year:** 1982

**Title:** Phylogenetic relationships within the New Zealand frog genus *Leiopelma* - immunological evidence.

**Journal:** New Zealand Journal of Zoology

**Volume:** 9

**Pages:** 239-242

**Label:** 26

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma archeyi*; *Leiopelma hochstetteri*; evolution; albumin; *Leiopelma pakeka*; genetics

**Abstract:** Albumin evolution is examined within the genus *Leiopelma* using the quantitative immunological technique of micro-complement fixation (MC'F). The albumins of *L. archeyi* and *L. hamiltoni* are relatively similar to each other, yet both differ greatly from the albumin of *L. hochstetteri*. Using albumin as a molecular clock, it was estimated that *L. hochstetteri* diverged from the lineage leading to *L. archeyi* and *L. hamiltoni* during the Miocene, about 15 million years ago. The divergence of *L. archeyi* and *L. hamiltoni* appears to have been a Pliocene event (about three million years ago).

Blood was collected from 26 individuals representing three species including five different populations of *L. hochstetteri*. The details of collection are given in Daugherty *et al.* 1981 (ref # 27). *L. hamiltoni* were collected from Maud Island (therefore referring to *L. pakeka*).

**Reference Type:** Journal Article

**Record Number:** 57

**Author:** Daugherty, Charles H.; Patterson, Geoff B.; Hitchmough, Rodney A.

**Year:** 1994

**Title:** Taxonomic and conservation review of the New Zealand herpetofauna

**Journal:** New Zealand Journal of Zoology Special Issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 317-323

**Label:** 57

**Keywords:** conservation; taxonomy

**Abstract:** The extant New Zealand herpetofauna is examined and is considered to consist of at least 65 endemic species of terrestrial reptiles and amphibians, an increase of about 64% of the known fauna since 1980. The list includes four species of *Leiopelma* (pending the formal description of *L. pakeka* as a new species). *Leiopelma* is described as 'Rare = rare, threatened, or endangered' with *L. hamiltoni* and *L. pakeka* are 'Limited mainly to islands'.

**Reference Type:** Magazine Article

**Record Number:** 150

**Author:** Dawbin, W. H.

**Year:** 1950

**Title:** The Stephens Island frog

**Magazine:** The Illustrated London News

**Volume:** November 18, 1950

**Pages:** 830-831

**Label:** 150

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; ecology; history

**Abstract:** This article describes the habitat of *Leiopelma hamiltoni* (as *Liopelma*) on Stephens Island as well as the history of its discovery (given as 1917) and subsequent observations on the island. The research carried out by EM and NG Stephenson is also referred to and the general ecology of all three species of *Leiopelma* is discussed.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 112

**Author:** de Vos, C. M.

**Year:** 1938

**Title:** Studies on the Liopelmidae, No. 1. The zonal and sternal skeleton of the Liopelmidae (Anura).

**Journal:** Anatomischer Anzeiger

**Volume:** 87

**Pages:** 54-81

**Label:** 112

**Keywords:** physiology; history; *Leiopelma hochstetteri*

**Abstract:** This paper deals with the microscopical structure of the zonal and linea alba derivatives. A historical review is given of the literature to date dealing with the internal structure of *Leiopelma* (as *Liopelma*).

Microtomed series were made of adult specimens of *Leiopelma hochstetteri* supplied by Prof. de Villiers of the University of Stellenbosch. Another *Leiopelma* specimen was provided by Gilbert Archey, Auckland.

The chief features of interest emerging from the microscopical examination of the zonal and sternal skeleton of Liopelmatidae are listed.

At the time of publication, *L. archeyi* was as yet unnamed, and it is not clear whether this work refers to *L. hochstetteri* or *L. archeyi*.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 113

**Author:** de Vos, C. M.

**Year:** 1938

**Title:** Studies on the Liopelmidae, No. 2. The inscripational ribs of *Liopelma* and their bearing upon the problem of abdominal ribs in vertebrates

**Journal:** Anatomischer Anzeiger

**Volume:** 87

**Pages:** 82-101

**Label:** 113

**Keywords:** physiology;

**Abstract:** This paper provides a general discussion on the nomenclature relating to the skeletal elements situated in the abdominal musculature of vertebrates and the interpretation of their phylogenetic significance. These cartilages in *Leiopelma* (as *Liopelma*) are then described in detail.

At the time of publication, *L. archeyi* was as yet unnamed, and it is not clear whether this work refers to *L. hochstetteri* or *L. archeyi*.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Book

**Record Number:** 282

**Author:** Department of Conservation

**Year:** 2002

**Title:** The Penguin guide to New Zealand wildlife: native and introduced birds, mammals, reptiles and amphibians

**City:** Auckland

**Publisher:** Penguin Books (NZ) Ltd

**Number of Pages:** 128

**ISBN:** 0141006374

**Label:** 282

**Keywords:** identification; natural history

**Abstract:** This is an illustrated guide to New Zealand's larger land animals. A physical description is provided for each species of *Leiopelma*. Distributions are given as *L. archeyi* - high in the hills of the Coromandel Peninsula, between about 300 m and 1000 m and Whareorino Forest west of Te Kuiti; *L. hamiltoni* - Stephens Island; *L. hochstetteri* - north Auckland, Auckland, Waikato, Coromandel Peninsula, Great Barrier Island, some coastal areas of Bay of Plenty, and East Cape; *L. pakeka* - Maud Island and one transfer population on an island in the Marlborough Sounds.

**Notes:** Hardcopy includes the introduction and pages relevant to *Leiopelma* only.

**Reference Type:** Report



**Record Number:** 221  
**Author:** Dix, Judy  
**Year:** 1991  
**Title:** Discussion paper: threatened reptiles and amphibians in captivity  
**City:** Wellington  
**Institution:** Threatened Species Unit, Department of Conservation  
**Pages:** 43  
**Type:** Unpublished discussion paper  
**Label:** 221

**Keywords:** captivity; conservation; reproduction

**Abstract:** The aim of this discussion paper is to review past captive management programmes for threatened reptiles and amphibians and to stimulate discussion on future initiatives. The paper briefly set out the current state of knowledge of threatened reptiles and amphibians, their current status in the wild, whether recovery plans exist or are planned, current management and research, plus the current state of knowledge of captive breeding. Species accounts are given for all four species (*Leiopelma pakeka* is referred to as Maud Island *L. hamiltoni*). The population for *L. hamiltoni* on Stephens Island is given as approximately 100, with 10 animals originally collected from Stephens Island in 1978 and placed in captivity with Ben Bell, Victoria University of Wellington. Discussion on the captive management programme includes concern over the lower fertility of *L. hamiltoni* from Stephens Island than Maud Island stock in captivity and lower productivity, possibly as a consequence of lower deme size on Stephens Island after a genetic bottleneck.

**Notes:** Hardcopy includes introduction and relevant pages to *Leiopelma* only.

**Reference Type:** Thesis

**Record Number:** 260  
**Author:** Douglas, Lorna  
**Year:** 1997  
**Title:** Hochstetter's frog (*Leiopelma hochstetteri*): A study of its habitat in native and pine forests in the Brynderwyn Hills, Northland  
**City:** Whangarei  
**University:** Northland Polytechnic  
**Number of Pages:** 20  
**Thesis Type:** Diploma of Environmental Management  
**Label:** 260

**Keywords:** *Leiopelma hochstetteri*; Brynderwyn Hills; habitat; survey; forestry; vocalisations

**Abstract:** This study of *Leiopelma hochstetteri* was undertaken as a student research project as part of the Northland Polytechnic's Environmental Management Diploma programme.

*L. hochstetteri* has been identified as at risk from damage to its habitat, with populations in Northland being seen as particularly vulnerable. This study compared habitat parameters in native (control) streams with those of streams in a catchment within an established pine (*Pinus radiata*) forest owned by Carter Holt Harvey (CHH). The study area is located in the Waipu/Brynderwyn Hills.

The habitats of streams in the CHH catchment where no frogs were found were compared with those where frogs were found. The parameters studied included vegetation type, canopy density, localised frog sites, stream width etc.

The most obvious correlation was that where pines were close to the stream flow (ie < 10 m), no frogs were found. This may have as much to do with geography and past land-use history as with the pines themselves, although the effects of pine litter in the water ought to be considered.

It was noted that the severe floods experienced during the later part of this study had more of an impact (eg fallen trees, slips and silt) on the pine catchments than the native control catchments. It is thus recommended that future plantings of *P. radiata* be confined to at least 10 m from the stream of any known *L. hochstetteri* habitat, to minimise effects of silt and debris.

Other data collected were used to determine population structure. This data suggested a younger, establishment type population in the CHH streams. However, without broader knowledge of the populations from data collected in previous years, the differences may be only temporary and/or insignificant.

It is suggested that, notwithstanding the limitations of this study, the information gained will be useful baseline data for future more detailed study.

Some areas identified specifically for further study include biological monitoring of streams, the effects of pine litter in streams, and more detailed habitat parameters. The trial of artificial cover objects in this area, because of the possible shortage of suitable shelter sites for the frogs, is also briefly discussed.

One individual from this survey was heard to emit chirruping sounds (very like a sparrow). A total of 172 frogs were found in the survey, of which 87 were found in the control streams and 85 in CHH streams. Snout-vent length ranged from 13-43 mm. Size categories were: juveniles (< 18 mm) = 10%; subadults (18-24 mm) = 23%; adults (> 24 mm) = 67%.

**Notes:** Hardcopy is from an electronic source, some of the figures are absent.

**Reference Type:** Report

**Record Number:** 106

**Author:** Douglas, Lorna

**Year:** 2000

**Title:** A study of two populations of Hochstetter's frog (*Leiopelma hochstetteri*) in pine forests at Mahurangi, north Auckland

**City:** Auckland

**Institution:** Carter Holt Harvey Forests

**Pages:** 19 + apps

**Label:** 106

**Keywords:** *Leiopelma hochstetteri*; survey; Warkworth; forestry

**Abstract:** This study aimed to investigate population parameters and seasonal fluctuations of *Leiopelma hochstetteri*. The study took place in two streams, in pine forest in Carter Holt Harvey's Mahurangi forest, north of Warkworth. Surveying was undertaken twice in February 1999, then at monthly intervals until January 2000. A mean number of frogs found in both streams during four February surveys since 1997, showed large confidence intervals. These may reflect changes in the populations over this time, or have been caused by the

high degree of variability inherent within the established sampling method. Small and therefore very young juvenile frogs were found throughout the winter months. This suggests that the breeding season may be longer than previously thought, or it is possibly longer in the milder climate of Northland. This could have been an isolated event however, a reaction to warmer than average autumn and winter temperatures.

There was no correlation found in this study between numbers of frogs and rainfall over the previous seven days or month. However, significant correlations with numbers of frogs found and weather effects, such as relative humidity and calculated drought indices, were obtained only at Dome Stream. The number of frogs found at Reines Rd showed no significant correlation with any weather effects at all. This suggests that other factors may be influencing frog numbers in the stream at Reines Rd.

A visual estimate of snout-vent length was used to place individuals into one of three size classes, in accordance with previous monitoring studies carried out at these sites.

The mean number of frogs found in the four February surveys from 1997 to 1999 was  $7.5 \pm 5.9$  for Dome and  $14 \pm 4.2$  for Reines Rd.

**Notes:** Hardcopy incomplete

**Reference Type:** Report

**Record Number:** 159

**Author:** Douglas, Lorna

**Year:** 2001

**Title:** Survey of possible habitat areas for the translocation of Hochstetter's frog (*Leiopelma hochstetteri*): a report for the Karori Wildlife Sanctuary

**Pages:** 6

**Type:** Unpublished report from the Karori Wildlife Sanctuary

**Label:** 159

**Keywords:** *Leiopelma hochstetteri*; translocation; Karori Wildlife Sanctuary; habitat; survey

**Abstract:** This report outlines the results of a survey undertaken to identify habitat in the Karori Wildlife Sanctuary, Wellington that could be suitable for the translocation of *Leiopelma hochstetteri*. The survey was undertaken in January 2001, during a dry period when stream water levels would have been quite low.

Although the current distribution of *L. hochstetteri* is from Northland south to the King Country, subfossil remains have been found in the South Island. It is therefore possible that this species has inhabited this region in the past, although there has been no fossil evidence of this as yet.

Two main areas were identified as suitable habitat, the 'Turbine Catchment' and the 'Long Gully Catchment'.

The need for appropriate management plans, including visitors, is highlighted.

**Reference Type:** Thesis

**Record Number:** 229

**Author:** Eggers, Karen E.

**Year:** 1998

**Title:** Morphology, ecology and development of leiopelmatid frogs (*Leiopelma* spp.), in Whareorino forest, New Zealand

**Academic Department:** Ecology

**University:** Massey University

**Number of Pages:** 169 + appendices

**Thesis Type:** MSc.

**Label:** 229

**Keywords:** morphology; ecology; development; Whareorino; *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma markhami*; husbandry

**Abstract:** *Leiopelma archeyi*, *L. hochstetteri* and a previously unrecognised leiopelmatid frog, Type A, occurred sympatrically in a small area of Whareorino forest when this was intensively surveyed between June 1996 and July 1997. *L. archeyi* was found predominately along ridges. Large specimens were mostly under rocks whereas small ones were in grasses. This association was shown to be significant using canonical variate analysis. All *L. hochstetteri* were under rocks, logs or grasses and were associated with streams. Type A frogs were in small rock piles on ridges. Type A frogs were shown to be distinct from both *L. archeyi* and *L. hochstetteri* by canonical variate analysis. They could also be distinguished by morphological features. Overall they resemble *L. hochstetteri* but have less webbing between the toes, a distinct paratoid gland and a stouter body. These differences, together with their sympatry with *L. archeyi* and *L. hochstetteri*, indicate that the Type A frog is possibly a new species. It appears to be closest to the extinct *L. markhami*.

Two clutches of *L. archeyi* eggs were reared artificially at 11°C and 15°C. Ten hatched but one died 10 days later. The tails took 48-75 days to be absorbed. Parentage and temperature significantly affected the rate of tail reduction. Three individuals were successfully maintained in captivity for 18-24 months.

The gut contents of eight frogs indicated that they eat a wider range of invertebrates than previously recorded. Their diet includes, in order of frequency of occurrence, Acari, insect larvae, Collembola, Amphipoda, Coleoptera, Araneae and Diptera. Unusual items were two diplopods, one ant and one gastropod. Large frogs with teeth ate a larger proportion of sclerotized prey. Small frogs lacked teeth and ate mostly small soft bodied invertebrates. However, they also took a wider range of prey. Potential prey was sampled using pitfall traps. Examples of all of the prey were caught but too few frog guts were analysed to indicate any relationship between pitfall trap catches and frog diet.

Mean snout-vent lengths were: *L. archeyi* - 22.7 mm ± 0.63 (range = 9.6 to 37.6 mm, n=151); *L. hochstetteri* - 26.8 mm ± 1.08 (range = 9.1 to 40 mm, n = 27); Type A - 27.9 mm ± 1.03 (range = 11.1 to 39.5 mm, n = 28).

**Notes:** Hardcopy includes title page, list of contents, figures etc and abstract only.

**Reference Type:** Report

**Record Number:** 232

**Author:** Eggers, Karen E.

**Year:** 1998

**Title:** Predation by ground dwelling spiders on *Leiopelma*

**Pages:** 11

**Type:** Unpublished report for the Frog Recovery Group, Department of Conservation

**Label:** 232

**Keywords:** predation; Stephens Island; *Leiopelma hamiltoni*; *Leiopelma archeyi*

**Abstract:** This investigation was to test the response of ground dwelling spiders to frogs. A predator-proof fence was erected to prevent access by tuatara to the frog bank, habitat of *Leiopelma hamiltoni*, on Stephens Island. Large numbers of ground dwelling spiders now occur in the frog bank, the impact of which on *L. hamiltoni* was unknown. Small individuals (< 14.0 mm snout vent length) from two substitute frog species (*L. archeyi* and *Litoria ewingi*) were given to spiders as potential prey items. The response of the spider to the frog, and the frog to the spider was gauged according to response criteria over a 15-minute period. No spider showed any 'predatory' response to either species of frog. Therefore, young *L. hamiltoni* are probably not under direct effect from predation by large ground dwelling spiders. However, ground dwelling spiders may pose an indirect threat through occupation of key habitat sites, by predation upon unguarded egg masses or by competing with *L. hamiltoni* for food resources. Recommendations for future management are made.

**Reference Type:** Book Section

**Record Number:** 278

**Author:** Eggers, Karen E.; Stringer, I. A. N.; Fordham, R. A.

**Year:** 1997

**Title:** Is habitat selection related to morphology in ancient New Zealand frogs?

**Editor:** Rocek, Zbynek; Hart, Scott

**Book Title:** Herpetology '97: abstracts of the Third World Congress of Herpetology 2-10 August 1997 Prague, Czech Republic

**Pages:** 248

**Label:** 278

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; habitat; morphology

**Abstract:** This is an abstract from a presentation made at the Third World Herpetology Congress held in Prague, Czech Republic in 1997.

In Whareorino forest, remnant populations of two species, the terrestrial *Leiopelma archeyi* and the semi-aquatic frog *L. hochstetteri*, occur sympatrically. Surveys of habitats throughout Whareorino forest were conducted to show displayed habitat preference by individuals of both species. A range of body measurements were also taken to allow correlation of body morphometrics with the habitat selected. Multi-variate data analysis enabled the species to be grouped according to habitat preference. It was found that separation into groups is size-related in *L. archeyi*. Small individuals (< 20 mm) are found in grass habitat while large individuals (> 20 mm) are found under rocks. In *L. hochstetteri* separation into groups is based on morphology. Each group is associated with a different habitat. Ecotypic divergence in *L. hochstetteri* has occurred.

**Notes:** This abstract was a late entry to the conference - therefore it has not been edited.

**Reference Type:** Magazine Article

**Record Number:** 287

**Author:** End, Simone

**Year:** 1998

**Title:** Frogs of New Zealand

**Magazine:** New Zealand Geographic

**Volume:** 38

**Pages:** 1

**Date:** April-June 1998

**Label:** 287

**Keywords:** identification; ecology

**Abstract:** This is a poster produced in the April-June 1998 issue of the New Zealand Geographic magazine. It describes all four native species of frog, as well as the three introduced species. A brief description and drawing of each species is included. A related article by Warren Judd (c.f. ref # 214) appears in the same issue.

**Reference Type:** Thesis

**Record Number:** 133

**Author:** Ensor, D. R.

**Year:** 1976

**Title:** The carotid labyrinth in the primitive New Zealand frog, *Leiopelma hochstetteri*

**University:** University of Auckland

**Number of Pages:** 366 + figs

**Thesis Type:** PhD.

**Label:** 133

**Keywords:** *Leiopelma hochstetteri*; physiology

**Abstract:** This thesis used *Leiopelma hochstetteri* because of its primitive status, which might render some characteristics of the carotid labyrinth more clearly evident. The 'gross' anatomy of the tiny (0.5 mm diameter) organ was examined by wax-plate reconstruction and by scanning electron microscopy. The cytology of the capillary plexus tissue was studied by light and transmission electron microscopy using conventionally prepared sections. The higher resolution of the electron microscope permitted a more exact study of the innervation of the organ. Neurophysiological experiments were undertaken, but the very short (0.6 mm) and fine carotid nerve proved intractable. A study of the *in vivo* flow of blood through the labyrinth, resolving the pulsatile variations in flow caused by the action of the heart, was first made by visual observation and then using instrumental methods.

The tissues of the capillary plexus contain the same characteristic associations of Type I and Type II cells, together with nerve fibres, as are described in the carotid bodies of the Mammalia, and in the carotid labyrinths of other Amphibia. These associations, which are believed to represent chemoreceptor units, apparently have efferent synaptic complexes against the membrane of the Type I cell. The dense-cored vesicles within the Type I cells fall within the size range described for the other species. Similar characteristic cell groups,

complete with nerve supplies, were also observed in the surrounding connective tissue. The carotid nerve contains about 15 myelinated and up to 150 fine (0.15-0.5 $\mu$ m) unmyelinated axons and leaves the sheath of the lingual ramus of the glossopharyngeal nerve through a ganglion of 25-40 cells. It supplies the labyrinth alone.

The capillary plexus tissue, in which the characteristic cells are dispersed, is a densely cellular connective tissue and provides a network of random channels for the throughflow of blood. Melanocytes, collagen and elastic fibres, and nerve fibres are embedded in the matrix. The organ is mechanically passive since the only smooth muscle is found in a thin layer in the proximal main chamber.

Blood flow measurements utilised the moving erythrocytes as tracers. Their movement, visible through the semi-transparent arterial walls, was recorded with a television camera and later analysed with a microkymograph. Simultaneous recording of the ECG-related velocity measurements to the phase of the cardiac cycle. Flow in the common carotid was markedly pulsatile, entering the labyrinth in bursts and causing it to swell, while flow in the internal carotid was steady. Flow in the external carotid reversed for a large part of the cycle, returning to the roots of that vessel as the entire organ was distended.

The organ owes its pulse-filtering behaviour to the resistive effect of the capillary plexus, combined with a reservoir-like storage due to the compliance of the fibroelastic capsule. This function concurs with Ask-Upmark's observation that all mammals have some pulse-filtering device interposed in their cranial arterial supply. This is proposed to be the main function of the labyrinth, accounting adequately for its complex vascular structure. Its undoubted chemoreceptor function clearly can coexist happily with this vascular one.

**Notes:** Hardcopy includes abstract

This thesis is in two volumes.

**Reference Type:** Journal Article

**Record Number:** 257

**Author:** Fawcett, James D.; Smith, Hobart M.

**Year:** 1971

**Title:** *Liopelmatina* Mivart, 1869 (Amphibia, Salientia): proposed emendation under the plenary powers to *Leiopelmatidae*. Z.N.(S.) 1936

**Journal:** The Bulletin of Zoological Nomenclature

**Volume:** 28

**Pages:** 50-52

**Label:** 257

**Keywords:** nomenclature; taxonomy

**Abstract:** This is the official application to ask the International Commission on Zoological Nomenclature to place the generic name *Leiopelma* Fitzinger, 1861, on the Official List of Generic Names in Zoology.

This is to amend the spelling of *Liopelma* as used by Günther in 1868 (ref # 111) and various spellings of the family-group name. The relevant supporting facts are presented.

**Reference Type:** Journal Article

**Record Number:** 17

**Author:** Fitzinger, L. J.  
**Year:** 1880  
**Title:** On the New Zealand frog. Translated from the Zoology of the Voyage of the 'Novara', by Professor Hutton  
**Journal:** Transactions and Proceedings of the New Zealand Institute  
**Volume:** 12  
**Pages:** 250-251  
**Label:** 17  
**Keywords:** *Leiopelma hochstetteri*; Coromandel; morphology; taxonomy  
**Abstract:** This article formally describes the morphology of *Leiopelma hochstetteri* from the Coromandel, putting the species into the family Bombinatoridae.  
**Reference Type:** Book Section  
**Record Number:** 270  
**Author:** Fleming, C. A.  
**Year:** 1975  
**Title:** The geological history of New Zealand and its biota  
**Editor:** Kuschel, G.  
**Book Title:** Biogeography and Ecology in New Zealand  
**City:** The Hague  
**Publisher:** Dr. W. Junk B.V. Publishers  
**Pages:** 1-86  
**Label:** 270  
**Keywords:** biogeography  
**Abstract:** This chapter describes the geological history of New Zealand. *Leiopelma* is described as having an Upper Jurassic relative classed in the same family in the primitive anuran suborder Archaeobatrachia. Dispersal of archaic invertebrates with limited abilities to cross the sea is considered likely to have occurred in the late Jurassic or early Cretaceous, before the disruption of Gondwanaland had proceeded to any considerable degree.  
**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.  
**Reference Type:** Journal Article  
**Record Number:** 269  
**Author:** Ford, Linda S.; Cannatella, David C.  
**Year:** 1993  
**Title:** The major clades of frogs  
**Journal:** Herpetological Monographs  
**Volume:** 7  
**Pages:** 94-117  
**Label:** 269  
**Keywords:** taxonomy; phylogeny  
**Abstract:** The relationships among the major lineages of frogs are summarised and an unranked phylogenetic taxonomy of Anura is proposed. The names of taxa are defined according to phylogenetic principles. Several currently recognised taxa, such as 'Archaeobatrachia', 'Discoglossoidae', 'Leiopelmatidae', and 'Discoglossidae' are paraphyletic, and the names are abandoned or redefined such that the associated taxa are monophyletic. Node-based names are pro-



posed for several unnamed but previously recognised taxa: *Leiopelmatanura*, *Bombinanura*, *Discoglossanura*, and *Pipanura*. The new node-based name of *Leiopelmatanura* is applied to the node that is the most recent ancestor of living *Leiopelma* + *Bombinanura*.

**Reference Type:** Book

**Record Number:** 284

**Author:** Forster, R. R.; Forster, L. M.

**Year:** 1980

**Title:** Small land animals of New Zealand

**City:** Dunedin

**Publisher:** John McIndoe Limited

**Number of Pages:** 175

**ISBN:** 0908565577

**Original Publication:** 1970

**Reprint Edition:** Third

**Label:** 284

**Keywords:** natural history

**Abstract:** This is a natural history publication on New Zealand wildlife, both endemic and introduced. A basic description of the ecology and distribution for *Leiopelma* is given.

**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 110

**Author:** Gao, Ke-Qin; Wang, Yuan

**Year:** 2001

**Title:** Mesozoic anurans from Liaoning Province, China, and phylogenetic relationships of archaeobatrachian anuran clades

**Journal:** Journal of Vertebrate Paleontology

**Volume:** 21

**Issue:** 3

**Pages:** 460-476

**Label:** 110

**Keywords:** phylogeny

**Abstract:** This paper describes two Jurassic-Cretaceous anurans based on well-preserved specimens from the lower part of the Yixian Formation, western Liaoning Province, northeastern China. Phylogenetic relationships of the major archaeobatrachian anuran clades are investigated with incorporation into the analysis of selected (well-established) early fossil taxa. Contradicting the widely accepted *Leiopelmatidae*-*Discoglossidae* sister group relationship, new evidence places the *Leiopelmatidae* as the most basal extant familial group and the sister group to other archaeobatrachian clades. The relationships and classification of the major archaic anuran clades are discussed, based on the phylogenetic results of this study. The monophyly of *Leiopelma* is supported by as many as 11 synapomorphies.

**Reference Type:** Report

**Record Number:** 194

**Author:** Gemmell, Neil J.; Waldman, Bruce  
**Year:** 2001  
**Title:** Research report - *Leiopelma* genetics  
**City:** Christchurch  
**Institution:** Department of Zoology, University of Canterbury  
**Pages:** 5  
**Type:** Unpublished report  
**Label:** 194

**Keywords:** genetics; conservation; cytochrome b; priority rankings  
**Abstract:** This report deals with molecular research carried out on *Leiopelma* at the University of Canterbury. In contrast to another study, the authors found that the variation in Cytochrome b between *L. hamiltoni* and *L. pakeka* was insufficient to warrant their classification as separate species, although they may be sufficiently distinct to warrant classification as evolutionary significant units. Should *L. pakeka* be classed as a separate species, the authors believe that the significant Cytochrome b variation found in at least eight *L. hochstetteri* populations (3-5% difference) should warrant them the same level of protection. A revised population priority list for conservation of this species is included. Suggestions for future work are made.

**Reference Type:** Book

**Record Number:** 45  
**Author:** Gill, Brian  
**Year:** 1986  
**Title:** Collins handguide to the frogs and reptiles of New Zealand  
**City:** Auckland  
**Publisher:** William Collins Publishers Ltd  
**Number of Pages:** 112  
**ISBN:** 0002175703  
**Label:** 45

**Keywords:** identification  
**Abstract:** This is a handguide to enable identification of New Zealand's frogs, including natives. Gives description, size, distribution, habitat, habits and notes on each species. Distribution for *Leiopelma hamiltoni* is given as Maud and Stephens Islands.

**Reference Type:** Book

**Record Number:** 44  
**Author:** Gill, Brian; Whitaker, Tony  
**Year:** 1996  
**Title:** New Zealand frogs & reptiles  
**City:** Auckland  
**Publisher:** David Bateman Limited  
**Number of Pages:** 112  
**ISBN:** 1869532643  
**Label:** 44

**Keywords:** identification  
**Abstract:** This is a fieldguide to enable identification of New Zealand's frogs,

including natives. Gives description, size, distribution, habitat, habits and notes on each species. Distribution for *Leiopelma hamiltoni* is given as Maud and Stephens Islands.

**Notes:** Tony Whitaker also publishes under A. H. Whitaker.

**Reference Type:** Journal Article

**Record Number:** 76

**Author:** Green, David M.

**Year:** 1988

**Title:** Antipredator behaviour and skin glands in the New Zealand native frogs, genus *Leiopelma*

**Journal:** New Zealand Journal of Zoology

**Volume:** 15

**Issue:** 1

**Pages:** 39-45

**Label:** 76

**Keywords:** antipredator behaviour; *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma pakeka*; *Leiopelma hamiltoni*; vocalisations

**Abstract:** This paper examines the antipredator behaviours of *Leiopelma* that are considered to be characteristic. *L. hochstetteri*, *L. archeyi* and *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*) all utter squeaks or chirps when annoyed. The acoustic structure of the vocalisations varied between individuals within a species. Vocalisations probably serve no function for intraspecific communication. Under duress, the terrestrial species, *L. pakeka* and *L. archeyi* both assumed a stiff-legged stance while rearing up, extended the legs, raised the body, and butted the head. *L. hochstetteri* did not assume so rigid a head-butting stance as it rarely raised its body or extended its legs. This species was more apt to try to escape. These behavioural differences correlated with differential distributions of defensive granular glands in the skin. The glands were concentrated into discrete dorsal patches arranged in six longitudinal rows in *L. pakeka* and *L. archeyi*. The anterior end of the middle row terminates in what has been termed a parotoid gland. In *L. hochstetteri*, the granular glands were distributed diffusely over the sides and belly and were sparse or absent from the dorsum. Head-butting and the presence of dorsal gland concentrations in *L. pakeka* and *L. archeyi* are correlated components of an antipredator defense adapted for terrestrial life.

Collections were: 50 *L. hochstetteri* from six localities on the North Island, five *L. archeyi* from Tokatea Ridge and five *L. pakeka* from Maud Island. The frogs were transported live to Montreal, Canada. All specimens are now deposited at the National Museum of Natural Sciences, Ottawa.

**Reference Type:** Journal Article

**Record Number:** 80

**Author:** Green, David M.

**Year:** 1988

**Title:** Cytogenetics of the endemic New Zealand frog, *Leiopelma hochstetteri*: extraordinary supernumerary chromosome variation and a unique sex-chromosome system

**Journal:** Chromosoma

**Volume:** 97

**Pages:** 55-70

**Label:** 80

**Keywords:** *Leiopelma hochstetteri*; chromosome; genetics

**Abstract:** Cytogenetic data from six populations demonstrated unusual supernumerary chromosome variation in *Leiopelma hochstetteri*. Frogs from the Coromandel Peninsula averaged very high numbers of supernumerary chromosomes while individuals from other populations outside of the Coromandel region rarely had more than one distinctive supernumerary chromosome found only in females. The maximum number observed was 16 supernumeraries, present in one individual from Mt Moehau. Supernumeraries showed meiotic instability as they failed to pair during prophase I in spermatocytes. In lampbrush preparations from oocytes, supernumeraries appeared as univalents or as highly unusual stellate aggregations consisting of up to seven chromosomes joined at their telomeres. Lateral loops on lampbrush supernumeraries indicated transcriptional activity. Contrary to a previous hypothesis, high supernumerary chromosome numbers in *L. hochstetteri* were not correlated with meiotic abnormalities. Neither were supernumerary chromosomes correlated with variations in heterochromatin distribution in the regular chromosomes. Rather, heterochromatin distribution was shown to vary geographically between populations. Sex determination in *L. hochstetteri* was found to be through a supernumerary, univalent W chromosome. Females in all populations invariably had one distinctive supernumerary chromosome not present in males. This chromosome could be distinguished from other supernumerary chromosomes by distinctive C-banding patterns and larger size. The W chromosome has undergone more rapid evolutionary change than the autosomes. Both telocentric and metacentric iso-chromosome forms were found in most populations. Heterochromatin distribution on the W chromosome varied between populations, from very little heterochromatin restricted to the centromere in Coromandel populations to an almost completely heterochromatic W chromosome among frogs from the East Cape region. In lampbrush preparations, the W chromosome was morphologically distinct from other supernumeraries. Loss of a Z chromosome leading to a univalent sex-determining W chromosome is difficult to explain through prevailing theories of sex-chromosome differentiation. The 0W female/00 male sex-determination system of *L. hochstetteri* appears to be unique among animals.

This paper is based upon the results obtained from 49 specimens collected from six localities.

**Reference Type:** Journal Article

**Record Number:** 82

**Author:** Green, David M.

**Year:** 1988

**Title:** Heteromorphic sex chromosomes in the rare and primitive frog *Leiopelma hamiltoni* from New Zealand

**Journal:** Journal of Heredity

**Volume:** 79

**Pages:** 165-169

**Label:** 82

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Maud Island; chromosome; genetics

**Abstract:** This paper describes the ZW female/ZZ male chromosomal system of sex determination in *Leiopelma hamiltoni* from Maud Island (therefore referring to *L. pakeka*). The karyotype has  $2n = 18$  chromosomes, all of which are metacentric or submetacentric, except for the smallest pair, which are telocentric. The distribution of constitutive heterochromatin as detected by C-banding allowed all but two pairs of chromosomes to be readily identified. Two C-band heteromorphisms were observed. In all individuals of both sexes, a band was present on the long arm of only one of the homologous chromosomes no. 3. The other heteromorphism was sex-specific. The centromeric region of one of the telocentric chromosomes was enlarged and highly heterochromatic in females only and was interpreted as denoting the W chromosome. Female heterogamety may be a primitive condition in frogs.

Three males and two females were collected from Maud Island and transported live to Montreal, Canada where they were maintained with no ill effects at 50C for up to six weeks.

**Reference Type:** Book Section

**Record Number:** 170

**Author:** Green, David M.

**Year:** 1991

**Title:** Supernumerary chromosomes in amphibians

**Editor:** Green, David M.; Sessions, Stanley K.

**Book Title:** Amphibian Cytogenetics and Evolution

**City:** San Diego

**Publisher:** Academic Press, Inc.

**Pages:** 333-357

**Label:** 170

**Keywords:** chromosome; genetics; *Leiopelma hochstetteri*

**Abstract:** This section in this book details the supernumerary chromosomes of *Leiopelma hochstetteri*, with references to past relevant research. Supernumerary, or B, chromosomes are not required for normal development. They vary greatly in size, extent of heterochromatinisation, numbers and influence. They have been found in over a dozen species of amphibians and *L. hochstetteri* has the greatest variation. A female-specific chromosome in *L. hochstetteri* is a supernumerary, by definition, because it is not found in all populations nor is it strictly necessary for normal development.

Each supernumerary chromosome is the product of a unique originating event distinct from mechanisms involved in its subsequent evolution within a species governed by a ratchet mechanism like that applicable to the degeneration of Y or W sex chromosomes.

**Notes:** The hardcopy just contains the sections relevant to *Leiopelma* plus a table of families and genera of anuran amphibian species with different chromo-

some numbers.

**Reference Type:** Journal Article

**Record Number:** 60

**Author:** Green, David M.

**Year:** 1994

**Title:** Genetic and cytogenetic diversity in Hochstetter's frog, *Leiopelma hochstetteri*, and its importance for conservation management

**Journal:** New Zealand Journal of Zoology Special Issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 417-424

**Label:** 60

**Keywords:** genetics; chromosome; conservation; *Leiopelma hochstetteri*

**Abstract:** This paper describes *Leiopelma hochstetteri* as a genetically and geographically discontinuous species. Every population may be an important component of total biogeographic diversity, since each isolate may represent an emergent historical entity. Variation in supernumerary chromosome number between populations and, particularly, the morphology of the sex chromosome, in conjunction with isozyme evidence, enable the identification of important subdivisions within *L. hochstetteri*. The population on Great Barrier Island is cytogenetically distinct since its members have no univalent, sex-specific chromosome such as is present in all females from the North Island. Frogs from Mt Ranginui in the Rangitoto Range are the most chromosomally and biochemically distinctive of the North Island populations. Identification of geographic subdivisions in *L. hochstetteri* indicates that conservation management practice should focus upon populations rather than the species as a whole.

Studies were carried out using collections of 96 specimens (between 1987 and 1989) from 11 localities (Waipu, Warkworth, Waitakere Mts, Hunua Mts, Mt. Ranginui, Mt. Moehau, Tokatea Ridge, Tapu, Golden Cross, Whanarua and Toatoa) on the North Island and one site on Great Barrier Island. An additional 25 specimens were collected at Golden Cross in 1991. Frogs were taken live to the Redpath Museum, McGill University, Canada, and all have been catalogued in the Canadian Museum of Nature.

A table of genetic distances between samples from different populations, based on 41 isozyme loci is included.

**Reference Type:** Book Section

**Record Number:** 175

**Author:** Green, David M.

**Year:** 1994

**Title:** Genetic partitioning in Hochstetter's frog, *Leiopelma hochstetteri*: identifying the significant units of conservation

**Editor:** Davies, Margaret; Norris, Rachel M.

**Book Title:** Abstracts of the Second World Congress of Herpetology

**City:** Adelaide

**Publisher:** University of Adelaide

**Pages:** 103

**Label:** 175

**Keywords:** *Leiopelma hochstetteri*; genetics; conservation

**Abstract:** This is an abstract of a paper presented at the Second World Congress of Herpetology held at the University of Adelaide, South Australia, December 29 1993 to January 6 1994.

*Leiopelma hochstetteri* exists in numerous, isolated populations of variable size and extent. Although the species, as a whole, is not considered endangered, some of these isolates may be threatened or vulnerable. In a genetically and geographically discontinuous species like *L. hochstetteri*, every population may be an important component in biogeographic diversity since each isolate may represent an emergent historical entity. In *L. hochstetteri*, cytogenetic diversity is extreme even though morphological divergence, biochemical divergence estimated using isozymes, and DNA sequence divergence are all small or trivial. Supernumerary chromosomes are variable within and between populations. The population on Great Barrier Island is cytologically unique within *L. hochstetteri* since the females do not possess the univalent, sex-specific chromosome found in all females from the North Island. This may not yet represent species-level divergence since no difference is discernible among males. Nevertheless, identification of cytogenetically distinct races indicates that conservation measures regarding *L. hochstetteri* might best be framed population by population rather than at the species level.

**Notes:** A hardcopy handout is also attached.

**Reference Type:** Journal Article

**Record Number:** 6

**Author:** Green, David M.

**Year:** 2002

**Title:** Chromosome polymorphism in Archey's Frog (*Leiopelma archeyi*) from New Zealand.

**Journal:** Copeia

**Volume:** 2002

**Issue:** 1

**Pages:** 204-207

**Label:** 6

**Keywords:** *Leiopelma archeyi*; chromosome; Whareorino; Coromandel; *Leiopelma hochstetteri*; genetics

**Abstract:** This paper reports on a W chromosome from *Leiopelma archeyi*. Members of the genus *Leiopelma* are the most primitive frogs in which a sex chromosome system has been determined. *L. pakeka* and *L. hochstetteri* have female heterogamety of the ZW/ZZ and OW/OO types, respectively. Despite its great karyotypic similarity to *L. pakeka*, a third species, *Leiopelma archeyi*, has not been known previously to possess heteromorphic sex chromosomes. Herein a highly differentiated putative W chromosome characterised by the addition of a completely heterochromatic short arm is reported from a female *L. archeyi* from the Whareorino forest.

Frogs were collected from Whareorino and Mt. Moehau, Coromandel in 1994.

Specimens are deposited in the Redpath Museum, McGill University, Canada.

**Reference Type:** Journal Article

**Record Number:** 231

**Author:** Green, David M.; Cannatella, D. C.

**Year:** 1993

**Title:** Phylogenetic significance of the amphicoelous frogs, Ascaphidae and Leiopelmatidae

**Journal:** Ethology Ecology & Evolution

**Volume:** 5

**Pages:** 233-245

**Label:** 231

**Keywords:** phylogeny; taxonomy

**Abstract:** This paper discusses the most morphologically primitive of all frogs, those with amphicoelous vertebrae. These frogs are *Ascaphus* from North America, *Leiopelma* from New Zealand, and the Jurassic fossils *Notobatrachus* and *Vieraella* from South America. Previous consideration of the evolutionary importance of these frogs has been almost exclusively concerned with their primitive characteristics relative to other frogs. Yet virtually no shared derived characters have been found among the genera. Genetic and cytogenetic divergence is extremely high. Present biochemical estimates of genetic divergence are at or beyond the limits of many of the techniques used. Although the living genera are very plesiomorphic, *Ascaphus* has such unique characteristics as an intromittent organ, high chromosome number ( $2n = 46$ ), and oocyte gene amplification via eight endomitotic germinal vesicles. Derived features of extant *Leiopelma* include inscriptional ribs, a reduced or absent tadpole stage, and low chromosome numbers ( $2n = 18$  or  $2n = 22$  male/23 female). *Notobatrachus* and *Vieraella* may be difficult to assign to either Ascaphidae or Leiopelmatidae.

**Reference Type:** Journal Article

**Record Number:** 172

**Author:** Green, David M.; Daugherty, Charles H.; Bogart, James P.

**Year:** 1980

**Title:** Karyology and systematic relationships of the tailed frog *Ascaphus truei*

**Journal:** Herpetologica

**Volume:** 36

**Issue:** 4

**Pages:** 346-252

**Label:** 172

**Keywords:** genetics; taxonomy; karyotype; *Ascaphus*

**Abstract:** This paper supports placing *Ascaphus* and *Leiopelma* in separate families on the basis of great karyotypic dissimilarity, long geographic isolation, unique life histories, and scarcity of shared derived characters.

The karyotype of *Ascaphus* is described and its systematic relationship with *Leiopelma* is discussed.

**Reference Type:** Journal Article

**Record Number:** 36

**Author:** Green, David M.; Kezer, James; Nussbaum, Ronald A.



**Year:** 1984

**Title:** Triploidy in Hochstetter's frog, *Leiopelma hochstetteri*, from New Zealand

**Journal:** New Zealand Journal of Zoology

**Volume:** 11

**Issue:** 4

**Pages:** 457-460

**Label:** 36

**Keywords:** *Leiopelma hochstetteri*; chromosome; polyploidy; karyotype; genetics; Warkworth

**Abstract:** Autotriploidy is described in a female *Leiopelma hochstetteri*. This frog was found to have  $3n=33$  chromosomes plus two supernumerary chromosomes. All the chromosomes in the karyotype of this species contained C-band heterochromatin at the centromeres. A prominent C-band was found to be associated with a secondary constriction on chromosome no. 7. The supernumerary chromosomes in this species appear to be mitotically stable and contain C-band heterochromatin at the centromeres. From the limited data presently available, the triploid individual may have resulted from fertilisation of a diploid egg produced when the second meiotic division had been suppressed.

Five females and one male *L. hochstetteri* were collected in 1976 from Dome Valley, Warkworth. The specimens have been deposited at the Museum of Zoology, University of Michigan, (UMMZ no. 146849-54).

**Reference Type:** Journal Article

**Record Number:** 81

**Author:** Green, David M.; Kezer, James; Nussbaum, Ronald A.

**Year:** 1987

**Title:** Supernumerary chromosome variation and heterochromatin distribution in the endemic New Zealand frog *Leiopelma hochstetteri*

**Journal:** Chromosoma

**Volume:** 95

**Pages:** 339-344

**Label:** 81

**Keywords:** *Leiopelma hochstetteri*; genetics; chromosome; Coromandel; karyotype

**Abstract:** This paper describes specimens of *Leiopelma hochstetteri* from Tapu that were found to have six, nine or 10 supernumerary chromosomes in their karyotypes. In comparison with previously published data, these results further indicate probable geographic variation in supernumerary chromosome number between populations. Increased numbers of supernumeraries in these frogs is correlated with apparent decrease of centromeric heterochromatin in the five large metacentric chromosomes of the karyotype, as detected by C-banding. Meiosis was abnormal in a male with a high number of supernumeraries. In lampbrush preparations from a single female with one supernumerary univalent, the supernumerary often had a denser, beaded appearance in comparison with the regular bivalents. Evidence is consistent with the notion that these supernumerary chromosomes may have arisen from centromeric fragments.

Four frogs collected on the west side of the Tapu-Coroglen Saddle on the Coro-

mandel Range in 1983 were examined. Chromosomes from one male and one female, deposited at the California Academy of Sciences and two males deposited at the Museum of Zoology, University of Michigan were also obtained. Lampbrush chromosome preparations were also obtained from two females from Dome Valley, Warkworth collected in 1976 by Joan Robb.

**Reference Type:** Journal Article

**Record Number:** 182

**Author:** Green, David M.; Sharbel, Timothy F.

**Year:** 1988

**Title:** Comparative cytogenetics of the primitive frog, *Leiopelma archeyi* (Anura, Leiopelmatidae)

**Journal:** Cytogenetics and Cell Genetics

**Volume:** 47

**Issue:** 4

**Pages:** 212-216

**Label:** 182

**Keywords:** *Leiopelma archeyi*; genetics; chromosome

**Abstract:** This paper describes the chromosomes of *Leiopelma archeyi*. Chromosomally, *L. archeyi* is extremely similar to *L. hamiltoni* (studies referred to in this paper are on frogs from Maud Island and are therefore referring to *L. pakeka*), a closely related species. Both have  $2n = 18$  chromosomes. Contrary to a previous report (Stephenson *et al*, 1972 ref # 158), the nucleolar organiser region and secondary constriction in *L. archeyi* are near the telomere of the smallest, telecentric chromosome, as in *L. pakeka*. The arm-length ratios of all chromosomes are virtually identical in the two species, except for chromosomes 2 and 3, which show evidence of a past translocation. However, *L. archeyi* has much less heterochromatin than does *L. pakeka*, and, unlike *L. pakeka*, heteromorphic sex chromosomes are not discernable. These frogs demonstrate two stages in the evolution of sex-chromosome differentiation related to the extent of heterochromatin accumulation.

Five specimens of *L. archeyi* (four females and one male) were collected from Tokatea Ridge, Coromandel in 1987 and transported live to Montreal, Canada for study. All are now deposited in the National Museum of Natural Sciences, Ottawa, Canada.

**Reference Type:** Journal Article

**Record Number:** 117

**Author:** Green, David M.; Sharbel, Timothy F.; Hitchmough, Rodney A.; Daugherty, Charles H.

**Year:** 1989

**Title:** Genetic variation in the genus *Leiopelma* and relationships to other primitive frogs

**Journal:** Zeitschrift für Zoologische Systematik und Evolutionsforschung

**Volume:** 27

**Pages:** 65-79

**Label:** 117

**Keywords:** genetics; taxonomy; allozyme

**Abstract:** Allozyme variation was studied in *Leiopelma*. *L. hamiltoni* (specimens were collected from Maud Island, therefore this study refers to *L. pakeka*) and *L. archeyi* are shown to be closely related to each other although *L. hamiltoni* is slightly more divergent relative to *L. hochstetteri*. This parallels previous cytogenetic data. The rarity and insularity of *L. hamiltoni* enables the calculation of a mutation rate based on genetic variance and population size. A mutation rate per generation of  $2.7 \times 10^{-6}$  is sufficient to account for the observed levels of variation. Six populations of *L. hochstetteri* show a pattern of genetic divergence that also closely parallels previously detected cytogenetic variation. *L. hochstetteri* is genetically distant from its congeneric species while all species of *Leiopelma* are at an extreme genetic distance from *Ascaphus truei*, the only other living amphicoelous frog. At the limits of resolution of the allozyme technique, *Ascaphus* clusters with the more morphologically advanced frogs, *Discoglossus* and *Bombina*, rather than with *Leiopelma*. Taken with other evidence, this supports recognition of two families, Leiopelmatidae and Ascaphidae, with *Leiopelma* the probable sister group of all other frogs.

Fifty *L. hochstetteri* were collected from six populations on the North Island (Big Omaha near Warkworth (10 specimens); Managatangi Dam in the Hunua Mountains (five specimens); Mt Moehau (five specimens); Tokatea Ridge (10 specimens) and the ridge east of Tapu (10 specimens), Coromandel; Toatoa, East Cape (10 specimens)). Five *L. archeyi* were collected from Tokatea Ridge. Five *L. hamiltoni* were collected from Maud Island (therefore *L. pakeka*). All collections were made in January 1987.

**Reference Type:** Journal Article

**Record Number:** 22

**Author:** Green, David M.; Tessier, Catherine

**Year:** 1990

**Title:** Distribution and abundance of Hochstetter's frog, *Leiopelma hochstetteri*

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 20

**Issue:** 3

**Pages:** 261-268

**Label:** 22

**Keywords:** *Leiopelma hochstetteri*; distribution; habitat; Coromandel; Waitakere; Great Barrier Island

**Abstract:** This paper results from observations made whilst collecting *Leiopelma hochstetteri* for various chromosomal, behavioural and biochemical variation studies. The relative abundance of Hochstetter's frog, *L. hochstetteri*, in streams throughout its range was surveyed in January 1989. Eighteen streams in 12 localities were populated by frogs. Streams either had plenty of frogs in them or they had none. Population densities of up to 50 frogs/100m were estimated. The small size of the frogs, their crypsis, and their habit of hiding under stones may make them difficult to find, but the frogs seem to be more abundant than commonly believed. Streams in the central Coromandel Range at Tokatea Ridge and in the southern Waitakere Range were the most densely populated sites. Watercourses that were sited or lacked forest cover were devoid of frogs. Frogs

ranged in size from 13 mm to 47 mm.

Fifty collections from six localities were made in 1987. Further collections were made in 1989 and 85 (measuring 20 mm to 47 mm snout-vent length) from 18 different streams were transported live to Montreal, Canada. Thirty (from Great Barrier, Tokatea Ridge and Toatoa) were kept in captivity for two months at 16°C and fed crickets. The authors observed that *L. hochstetteri* appeared to display some degree of site loyalty in the field and noted that in captivity, individuals could be found under the same rock every day. All frogs over 37 mm were female.

**Reference Type:** Journal Article

**Record Number:** 116

**Author:** Green, David M.; Zeyl, Clifford W.; Sharbel, Timothy F.

**Year:** 1993

**Title:** The evolution of hypervariable sex and supernumerary (B) chromosomes in the relict New Zealand frog, *Leiopelma hochstetteri*

**Journal:** Journal of Evolutionary Biology

**Volume:** 6

**Pages:** 417-441

**Label:** 116

**Keywords:** *Leiopelma hochstetteri*; chromosome; genetics; evolution

**Abstract:** Both hypervariable sex and supernumerary (B) chromosomes were investigated in *Leiopelma hochstetteri*, which is chromosomally polymorphic both within and between populations and has sufficiently elevated variation that different populations can be identified solely by their C-banded karyotypes. *L. hochstetteri* is further distinguished by the univalent, female-specific W-chromosome (0W/00 sex determination) uniquely possessed by these populations. This sex chromosome exhibited variation in morphology, size, and heterochromatin distribution, sufficient to resolve 11 different types, including isochromosomes. Five of the 12 populations examined also had supernumerary chromosomes that varied in number (up to 15 per individual) and morphology. Specific variations seen among the hypervariable chromosomes could have resulted from heterochromatinisation, chromosome fusions, loss-of-function mutations, deletions, and/or duplications. Frogs of the same species from Great Barrier Island, however, had neither supernumeraries nor the female-specific chromosome. The 0W/00 sex chromosome system must have been derived after the isolation of Great Barrier Island from North Island populations by raised sea levels between 14,000 and 8,000 years ago. Furthermore, biochemical divergence between populations is minor and therefore the chromosomal variation seen is comparatively recent in origin. The one characteristic common to all known hypervariable chromosomes is curtailment or lack of recombination. Their accelerated evolution therefore is possible via the mechanism of Muller's ratchet, either alone or in concert with other factors.

In January 1989, frogs were collected from eight localities on the North Island and one site on Great Barrier Island. All frogs were brought live to the Redpath Museum, McGill University, Canada. All have been catalogued in the Canadian Museum of Nature (previously, National Museum of Natural Sciences), Ottawa,

Canada. Chromosomes from 41 specimens were used for this study.

**Reference Type:** Report

**Record Number:** 256

**Author:** Greene, Brenda; McNaughton, Anna; Singh, Adrian

**Year:** 1995

**Title:** Hochstetter's frog (*Leiopelma hochstetteri*) survey in the Hunua Ranges 1995

**Pages:** 16 + app

**Type:** Unpublished report for the Auckland Regional Council Parks Service

**Label:** 256

**Keywords:** *Leiopelma hochstetteri*; Hunua Ranges; survey

**Abstract:** This report follows up on the survey of *Leiopelma hochstetteri* carried out in the Hunua Ranges in 1994 (ref # 89), which identified several factors influencing frog numbers including temperature, stream width and observer bias. To investigate the relative importance of these factors, frog numbers were monitored for a similar time the following year.

*L. hochstetteri* numbers averaged  $12 \pm 6$  and  $5 \pm 3$  frogs every 100 m of the stream bank area of two streams within the Mangatawhiri catchment. Frog numbers in the two streams in 1995 were similar to those found in the 1994 survey. A higher number of frogs were found in the tributary compared to the main river in both 1995 and 1994, due to high habitat quality - a closed forest canopy, stable rocky stream bed, and moderate water flow. The population structure between the two streams was markedly different. The tributary contained mostly juveniles and mature males with a small number of mature females, while the main river appeared to contain similar numbers of male and female frogs and a small number of juveniles (these estimates are based on juveniles being < 25 mm, males usually in the range 30-38 mm and females usually in the range 36-47 mm). Frog numbers were correlated with minimum overnight temperature. This implies that temperature is a major, but not the only causative influence on frog numbers. Other influences may include sedimentation or humidity. Changes in stream width due to heavy rainfall probably decreased the area searched between 1994 and 1995, resulting in an underestimation of frog numbers, particularly in site 2. A quantitative method of determining area searched needs to be included in future surveys.

**Reference Type:** Journal Article

**Record Number:** 111

**Author:** Günther, A.

**Year:** 1868

**Title:** First account of species of tailless batrachians added to the collection of the British Museum

**Journal:** Proceedings of the Zoological Society of London

**Pages:** 478-490

**Label:** 111

**Keywords:** *Leiopelma hochstetteri*

**Abstract:** This paper lists *Leiopelma hochstetteri* (as *Liopelma*) as a 'species acquired which were previously desiderata' by the British Museum by 1868. The

specimen was acquired from Sir A. Smith. The alternative spelling of *Leiopelma* appears to be first used by Günther in this publication. No further description is given in the article.

**Reference Type:** Magazine Article

**Record Number:** 134

**Author:** Hansford, Dave

**Year:** 2001

**Title:** Deadly frog fungus strikes NZ species

**Magazine:** New Zealand Geographic

**Volume:** 54

**Pages:** 5-6

**Label:** 134

**Keywords:** chytrid fungus; *Leiopelma archeyi*; Coromandel

**Abstract:** This article reports on the discovery of a dead *Leiopelma archeyi* in the Coromandel Range suspected of being infected with *Batrachochytrium dendrobatidis*. The fungus and how it affects amphibians is described.

Andrew Harrison (Department of Conservation) and Ben Bell (Victoria University of Wellington) are quoted.

**Reference Type:** Book

**Record Number:** 286

**Author:** Harris, L. H.

**Year:** 1985

**Title:** Forest wildlife

**City:** Wellington

**Publisher:** P. D. Hasselberg, Government Printer

**Number of Pages:** 52

**Edition:** Second

**ISBN:** 0477012833

**Original Publication:** 1974

**Label:** 286

**Keywords:** natural history

**Abstract:** This is a natural history publication on New Zealand wildlife, both endemic and introduced. Three native species of frog are mentioned. A basic description of the ecology and distribution for *Leiopelma hochstetteri*, which is described as 'fully protected', is given.

**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 7

**Author:** Hay, Jennifer M.; Ruvinsky, Ilya; Hedges, S. Blair; Maxson, Linda R.

**Year:** 1995

**Title:** Phylogenetic relationships of amphibian families inferred from DNA sequences of mitochondrial 12S and 16S ribosomal RNA genes.

**Journal:** Molecular Biology and Evolution

**Volume:** 12

**Issue:** 5

**Pages:** 928-937

**Label:** 7

**Keywords:** phylogeny; taxonomy; genetics

**Abstract:** This paper investigates ordinal and familial relationships within the class Amphibia using nucleotide sequence comparisons. Approximately 850 base pairs of the mitochondrial 16S rRNA gene from representatives of 28 of the 40 families of extant amphibians were sequenced. Phylogenetic analysis of these data together with published data of the 12S rRNA gene for the same families and both genes for three more taxa support the monophyly of each of the three amphibian orders: Anura (confidence value with the interior-branch test:  $P_c = 99\%$ ), Caudata ( $P_c = 100\%$ ), and Gymnophiona ( $P_c = 99\%$ ). An analysis using the four-cluster method cannot discriminate significantly between all three possible unrooted trees involving the three orders of amphibians and an outgroup. Within the Anura, there is support for the monophyly of the two suborders: Neobatrachia ( $P_c = 100\%$ ) and Archaeobatrachia ( $P_c = 97\%$ ); the later was believed to be paraphyletic on the basis of morphology. Within the Archaeobatrachia, the following pairs of taxa cluster: Pelobatidae + Pelodytidae ( $P_c = 99\%$ ), Pipidae + Rhinophrynidae ( $P_c = 99\%$ ), *Ascaphus* + Leiopelmatidae ( $P_c = 89\%$ ), and *Bombina* + Discoglossidae ( $P_c = 99\%$ ). The latter six taxa cluster ( $P_c = 94\%$ ) such that Pelobatidae + Pelodytidae forms a basal lineage within the Archaeobatrachia.

The data for *Leiopelma* was obtained from a Maud Island frog (therefore referring to *L. pakeka*).

**Reference Type:** Magazine Article

**Record Number:** 239

**Author:** Henry, Alison

**Year:** 1997

**Title:** Under the long white cloud: the local hop

**Magazine:** Aotearoa

**Volume:** 7

**Pages:** 32-35

**Label:** 239

**Keywords:** ecology

**Abstract:** This article gives a basic introduction to the ecology and life history of *Leiopelma*. The translocation of 300 *L. pakeka* from Maud Island to Motuara Island is briefly discussed.

**Reference Type:** Electronic Source

**Record Number:** 204

**Author:** Hilton-Taylor, C.

**Year:** 2000

**Title:** 2000 IUCN Red List of Threatened Species

**Producer:** IUCN, Gland, Switzerland

**Access Date:** 21 August 2002

**Type of Medium:** webpage

**Label:** 204

**Keywords:** IUCN; *Leiopelma archeyi*; *Leiopelma hamiltoni*; status

**Abstract:** This is the Red List status listing for *Leiopelma* from the IUCN's

Red List website. *L. archeyi* is listed as LR/nt (Lower Risk/Near Threatened) and *L. hamiltoni* is listed as VU D2 (Vulnerable - population is characterised by an acute restriction in its area of occupancy).

**Notes:** Printout provided includes explanation of criteria used.

**URL:** www.redlist.org

**Reference Type:** Book Section

**Record Number:** 245

**Author:** Hochstetter, Ferdinand von

**Year:** 1867

**Title:** The fauna

**Book Title:** New Zealand: its physical geography, geology and natural history

**City:** Stuttgart

**Publisher:** J. G. Cotta

**Pages:** 518

**Edition:** Translated from the German original published in 1863, with additions up to 1866 by the author.

**Translator:** Sauter, Edward

**Label:** 245

**Keywords:** *Leiopelma hochstetteri*

**Abstract:** This book is one of the publications resulting from Hochstetter's journey to New Zealand as a geologist on the Austrian man-of-war, the frigate Novara. Hochstetter was in New Zealand from late December 1858 for nine months. Hochstetter returned to Austria with two specimens of the native frog, collected by Maori, which were then formally described by Dr L. J. Fitzinger in the Records of the Imperial Zoolog. Botan. Society in Vienna (series of 1861) as *Leiopelma hochstetteri*.

At this time the closest relative of *Leiopelma* was believed to be a Peruvian species, *Telmatobius peruvianus* Wiegman.

**Reference Type:** Journal Article

**Record Number:** 35

**Author:** Holyoake, Andrew; Waldman, Bruce; Gemmell, Neil J.

**Year:** 1999

**Title:** A re-examination of the species status of *Leiopelma hamiltoni* and *L. pakeka*

**Journal:** New Zealand Journal of Zoology

**Volume:** 26

**Pages:** 258

**Label:** 35

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; taxonomy; cytochrome b; genetics

**Abstract:** This is an abstract of a paper presented at the 8th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at Great Barrier Island, 5-7 February 1999. Based on the recent designation of *Leiopelma pakeka* as a separate species from *L. hamiltoni*, this study undertook to re-investigate the molecular systematics of the Leiopelmatidae. Partial 12S rRNA and Cytochrome b (Cyt b) sequences were obtained for 57 frogs from six



populations representing all four *Leiopelma* species. Contrary to previous reports, this study found *L. pakeka* and *L. hamiltoni* to be monophyletic. The amount of variation seen between these present species (<1% for Cyt b) was comparable to that seen between King Country and Coromandel populations of *L. archeyi*. The *L. pakeka* and *L. hamiltoni* monophyletic clade was distinct from *L. archeyi* with all three species being quite divergent from *L. hochstetteri*. There was little within-or between-population variation for any species. The authors consider that it is likely that *L. pakeka* and *L. hamiltoni* are two populations of the same species.

**Reference Type:** Journal Article

**Record Number:** 115

**Author:** Holyoake, Andrew; Waldman, Bruce; Gemmell, Neil J.

**Year:** 2001

**Title:** Determining the species status of one of the world's rarest frogs: a conservation dilemma

**Journal:** Animal Conservation

**Volume:** 4

**Pages:** 29-35

**Label:** 115

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; *Leiopelma hochstetteri*; *Leiopelma archeyi*; genetics; cytochrome *b*; conservation; taxonomy

**Abstract:** This paper addresses the issue relating to the status of *Leiopelma pakeka* as a separate species from *L. hamiltoni*. Previous investigations have suggested, based on patterns of allozyme variation, that the Stephens Island frog, *L. hamiltoni* and *L. archeyi* are sister taxa to the exclusion of the Maud Island frog, a species in close geographical proximity to the Stephens Island frog and previously viewed as a population of this species. As a consequence of these data, a new species, *L. pakeka*, the Maud Island Frog, has been described. This new species definition has dramatically enhanced the conservation status of *L. hamiltoni*, of which there are probably fewer than 150 individuals. This study re-examines the systematics of the Leiopelmatidae using mtDNA sequence analyses. Partial 12 S ribosomal RNA and cytochrome *b* (Cyt *b*) gene sequences were obtained for 57 frogs from six populations representing all four extant *Leiopelma* species. Contrary to previous reports, the authors find *L. pakeka* and *L. hamiltoni* to be monophyletic. The amount of variation evident between these present species (<1% for Cyt *b*) is comparable to that seen between populations of *L. archeyi*. Based on these data, classification of *L. pakeka* and *L. hamiltoni* as separate species appears to be unwarranted, but they may be sufficiently distinct to warrant classification as evolutionarily significant units.

Toe clips were obtained from all four *Leiopelma* species for these analyses. Populations were: two of *L. archeyi* were obtained from near Tapu, Coromandel and one from Whareorino, King Country; *L. hochstetteri* were also obtained near Tapu, Coromandel; *L. hamiltoni* from Stephens Island and *L. pakeka* from Maud Island.

**Reference Type:** Report

**Record Number:** 250

**Author:** Holzapfel, Avi

**Year:** 2002

**Title:** Native frog Recovery Group: Annual Report 2002

**Institution:** Department of Conservation

**Pages:** 25 + apps

**Type:** Annual Report

**Label:** 250

**Keywords:** *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*; recovery plan; chytrid fungus; survey; monitoring; research priorities

**Abstract:** This report was prepared from data submitted to the 2002 recovery group meeting held in Hamilton, Waikato Conservancy (Department of Conservation), 20-21 May 2002. A large focus for the recovery group over the financial year had been to prepare for management of chytrid fungus in New Zealand, and to encourage/fund research into a number of aspects of the disease in the New Zealand context.

Objectives in the recovery plan (ref # 90), summary of achievements since the last annual report and recommendations from this report are outlined. The full minutes of the meeting are included. Appendices include Conservancy reports; summaries are as follows:

Northland - the main focus of the Conservancy for the past year has been on promoting awareness of and impacts of chytrid fungus to frog populations.

Auckland - a covenant in a private forest block to protect a frog population in Dome Valley achieved. Waikato - four Coromandel *L. archeyi* have been confirmed with having chytrid fungus to date. Monitoring for *L. archeyi* was carried out in July 2001 and January 2002 on the Stony Bay side of Mt. Moehau, Coromandel using the Mike Thorsen method. The number of *L. archeyi* found using this method in the monitoring area for this period indicates an apparent decline. A survey for *L. hochstetteri* and *L. archeyi* was also carried out in the Central Coromandel. *L. hochstetteri* were found at nine of the 10 streams surveyed in the Rangihau and Kauaeranga catchments. A cluster of eggs, believed to be *L. hochstetteri* was also found. No *L. archeyi* were found. Four dead *L. archeyi* found in the Whareorino Forest have been sent to Canterbury University. The preliminary results for two suggest the presence of chytrid fungus. Information has been circulated to interested parties to raise awareness on chytrid fungus. Surveys of five transects last searched in November 1993 were researched in November 2001, with no apparent evidence for declines. Searches continue for a suitably dense population in Whareorino Forest to set up a permanent study grid. A presence/absence survey of *L. hochstetteri* was carried out in nine streams at Whareorino Forest. Frogs were found in eight of the nine streams.

Bay of Plenty - A report on a survey of Otawa/Otanewainuku is due by the end of June 2002. *L. hochstetteri* was found in only two small tributaries within the know quarry lease area in the southeastern corner of Otawa.

East Coast Hawke's Bay - a survey of the Pakahi Heads Hut area of the Urutawa Conservation Area also found *L. hochstetteri*. Final numbers are still to be de-

terminated from the survey sheets.

Nelson/Marlborough - a protocol has been drafted to minimise the risk of chytrid infection in island frog populations. The boardwalk over the frog bank in Stephens Island has been strengthened and monitoring of *L. hamiltoni* has continued. Research carried out on *L. pakeka* over the past year on Maud Island includes continued population studies by Ben Bell, Victoria University, and sex determination studies by Phil Bishop, Otago University. Monitoring of the translocation population of *L. pakeka* to Motuara Island continues.

The translocation proposal form for the planned transfer of 50 *L. archeyi* from Whareorino Forest to Bruce Waldman at the University of Canterbury is also included as an appendix. This is to establish an indoor captive population of *L. archeyi*. The facility is a PC2 lab with an in-built security system and computer controlled temperature, humidity and lighting conditions.

Research at Victoria University, including population studies of *L. archeyi* and amphibian ecophysiology and chytrid fungus is also outlined as appendices.

Bruce Waldman of the University of Otago provided a research update on the susceptibility of both native and introduced frogs to chytrid fungus and mechanisms for transmission.

A draft protocol to minimise risk of chytrid infection in mainland populations of *L. archeyi* and *L. hochstetteri* is presented, as is legislation relating to chytrid. Other appendices appear as separate reports.

**Reference Type:** Book

**Record Number:** 165

**Author:** Hudson, Bruce

**Year:** 1994

**Title:** Reptiles & amphibians in New Zealand. Handbook for species identification

**City:** Auckland

**Publisher:** Print Media Specialists

**Number of Pages:** 50

**ISBN:** 0473029200

**Label:** 165

**Keywords:** identification; legislation

**Abstract:** This is a handbook for the identification of reptiles and amphibians in New Zealand. A brief introduction includes an outline of The Wildlife Act (1953) and the Resource Management Act (1991).

Brief details on both endemic and introduced frogs are given for identification purposes. The distribution of *Leiopelma hamiltoni* is given as both Stephens and Maud Islands, although a fourth species of *Leiopelma* is given as an as yet unnamed 'Northern King Country frog'. This was subsequently found to be another population of *L. archeyi* (ref # 5).

**Reference Type:** Book

**Record Number:** 272

**Author:** Hutching, Gerard

**Year:** 1998

**Title:** The natural world of New Zealand

**City:** Auckland

**Publisher:** Penguin Books (NZ) Ltd

**ISBN:** 0670877824

**Label:** 272

**Keywords:** ecology;

**Abstract:** This natural history guide to New Zealand includes references to the general ecology of *Leiopelma*.

**Reference Type:** Journal Article

**Record Number:** 211

**Author:** Hutton, F. W.

**Year:** 1872

**Title:** On the geographical relations of the New Zealand fauna

**Journal:** Transactions and Proceedings of the New Zealand Institute

**Volume:** 5

**Pages:** 227-256

**Label:** 211

**Keywords:** biogeography; *Leiopelma hochstetteri*

**Abstract:** This paper describes New Zealand's fauna as remnants of a continental fauna and is discussed in detail. Only one species of *Leiopelma* (as *Liopelma*) was known at the time of publication, *L. hochstetteri*. The distribution is given as three localities, the Cape Colville ranges from Coromandel to Puriri; the Huia on the north side of the Manukau harbour; and in the mountains behind Opotiki in the Bay of Plenty. A land connection with South America in the past is suggested as the closest relative to *Leiopelma* was thought to be from Peru.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Book

**Record Number:** 213

**Author:** Hutton, F. W.; Drummond, James

**Year:** 1923

**Title:** The animals of New Zealand: An account of the Dominion's air-breathing vertebrates

**City:** Auckland

**Publisher:** Whitcombe and Tombs Limited

**Number of Pages:** 434

**Edition:** Fourth

**ISBN:** '(no number)'

**Label:** 213

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; identification

**Abstract:** This book describes the terrestrial fauna of New Zealand. A brief description of *Leiopelma hochstetteri* (as *Liopelma*) and *L. hamiltoni* is given. The order is given as Ecaudata, the family as Discoglossidae. *Leiopelma* characteristics are given as tongue, circular, entire, free behind; pupil triangular; no tympanic disc; fingers free; toes webbed, the tips not dilated. The suggested

origin of *Leiopelma* is through a land connection with southeastern China. The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Report

**Record Number:** 202

**Author:** Imboden, Christoph

**Year:** 1978

**Title:** Wildlife values and wildlife conservation in the Hauhungaroa and Rangitoto Ranges

**City:** Wellington

**Institution:** New Zealand Wildlife Service Fauna Survey Unit

**Pages:** 33

**Type:** Report No. 10

**Label:** 202

**Keywords:** survey; distribution; *Leiopelma hochstetteri*

**Abstract:** This report is one of the results of surveys carried out by the Wildlife Service in all major parts of the West Taupo forest over seven years. Three King Country records of *Leiopelma hochstetteri* are all from the Rangitoto Range (in the vicinity of Mt Rangitoto and Mt Ranginui).

**Notes:** Hardcopy includes summary and pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 258

**Author:** International Commission on Zoological Nomenclature

**Year:** 1977

**Title:** Opinion 1071: Emendation under the plenary powers of Liopelmatina to Leiopelmatidae (Amphibia Salientia)

**Journal:** The Bulletin of Zoological Nomenclature

**Volume:** 33

**Pages:** 167-169

**Label:** 258

**Keywords:** nomenclature; taxonomy

**Abstract:** This is the opinion of The International Commission on Zoological Nomenclature in response to a proposal to officially change the family name of *Leiopelma* to Leiopelmatidae and invalidate the name *Liopelma* (ref # 257). The proposal was accepted. Comments relating to the use of plenary powers in this case are also included.

**Reference Type:** Book

**Record Number:** 46

**Author:** Jones, Jenny

**Year:** 1994

**Title:** Hamilton's Frog

**City:** Auckland

**Publisher:** WWF-New Zealand, Heinemann Education

**Number of Pages:** 24

**ISBN:** 1869440749

**Label:** 46

**Keywords:** *Leiopelma hamiltoni*; Maud Island; Stephens Island; *Leiopelma pakeka*

**Abstract:** This is a children's book describing *Leiopelma hamiltoni* and its ecology. The distribution for *L. hamiltoni* is given as both Maud and Stephens Islands (and is therefore also referring to *L. pakeka*).

**Reference Type:** Magazine Article

**Record Number:** 114

**Author:** Judd, Warren

**Year:** 1998

**Title:** The truth about tadpoles and frogs

**Magazine:** New Zealand Geographic

**Volume:** 38

**Pages:** 86-109

**Label:** 114

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; ecology; history; phylogeny

**Abstract:** This article gives a comprehensive introduction to both native and introduced species of frogs in New Zealand. General ecology is discussed for *Leiopelma* and *Litoria*.

*Leiopelma pakeka* is described as being first discovered on Maud Island in the 1930's, eventually being confirmed by the Wildlife Service in 1958 (at which time it was considered to be another population of *L. hamiltoni*). The author made visits to both Maud Island and to Whareorino (with Karen Eggers during her MSc thesis field research). Possible agents of global amphibian declines are discussed.

Basic phylogeny is presented and amphibians in history and literature are discussed.

**Reference Type:** Thesis

**Record Number:** 135

**Author:** Kane, Paul A.

**Year:** 1980

**Title:** A comparison of the diet and feeding behaviour of Hamilton's frog *Leiopelma hamiltoni* and the brown tree frog *Litoria ewingi*

**Academic Department:** Zoology

**University:** Victoria University of Wellington

**Number of Pages:** 58

**Thesis Type:** BSc. (hons)

**Label:** 135

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; *Leiopelma archeyi*; *Leiopelma hochstetteri*; *Litoria ewingi*; diet

**Abstract:** 120 faecal pellets from each of the two allopatric frogs, *Leiopelma hamiltoni* (from Maud Island, therefore referring to *L. pakeka*) and *Litoria ewingi* (an introduced hylid frog) were examined and the numbers and frequencies of occurrence of food items were compared.

*L. hamiltoni* had significantly more mites and flies, while the brown tree frog

took significantly more amphipods and spiders. Whether this is due to different feeding preferences, or to different invertebrate faunas, is uncertain.

In addition, 35 faeces from *L. archeyi* and 24 from *L. hochstetteri* were examined. A comparison of food items for all three native frogs showed beetles as important foods in all three. Strong inference on diet differences could not be made because of the small sample size from *L. archeyi* and *L. hochstetteri*, and because of the problem of allopatry.

A series of morphometric measurements showed *L. ewingi* to have significantly longer hindlimbs (relative to snout-vent length) than *L. hamiltoni*, forelimb length being significantly greater in *L. hamiltoni*. Measurements of the distance of tongue tip to snout tip quantified the difference in tongue morphology and attachment, in the two species.

Attempts to observe the feeding behaviour of both frogs were unrewarded in the case of *L. hamiltoni*, so comparisons between the feeding behaviours of the two species were not possible.

In keeping with its relatively longer hindlimbs, *L. ewingi* jumped further on average than *L. hamiltoni* in a series of tests. Further tests concerning gripping ability on a glass plate were carried out and significant differences were recorded. It was suggested that further work on the diet of these two diverse frog species throughout the year was necessary to assess more fully diet differences. Comparative feeding behaviour studies for both species would also have importance here.

**Notes:** Hardcopy includes title page, contents, list of text figures and abstract plus table of total number of items in the faeces of *L. hamiltoni* and *L. ewingi*.

**Reference Type:** Journal Article

**Record Number:** 128

**Author:** Kasinsky, H. E.; Gutovich, L.; Kulak, D.; Mackay, M.; Green, David M.; Hunt, J.; Ausio, J.

**Year:** 1999

**Title:** Protamine-like sperm nuclear basic proteins in the primitive frog *Ascapheus truei* and histone reversions among more advanced frogs

**Journal:** Journal of Experimental Zoology

**Volume:** 284

**Pages:** 717-728

**Label:** 128

**Keywords:** physiology; *Leiopelma hochstetteri*

**Abstract:** This paper examined the sperm nuclear basic proteins (SNBPs) of 11 anuran species. In animals, evolution of SNBPs has proceeded from lysine-rich histone H type in sponges to more arginine-rich protamine-like PL and protamine P types. This study was to determine why sporadic PL/P to H reversions occur in both protostomes and deuterostomes. It was found that the sperm of the primitive, internally fertilising archeobatrachian frog *Ascapheus truei* has PL/P type (42 mol % arginine), with an electrophoretic profile similar to SNBPs in another archeobatrachian, externally fertilising *Leiopelma hochstetteri*.

A specimen of *L. hochstetteri*, from the Coromandel Peninsula, was provided

by B.D. Bell, C.H. Daugherty and L. Maxson.

**Reference Type:** Report

**Record Number:** 208

**Author:** Krzystyniak, Steve

**Year:** 1984

**Title:** Pureora North Block animal survey

**City:** Te Kuiti

**Institution:** New Zealand Forest Service

**Pages:** 48

**Type:** Unpublished report

**Label:** 208

**Keywords:** survey; *Leiopelma hochstetteri*; Rangitoto Range

**Abstract:** An animal survey was carried out in the North Block of Pureora State Forest during the summer of 1983/84. This survey was primarily for mammals, but other species such as amphibians and reptiles were also noted when time permitted.

Twelve specimens of *Leiopelma hochstetteri* were observed, all in the Rangitoto Range. *Litoria aurea* was also observed, but there was no overlap in habitat requirements with *L. hochstetteri*. A map showing the recorded locations of both species is included.

**Reference Type:** Journal Article

**Record Number:** 281

**Author:** Lee, Jonathan S. F.; Waldman, Bruce

**Year:** 2002

**Title:** Communication by fecal chemosignals in an archaic frog, *Leiopelma hamiltoni*

**Journal:** Copeia

**Volume:** 2003(3)

**Pages:** 679-686

**Label:** 281

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; chemical cues

**Abstract:** This paper shows that *Leiopelma hamiltoni* [sic!], (from Maud Island, therefore referring to *L. pakeka*), communicates through faecal chemosignals. When given a choice between their own and other individuals' faeces, subjects spent more time near their own faeces. Further, this effect was greatest when the conspecific was larger in body size, suggesting that information about size as well as individuality is communicated. Time spent near conspecific faeces correlated negatively with the distance between the collection sites of the frogs. This correlation may reflect differential responses to the faeces of frogs of varied levels of kinship and social familiarity: frogs may avoid nonrelatives and unfamiliar conspecifics. To test the hypothesis that frogs alter faecal production upon exposure to conspecific faeces, we presented subjects with either one smear of their own and one smear of a conspecific's faeces or two smears of their own faeces. Frogs did not defecate more when exposed to conspecific faeces. However, when the frogs did defecate, they placed their faeces closer to the conspecific's faeces than to their own. This supports the hypothesis that faeces



serve as signals to conspecifics. Visual and tactile cues were eliminated in the experiments. The results show that the frog *L. hamiltoni* communicates with conspecifics through chemical signals. It is suggested that chemical signalling may be widespread in anuran amphibians.

Fieldwork was carried out on Maud Island during November 1999 and February 2000.

**Reference Type:** Book

**Record Number:** 215

**Author:** Lindsey, Terence; Morris, Rod

**Year:** 2000

**Title:** Collins field guide to New Zealand wildlife

**City:** Auckland

**Publisher:** Harper Collins Publishers (New Zealand) Limited

**Number of Pages:** 263

**ISBN:** 1869503007

**Label:** 215

**Keywords:** natural history

**Abstract:** This is a field guide for identifying New Zealand wildlife, both endemic and introduced. A basic description of the ecology and distribution for *Leiopelma* is given. Details are not given separately for each species and could therefore be misleading. A Maori name is given as poko-poko.

**Reference Type:** Journal Article

**Record Number:** 13

**Author:** McCulloch, Allan R

**Year:** 1919

**Title:** A new discoglossoid frog from New Zealand

**Journal:** Transactions and Proceedings of the New Zealand Institute

**Volume:** 51

**Pages:** 447-449

**Label:** 13

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; biogeography; taxonomy

**Abstract:** This paper lists the genus as the alternative spelling - *Liopelma* and formally describes *Leiopelma hamiltoni* as a new species.

Includes a supplementary note by Charles Hedley, which discusses possible origins of Leiopelmatidae.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 25

**Author:** McKenna, P.B.

**Year:** 2001

**Title:** An annotated checklist of helminth and protozoan parasites of frogs in New Zealand

**Journal:** Surveillance

**Volume:** 28

**Issue:** 2

**Pages:** 11-12

**Label:** 25

**Keywords:** helminth; protozoan; parasites; *Leiopelma archeyi*; *Leiopelma hochstetteri*

**Abstract:** This article lists the parasites recorded in native and introduced frogs in New Zealand and includes some brief notes about them.

Parasites of *Leiopelma archeyi* are listed as Nematoda - *Cosmocerca archeyi*; Trematoda - *Dolichosaccus novaezealandiae*. For *L. hochstetteri* they are listed as Nematoda - *Aplectana novaezealandiae* and *Cosmocerca australis*; Trematoda - *Dolichosaccus novaezealandiae*.

**Reference Type:** Journal Article

**Record Number:** 92

**Author:** McLennan, J. A.

**Year:** 1985

**Title:** Some observations on Hochstetter's frog in the catchment on the Motu River, East Cape

**Journal:** New Zealand Journal of Ecology

**Volume:** 8

**Pages:** 1-4

**Label:** 92

**Keywords:** *Leiopelma hochstetteri*; East Cape; survey; distribution; reproduction

**Abstract:** This paper assesses the distribution and abundance of *Leiopelma hochstetteri* in part of the catchment of the Motu River during two short surveys in 1981 and 1983. Specimens were found in most tributaries examined and on the banks of the main river, above extreme flood level. Crude indices of abundance were obtained by relating the numbers found to the time spent searching and number of stones and logs turned. Generally about four frogs were found per hour, but there was considerable variation in counts obtained in simultaneous searches by different observers. The highest counts were obtained in areas with stable, moss-covered substrates, shaded by overhanging vegetation. Frogs in the upper Motu River were significantly further away from the edge of streams than those in the catchment of the Takaputahi River. Most adults were dark grey or dull khaki, spotted with rust or brown, whereas juveniles less than 20 mm long were bright lime green. Snout-vent lengths ranged from 15-46 mm and weights from 1.0-7.1 g. A cluster of eggs (10-20) with well-developed embryos was found in a rocky seepage on the banks of the Otipi River in March 1983. Four adults, all longer than 40 mm, were beside the eggs. This is apparently the first record of autumn breeding in *L. hochstetteri*.

The Ruakumara Range was hit by a severe storm in April 1982, affecting much of the habitat of *L. hochstetteri*. The decline in numbers observed and the move away from the water between 1981 and 1983 may have been caused by the storm.

**Reference Type:** Report

**Record Number:** 203

**Author:** McLennan, J. A.; MacMillan, B. W. H.  
**Year:** 1982  
**Title:** Ecological investigations of the Takaputahi dam site  
**City:** Havelock North  
**Institution:** Ecology Division, DSIR  
**Pages:** 17  
**Type:** Unpublished report  
**Label:** 203

**Keywords:** survey; *Leiopelma hochstetteri*; dam;  
**Abstract:** This is a provisional report evaluating the environmental implications of the proposed building of dams on the Motu River for generating hydroelectric power. The main focus of the Ecology Division for this project was to establish the distribution and habitat requirements of native frogs in tributaries of the Motu. This report deals with the field trip in December 1981 to the proposed dam site on the Takaputahi River (the largest tributary of the Motu). *Leiopelma hochstetteri* was found in all four streams searched (n= 76). Snout-vent lengths ranged from 15-38 mm (most between 31-35 mm) and weights between 1-6.8 g. Both day and night searches were undertaken, however, only one *L. hochstetteri* was found at night over a stretch of stream that had yielded 13 frogs in the day searches (turning rocks). Spotlighting was not considered to be an effective method of searching for *L. hochstetteri*. Attention is drawn to difficulties associated with observer bias in daytime searches.

**Reference Type:** Report

**Record Number:** 89

**Author:** McNaughton, Anna; Greene, Brenda

**Year:** 1994

**Title:** The effect of 1080 on the native Hochstetter's frog (*Leiopelma hochstetteri*) population in the Hunua Ranges

**City:** Auckland

**Institution:** Auckland Regional Parks Service

**Pages:** 30 + apps

**Type:** Unpublished report

**Label:** 89

**Keywords:** *Leiopelma hochstetteri*; Hunua Ranges; 1080;

**Abstract:** This reports describes counts of *Leiopelma hochstetteri* at three sites within the Mangatawhiri stream of the Hunua Catchment Parkland prior to and following an aerial 1080 poison drop (possum control) in June 1994. Frogs were counted along a 200 m length of stream, weekly three times before and weekly four times after the drop. One more count was undertaken 18 weeks after the 1080 operation.

A regression analysis showed that frog numbers at site 1 and site 2 were strongly correlated with minimum temperature ( $r_{site1} = 0.78$  and  $r_{site2} = 0.82$ ). Frog numbers at site 3 remained similar before and after the 1080 drop. The sample size of frogs at site 3 was low, and may have obscured any trends.

There was evidence at all three sites that frog numbers counted in streams were affected by stream volume. When stream levels rose following heavy rain, the

area available to search become less, so that sampling effort was neither constant within nor between sites. Excluding days of heavy rain ( $> 8$  mm), regression analysis showed that frog numbers at sites 1 and 2 were very strongly correlated with minimum temperature ( $r_{site1} = 0.91$  and  $r_{site2} = 0.82$ ). Observer bias, caused by a change in survey personnel after the 1080 drop also explained some of the variation in frog numbers.

Sites 1, 2 and 3 had an average frog density of 22, 12 and 6 frogs per 100 m stream respectively. Sites 1 and 2 were at 440 m above sea level, whereas site 3 was at 240 m above sea level. Site 1 was a tributary to the Mangatawhiri River and less prone to flooding than site 2 on the main river and site 3 on a tributary at lower altitude. The higher number of frogs in site 1 may be explained by less variation in stream volume, higher relative humidity due to greater forest cover and shading, as well as more suitable rocky habitat.

Results were compromised by the lack of a control area (surveys in catchments not treated with 1080), but the fluctuations in frog numbers suggested that the influence of short-term natural environmental effects were important. There was no evidence that frog populations or individual frogs were affected by 1080. One frog found dead immediately after the 1080 drop tested negative for the presence of 1080.

**Reference Type:** Journal Article

**Record Number:** 276

**Author:** Metcalf, Maynard M.

**Year:** 1934

**Title:** Frogs and Opalinidae

**Journal:** Science

**Volume:** 79

**Issue:** 2044

**Pages:** 213-214

**Label:** 276

**Keywords:** biogeography

**Abstract:** This article, possibly a letter, discusses the geological times of origin and of the routes and times of spreading of frogs, using concomitant studies of the taxonomy and geographical distribution of the Anura and their intestinal commensals, the Opalinidae. Bell-toads are described as migrating from Asia to New Zealand in the early Cretaceous period or possibly earlier. Descendants of this family, the *Leiopelma* (as *Liopelma*), lost its larval stage and therefore show no Opalinids, which can infect aquatic tadpoles only. The ancestors of *Leiopelma*, when crossing Australia had aquatic tadpoles and characteristic Bell-toad *Protoopalinae* of subgeneric group II, through which they infected Australian frogs of other families, as found today.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 126

**Author:** Meyer-Rochow, V. Benno; Pehlemann, F.W.

**Year:** 1990

**Title:** Retinal organisation in the native New Zealand frogs *Leiopelma archeyi*, *L. hamiltoni*, and *L. hochstetteri* (Amphibia: Anura; Leiopelmatidae)

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 20

**Issue:** 4

**Pages:** 349-366

**Label:** 126

**Keywords:** *Leiopelma archeyi*; *Leiopelma pakeka*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; physiology

**Abstract:** This paper presents an account of retinal ultrastructure in three species of *Leiopelma*. The *Leiopelma* retina is approximately 150  $\mu\text{m}$  thick from the inner limiting to Bruch's membrane, and has the layered structure typical of vertebrates. It has large and uniform rod photoreceptors, varying between 50-65  $\mu\text{m}$  in length and 9-14  $\mu\text{m}$  in diameter. *L. archeyi* and *L. hochstetteri* have a few cone cells (under 10% of the total) associated with paraboloid or ellipsosome-like structures in the inner segments. Cone outer segments were not seen in *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*), although there was a typical cone paraboloid, which suggests that cones are present, albeit in very small numbers. In all three species the retinal pigment epithelium contained numerous organelles, notably fasciculated smooth endoplasmic reticulum, elongated screening pigment grains, and pieces of shedded outer segment discs in all stages of internalisation. On the basis of interspecific comparison, it was concluded that the eyes of all three species are principally adapted to operate under low intensities of light; but that of the three, *L. archeyi* would be the least nocturnal species. A density of  $10^{10}$  photopigment molecules per rod outer segment disc in the eye of *L. hamiltoni* was calculated, and the authors believe that the typical amphibian rod outer segment with large diameter and numerous radial incisures has not changed since the ancestors of extant amphibians first began to conquer solid ground 300 million years ago. One of each of *L. archeyi* and *L. hochstetteri* were collected from the Coromandel and one *L. hamiltoni* was collected from Maud Island (therefore *L. pakeka*). All three frogs were female.

**Reference Type:** Report

**Record Number:** 199

**Author:** Millener, Phil R.

**Year:** 1984

**Title:** Honeycomb Hill Cave: A survey of scientific and scenic resources

**City:** Wellington

**Institution:** National Museum of New Zealand

**Pages:** 100

**Type:** Unpublished report

**Label:** 199

**Keywords:** subfossil; Honeycomb Hill; survey

**Abstract:** This is a survey of the Honeycomb Hill Cave system, which is approximately 16 km northeast of Karamea, within the Karamea subregion of

Buller County. Frog bones were collected from several sites, with indications that they belong to the endemic genus *Leiopelma*. However, many of the subfossil frog bones found were too large to belong to any of the known extant species. A research programme (Dr Ben Bell, Victoria University) is to address the issue of taxonomy of subfossil *Leiopelma*.

**Notes:** Hardcopy only includes the introduction, map of the region and page relevant to *Leiopelma*.

**Reference Type:** Journal Article

**Record Number:** 271

**Author:** Mittleman, M. B.; Myers, George S.

**Year:** 1949

**Title:** Geographic variation in the ribbed frog, *Ascaphus truei*

**Journal:** Proceedings of the Biological Society of Washington

**Volume:** 62

**Pages:** 57-68

**Label:** 271

**Keywords:** nomenclature

**Abstract:** This paper gives a brief history of the classification of *Leiopelma*, as well as drawing attention to the alternative spelling of *Liopelma* by some authors. The authors point out that whereas the classically correct transliteration of the name would be *Liopelma*, Fitzinger spelled it *Leiopelma* in 1861 and the International Rules require the retention of this orthography.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 246

**Author:** Moffat, Lynette A.

**Year:** 1974

**Title:** The development and adult structure of the vertebral column in *Leiopelma* (Amphibia: Anura)

**Journal:** Proceedings of the Linnean Society of New South Wales

**Volume:** 98

**Issue:** 3

**Pages:** 142-174

**Label:** 246

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; physiology

**Abstract:** The development of the vertebral column in an anuran with notochordal amphicoelous vertebrae, *Leiopelma* is described. A detailed description is given of its internal morphology in adult stages. Long-standing claims that the persistent notochord and the absence of ball-and-socket joints in the vertebral column are primitive character-states in the Anura are upheld, contrary to a recent claim (Inger, 1967) that the ectochordal state of the vertebrae of *Leiopelma* has evolved secondarily as a result of neoteny from the holochordal condition found in most other frogs. All the so-called traverse processes of the vertebrae are pleurapophyses because discrete ribs are present during develop-

ment stages, and the forked rib of the third or fourth vertebrae enclose the anterior lymph hearts. The urostyle of *L. archeyi* develops from the first four pairs of postsacral neurapophyses and the ventral region of the perichordal tube of the first five postsacral vertebrae, which undergoes squamous cell hyperplasia and subsequent metaplasia into hyaline cartilage to form the hypochord. Factors contributing to the evolution of the short presacral column and long pelvic girdle in anurans are also discussed.

Twelve specimens of developing *L. archeyi* were available for investigation in the form of transverse, longitudinal or approximately horizontal serial sections. Five serially sectioned specimens of developing *L. hochstetteri* were also available (previously used in experiments by N.G. Stephenson, ref # 247). The adult material examined included a male *L. archeyi*, and a male *L. hochstetteri*.

**Reference Type:** Book

**Record Number:** 205

**Author:** Molloy, Janice; Davis, Alison

**Year:** 1994

**Title:** Setting priorities for the conservation of New Zealand's threatened plants and animals (2<sup>nd</sup> edition collated by C. Tisdall)

**City:** Wellington

**Publisher:** Department of Conservation

**Number of Pages:** 64

**ISBN:** 0478013779

**Label:** 205

**Keywords:** status; conservation

**Abstract:** This is an update of the original publication (1992) and describes a ranking system developed to aid the Department of Conservation in identifying threatened plants and animals which require urgent assessment for conservation action. The criteria used are explained. *Leiopelma hamiltoni* (Stephens Island) is listed as Category A (highest priority threatened species). *L. archeyi*, *L. hochstetteri* and *L. hamiltoni* (Maud Island - therefore referring to *L. pakeka*) are all listed as Category B (second priority threatened species). Conservancies where each species is found are also listed.

**Notes:** Hardcopy includes introduction, explanation of criteria and category listings only.

**Reference Type:** Book

**Record Number:** 285

**Author:** Moon, Geoff

**Year:** 1994

**Title:** The Reed field guide to New Zealand wildlife

**City:** Auckland

**Publisher:** Reed Publishing (NZ) Ltd

**Number of Pages:** 192

**ISBN:** 0790003074

**Label:** 285

**Keywords:** natural history

**Abstract:** This is a natural history publication on New Zealand wildlife, both

endemic and introduced. A basic description of the ecology and distribution for *Leiopelma* is given. This publication describes that recent observations (supported by photographs) of *L. hochstetteri* hatchlings show that 'tadpoles emerged from the capsules and swam freely in small pools of water beneath rocks close to a stream. They remained at that tadpole stage for a few weeks before developing into tailed froglets, the tails then being gradually absorbed.' The source of this information is not mentioned.

A liberation of *L. hochstetteri* on Kapiti Island in 1924 is also mentioned (cf. Wilkinson 1925, ref. # 289).

**Notes:** Hardcopy includes the introduction and pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 109

**Author:** Morescalchi, Alessandro

**Year:** 1968

**Title:** The karyotypes of two specimens of *Leiopelma hochstetteri* Fitz. (Amphibia Salientia)

**Journal:** Caryologia

**Volume:** 21

**Issue:** 1

**Pages:** 37-46

**Label:** 109

**Keywords:** *Leiopelma hochstetteri*; genetics; karyotype

**Abstract:** The karyotype of two female specimens of *Leiopelma hochstetteri* are described. The chromosome set of female 1 consisted of 34 chromosomes, divisible into five pairs of large meta- or submetacentric homologues, six pairs of medium-small acrocentric homologues (one pair of which is provided with heterochromatic areas) and six pairs of microchromosomes, mostly acrocentric. The chromosome set of female 2 consists of 23 chromosomes, divisible into five pairs of large meta- or submetacentric homologues, six pairs of medium-small acrocentric homologues (corresponding, in shape and dimensions, to the large and medium-small chromosomes of female 1), and one small acrocentric chromosome, without homologue, corresponding morphologically to one of the microchromosomes of female 1. Theories are proposed on the nature of the microchromosomes present in female 1 but absent in female 2.

This is the first description of supernumerary chromosomes in *L. hochstetteri*.

The specimens were collected by Prof. J. Robb in March 1967 (from the Dome Valley, near Warkworth) and exported live to Naples, Italy.

**Reference Type:** Journal Article

**Record Number:** 191

**Author:** Morescalchi, Alessandro

**Year:** 1980

**Title:** Evolution and karyology of the amphibians

**Journal:** Bollettino di Zoologia

**Volume:** 47 (suppl.)

**Pages:** 113-126



**Label:** 191

**Keywords:** evolution; karyotype; phylogeny

**Abstract:** The karyological characters of Amphibia are discussed. The karyology of *Leiopelma* and *Ascaphus* are examined to determine their phyletic relationship. The author cites research by the Stephenson *et al* (ref # 158 & 179) as demonstrating that the karyotype of *Leiopelma* is less similar to the one from the monotypic *Ascaphus*, but believes a striking similarity is shown by the karyotypes of the two genera. Both are asymmetrical and possessing homologue pairs which have the same morphology in *A. truei* and *L. hochstetteri*. The author finds on the whole that the karyological findings favour, therefore, the hypothesis of phyletic relationships between the two genera, and hence their inclusion in a single family.

**Notes:** Bollettino di Zoologia is now The Italian Journal of Zoology.

**Reference Type:** Book

**Record Number:** 216

**Author:** Natusch, Sheila

**Year:** 1999

**Title:** Animals of New Zealand

**Publisher:** Nestegg Books

**Number of Volumes:** 2

**Number of Pages:** 342

**ISBN:** 0958200734 (Pt 1), 0958200742 (Pt II)

**Original Publication:** 1967, Whitcombe and Tombs Limited

**Reprint Edition:** Reprinted with minor alterations 1999

**Label:** 216

**Keywords:** natural history; identification

**Abstract:** This book gives a basic introduction to *Leiopelma*. A brief physical description of *L. hochstetteri*, *L. archeyi* and *L. hamiltoni* (from both Stephens and Maud Island, therefore also referring to *L. pakeka*) is provided.

**Reference Type:** Journal Article

**Record Number:** 118

**Author:** Newman, Donald G.

**Year:** 1977

**Title:** Hamilton's frog

**Journal:** Wildlife - A Review

**Volume:** 8

**Pages:** 48-53

**Label:** 118

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Stephens Island; Maud Island; habitat; translocation

**Abstract:** This paper describes the habitat of *Leiopelma hamiltoni* on both Stephens and Maud Islands (therefore also referring to *L. pakeka*). Research on both islands is also covered.

Photographic records of *L. hamiltoni* on Stephens Island were used for unique identification, using individual skin colour and pattern, especially the series of black markings along the frogs' upper lips.

Possibilities of translocations within each island are discussed.

**Reference Type:** Journal Article

**Record Number:** 153

**Author:** Newman, Donald G.

**Year:** 1977

**Title:** Some evidence of the predation of Hamilton's frog (*Leiopelma hamiltoni* (McCulloch)) by tuatara (*Sphenodon punctatus* (Grey)) on Stephens Island

**Journal:** Proceedings of the New Zealand Ecological Society

**Volume:** 24

**Pages:** 43-47

**Label:** 153

**Keywords:** *Leiopelma hamiltoni*; tuatara; predation; Stephens Island

**Abstract:** This article reports on some evidence, based on a single observation, suggesting that predation of *Leiopelma hamiltoni* by tuatara is occurring on Stephens Island. Bones of the left hind limb of a frog were identified from a tuatara dropping collected from the frogs' habitat. Because of the tenuous state of the island's frog population, factors thought to limit the incidence of predation and the distribution of the frog are discussed.

The protection offered to frogs by rock crevices in their habitat, the differences in surface activity in response to temperature of the two species and their behaviour patterns all tend to reduce the incidence of predation. A future management proposal of creating another habitat for the frog on the island is outlined. This article also includes a comparison between Maud and Stephens Islands for annual temperature and relative humidity.

**Reference Type:** Book Section

**Record Number:** 8

**Author:** Newman, Donald G.

**Year:** 1982

**Title:** A management plan for Hamilton's frog *Leiopelma hamiltoni* on Stephens Island.

**Editor:** Newman, Donald G.

**Book Title:** New Zealand Herpetology: Proceedings of a symposium held at Victoria University of Wellington, January 1980

**City:** Wellington

**Publisher:** New Zealand Wildlife Service

**Volume:** Occasional Publication No. 2

**Pages:** 93-99

**Label:** 8

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; management; habitat

**Abstract:** This paper presents a management plan for *Leiopelma hamiltoni* on Stephens Island. Recommendations for the future management of the frogs' existing habitat are made (aimed, principally, at the habitat's re-afforestation) and a proposal is outlined for the creation of an additional habitat on the island. The existing habitat probably supports at least 200 frogs, and it is suggested that 10-15 could, with safety, be removed to start a new colony.

A description, climatic data and history of the 'frog bank' and details on the

proposed new habitat (later to be called the 'frog pit') are given. On 17 trips to the island between February 1975 and November 1978, 127 searches of the bank resulted in 405 captures of 97 frogs.

Includes notes on discussion after presentation of the paper at the Symposium.

**Reference Type:** Journal Article

**Record Number:** 223

**Author:** Newman, Donald G.

**Year:** 1982

**Title:** New Zealand herpetological research - the work of the NZ Wildlife Service

**Journal:** Herpetofauna

**Volume:** 14

**Issue:** 1

**Pages:** 1-10

**Label:** 223

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Maud Island; Stephens Island; habitat

**Abstract:** Herpetological research carried out by the New Zealand Wildlife Service is described. Results of completed work are summarised and the aims of current projects outlined. Research relevant to *Leiopelma* includes the population studies of *L. hamiltoni* on Stephens Island since 1975, and the proposed creation of a second suitable habitat on the island. The discovery of three *L. hamiltoni* climbing in thick grass and *Muehlenbeckia* vines on Stephens Island in 1970 enabled the population studies to be carried out through surface activity of frogs at night, rather than the previous method of excavating the habitat (prior to 1970, all but one observation had been achieved this way). Climate comparison studies were also carried out between the frog habitats on Stephens and Maud Islands.

**Reference Type:** Journal Article

**Record Number:** 151

**Author:** Newman, Donald G.

**Year:** 1990

**Title:** Activity, dispersion, and population densities of Hamilton's frog (*Leiopelma hamiltoni*) on Maud and Stephens Islands, New Zealand

**Journal:** Herpetologica

**Volume:** 46

**Issue:** 3

**Pages:** 319-330

**Label:** 151

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Stephens Island; Maud Island; conservation; densities

**Abstract:** The paper looks at *Leiopelma hamiltoni* on both Stephens and Maud Islands (therefore also referring to *L. pakeka*). The habitat is described as a 15 ha forest remnant on Maud Island and a 600 m<sup>2</sup> rock-tumble on Stephens Island. No difference in size, or mass, appears to occur between individuals of the two populations. Minimum adult snout-vent length (SVL) is 35 ± 1 mm

(adult size range: 35-47 mm SVL). The frogs are terrestrial and nocturnal, and their activity, as measured by the number caught/night, is best accounted for by environmental factors relating to moisture: rainfall during or preceding searches and high relative humidity. However, within the generally cool and humid Maud Island forest, the activity of adult frogs was also positively correlated with atmospheric temperature. Lack of diurnal retreat sites appears to limit the distribution of the species on Stephens Island. On both islands, but especially on Stephens, frogs spend the day mainly under rocks. At night, most frogs were found at rocky sites. On Maud Island, frog capture sites were positively correlated with rock substrate, their dispersion paralleling that of the rocky ground cover. In two study plots, the density of adult frogs was calculated to be higher in the plot containing the most extensive rocky ground cover (131 versus 29 frogs/100 m<sup>2</sup>). On Stephens Island, the dispersion of frog capture sites was highly clumped, concentrations of captures being made on *Muehlenbeckia* vines covering rocky areas with southerly aspect. There the population density of adult frogs was calculated to be 58/100 m<sup>2</sup>. Frogs limit their activity on the surface to small areas, which may overlap with those of other individuals. The median distances between successive captures of individuals were 0.8 m on Stephens and 0.9 m on Maud Island. At Maud Island, juvenile frogs showed stronger site tenacity than adults. It is suggested that 0.5-1.0 ha of rocky habitat, preferably under forest, should suffice to sustain a population of *L. hamiltoni* and that, consequently, the Stephens Island habitat is too small to support long-term a viable population. As a conservation measure, a previously formulated proposal to create further rock habitat (or habitat providing retreat sites) in the vicinity of the Stephens Island habitat is supported.

127 searches for frogs were made at night on 17 trips to Stephens Island between 1975 and 1978. Stephens Island frogs were photographed for identification rather than toe-clipped. As some individuals on Maud Island were uniform dark-brown in colour, individual toe-clip combinations were used as well as photographs.

**Reference Type:** Journal Article

**Record Number:** 90

**Author:** Newman, Donald G.

**Year:** 1996

**Title:** Native frog (*Leiopelma* spp.) Recovery Plan

**Journal:** Threatened Species Recovery Plan

**Volume:** 18

**Issue:** Department of Conservation

**Pages:** 1-29 + apps

**Label:** 90

**Keywords:** recovery plan; habitat; population studies; advocacy; captivity

**Abstract:** Recovery plans published by the Department of Conservation are statements of the Department's intentions for the conservation of particular plants and animals for a defined period. Past and present distribution of *Leiopelma* spp. is presented, threats to each species are outlined and their ability for recovery is addressed. Options for recovery are discussed and a recovery strategy with goals and objectives is given.

The long-term (50-year) goal of this recovery programme is to maintain and enhance, in the wild, existing genetic stocks of native frogs (*Leiopelma* spp.). The following seven objectives are then explained:

1. Maintain as far as is practicable, all known populations of native frog and protect them from adverse human impacts.
2. Work towards establishing two new wild populations of Hamilton's frog (one of Stephens Island and a second on another predator-free island).
3. Establish a population of the Maud Island frog on a second predator-free island.
4. Establish long-term monitoring at selected sites for all species of native frog to determine population trends.
5. Survey areas of potential habitat seeking to locate further as yet unknown, populations of native frogs and integrate all existing native frog distribution data.
6. Raise public awareness and public advocacy for protection of native frogs and their habitat.
7. Maintain at least one long-term, self-sustaining, captive population of each species of native frog (low priority).

Research priorities are also given.

**Notes:** Missing pages in the hardcopy are just blank pages.

**Reference Type:** Journal Article

**Record Number:** 75

**Author:** Newman, Donald G.

**Year:** 1998

**Title:** Conservation of the world's amphibians and reptiles

**Journal:** Conservation Advisory Science Notes

**Volume:** 204

**Pages:** 14

**Label:** 75

**Keywords:** conservation;

**Abstract:** This paper reports on the Third World Congress of Herpetology held in Prague, Czech Republic, from 2 to 10 August 1997. Contributions from New Zealand on amphibians were:

'Demographic profiles of terrestrial *Leiopelma* (Anura: Leiopelmatidae) in New Zealand' by Ben Bell, Victoria University of Wellington.

'Predation, body-size and survival of New Zealand endemic frogs (Anura: Leiopelmatidae)' by Ben Bell, Victoria University of Wellington.

'Is habitat selection related to morphology in ancient New Zealand frogs?' by Karen Eggers, Massey University (co-authors: I.A.N. Stringer & R.A. Fordham).

**Reference Type:** Journal Article

**Record Number:** 87

**Author:** Newman, Donald G.; Crook, Ian G.; Imboden, C. H.

**Year:** 1978

**Title:** Comparisons of the climates of the two habitats of Hamilton's frog (*Leiopelma hamiltoni* (McCulloch))

**Journal:** New Zealand Journal of Ecology

**Volume:** 1

**Pages:** 84-90

**Label:** 87

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Maud Island; Stephens Island; habitat

**Abstract:** This paper compares the climate data from the two known habitats of *Leiopelma hamiltoni* (a small deforested rock tumble near the summit of Stephens Island called the 'frog bank' and a forest remnant on Maud Island (therefore referring to *L. pakeka*)). These are shown to be remarkably similar, apart from greater extremes of temperature and humidity occurring at the open rock surface of the frog bank than on the surface of the Maud Island habitat. Furthermore, the air space between the rocks of the frog bank is significantly cooler, more humid and subject to less temperature fluctuation than the surface. The frogs, being nocturnal, shelter under these rocks during the day. This habit and the climate of the frog bank are the major factors permitting the survival of the frog on Stephens Island since the frog bank lost its forest cover. Climate data from a nearby remnant of the original forest suggest that the Stephens Island habitat would have been more suitable for frogs in its original forested form than in its present state. Although grasses and *Muehlenbeckia* vines are encroaching onto the frog bank and creating a more favourable microclimate at the habitat's surface, such cover may eventually restrict the access of frogs to sheltering rock crevices.

**Notes:** A hardcopy of the preliminary report by I.G. Crook and C. Imboden 'The microclimates of the two island habitats of the frog *Leiopelma hamiltoni*: a preliminary report' is attached.

**Reference Type:** Journal Article

**Record Number:** 19

**Author:** Newman, Donald G.; Towns, D.R.

**Year:** 1985

**Title:** A survey of the herpetofauna of the northern and southern blocks, Great Barrier Island, New Zealand

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 15

**Issue:** 3

**Pages:** 279-287

**Label:** 19

**Keywords:** Great Barrier Island; *Leiopelma hochstetteri*; habitat

**Abstract:** This is a report on a survey of the herpetofauna of the northern and southern blocks, Great Barrier Island. One species of frog and 11 species of lizard were recorded. This fauna includes three species listed in the 'New Zealand Red Data Book': including *Leiopelma hochstetteri*. Extensive damage is being caused to forests of the northern block by feral pigs and goats, which places the three rare species at risk through erosion and habitat destruction. Not all streams were searched systematically, therefore the numbers found was not a true reflection of local abundance. Two daylight observations were made

of frogs swimming in pools. Measurements were taken from 43 of the 234 frogs located in 11 catchments, all in the northern block. The largest snout-vent length was 47mm.

**Reference Type:** Book

**Record Number:** 166

**Author:** Noble, G. Kingsley

**Year:** 1955

**Title:** The biology of Amphibia

**City:** New York

**Publisher:** Dover Publications Inc.

**Number of Pages:** 577

**ISBN:** '(no number)'

**Original Publication:** 1931

**Label:** 166

**Keywords:** physiology

**Abstract:** This book discusses a comprehensive range of aspects relating to the biology of Amphibia.

Details dealing with *Leiopelma* (as *Liopelma*) include a discussion and illustration of the cartilaginous abdominal ribs. Noble describes the family of 'Liopelmidae' as consisting of two genera - '*Liopelma* and *Ascaphus*'.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Notes:** Hardcopy includes title page, table of contents and pages relevant to *Leiopelma*.

**Reference Type:** Thesis

**Record Number:** 241

**Author:** Norris, Thomas Bruce

**Year:** 1997

**Title:** Chromosomal studies of the New Zealand herpetofauna

**University:** Victoria University of Wellington

**Number of Pages:** 206

**Thesis Type:** MSc.

**Label:** 241

**Keywords:** chromosome; genetics; *Leiopelma hochstetteri*

**Abstract:** This thesis deals with four separate topics relating to New Zealand's herpetofauna. One explores the cytogenetics of *Leiopelma hochstetteri*. Research by D.M. Green of McGill University, Canada, has suggested a novel sex determination system, where the W sex chromosome is on a supernumerary (or B) chromosome. This essay reassesses Green's research and suggests a more parsimonious conclusion, namely that the sex chromosomes have yet to be found.

**Notes:** Hardcopy includes title page, abstract, preface, table of contents, lists of figures and tables, conclusions and concluding remarks.

**Reference Type:** Book

**Record Number:** 212

**Author:** O'Brien, C.

**Year:** 1981  
**Title:** AA Book of New Zealand wildlife  
**City:** Auckland  
**Publisher:** Lansdowne Press  
**Number of Pages:** 161  
**ISBN:** 0868660612  
**Label:** 212  
**Keywords:** biogeography; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*  
**Abstract:** This book is an introduction to the wildlife, both endemic and introduced, of New Zealand. The geological origin of New Zealand is discussed in relation to its fauna. A brief introduction to *Leiopelma* is included. The fauna of Stephens and Maud Islands is also separately covered, including *L. hamiltoni* (and therefore also *L. pakeka*). All three species are described as endangered, due to restricted habitat.  
**Notes:** Hardcopy includes the introduction and pages relevant to *Leiopelma* only.

**Reference Type:** Report

**Record Number:** 183  
**Author:** Ogle, C.C.  
**Year:** 1980  
**Title:** Wildlife and wildlife habitat of Great Barrier Island  
**City:** Wellington  
**Institution:** Fauna Survey Unit, N.Z. Wildlife Service  
**Pages:** 43 + appendices  
**Type:** Report No. 24  
**Label:** 183

**Keywords:** Great Barrier Island; survey; habitat; *Leiopelma hochstetteri*  
**Abstract:** This is a report of a survey carried out by the Fauna Survey Unit of the Wildlife Service to inventory wildlife and habitats on Great Barrier Island. The survey was carried out from 26 March to 12 April 1980. A history of the wildlife and wildlife habitat is also given.  
Although no native frogs had been reported previously on this island, Great Barrier's geological links with the Coromandel Peninsula suggested that either or both *Leiopelma hochstetteri* and *L. archeyi* could be present. Likely habitat was searched and small numbers of *L. hochstetteri* were found in five different catchments in the Northern Block of forest. Scouring of streams during kauri log 'drives' and the decline in stream bed quality, particularly resulting from goat and pig damage, are likely to have resulted in a reduced range and lower numbers of frogs on the island.  
Recommendations for habitat conservation and species preservation are given.  
**Notes:** Hardcopy includes maps showing both forest and wetland habitats of value to wildlife.

**Reference Type:** Journal Article

**Record Number:** 15  
**Author:** Ogle, C.C.



**Year:** 1981  
**Title:** Great Barrier Island wildlife survey  
**Journal:** Tane  
**Volume:** 27  
**Pages:** 177-200  
**Label:** 15

**Keywords:** Great Barrier Island; *Leiopelma hochstetteri*; genetics; habitat  
**Abstract:** A survey of Great Barrier was carried out in March-April 1989 as a contribution to a multi-disciplinary land-use study of the island. This is the first recording of *Leiopelma hochstetteri* on Great Barrier. 20 specimens were found in five catchments of the Northern Block of forest. Two were subsequently given to Dr Ben Bell of Victoria University of Wellington. One of these was used for electrophoretic studies, no significant difference was found between this and the mainland populations. The frogs' habitat was found to be most effected by deterioration of the forest and surrounding streams due to goats, wild pigs and wandering farm stock.

**Reference Type:** Report

**Record Number:** 195  
**Author:** Ometto, Lino; Waldman, Bruce  
**Year:** 2001  
**Title:** Chemical cues in Maud Island frogs, *Leiopelma hamiltoni*  
**City:** Christchurch  
**Institution:** University of Canterbury  
**Pages:** 4  
**Type:** Unpublished report  
**Label:** 195

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; chemical cues  
**Abstract:** The main objective of these studies was to establish if *Leiopelma hamiltoni* (from Maud Island, therefore referring to *L. pakeka*) is able to discriminate between two different chemical stimuli. The two sources of chemical signal were soil, paper towel (marked by frogs when housed for short periods) and faeces. The origins of these cues were both self and non-self. Tests were carried out in January and February/March 2001. In the January trials, frogs spend significantly more time on the side with their own soil than on the side with non-self soil (binomial distribution,  $n = 28$ ,  $p = 0.044$ ). In the February/March tests frogs were housed for two weeks before testing. Most frogs chose their own soil when presented with unfamiliar soil, whereas most frogs preferred familiar soil to own soil. However, sample sizes were insufficient to make these results statistically significant. This study may have implications for translocations, in that frogs may attempt to 'home'. In one observation on Maud Island, an adult and seven juveniles (snout-vent length 15-23 mm) were found under a single rock.

**Reference Type:** Magazine Article

**Record Number:** 136  
**Author:** Pain, Stephanie  
**Year:** 2002

**Title:** Ready to croak  
**Magazine:** New Scientist  
**Volume:** 6 April 2002  
**Pages:** 17  
**Label:** 136  
**Keywords:** chytrid fungus; *Leiopelma archeyi*; *Leiopelma pakeka*; *Leiopelma hamiltoni*

**Abstract:** This article quotes Bruce Waldman and Ben Bell, after the discovery of dead and dying *Leiopelma archeyi* from three separate populations being tested positive for the fungus *Batrachochytrium dendrobatidis*.

The article states that 'biologists have noticed a decline in these [*L. archeyi*] terrestrial frogs since 1996, and at some sites 80% of the frogs have gone.' *L. pakeka* is stated as being 'down to a few thousand individuals' and *L. hamiltoni* as being 'fewer than 300'.

**Reference Type:** Report

**Record Number:** 188

**Author:** Parrish, Richard

**Year:** 1993

**Title:** Hochstetter frog survey in the Waipu Gorge and Brynderwyn Hills area

**City:** Whangarei

**Pages:** 8

**Type:** Unpublished report for the Northland Conservancy, Department of Conservation

**Label:** 188

**Keywords:** *Leiopelma hochstetteri*; Waipu; Brynderwyn Hills; survey

**Abstract:** A survey for *Leiopelma hochstetteri* in the Waipu Gorge area and the Brynderwyn Hills east to King Road and south to Bald Rock was conducted between March and June 1993. The survey was carried out mainly by students from the Northland Polytech Conservation Corps with assistance from DoC Conservancy Office and Field Centre staff and volunteers.

248 frogs were observed over 29,035 m distance covered with 4,510+ minutes searching time. Habitat modification as a result of pig activity was noted by several of the observers.

A progress report of a survey between January and May 1991 in the headwaters of 11 small streams (approximately 6 km) in the Ruakaka Forest and the Takahiwai Hills is also included. No *L. hochstetteri* were found.

**Reference Type:** Report

**Record Number:** 189

**Author:** Parrish, Richard

**Year:** 1994

**Title:** Hochstetter frog survey of the Mareretu Forest and Waipu Caves area

**City:** Whangarei

**Pages:** 8

**Type:** Unpublished report for the Northland Conservancy, Department of Conservation

**Label:** 189

**Keywords:** *Leiopelma hochstetteri*; survey; Waipu; Mareretu

**Abstract:** A survey for *Leiopelma hochstetteri* was conducted in the Mareretu Forest, Waipu Caves Bush, Caves Road Bush, North River Bush and the bush north of Mountfield Road (Ruakaka Forest). Maps of these locations are included. The survey was carried out by students from the Northland Polytech Conservation Corps with assistance from DoC staff and a volunteer. A total of 117 frogs were located, covering 18,950 m in 1,970 minutes searching time. Pig damage was less severe than recorded in the Brynderwyn/Waipu Gorge area (ref # 188) and goats were also in low numbers in the area. Damage by stock (principally cattle) was widespread although mainly confined to the lower reaches of the streams closest to pasture. The worst damage was in the North River Scenic Reserve, which is unfenced.

**Reference Type:** Journal Article

**Record Number:** 209

**Author:** Parrish, Richard

**Year:** 1994

**Title:** Hochstetter frog survey of the Mareretu Forest and Waipu Caves area

**Journal:** Moko

**Volume:** 94

**Issue:** 4

**Pages:** 7-8

**Label:** 209

**Keywords:** survey; *Leiopelma hochstetteri*; Waipu; Mareretu

**Abstract:** This is a short article on the survey of *Leiopelma hochstetteri* that was conducted in the Mareretu Forest, Waipu Cave Bush, Caves Road Bush, North River Bush and bush north of Mountfield Road (Ruakaka Forest). A full report on this is provided in an unpublished report to the Northland Conservancy, Department of Conservation (ref # 189).

**Reference Type:** Journal Article

**Record Number:** 50

**Author:** Penniket, A.

**Year:** 1977

**Title:** A study of the distribution of the native frog (*Leiopelma hochstetteri*) in the greater Warkworth area.

**Journal:** Pepeke

**Volume:** 2

**Issue:** 1

**Pages:** 1-5

**Label:** 50

**Keywords:** *Leiopelma hochstetteri*; Warkworth; survey

**Abstract:** The study looked at locations where *Leiopelma hochstetteri* were found in the greater Warkworth area. This was done by searches as well as inquiry with local farmers. Map references are given where *L. hochstetteri* were found extending the known range to approximately 15 miles in the area. The frog was found in a wide variety of habitats and often found in association with the plant *Elatostema rugosum* and the freshwater lobster *Paranephrops*

*planifrons*. In no location were frogs and eels present together - possibly as any stream large enough to support eels would be susceptible to flooding and therefore unsuitable for *L. hochstetteri*.

**Reference Type:** Thesis

**Record Number:** 230

**Author:** Perfect, Alison

**Year:** 1996

**Title:** Aspects of the ecology of the native frogs *Leiopelma archeyi* and *L. hochstetteri*, and the impact of compound 1080

**University:** Victoria University of Wellington

**Number of Pages:** 167

**Thesis Type:** MSc.

**Label:** 230

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; 1080; ecology

**Abstract:** A study of *Leiopelma archeyi* and *L. hochstetteri* was undertaken in the Tapu area, Coromandel, in 1995 to assess the impact of 1080 poison. Frog populations within and outside the poisoned area were monitored by repeated monthly counts over strip transects. Frog numbers were assessed using generalised linear models. Test power ( $\beta$ , the probability of correctly identifying the presence of a 1080 effect on frog numbers), was determined using the non-central chi-squared distribution. Vegetation was assessed by two-way indicator species analysis (TWINSPAN) to establish the similarity of habitat in 1080-treated and untreated areas.

Poison application did not cause a decline in *L. archeyi*. The low numbers of *L. hochstetteri* found were insufficient to determine with statistical certainty whether any population decrease occurred. Theoretically the native frog populations are unlikely to be affected by 1080 used in pest control; however, the applicability of results from this field study to other 1080 operations may be compromised by high rainfall following bait distribution, and subsequent rapid poison breakdown. The necessity of analysing test power (ie probability that a decline will be detected) in any future study of 1080 impact is stressed.

*L. hochstetteri* density varied from 0-22 frogs per 100 m length of stream (0-15 per 50 m transect), and 0-8 frogs/100m<sup>2</sup> (0-8 per 50 m strip transect) on terrestrial forest floor transects. *L. hochstetteri* appears to be reasonably mobile on land, and to utilise terrestrial habitat more commonly than previously indicated. *L. hochstetteri* individuals found in terrestrial locations were significantly larger ( $p$  less than or equal to 0.005) than those discovered along creeks.

*L. archeyi* density ranged from 1-35 frogs/100<sup>2</sup> (1-35 per 50 m strip transect) on forest floor transects. A scarcity of *L. archeyi* sightings along creeks (three frogs found) confirms reports of near-exclusive terrestrial habitat use by this species in Coromandel. Both species were found predominately under rocks (96% of *L. archeyi* sightings, 93.3% of *L. hochstetteri* sightings).

Pairs or groups of frogs were found on numerous occasions. Social or environmental factors are at least partially responsible for multiple sightings in *L. hochstetteri*; the occurrence of *L. archeyi* pairs and groups appears density-dependent. Monthly counts of *L. hochstetteri* along creeks were significantly

correlated ( $p$  less than or equal to 0.05) to maximum and minimum temperatures leading up to and including the search day, and rainfall over the preceding 10 days. No consistent correlation was found between *L. archeyi* numbers and temperature or rainfall variables.

Frog density indices commonly used in native frog research were compared for reliability.

**Notes:** Hardcopy includes title page, list of contents, figures etc and abstract only.

**Reference Type:** Journal Article

**Record Number:** 38

**Author:** Perfect, Alison

**Year:** 1997

**Title:** The use of density indices for monitoring native frogs, *Leiopelma archeyi* and *L. hochstetteri*

**Journal:** New Zealand Journal of Zoology

**Volume:** 24

**Pages:** 328

**Label:** 38

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; monitoring; densities

**Abstract:** This is an abstract of a paper presented at the 7th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held in Kaikoura, from 31 January-2 February 1997.

A study of *Leiopelma archeyi* and *L. hochstetteri* was undertaken in the Tapu area, Coromandel. Index counts of *L. archeyi* were made along terrestrial forest floor transects, and of *L. hochstetteri* along stream transects, at approximately monthly intervals between January and October 1995. Data and observations from this monitoring exercise are used to compare density indices commonly used in native frog studies, contrasting search effort-based indices with an index of sample densities. The limitations of search effort indices (frogs per number of retreat sites examined or frogs per hour of search effort) are illustrated.

**Reference Type:** Report

**Record Number:** 56

**Author:** Pickard, C.R.; Towns, D.R.

**Year:** 1988

**Title:** Atlas of the amphibians and reptiles of New Zealand

**City:** Wellington

**Institution:** Science and Research Directorate, Department of Conservation

**Pages:** 59

**Type:** Conservation Sciences Publication No. 1

**Label:** 56

**Keywords:** distribution

**Abstract:** This publication maps the known distributions of both native (*Leiopelma hochstetteri*, *L. archeyi* and *L. hamiltoni*) and introduced frogs in New Zealand.

**Reference Type:** Journal Article

**Record Number:** 88

**Author:** Pledger, Shirley

**Year:** 1998

**Title:** Monitoring protocols for Hamilton's frogs *Leiopelma hamiltoni* on Stephens Island

**Journal:** Conservation Advisory Science Notes

**Volume:** 205

**Issue:** Department of Conservation

**Pages:** 1-17

**Label:** 88

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; monitoring

**Abstract:** This report provides recommendations for a sampling scheme for a mark-recapture study of *Leiopelma hamiltoni* on Stephens Island. This is a threatened species and monitoring is required for the next five years, with a view to ascertaining if the population is steady, increasing or decreasing. Recommendations are given for appropriate numbers of trips per year (four) and numbers of sampling nights per trip (five nights per trip if five or more new frogs captured each night). Advice is also given about the sampling intensity and methods, the records to keep, and the appropriate statistical analyses to be used.

Most of the sections refer to the frog bank population; the frog pit population being discussed separately.

**Reference Type:** Report

**Record Number:** 140

**Author:** Pledger, Shirley

**Year:** 1999

**Title:** Monitoring protocols for Motuara Island frogs *Leiopelma pakeka*

**Institution:** School of Mathematical and Computing Sciences, Victoria University of Wellington

**Pages:** 22

**Type:** Unpublished Research Report 99-9

**Label:** 140

**Keywords:** *Leiopelma pakeka*; monitoring; Motuara Island

**Abstract:** This research report shows that analysis of the post-release capture-recapture data for the Motuara Island frog population shows a statistically significant drop in the population size on the grid between July 1997 and October 1998. This drop is due to a mixture of deaths and movement off the grid, but there is no appropriate off-grid information to distinguish how much of the drop is attributable to each cause.

The small numbers now remaining on the grid will be too low for future capture-recapture analyses to have the power to detect even quite substantial drops in the population. It will be necessary to enlarge the search grid, in order to sample enough animals for adequate detection of population trends.

Recommendations include three trips per year, each with at least 50 captures, including 19 or more within-trip recaptures.

**Reference Type:** Book

**Record Number:** 214

**Author:** Powell, A. W. B.

**Year:** 1998  
**Title:** Powell's Native animals of New Zealand  
**Series Editor:** Gill, Brian  
**City:** Auckland  
**Publisher:** David Bateman Ltd  
**Number of Pages:** 94  
**Edition:** Fourth  
**ISBN:** 1869533933  
**Original Publication:** 1961, Unity Press Ltd, updated by W.O. Cernohorsky, B.J. Gill, A.B. Stephenson and K.A.J. Wise  
**Label:** 214  
**Keywords:** natural history  
**Abstract:** This is an updated version of an Auckland Museum handbook of zoology. A brief reference gives the distribution of *Leiopelma* as: *L. hochstetteri* - several northern North Island mountain ranges; *L. archeyi* - the Coromandel Range; and *L. hamiltoni* - Stephens Island and Maud Island (therefore also referring to *L. pakeka*).  
**Reference Type:** Book  
**Record Number:** 283  
**Author:** Riley, Murdoch  
**Year:** 1983  
**Title:** New Zealand wildlife  
**City:** Wellington  
**Publisher:** Viking Sevenses Ltd  
**Number of Pages:** 65  
**ISBN:** '(no number)'  
**Label:** 283  
**Keywords:** natural history  
**Abstract:** This is a natural history publication on New Zealand wildlife, both endemic and introduced. Three species of *Leiopelma* are referred to. A distribution for *Leiopelma hochstetteri* is given as the Coromandel Peninsula, Waitakere Ranges, some parts of Northland and Bay of Plenty.  
**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.  
**Reference Type:** Book Section  
**Record Number:** 274  
**Author:** Robb, Joan  
**Year:** 1973  
**Title:** Reptiles and Amphibia  
**Editor:** Williams, Gordon R.  
**Book Title:** The natural history of New Zealand: an ecological survey  
**City:** Wellington  
**Publisher:** A. H. & A. W. Reed Ltd  
**Pages:** 434  
**Label:** 274  
**Keywords:** ecology; physiology; history  
**Abstract:** This chapter provides a general introduction to the ecology and

physiology of *Leiopelma*. A history of discoveries for each species is also given.

**Reference Type:** Book

**Record Number:** 11

**Author:** Robb, Joan

**Year:** 1986

**Title:** New Zealand amphibians & reptiles

**City:** Auckland

**Publisher:** William Collins Publishers Ltd

**Number of Pages:** 128

**Edition:** Originally published 1980, revised 1986

**ISBN:** 0002175754

**Original Publication:** 1980

**Reprint Edition:** 1986

**Label:** 11

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma hamiltoni*; *Leiopelma archeyi*; history; natural history

**Abstract:** The book describes the herpetofauna of NZ and includes a brief note on their origins. A history of discoveries for *Leiopelma* is also included. *L. hochstetteri*, *L. archeyi* and *L. hamiltoni* (from both Stephens and Maud Islands, therefore includes *L. pakeka*) are all described, including life history, distribution. An explanation of personal names given to NZ frogs is given: *L. archeyi* after Sir Gilbert Archey, *L. hamiltoni* after Mr H. Hamilton and *L. hochstetteri* after Dr Ferdinand Ritter von Hochstetter.

**Notes:** Hardcopy of relevant pages from the 1980 edition also attached.

**Reference Type:** Book

**Record Number:** 275

**Author:** Roberts, Gordon; Tunnicliffe, Geoffrey

**Year:** 1974

**Title:** Wild animals of New Zealand

**Series Title:** A Microtone Colour Book

**City:** Christchurch

**Publisher:** Bascands Limited

**Number of Pages:** 32

**ISBN:** '(no number)'

**Label:** 275

**Keywords:** ecology

**Abstract:** This book provides a general introduction to *Leiopelma* and introduced frogs in New Zealand.

**Reference Type:** Journal Article

**Record Number:** 220

**Author:** Robinson, E. S.; Stephenson, Elsie M.; Stephenson, N.G.

**Year:** 1973

**Title:** Nuclear constitution of primary oocytes of the frog *Leiopelma hochstetteri* (Ascaphidae)

**Journal:** Copeia

**Volume:** 1



**Pages:** 173-176

**Label:** 220

**Keywords:** genetics; *Leiopelma hochstetteri*; physiology

**Abstract:** This study was to determine whether a gene amplification mechanism similar to that of *Ascaphus* is also found in *Leiopelma*. *Ascaphus* and *Leiopelma* were considered to be genera of the same family at the time of this publication. Five specimens of *L. hochstetteri* were collected, primarily for karyotype analysis. Only one specimen was a female, therefore these observations were necessarily based on limited material. *L. hochstetteri* was found to possess a mononucleate mechanism for nucleolar gene amplifications of a type also found in other anuran families. Multinucleate gene amplification in *Ascaphus* is apparently a remarkable and highly specialised mechanism but its adaptive significance remains to be established. The difference between the mechanism of amplification in the oocytes of *Leiopelma* and *Ascaphus* adds an important cytological distinction to the quite extensive array of anatomical and development differences (which are also described). Thus the current phylogeny of the two species is questioned.

**Reference Type:** Book Section

**Record Number:** 70

**Author:** Savage, Jay M.

**Year:** 1973

**Title:** The geographic distribution of frogs: patterns and predictions

**Editor:** Vial, James L.

**Book Title:** Evolutionary Biology of the Anurans

**City:** Columbia

**Publisher:** University of Missouri Press

**Pages:** 351-445

**Label:** 70

**Keywords:** biogeography; distribution

**Abstract:** This paper aims to relate known facts of frog distribution to the known facts of present and past climate and geography. At the time, the status of Leiopelmatidae was regarded as uncertain (ie whether to be considered as a separate suborder). Jurassic fossils from Argentina that are extremely close to *Leiopelma* in adult skeletal features are briefly discussed. *Leiopelma* is described as a relict of an ancient temperate Gondwanland radiation.

**Reference Type:** Journal Article

**Record Number:** 129

**Author:** Scheltinga, David M.; Jamieson, Barrie G. M.; Eggers, Karen E.; Green, David M.

**Year:** 2001

**Title:** Ultrastructure of the spermatozoon of *Leiopelma hochstetteri* (Amphibia, Anura, Leiopelmatidae)

**Journal:** Zoosystema

**Volume:** 23

**Issue:** 1

**Pages:** 157-171

**Label:** 129

**Keywords:** *Leiopelma hochstetteri*; physiology; phylogeny

**Abstract:** The spermatozoon of the basal frog *Leiopelma hochstetteri* is examined and compared with previously investigated lissamphibian spermatozoa. *L. hochstetteri* spermatozoa share with those of urodeles and *Ascaphus* the plesiomorphic (primitive) features of an elongated conical acrosome, and an elongate nucleus, with distinct nuclear shoulders, which tapers to a point (as the nuclear rostrum) in the subacrosomal space. The spermatozoon of *L. hochstetteri*, alone among the Anura, resembles those of urodeles in having a juxta-axonemal fibre at doublet 8. *L. hochstetteri* shares with *Ascaphus truei* (homoplastically) the reduction of the undulating membrane to a short, thick paraxonemal rod. *L. hochstetteri* spermatozoa have the plesiomorphic condition, also seen in dipnoans, of a cytoplasmic collar, containing mitochondria, around the axoneme. Although the sperm of *L. hochstetteri* lacks the endonuclear perforatorium seen in *Ascaphus*, Bombinidae, urodeles and caecilians, it has what may be remnants of an endonuclear perforatorium within the nuclear rostrum. No synapomorphic spermatozoal characters are present to support the placement of *Leiopelma* and *Ascaphus* in the same family. Spermatologically, *Leiopelma* is the plesiomorphic sister taxon of all other anurans and is thus confirmed as the most basal (primitive) anuran.

Four specimens of *L. hochstetteri* were collected from Whareorino forest, King Country, maintained at Massey University for one week then transported to Victoria University of Wellington where each frog was euthanased. The testes of the only male were fixed for transmission electron microscopy (TEM) by C. H. Daugherty. Testis material was then sent to Brisbane, Australia for TEM processing.

**URL:** [www.mnhn.fr/publication/](http://www.mnhn.fr/publication/)

**Reference Type:** Thesis

**Record Number:** 244

**Author:** Sharbel, Timothy F.

**Year:** 1996

**Title:** Molecular genetic composition, origin, and evolution of B chromosomes in the New Zealand frog *Leiopelma hochstetteri*

**Academic Department:** Department of Biology

**City:** Montreal

**University:** McGill University

**Number of Pages:** 93

**Thesis Type:** MSc.

**Label:** 244

**Keywords:** *Leiopelma hochstetteri*; genetics; evolution; chromosome

**Abstract:** *Leiopelma hochstetteri* is characterised by variable numbers of mitotically-stable B chromosomes. In order to assess whether the B chromosomes had been derived from the autosome complement, B DNA was isolated and amplified by micromanipulation in conjunction with degenerate oligonucleotide-primed PCR. Southern hybridisation patterns of B DNA probes to genomic DNA from males and females characterised by differing numbers of B's demonstrated that the B

chromosomes were derived from the univalent W chromosome which is specific to females. The presence of homologous B specific sequences in B chromosomes from geographically-distinct populations show that only a single univalent W to B event had occurred. Furthermore, a plesiomorphic homology shows that the B chromosomes originated soon after the univalent W had been derived from the ancestral WZ/ZZ karyotype, which is still present in frogs from Great Barrier Island. Finally, sequence analysis of the probes reveals that B DNA is composed of repeat sequences, and has the ability to form stable hairpin structures *in vivo*. The molecular dynamics of these structures may reflect the inherent propensity to undergo rapid change in nucleotide sequence and chromosome structure. Specimens used were those collected by David Green in 1987, 1989 and 1993 from 11 different localities on the North Island. Frogs were taken back to Montreal and housed in specially designed aquaria. The frogs were maintained on a 12-hour photoperiod with temperatures that varied from 19°C during the day to 17°C during the night.

**Notes:** Hardcopy is from microfiche and includes title page, abstract, table of contents and introduction.

**Reference Type:** Journal Article

**Record Number:** 225

**Author:** Sharbel, Timothy F.; Green, David M.

**Year:** 1992

**Title:** Captive maintenance of the primitive New Zealand frog, *Leiopelma hochstetteri*

**Journal:** Herpetological Review

**Volume:** 23

**Issue:** 3

**Pages:** 77-79

**Label:** 225

**Keywords:** *Leiopelma hochstetteri*; captivity; disease; artificial induction of egg-laying; husbandry

**Abstract:** This paper describes the experience of the authors of maintaining *Leiopelma hochstetteri* in captivity at the Redpath Museum, McGill University, Montreal, Canada. These animals were kept for chromosomal studies. The construction of 'riffle' tanks is described. The frogs were fed second and fourth instar crickets once weekly. The crickets were fed high protein rat chow for a day before being fed to the frogs.

From an original stock of 28 frogs, 11 were euthanised for research purposes and four died, apparently from disease. Two of those may have died from kidney dysfunction or a form of subcutaneous lymphatic edema. Frogs showed significant growth over the two years in captivity. Attempts were made to artificially induce egg-laying with hormones. Amplexus and egg-laying were observed, but none of the resulting eggs were fertile. A dose of 10 µg of LHRH given to one gravid female resulted in apparent overstimulation leading to death.

**Reference Type:** Journal Article

**Record Number:** 4

**Author:** Sharbel, Timothy F.; Green, David M.; Houben, Andreas

**Year:** 1998

**Title:** B-chromosome origin in the endemic New Zealand frog *Leiopelma hochstetteri* through sex chromosome devolution.

**Journal:** Genome

**Volume:** 41

**Issue:** 1

**Pages:** 14-22

**Label:** 4

**Keywords:** *Leiopelma hochstetteri*; chromosome; Great Barrier Island; Waitakere; Moehau; Whareorino; genetics

**Abstract:** This paper examines the origin of B-chromosomes in *Leiopelma hochstetteri*, which has variable numbers of mitotically stable B chromosomes. To assess whether the B chromosomes were derived from the autosome complement, they were isolated by micromanipulation and their DNA amplified by degenerate oligonucleotide primed PCR. Southern hybridisations of B chromosome DNA probes to genomic DNA from males and females characterised by differing numbers of B chromosomes demonstrated that the B chromosomes were derived from the univalent W sex chromosome characteristic of North Island populations. The presence of homologous B chromosome specific sequences from geographically distinct populations indicates a single origin of the B chromosomes. Furthermore, a primitive homology shared by B chromosomes and the W sex chromosome from an ancestral WZ/ZZ karyotype, which is still present in frogs from Great Barrier Island, shows that the B chromosome originated soon after the univalent W sex chromosome has originated. Sequence analysis revealed that B chromosome DNA is composed of repeat sequences and has the potential to form stable hairpin structure. The molecular dynamics of these structures may reflect an inherent propensity to undergo rapid change in nucleotide sequence and chromosome structure.

Frogs were collected from 12 different locations in the North Island in 1987, 1989 and 1993.

Southern hybridization analyses were carried out on *L. hochstetteri* from the Waitakere Mountains, Mount Moehau, Whareorino and Great Barrier Island. A single female *L. archeyi* from Whareorino was also analysed.

**Reference Type:** Book

**Record Number:** 47

**Author:** Sharell, Richard

**Year:** 1966

**Title:** The tuatara, lizards and frogs of New Zealand

**City:** London

**Publisher:** Collins

**Number of Pages:** 94

**ISBN:** '(no number)'

**Label:** 47

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma hamiltoni*; natural history

**Abstract:** This book gives a history of discoveries of *Leiopelma hochstetteri*,

*L. archeyi* and *L. hamiltoni* (on Stephens and Maud Islands). There is also a brief physical description of the above species as well as some notes on ecology.

**Reference Type:** Report

**Record Number:** 181

**Author:** Shaw, Pete G.

**Year:** 1993

**Title:** Hochstetters frog survey Eastern Bay of Plenty

**Pages:** 13 + appendices

**Type:** Unpublished report for the Department of Conservation

**Label:** 181

**Keywords:** *Leiopelma hochstetteri*; Bay of Plenty; survey; distribution

**Abstract:** This is a report on a field survey of *Leiopelma hochstetteri* in the Eastern Bay of Plenty for the Department of Conservation over the period 1-5 March 1993. Frogs were searched for over a range of habitats and locations. Frogs were found in or immediately adjacent to a range of watercourses from rivers down to small seepages undefined on the 1:50,000 topographical maps. They were found under a variety of vegetation cover that provided direct shade for the watercourse. Open pasture or open shingle riverbeds were a severely limiting factor on presence/absence of the frogs.

The survey covered two broad areas; the Rawea-Takaputahi, and secondly the lower Meremere, lower Otara, Waiaua and lower Waioweka Catchments. The latter area appears to be on the fringe of frog distribution. The Rawea-Takaputahi area had noticeably higher frog numbers per search area.

A total of 183 frogs were encountered. These displayed various shades of brown or green colouration sometimes with orange markings while five had white snouts. Frog size ranged from 17-49 mm in snout-vent length.

**Notes:** Hardcopy includes the initial survey proposal and locations map as appendices

**Reference Type:** Report

**Record Number:** 180

**Author:** Shaw, Pete G.

**Year:** 1994

**Title:** Hochstetters frog survey Opotiki Field Centre

**Pages:** 10 + appendices

**Type:** Unpublished report for the Department of Conservation

**Label:** 180

**Keywords:** *Leiopelma hochstetteri*; survey; distribution; Bay of Plenty

**Abstract:** This is a report on a field survey of *Leiopelma hochstetteri* conducted from the Opotiki Field Centre, Department of Conservation during March 1994. A total of 20 watercourses were surveyed with six yielding a total of 32 frogs. Snout-vent lengths ranged from 15-46 mm. Fourteen of these frogs came from one small watercourse in the Kotepato whilst the other five frog positive watercourses yielded seven and lower. This appears to continue the trend perceived in 1993 where frog density on the fringe of their range appears lower than within the heart of their distribution.

A site in the Pakihi Valley was investigated by field centre staff in conjunc-

tion with a local forest contracting firm. This was to investigate the viability of establishing monitoring sites prior to a scrub clearance and pine planting programme. No frogs were located in the four watercourses surveyed and this option was abandoned.

This years survey has extended the known range of the frogs on the true right of the Waioeka River. The upstream limit in this area appears to be around the Okarewa Stream. It has also confirmed the apparent absence of frogs on the true left of the Waioeka. This report is seen as being part of the ongoing annual information gathering on these frogs.

Locations searched by both Shaw and Field Centre staff are given.

**Reference Type:** Report

**Record Number:** 263

**Author:** Slaven, David C

**Year:** 1989

**Title:** The impact of gold mining operations on the endemic frog *Leiopelma hochstetteri*

**City:** Hamilton

**Institution:** Waikato Conservancy, Department of Conservation

**Pages:** 22

**Type:** Unpublished working report # 1 project initiation

**Label:** 263

**Keywords:** *Leiopelma hochstetteri*; Golden Cross Mine; Coromandel

**Abstract:** This report sets out the context of a study to investigate the effects of gold mining operations (by Cyprus Gold (NZ)) on the local populations of *L. hochstetteri* at Golden Cross, Coromandel, other than those of direct habitat destruction via stream pollution. The experimental design and details of the methodology employed in initiating the experiment are discussed.

A reconnaissance of fourteen tributaries of the Waitekauri River in the immediate vicinity of the open pit site was undertaken in July 1989. Nine of these were searched for frogs, with six streams found to support populations of *L. hochstetteri*. Night search techniques proved unsuccessful and were abandoned in favour of daytime searches. Fifty-two frogs were captured, of which 40 were toe clipped. Snout-vent lengths ranged from 10 - 42 mm. Individuals were assigned to one of three broad age categories as follows: 10 - 19 mm as juvenile (28.8%); 22 - 29 mm as young-adult (25.0%); and 30 - 42 mm as adult-mature (46.2%).

Two frogs uncovered were deformed. One was clubfoot, possibly as a result of an accident, but also possibly genetically based. The other also had a clubfoot and a complete third hind leg which was perfectly formed including five toes. The frog did not appear to be handicapped by this genetic deformity.

**Reference Type:** Thesis

**Record Number:** 132

**Author:** Slaven, David C

**Year:** 1992

**Title:** *Leiopelma hochstetteri* a study of migratory thresholds and conservation status

**Academic Department:** Environmental Science and Geography

**University:** University of Auckland

**Number of Pages:** 177 + apps

**Thesis Type:** MSc.

**Label:** 132

**Keywords:** *Leiopelma hochstetteri*; conservation; genetics; migration; status; legislation

**Abstract:** This research assists in refining current knowledge as to the true conservation status of *Leiopelma hochstetteri* by way of a detailed investigation into the migratory thresholds of a sample group within a reported stronghold area. Additionally an ancillary investigation is made into both the abundance and population structure of this same group. Both field observations and genetic and cytogenetic diagnoses are undertaken in the analysis of migration, and computer-assisted investigations are undertaken with regard to the other criteria.

Migration between adjacent streams within the same catchment was found to be very limited, but of great enough magnitude to apparently offset any problems normally associated with genetic isolation. With all things considered, there is no compelling evidence to suggest other than that the groups in the five sample streams constitute one population.

Notwithstanding this, it is also noted that the species may exhibit strong spatial affinity (ie: site faithfulness). However, this may not be entirely compatible with any notion of *L. hochstetteri* being a markedly sedentary creature. Given appropriate climatic conditions, there seems to be no reason to reject the hypothesis that *L. hochstetteri* is capable of significant terrestrial (as well as aquatic) mobility.

The abundance analysis utilised two techniques, being the minimum alive method and a computer programme called CAPTURE7. The former yielded a mean minimum estimation of 65 frogs per 100 m of stream length. The latter yielded a mean best estimate of 140 frogs per 100 m of stream length.

The problems of species management and nature conservation are discussed within a legislative context, and the recently enacted Resource Management Act 1991 identified as a significant move towards effecting appropriate preservation strategies.

**Notes:** Hardcopy includes title page, abstract, table of contents, lists of figures and tables and maps of the study area and stream locations.

**Reference Type:** Journal Article

**Record Number:** 156

**Author:** Smith, S. Percy

**Year:** 1921

**Title:** Letter - Frogs in New Zealand

**Journal:** The New Zealand Journal of Science and Technology

**Volume:** 3

**Pages:** 308 (with a note by J.A. Thomson)

**Label:** 156

**Keywords:** Coromandel; *Leiopelma archeyi*; history

**Abstract:** This letter describes a visit in 1862 by Percy Smith to the Coromandel to define the boundaries of the Tokatea Ridge, as a Government surveyor. While surveying, several frogs were discovered 'which were about 1 in. in length and  $\frac{1}{2}$  in. in width. They were green and golden-brown in colour'. Maoris accompanying Mr Smith were unable to provide a Maori name for them. Two of these specimens were removed by Mr Smith (in a tin match-box) and later given to Sir George Grey.

This is considered to be the first recorded discovery of *Leiopelma archeyi*.

The note by J.A. Thomson refers to his own unsuccessful searches around the Coromandel and Oponui for frogs.

**Reference Type:** Report

**Record Number:** 192

**Author:** Smuts-Kennedy, C. J.

**Year:** 1997

**Title:** Testing of artificial cover objects (ACOs) for native frogs

**Pages:** 2

**Type:** Unpublished report for the Frog Recovery Group, Department of Conservation

**Label:** 192

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; artificial cover objects

**Abstract:** This brief report describes the setup of an investigation into artificial cover objects (ACOs) to be used in frog monitoring. Standard survey and monitoring techniques for *Leiopelma hochstetteri* and *L. archeyi* involve disturbing natural cover objects such as logs and rocks and the effects of this on the frogs is of concern. On 2 July 1991, the author put out two different models of ACO at a study site in Whareorino. These models are described. No results were available as this time.

**Reference Type:** Report

**Record Number:** 240

**Author:** Smuts-Kennedy, C. J.

**Year:** 2002

**Title:** A survey for Hochstetter's frogs in the Otawa and Otanewainuku Forests

**City:** Tauranga

**Pages:** 30

**Type:** Unpublished report for the Department of Conservation

**Report Number:** 516

**Label:** 240

**Keywords:** *Leiopelma hochstetteri*; survey; recruitment

**Abstract:** *Leiopelma hochstetteri* were reported from one small catchment of the Raparapahoe Stream on the eastern side of Otawa Forest in 1992. A survey of this area was undertaken in early 2002 (11 days). A total of 38 streams/tributaries were searched by turning over surface cover during daylight hours. A total of seven *L. hochstetteri* were found in streams A and B (the site of the original 1992 report), and in the catchments of those streams. Most frogs found could be considered sub-adult, suggesting a healthy population that is recruiting juveniles (snout-vent lengths ranged from 17 to 44 mm). At least one



(the largest) was an adult female, which may have been gravid. In all three survey sites where frogs were found, the first frog was found in 15 person minutes or less of search time (1 minute 40 seconds, 12 minutes, 7 minutes 30 seconds, at one site two frogs were found simultaneously after 15 minutes), suggesting a reasonably abundant population in streams A and B. Searching was discontinued in each site after the first frog was found. No frogs were found in the remaining 36 streams/tributaries searched in the two forest blocks. The habitat seen in streams A and B was considered to be the best covered in the survey. Recommendations for future management are made.

**Notes:** The page numbers on the hardcopy are slightly out of order to allow for A3 copying.

**Reference Type:** Magazine Article

**Record Number:** 149

**Author:** Soper, M. F.

**Year:** 1966

**Title:** Native frogs as rare as the tuatara

**Magazine:** New Zealand Weekly News

**Volume:** October 26, 1966

**Pages:** 32

**Label:** 149

**Keywords:** ecology

**Abstract:** This article briefly introduces the ecology of New Zealand's rare herpetofauna, including *Leiopelma*.

**Reference Type:** Journal Article

**Record Number:** 207

**Author:** Spurr, Eric B.; Powlesland, R. G.

**Year:** 2000

**Title:** Monitoring the impacts of vertebrate pest control operations on non-target wildlife species

**Journal:** Department of Conservation Technical Series

**Volume:** 24

**Pages:** 52

**Label:** 207

**Keywords:** monitoring; pest control; 1080

**Abstract:** This paper outlines protocols for determining bait quality, monitoring the impacts of pest control operations on populations of non-target wildlife species, and collecting tissues from dead animals and samples of water for toxicity testing. Protocols for monitoring frogs are still being developed. The methodology for strip transects counts is discussed. Methods of statistical analysis of the data are also recommended.

**Notes:** Hardcopy includes the introduction, aspects of monitoring to be taken into consideration and pages relevant to *Leiopelma* only.

**Reference Type:** Thesis

**Record Number:** 243

**Author:** Stephenson, Elsie M.

**Year:** 1945

**Title:** Aspects of the ecology and anatomy of *Leiopelma hochstetteri* (Fitzinger)

**University:** Auckland University College

**Number of Pages:** 115

**Thesis Type:** MSc.

**Label:** 243

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; ecology; morphology

**Abstract:** This thesis describes the ecology and anatomy of *Leiopelma hochstetteri*. The distinction between *L. hochstetteri* and *L. archeyi* based on morphology alone is questioned. Fourteen frogs, selected at random at Tokatea ranged in snout-vent length from 28 to 41 mm. *L. hochstetteri* and *L. archeyi* were found to be sympatric in this investigation, contrary to Turbott's suggestion (ref # 43). The author found one *L. hochstetteri* and a *L. archeyi* under the same stone, the nearest stream being approximately half a mile away. The author suggests that until it can be shown conclusively that there is a difference in the breeding habits and mode of development of the two types, it seems undesirable to refer to them as different species.

**Notes:** Unable to interloan as only one copy in Auckland, therefore only have copy of introduction, which was all they sent!

**Reference Type:** Journal Article

**Record Number:** 69

**Author:** Stephenson, Elsie M.

**Year:** 1951

**Title:** The anatomy of the head of the New Zealand frog, *Leiopelma*

**Journal:** Transactions of the Zoological Society of London

**Volume:** 27

**Issue:** 2

**Pages:** 255-305

**Label:** 69

**Keywords:** physiology; *Leiopelma archeyi*; *Leiopelma hochstetteri*

**Abstract:** This paper attempts to present a full account of the anatomy of the head (exclusive of the inner ear) of *Leiopelma hochstetteri* and *L. archeyi*. Comparisons are made with the head of *Ascaphus*. Specific differences between the two species are described and listed. A possible homology is suggested between the processus lingularis of Anura and Seydel's palatal process of Urodela. Particular emphasis is placed on the controversial topic of the basal connection between the quadrate and the neurocranium. An historical account of previous ideas on this subject is included, followed by a discussion based on the view that the 'basal' or 'pseudobasal' process of *Leiopelma*, together with the ledge of cartilage forming the floor of the hyomandibular canal, are of hyoid origin. Twenty specimens of *L. hochstetteri* and *L. archeyi* were exported to London.

**Reference Type:** Journal Article

**Record Number:** 279

**Author:** Stephenson, Elsie M.

**Year:** 1952

**Title:** The vertebral column and appendicular skeleton of *Leiopelma hochstetteri* Fitzinger

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 79

**Issue:** 3-4

**Pages:** 601-613

**Label:** 279

**Keywords:** *Leiopelma hochstetteri*; physiology

**Abstract:** This paper describes the vertebral column, appendicular skeleton and spinal nerves of *Leiopelma hochstetteri*. Reference is made to variations encountered when dealing with several rather than single specimens. Where possible, comparison has been made with *Ascaphus truei* and with members of the Discoglossidae.

*Leiopelma* shows many skeletal features that may be regarded as primitive. These include the possession of nine presacral amphicoelous vertebrae; at least two pairs of true ribs; simple and only slightly expanded sacral diapophyses; up to three postsacral vertebrae fused to the hypochordal element of the urostyle; thirteen pairs of spinal nerves, of which the most anterior nerve is the N. suboccipitalis; an arciferous pectoral girdle; a cleithrum; abdominal ribs; an epipubis; a persistently cartilaginous pubis; a phalanx on the metacarpal of the prepollex; eight free adult carpal elements and five free tarsal elements.

**Notes:** The basis for this paper is a PhD (University of London), for which a number of specimens of *Leiopelma* were exported to London. Hardcopy is a copy of a copy.

**Reference Type:** Journal Article

**Record Number:** 64

**Author:** Stephenson, Elsie M.

**Year:** 1955

**Title:** The head of the frog, *Leiopelma hamiltoni* McCulloch

**Journal:** Proceedings of the Zoological Society of London

**Volume:** 124

**Issue:** 4

**Pages:** 797-801 + plates

**Label:** 64

**Keywords:** physiology; *Leiopelma hamiltoni*; *Leiopelma archeyi*; *Leiopelma hochstetteri*

**Abstract:** This paper gives anatomical details of the head of a single *Leiopelma hamiltoni* from Stephens Island and a brief comparison is made with both *L. archeyi* and *L. hochstetteri*. A previous publication (ref # 69) gives detailed descriptions of the cranial anatomy of both *L. archeyi* and *L. hochstetteri*, therefore this paper deals only with the specific variations of *L. hamiltoni* to avoid repetition. The main observations include a well-developed parotoid gland present behind the eye (as in *L. archeyi*). Of eight characters known to be constant specific differences between *L. archeyi* and *L. hochstetteri*, *L. hamiltoni* agrees with *L. archeyi* in five and with *L. hochstetteri* in three.

**Reference Type:** Journal Article

**Record Number:** 66

**Author:** Stephenson, Elsie M.

**Year:** 1960

**Title:** The skeletal characters of *Leiopelma hamiltoni* McCulloch, with particular reference to the effects of heterochrony on the genus

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 88

**Issue:** 3

**Pages:** 473-488

**Label:** 66

**Keywords:** physiology; *Leiopelma hamiltoni*; *Leiopelma archeyi*

**Abstract:** A comparison of the main skeletal features of the three species of *Leiopelma* is made, the greater part of the skeleton of *L. hamiltoni* being described and illustrated for the first time. The suggestion is made that *L. archeyi* is a genetically neotenic form of *L. hamiltoni*. The skeletal features of sexually mature specimens of *L. archeyi* resemble those of immature stages of *L. hamiltoni*. As far as external features are concerned, it appears that the only important difference between *L. archeyi* and *L. hamiltoni* is that of maximum size.

The specimen of *L. hamiltoni* was provided by Mr W.H. Dawbin and had been held in captivity for some time beforehand (and was the same specimen used for the study on cranial anatomy in ref # 64).

Three specimens of the Maud Island frog were provided to ascertain whether a new species status should be applied in conjunction with a series of measurements carried out by Brian Bell, Wild Life Branch of the Department of Internal Affairs. These were compared with a specimen of the Stephens Island frog in the Dominion Museum and one in the Canterbury Museum. Based on the evidence available at the time, no justification for a change in the specific status of the Maud Island frog existed.

**Reference Type:** Journal Article

**Record Number:** 55

**Author:** Stephenson, Elsie M.

**Year:** 1961

**Title:** New Zealand native frogs

**Journal:** Tuatara

**Volume:** 8

**Issue:** 3

**Pages:** 99-106

**Label:** 55

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; history; identification; taxonomy; parental care

**Abstract:** This paper briefly outlines the history of discoveries and highlights several problems still remaining to be resolved. These include classification as well as the spelling of *Leiopelma*, which had been altered by Günther in 1868 to *Liopelma* (as outlined in Turbott, 1942 ref # 43). A key for identification is given for *L. hochstetteri*, *L. archeyi* and *L. hamiltoni* (from Stephens and Maud Islands). Frogs from Maud Island (discovered by W.H. Dawbin in 1950) were examined externally and internally and it was decided for the present not to

assign any difference in specific status to the Stephens and Maud Island's frogs. The author suggests that the position of the nostrils relative to the tip of the snout and the eye was not a desirable attribute on which to base a scientific diagnosis on (as had previously been done to distinguish *L. hamiltoni* and *L. archeyi*).

At the time of this article, no observations had been made of mating in any species. A description of *L. archeyi* egg clusters is given, and the behaviour of adult males sitting over the egg clusters is noted.

The author discovered a bright green specimen in 1959 that did not appear to be either *L. hochstetteri* or *L. archeyi*. There was insufficient information to know whether it represented a hybrid or not however.

**Reference Type:** Journal Article

**Record Number:** 158

**Author:** Stephenson, Elsie M.; Robinson, E. S.; Stephenson, N.G.

**Year:** 1972

**Title:** Karyotypic variation within the genus *Leiopelma* (Amphibia: Anura)

**Journal:** Canadian Journal of Genetics and Cytology

**Volume:** 14

**Issue:** 3

**Pages:** 691-702

**Label:** 158

**Keywords:** genetics; chromosome; *Leiopelma hochstetteri*; karyotype; *Leiopelma archeyi*

**Abstract:** The chromosome complements of four specimens of *Leiopelma hochstetteri* are described from cultured cells and squashes. The basic karyotype in all cases consists of 22 chromosomes, 12 of which are acrocentric. Supernumerary chromosomes are either absent or variable in number, but appear to be constant in the somatic cells of any one individual. The limited evidence available suggests that the supernumerary chromosomes do not pair during male meiosis. The karyotype of *L. archeyi* is described for the first time. Only the smallest pair of the total complement of 18 chromosomes is acrocentric. Supernumeraries are absent.

The distribution and probable relationships of the species of *Leiopelma* are discussed. The karyotypes of *Leiopelma* and the North American ascaphid frog *Ascaphus truei* are compared, with particular reference to the relationship of the supernumerary chromosomes of *Leiopelma* and the microchromosomes of *Ascaphus*.

*L. hochstetteri* were collected from the Dome Valley, Warkworth (one female and one male), and Tokatea Ridge, Coromandel (three males). *L. archeyi* was also collected from Tokatea Ridge (two females).

**Reference Type:** Journal Article

**Record Number:** 179

**Author:** Stephenson, Elsie M.; Robinson, E. S.; Stephenson, N.G.

**Year:** 1974

**Title:** Inter-specific relationships of *Leiopelma* (Amphibia: Anura): further karyological evidence

**Journal:** Experientia

**Volume:** 30

**Pages:** 1248-1250

**Label:** 179

**Keywords:** genetics; karyotype; taxonomy

**Abstract:** This karyological investigation was undertaken to assist in the taxonomic clarification of *Leiopelma*, both in regards to *Ascaphus* and the interspecific relationships with the genus *Leiopelma* itself.

This is the first description of the karyotype of *L. hamiltoni* (from Maud Island, therefore referring to *L. pakeka*). Nine pairs of chromosomes were present. Only the smallest pair was acrocentric and with this pair were associated secondary constrictions and small, terminal satellites. Microchromosomes were absent. The karyotype of *L. pakeka* resembled that of *L. archeyi* in total chromosome number, overall pattern and number and position of acrocentric chromosomes. Some differences were found in the relative lengths of specific chromosomes, but the most obvious divergence was the location of the secondary constrictions. This study supports previous evidence from external features and skeletal anatomy that *L. archeyi* and *L. hamiltoni/L. pakeka* have a closer affinity with each other than either does with *L. hochstetteri*.

Collections of three adult females and one adult male *L. pakeka* were made from Maud Island.

**Reference Type:** Journal Article

**Record Number:** 73

**Author:** Stephenson, Elsie M.; Stephenson, N.G.

**Year:** 1947

**Title:** On the circulatory system of *Leiopelma hochstetteri* with particular reference to the posterior cardinal veins and to the blood-vessels of the kidneys

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 76

**Issue:** 4

**Pages:** 492-503

**Label:** 73

**Keywords:** *Leiopelma hochstetteri*; physiology

**Abstract:** A description of the circulatory system of *Leiopelma hochstetteri* is given. With respect to the arterial system, *Leiopelma* is typically Anuran in character and differs little except in minor details from even the more specialised types such as *Rana* and *Hyla*. *Leiopelma* exhibits invariably persistent and well-developed right and left postcardinal veins, the presence of which (and in *Ascaphus*) supports the evidence already known regarding their primitive nature.

**Reference Type:** Journal Article

**Record Number:** 72

**Author:** Stephenson, Elsie M.; Stephenson, N.G.

**Year:** 1957

**Title:** Field observations on the New Zealand frog, *Leiopelma* Fitzinger

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 84

**Issue:** 4

**Pages:** 867-882

**Label:** 72

**Keywords:** ecology; taxonomy; reproduction; *Leiopelma archeyi*; *Leiopelma hochstetteri*; history; artificial induction of egg-laying

**Abstract:** A summarised account is given of published field observations of *Leiopelma* since its discovery in 1852. To this is added information obtained from the authors' field investigations of *L. archeyi* and *L. hochstetteri*, including such topics as range, habitat, feeding habits, colour patterns and life history. The taxonomic position of the genus and possible subspeciation of *L. archeyi* are discussed. A revised key for *L. archeyi* and *L. hochstetteri* is proposed. Initial experiments in assessing population numbers and pattern of distribution of *L. archeyi* are described. An attempt was made to artificially induce egg-laying in *L. archeyi* and *L. hochstetteri* from Tokatea, Coromandel. A gonadotrophic hormone preparation called Pregnyl was used with no apparent effect. Small quantities of fresh anterior pituitary from female specimens of *Rana temporaria* crushed in 1/10th Holtfreter were also tried. Four batches of eggs were laid, but all were infertile. Amplexus was not observed.

**Reference Type:** Journal Article

**Record Number:** 68

**Author:** Stephenson, N.G.

**Year:** 1951

**Title:** On the development of the chondrocranium and visceral arches of *Leiopelma archeyi*

**Journal:** Transactions of the Zoological Society of London

**Volume:** 27

**Issue:** 2

**Pages:** 203-253

**Label:** 68

**Keywords:** physiology; *Leiopelma archeyi*; development

**Abstract:** This paper gives the first description of the internal embryology of any species of *Leiopelma*. A few clusters of eggs were collected from Mt. Moehau, Coromandel and transported to London for development studies. The development of the chondrocranium and visceral arches of *L. archeyi* is followed through intracapsular and post-hatching stages. Certain outstanding features of development are considered. An account of the previous views on the nature of the basal connection of the quadrate to the neurocranium in *Leiopelma* and *Ascaphus* is given.

**Reference Type:** Journal Article

**Record Number:** 167

**Author:** Stephenson, N.G.

**Year:** 1951

**Title:** Observations of the development of the amphicoelous frogs, *Leiopelma* and *Ascaphus*

**Journal:** Journal of the Linnean Society of London Zoology

**Volume:** 42

**Pages:** 18-28 + plates

**Label:** 167

**Keywords:** physiology; development; taxonomy

**Abstract:** This paper summarises the life history of *Leiopelma* and *Ascaphus*. A background to the taxonomy of *Leiopelma* is also given. Diagnostic features of both species that place them as primitive genera are discussed. The development of *Leiopelma* eggs is described, reference is also made to several adult specimens that were brought from New Zealand in 1947 and were since kept alive by Elsie Stephenson in the Department of Zoology, University College, London. Two of these frogs were used in artificial induction of egg-laying experiments, although the eggs laid were infertile (ref # 72).

**Reference Type:** Journal Article

**Record Number:** 247

**Author:** Stephenson, N.G.

**Year:** 1955

**Title:** On the development of the frog, *Leiopelma hochstetteri* Fitzinger

**Journal:** Proceedings of the Zoological Society of London

**Volume:** 124

**Issue:** 4

**Pages:** 785-795

**Label:** 247

**Keywords:** *Leiopelma hochstetteri*; physiology

**Abstract:** The development of the chondrocranium and visceral arches of *Leiopelma hochstetteri* is described. The more important, basic developmental features of the genus, which were first noted in *L. archeyi*, are confirmed, while specific differences are indicated. Additional evidence for the theory (Stephenson 1951, ref # 68) of the hyoid nature of the basal connexion between the quadrate and the neurocranium in Amphibia is presented and discussed. The two groups of egg clusters collected by Turbott in 1949 (ref # 16) in Warkworth were also used for this investigation.

**Reference Type:** Journal Article

**Record Number:** 234

**Author:** Stephenson, N.G.; Thomas, Elsie M.

**Year:** 1945

**Title:** A note concerning the occurrence and life history of *Leiopelma* Fitzinger

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 75

**Issue:** 3

**Pages:** 319-320 + plates

**Label:** 234

**Keywords:** ecology; *Leiopelma archeyi*; *Leiopelma hochstetteri*

**Abstract:** This paper describes observations made in the field on Mt Moehau in 1944, indicating that *Leiopelma archeyi* and *L. hochstetteri* are sympatric. The authors also found one frog of each species (both females) under the same stone. Snout vent lengths of 14 specimens of *L. archeyi* from Tokatea ranged



from 28 - 41 mm.

**Reference Type:** Journal Article

**Record Number:** 236

**Author:** Szarski, Henryk

**Year:** 1951

**Title:** Remarks on the blood-vascular system of the frog *Leiopelma hochstetteri*  
Fitzinger

**Journal:** Transactions of the Royal Society of New Zealand

**Volume:** 79

**Issue:** 1

**Pages:** 140-147

**Label:** 236

**Keywords:** *Leiopelma hochstetteri*; physiology

**Abstract:** This paper describes an investigation of the arrangement of the principal arteries and veins in *Leiopelma hochstetteri*. The author only discusses some details not observed by the Stephenson's in a similar paper (c.f. ref # 73). Three female *L. hochstetteri* were collected in a stream at Huia, Waitakere Ranges in 1947 by Mr EG Turbott and injected with Indian ink in Wellington before being eventually sent to Copernicus University, Poland.

The principal findings are the strong development of the large cutaneous artery, the presence of postcardinals in adult specimens, the peculiar mode of origin of the facial and faciomandibular veins, the fact that the greater part of the blood from the brain leaves the skull through the vagus foramen and flows into the vertebral vein, and, the presence in the thigh of v. ischiadica and v. femoralis dorsalis.

**Reference Type:** Journal Article

**Record Number:** 233

**Author:** Tessier, Catherine; Slaven, David C; Green, David M.

**Year:** 1991

**Title:** Population density and daily movement patterns of Hochstetter's frogs, *Leiopelma hochstetteri*, in a New Zealand mountain stream

**Journal:** Journal of Herpetology

**Volume:** 25

**Issue:** 2

**Pages:** 213-214

**Label:** 233

**Keywords:** *Leiopelma hochstetteri*; densities; Waitakere;

**Abstract:** This paper investigates movement patterns, population size, and microhabitat of *Leiopelma hochstetteri* in a portion of upper Seagull Stream in the southern Waitakere Ranges near Huia. The study was conducted on nine consecutive days from 11-19 February 1989. Frogs captured were toe-clipped and released. The stream was revisited on April 14, 1989, to search for marked frogs. Thirty-two frogs captured and marked, 16 of these were recaptured more than once, yielding a total of 62 captures. Frogs ranged in size from 22 to 45 mm snout vent length (mean = 35.8 mm  $\pm$  5.9mm). The mean straight-line distance moved by the frogs between captures was 1.2 m.

**Reference Type:** Journal Article  
**Record Number:** 157  
**Author:** Thomson, Arthur Saunders  
**Year:** 1853  
**Title:** On the discovery of a frog in New Zealand  
**Journal:** Edinburgh New Philosophical Journal  
**Volume:** 55  
**Pages:** 66-69  
**Reprint Edition:** 1920 in The New Zealand Journal of Science and Technology 3: 220-222.  
**Label:** 157  
**Keywords:** *Leiopelma hochstetteri*; history; Coromandel  
**Abstract:** This article reports on the discovery of a frog in 1852 by A.S. Thomson, M.D., Surgeon, 58th Regiment, in the Coromandel. The frog had been found by gold-diggers but was dead and dried when given to Thomson. Three later specimens were caught but were lost or released (at the request of the local Maoris, who were unable to provide a Maori name for the frog). A physical description of the preserved specimen is given including 'length of body, 1 in;... skin smooth and shining, with small rounded tubercles or papillae on the sides;... the colour of greyish-white, back brown, the belly of a lighter brown.... The extremities are marked across with lines of brown and greyish-white alternately.' The specimen was sent to James Thomson of Glendoman. Previous reports of 'toads and frogs' in New Zealand by Mr Polack in a publication by J.E. Gray of the British Museum (appended to Dieffenbach's 'Travels in New Zealand' 1842) are questioned. This is considered to be the first reported discovery of *Leiopelma hochstetteri*.

**Reference Type:** Journal Article  
**Record Number:** 39  
**Author:** Thomson, Olwen C.  
**Year:** 1997  
**Title:** Aspects of the ecology of *Leiopelma hamiltoni* (McCulloch) on Stephens Island (Takapourewa) and the implications for conservation  
**Journal:** New Zealand Journal of Zoology  
**Volume:** 24  
**Pages:** 329-330  
**Label:** 39  
**Keywords:** *Leiopelma hamiltoni*; ecology; conservation; Stephens Island  
**Abstract:** This is an abstract of paper presented at the 7th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand at Kaikoura, 31 January-2 February 1997. This project analysed data from a population study of *L. hamiltoni* on Stephens Island from 1990 to 1995. When possible, comparisons were also made with Newman's prior study from 1975 to 1978. The population was estimated to be 53 frogs/100 m<sup>2</sup>, and the probability of survival had decreased from 1975 to 1978. A linear trend in the yearly variation was detected, and was interpreted to be an increase in population size over the six years. The variables that predicted

the variation in the data and consequently predicted the occurrence of frogs on the 'frog bank' were primarily search effort and yearly changes.

**Reference Type:** Report

**Record Number:** 266

**Author:** Thorpe, Rick

**Year:** 1999

**Title:** Survey & monitoring of Archey's frog in three areas of the Coromandel Peninsula

**Institution:** Nga Hao O Te Whenua Environmental Consultants

**Pages:** 10 + apps

**Type:** Unpublished report for the Waikato Conservancy, Department of Conservation

**Label:** 266

**Keywords:** *Leiopelma archeyi*; survey; monitoring; Coromandel

**Abstract:** The report is a result of concerns raised over apparent declines of *Leiopelma archeyi* in the Coromandel. Three localities were surveyed: Waitekauri, Mania Forest sanctuary, Waiau Falls (309 Road summit). Surveys were carried out in February 1999.

The Waitekauri site had previously been surveyed in 1986 by Garrick and Associates and a total of 54 frogs were found. In February 1999, the same track was followed as in the 1986 survey, only two frogs were found. An area to the true right of the headwaters of the Waitekauri River that had been reported as having significant numbers in 1986 was also surveyed, no frogs were found. The forest floor was reported as being particularly dry. *L. hochstetteri* were found in three locations on the north/northwest side of Whakamoehau.

The Manaia Forest Sanctuary was surveyed in January 1992 by the Department of Conservation (DoC) and a total of six *L. archeyi* were found. The same track was resurveyed in 1999, no *L. archeyi* were found. Two frogs were later found when optimal habitat was searched on the way back to the campsite. The forest floor was reported as being very dry.

The Waiau Falls sites has been surveyed in 1994, with 14 captures over four nights on Quadrat 1 and seven captures over four nights in Quadrat 2 (number of individuals captured is not known). In 1999, the same quadrats were searched (these were night time searches as per the 1994 survey); one frog was found on Quadrat 1. The forest floor was reported as damp.

**Notes:** Appendices include extracts from Garrick Associates, Golden Cross Wildlife Survey Report, 1987, the Fauna Survey of the Manaia Forest Sanctuary 27th-29th January 1992 and the Waiau Falls Possum Control Post-Operational Report, August 1994 (in draft). A handwritten note by John Gumbly (Waikato Conservancy, DoC) is also included which refers to five *L. archeyi* found in rough pastureland within the Cyprus Gold/Coeur Gold Mining Licence area, prior to commencement of mining in 1988. These were considered to be living in sub-optimal habitat and were translocated into steep forestland.

**Reference Type:** Report

**Record Number:** 264

**Author:** Thorsen, Mike

**Year:** 1998

**Title:** Determination of a standardised methodology for long-term monitoring of mainland *Leiopelma* species

**Institution:** Department of Conservation

**Pages:** 34

**Type:** Unpublished report

**Label:** 264

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; monitoring; Whareorino; Moehau

**Abstract:** A technique that can be used as a standard for long-term monitoring of mainland populations of *Leiopelma* species was developed and implemented. For terrestrial species of *Leiopelma* a technique of searching of retreats during daytime along randomised 50 m long 2 m wide transects is used. This minimises disturbance to frog habitat and observer variance. It is also quantifiable allowing comparison with other studies. A minimum of 20 transects and preferably over 50 transects in each area were needed for statistical analysis purposes.

Monitoring of sites at night was trialed but found to be ineffective due to physical limitations and discrepancies in number of frogs found.

For the semi-aquatic *L. hochstetteri* presence/absence surveys of a skeleton of streams around known populations was implemented.

Whareorino Forest and the Mt. Moehau area were used for development of these techniques and were the sites for initial monitoring work. The Waitakauri/Maratoto area and Rangitoto Range should be incorporated into future monitoring areas.

Results from initial monitoring revealed an average density of 3.3 *Leiopelma*/100m<sup>2</sup> for Mt. Moehau and 1.2 *Leiopelma*/100m<sup>2</sup> for Whareorino Forest. No significant differences in density were found between the two monitoring areas, however the density of frogs at the Ongohi site on Mt. Moehau was higher than for other sites monitored.

Five of 13 streams searched in the Whareorino Forest and seven of 12 streams in the Mt. Moehau area had *L. hochstetteri* present.

Body length measurements of terrestrial *Leiopelma* found proportionally larger frogs in the Whareorino Forest. Rear limb asymmetry measurements were taken but due to wide error variance little significance can be attached to results. At the time of publication, the taxonomic status of the terrestrial *Leiopelma* species in Whareorino Forest was unresolved. Therefore this report refers to *L. archeyi* and 'Type A' frogs as terrestrial *Leiopelma*. 'Type A' frogs were subsequently determined to be *L. archeyi* by allozyme electrophoresis of toe tissue (ref # 5). The major use of vegetation as a retreat site was confirmed at Whareorino Forest and discovered for the Mt. Moehau area.

More research is needed into minimising and quantifying observer variance using these techniques. This type of monitoring should be repeated at 2-4 year intervals. The development of artificial cover objects as a non-invasive monitoring technique should be given priority.

**Reference Type:** Journal Article

**Record Number:** 71

**Author:** Thorsen, Mike

**Year:** 1999

**Title:** Resurvey of Archey's frogs, Mt Moehau, 24 December 1998.

**Journal:** Conservation Advisory Science Notes

**Volume:** 251

**Pages:** 1-4

**Label:** 71

**Keywords:** *Leiopelma archeyi*; Coromandel; survey

**Abstract:** This work was commissioned in response to reports of population declines in *Leiopelma archeyi* in central Coromandel. Transects of 50 m long were taken in random directions from random altitudes between 500 and 600 m on the eastern summit tract of Mt Moehau. All possible frog retreats were searched within 1 m either side of the transect tape (area = 100 m<sup>2</sup>). Over 10 transects, 23 *L. archeyi* and three *L. hochstetteri* were found (440 minutes searching time). Sizes varied from 14 to 32 mm snout-vent length. A cluster of three half-developed eggs was found. A comparison to a similar survey in July 1998 was made and no significant difference was found. Therefore, no evidence for a decline of the extent reported by Ben Bell, Victoria University of Wellington, for central Coromandel was found. However a lower number of frogs were found when considering effort-based indices, indicating a decline of lower magnitude.

**Reference Type:** Report

**Record Number:** 265

**Author:** Thorsen, Mike

**Year:** 1999

**Title:** A resurvey of Archey's frogs Whareorino Forest and Mt. Moehau 18-24 August 1999

**City:** Hamilton

**Institution:** Department of Conservation

**Pages:** 7

**Type:** Unpublished report

**Label:** 265

**Keywords:** *Leiopelma archeyi*; survey; Whareorino; Moehau

**Abstract:** This report details the visit to Whareorino Forest and Mt. Moehau to resurvey these sites in August 1999, using the standardised random transect methodology to determine current population status (the previous survey is outlined in ref # 71).

The same methods were used as for the previous visit (December 1998). Seven transects were completed at two sites in Whareorino Forest and a total of 33 *Leiopelma archeyi* were found. Seven transects were completed in Mt. Moehau and a total of 17 *L. archeyi* were found. There were no differences between the mean numbers of frogs found between this visit and one carried out in July 1998. Therefore there was no evidence of decline using the randomised transect method.

**Reference Type:** Thesis

**Record Number:** 242

**Author:** Thurley, Tertia

**Year:** 1996

**Title:** A survey of native frogs (*Leiopelma archeyi* and *L. hochstetteri*) in Whareorino Forest, northern King Country

**Academic Department:** Environmental Studies

**University:** Victoria University of Wellington

**Number of Pages:** 99

**Thesis Type:** MA. (Applied)

**Label:** 242

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; survey; Whareorino; habitat; morphology; distribution

**Abstract:** *Leiopelma archeyi* and *L. hochstetteri* were discovered in Whareorino Forest, northern King Country, in 1991. This thesis reports on the results of a survey carried out there in 1993 to document the range, variation in habitat, local distribution and external morphology of these two species.

Both species had a localised range of approximately 6 km<sup>2</sup>, and were broadly sympatric throughout this area.

Nearly all *L. hochstetteri* were found in streambeds. *L. archeyi* was less restricted in its distribution, occurring from gullies to ridges, from in streambeds to far away from streams, and from under dense forest cover to no vegetative cover at all. The most important habitat factor affecting the distribution and abundance of *L. archeyi* was altitude, with most frogs found above 500 m asl, and abundance showing a positive correlation with altitude.

*L. hochstetteri* was found mostly under stones. *L. archeyi* occupied daytime retreat sites under logs and stones, and amongst vegetation. Vegetative sites included those amongst hook grass (*Uncinia* sp.), rice grass (*Microlaena avenacea*), tree fern (*Cyathea smithi*) and crown fern (*Blechnum discolor*). Although a preference was shown for log sites, these sites were not common and 52% of *L. archeyi* were found sheltering amongst vegetation. Egg clusters of *L. archeyi* were also found in vegetation, as well as under stones.

Snout-vent length in *L. hochstetteri* ranged from 16.7 to 43.8 mm, and weight from 0.6 to over 10 g. Dorsal colour was mostly brown, but there were also a few frogs with green colouration present. The brown colour ranged from light to dark. *L. archeyi* snout-vent length ranged from 11.5 to 38.4 mm, and weight from 0.2 to 5.2 g. Colour was very variable, ranging from brown through to patterned green and brown, to green, sometimes with conspicuous pink colouration along the flanks and at the bases of the limbs. The brown colour also ranged from light to dark.

Relationships were found between *L. archeyi* size and colour, with pink colouration tending to be found more in smaller frogs, whereas larger frogs were more likely to be all brown in their colouring. Larger frogs were also more often found under logs and stones than smaller frogs that predominated in vegetative sites, especially hook grass. A relationship between retreat site and dorsal colour is suggested.

The introduced frog *Litoria aurea* and rats (*Rattus* sp.) preyed on *L. archeyi*. This causes concern for the future of *Leiopelma* in Whareorino Forest, and

further investigation into the impact of these predators is needed. It is recommended that *Leiopelma* be monitored at several sites at Whareorino, with care taken to minimise disturbance of their retreat sites.

**Notes:** Hardcopy includes title page, abstract, table of contents, list of figures, site map as well as pages relating to egg clusters or predation.

**Reference Type:** Report

**Record Number:** 139

**Author:** Thurley, Tertia

**Year:** 2000

**Title:** Monitoring of Archey's frog (*Leiopelma archeyi*) at Whareorino Forest, August/September 2000

**City:** Te Kuiti

**Institution:** Maniapoto Area Office, Department of Conservation

**Pages:** 9

**Type:** Unpublished report

**Label:** 139

**Keywords:** *Leiopelma archeyi*; monitoring; Whareorino; *Leiopelma hochstetteri*

**Abstract:** This report presents the results of monitoring *Leiopelma archeyi* at Whareorino Forest in August/September 2000, which attempted to repeat two previous surveys (1998 and 1999). The methodology used was the same as outlined in Thorsen (1998).

A total of 29 *L. archeyi* and 15 *L. hochstetteri* were found along 14 transects (each of 50 m). Nearly all *L. archeyi* were found in vegetative sites (ricegrass *Microlaena avenacea*, hookgrass *Uncinia* spp., *Blechnum fluviatile* and treefern) and leaf litter. Average snout-vent length was 20.7 mm (n = 28). Most *L. hochstetteri* were found under rocks. Nine were found along two transects which either crossed or ran alongside a stream, and six were found away from streams. Average snout-vent length was 28.2 mm (n = 14).

A similar number of *L. archeyi* were found as in the 1999 survey, and approximately twice as many as in the 1998 survey. However, when comparing frogs found per unit time spent searching, only half as many were found compared to the two previous surveys. This could be a result of a decrease in the population, but could also be due to differing methodology between years and/or chance variation of frog density at chosen transects.

**Reference Type:** Journal Article

**Record Number:** 62

**Author:** Thurley, Tertia; Bell, Ben D.

**Year:** 1994

**Title:** Habitat distribution and predation on a western population of terrestrial *Leiopelma* (Anura: Leiopelmatidae) in the northern King Country, New Zealand

**Journal:** New Zealand Journal of Zoology Special issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 431-436

**Label:** 62

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; conservation; distribution; predation; Whareorino

**Abstract:** This paper deals with a new population of terrestrial *Leiopelma* discovered in the Whareorino Forest, northern King Country in 1991. Searches were carried out from June 1991 to December 1993 to determine the species present and to document variation in external morphology, habitat and local distribution. These confirmed that a terrestrial frog resembling *L. archeyi* is present in the area, as well as *L. hochstetteri*. In Whareorino Forest, the terrestrial *Leiopelma* was mostly above 500 m altitude and *L. hochstetteri* above 350 m. The terrestrial *Leiopelma* occupies sites under rocks and logs in forest. It also occurs in vegetation, such as crown fern *Blechnum discolor*, tree fern *Cyathea smithii*, hock grass *Uncinia uncinata*, and rice grass *Microlaena avenacea*. Egg clusters of this frog were found in crown fern and tree fern, as well as under stones.

This paper is also the first documented evidence of predation on terrestrial *Leiopelma* by *Litoria aurea* and rats.

**Reference Type:** Book Section

**Record Number:** 176

**Author:** Thurley, Tertia; Bell, Ben D.

**Year:** 1994

**Title:** Distribution of a new population of terrestrial *Leiopelma* in the northern King Country, New Zealand

**Editor:** Davies, Margaret; Norris, Rachel M.

**Book Title:** Abstracts of the Second World Congress of Herpetology

**City:** Adelaide

**Publisher:** University of Adelaide

**Pages:** 261

**Label:** 176

**Keywords:** *Leiopelma archeyi*; distribution; conservation; Whareorino

**Abstract:** This is an abstract of a paper presented at the Second World Congress of Herpetology held at the University of Adelaide, South Australia, December 29 1993 to January 6 1994.

A new population of *Leiopelma* was discovered in the northern King Country in 1991. Frog surveys have been carried out since June 1991 to identify the species and to document variation in external morphology, habitat and local distribution. These confirmed that a terrestrial frog resembling *L. archeyi* was present in the area, as well as *L. hochstetteri* and the introduced *Litoria aurea*. The terrestrial *Leiopelma* species was recorded by day in sites more open than those known for other *Leiopelma* species, such as in crown fern *Blechnum discolor*, tree fern *Cyathea smithii* and rice grass *Microlaena avenacea*. Biochemical studies are needed to clarify the taxonomic status of this new population of terrestrial frog. The local impact of *Litoria aurea* on the endemic frog needs to be assessed.

**Reference Type:** Report

**Record Number:** 235

**Author:** Tocher, Mandy D.



**Year:** 1999

**Title:** Summary of research and interim report of *Leiopelma hamiltoni* monitoring at the frogbank and frogpit, Stephens Island

**City:** Dunedin

**Institution:** Department of Conservation

**Pages:** 18

**Type:** Unpublished report

**Label:** 235

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; monitoring

**Abstract:** This report summarises the planned research on *Leiopelma hamiltoni* on Stephens Island and gives interim results of population monitoring at the frog bank and the frog pit.

In 1996, the native frog recovery group decided to embark on a five-year monitoring programme in order to research the population dynamics and limiting factors of the *Leiopelma hamiltoni* population on Stephens Island. Genetic work is required to define the species status of *L. hamiltoni*, and to determine the level of heterozygosity in the population (to correlate this to fitness). The history of data collection on the island is given.

A summary of captures at the frog bank between July 1997 and August 1998 is provided. Few captures were made during monitoring of the frog pit translocated population (of 12). In May 1999 one of the frogs transferred to the frog pit was located back in the frog bank within 30 cm of the original capture site. Previously, juveniles (< 19 mm snout-vent length) were not toe clipped, but this commenced in early August 1998.

Factors that may have lead to the 'failed' frog pit translocation are given as: transferred frogs attempting to 'home' back to the frog bank; unsuitability of the frog pit habitat; predation and/or competition by resident invertebrates; frogs may have established below the rock surface and; low heterozygosity affecting recruitment.

Recommendations for future monitoring are given.

**Notes:** Interim report only - some changes may have been made subsequently.

**Reference Type:** Report

**Record Number:** 253

**Author:** Tocher, Mandy D.

**Year:** 2002

**Title:** Report to Native Frog Recovery Group May 2002

**Pages:** 10

**Type:** Unpublished report for the Department of Conservation

**Label:** 253

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma pakeka*; Stephens Island; Motuara Island; monitoring

**Abstract:** This report appears as Appendix 6 in the Native frog Recover Group Annual Report 2002 (ref # 250).

This report provides an update on monitoring of *Leiopelma hamiltoni* at the frog bank and frog pit on Stephens Island and *L. pakeka* on Motuara Island. Recommendations for the future monitoring of these populations are given.

Twenty monitoring sessions have now been completed at the frog bank on Stephens Island. From July 1997 to May 2001, 291 frogs have been toe-clipped. A total population of *L. hamiltoni* at the frog bank search area is estimated at 180; however, a reasonable estimate for the available habitat is given as 600-900 frogs. A total of four frogs have been observed in the frog pit over 20 sampling sessions. A modelling exercise has been carried out to determine which option for translocation is likely to be best for *L. hamiltoni* (ref # 217).

On Motuara, a total of 100 individuals have been caught in the release grid since July 1997. Seventy-five individuals have been recaptured outside the release grid. The best estimate for the frog population inside the release grid is 26.5 ( $\pm 4.9$  SEM), but on average the population is estimated to be around 50 frogs. An estimate for the population outside the grid is given as 69.9 ( $\pm 17.7$  SEM) frogs. In total, 32 new recruits have been captured inside and outside the release grid. No juveniles were found in August 2001 of the size expected from eggs laid in late 2000.

**Reference Type:** Journal Article

**Record Number:** 218

**Author:** Tocher, Mandy D.

**Year:** 'in prep'

**Title:** The translocation of *Leiopelma pakeka* (Anura: Leiopelmatidae) from Maud Island to Motuara Island, Marlborough Sounds, New Zealand

**Label:** 218

**Keywords:** translocation; conservation; *Leiopelma pakeka*; Maud Island; Stephens Island; recruitment

**Abstract:** This paper describes the translocation of *Leiopelma pakeka* from Maud Island to Motuara Island. Frogs appear to be in decline worldwide. This is a particular concern in New Zealand where two of the four species of native frogs have extremely restricted distributions. *L. pakeka* is confined to two populations totalling approximately 19,000 on Maud Island. In May 1997, 300 *L. pakeka* were translocated to nearby Motuara Island in an effort to extend their distribution and therefore lower their risk of extinction. Follow-up monitoring of the translocated frogs was continued every three months until the end of 1998. By October 1998, 334 recaptures of 106 of the translocated frogs had been made. Most frogs had increased significantly in weight; in contrast 5-10 % of frogs originally captured on Maud Island appeared emaciated suggesting a possible overcrowding problem on Maud Island. The first juvenile frog was found in January 1998, only 10 months after the translocation. Analyses indicate the population within the 10x10 m release grid has declined; however data suggest the decline is due to emigration rather than mortality. The *a priori* criteria for a successful transfer have been met - the appropriateness of the habitat for adult survival, movement and breeding has been demonstrated.

**Notes:** No hardcopy.

**Reference Type:** Journal Article

**Record Number:** 217

**Author:** Tocher, Mandy D.; Bishop, Phil

**Year:** 'in prep'

**Title:** A modelling approach to determine a translocation scenario for the endangered New Zealand frog *Leiopelma hamiltoni* (McCulloch)

**Label:** 217

**Keywords:** *Leiopelma hamiltoni*; Stephens Island; translocation; conservation; population model

**Abstract:** A stage-structured population model allowing for both demographic and environmental stochasticity was developed to predict which of eight hypothetical translocation scenarios (frogs translocated to a new island, from Stephens Island) was likely to produce the best outcome for *Leiopelma hamiltoni*. Model outcome was measured in terms of population growth rate and probability of extinction. A collation of available life history data for *L. hamiltoni* was used to parameterise the model, which considered only females. Uncertainty in all key vital rates was allowed for, and sensitivity analyses were used to determine the importance of uncertainty in input parameters in determining the outcome of the model.

The model predicted that moving <sup>TM</sup> 50 female adult frogs was the best strategy, and moving 25, or fewer, female frogs was the worst, in terms of mean growth rate of both populations combined. When the new population was considered separately, introducing low-medium numbers of sub adults alone was the worst strategy (25 or 50 sub adults) in terms of mean growth rate, followed closely by introducing only 25 adults alone. This result was identical when the extinction probability of the new population is considered; ie extinction probability was highest when low-medium numbers of sub adults alone were introduced, followed closely by introducing only 25 adults alone.

Extinction in the donor population was not threatened by any of the hypothetical translocation scenarios. Sensitivity analyses indicated that uncertainty in input parameters only affected the new population, and in particular, variation in adult survival influenced both growth rate and probability of extinction. Overall however, variation in input parameters did not affect the choice of preferable translocation scenario. The most reasonable management strategy, supported by the model, is considered to be the translocation of 100 frogs (a random collection of male and female adults and sub adults > 16mm snout-vent length) from the donor population to a new site.

**Notes:** No hardcopy.

**Reference Type:** Magazine Article

**Record Number:** 210

**Author:** Tocher, Mandy D.; Newman, Donald G.

**Year:** 1997

**Title:** Leaps & bounds - the conservation of New Zealand native frogs

**Magazine:** Forest & Bird

**Volume:** 285

**Pages:** 14-20

**Date:** August 1997

**Label:** 210

**Keywords:** conservation; translocation; *Leiopelma pakeka*; Motuara Island; ecology; Maud Island

**Abstract:** This article provides a background on the ecology and status of all four species of *Leiopelma*. The recovery plan for native frogs by the Department of Conservation is briefly discussed. Possible agents of decline and fatalities of native frogs due to road kill are also considered. The translocation of 300 *Leiopelma pakeka* from Maud Island to Motuara Island (25 km away) in 1997 is discussed. Motuara Island has extensive areas of suitable rock habitat under a closed forest canopy similar to that on Maud. The island is also free of predators following the recent eradication of kiore. Monitoring of the translocation population will continue.

**Reference Type:** Journal Article

**Record Number:** 58

**Author:** Towns, D.R.; Daugherty, Charles H.

**Year:** 1994

**Title:** Patterns of range contractions and extinctions in the New Zealand herpetofauna following human colonisation

**Journal:** New Zealand Journal of Zoology Special issue: Second World Congress of Herpetology

**Volume:** 21

**Issue:** 4

**Pages:** 325-339

**Label:** 58

**Keywords:** conservation; subfossil; distribution

**Abstract:** This paper examines evidence from subfossils and from present distributions and confirms that range contractions and extinctions of New Zealand amphibians and reptiles is consistent with that from New Zealand landbirds, in which 40% of the fauna, including the largest species, has become extinct in the 1000 years since human arrival. The largest extant species of all higher taxa of herpetofauna, including leiopelmatid frogs, are extinct on the mainland; 41% of the extant fauna survive largely or entirely on rat-free offshore islands (two species of leiopelmatid); and any species are now restricted to a few isolated locations, remnants of once wider distributions, a pattern call 'secondary endemism'. The primary factor in extinctions is almost certainly introduced mammals, especially rats.

**Reference Type:** Thesis

**Record Number:** 261

**Author:** Turbott, E.G.

**Year:** 1937

**Title:** Some observations on the distribution and anatomy of *Leiopelma hochstetteri* Fitzinger

**University:** University of Auckland

**Number of Pages:** 48

**Thesis Type:** MSc.

**Label:** 261

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; distribution; physiology

**Abstract:** The geographical distribution and anatomy of *Leiopelma hochstet-*

*teri* (as *Liopelma*) are investigated. The study of anatomy included external characters such as form, colour and posture. The frogs at present included in *L. hochstetteri* fall into two groups inhabiting respectively forested streambeds and moist hilltops (this is probably referring to *L. archeyi*, as yet unnamed at the time of publication). The streamside group is distributed over a considerable portion of the North Island of New Zealand. Individuals from this habitat are small and moderately robust. The protractor muscle of the tongue is rudimentary, but a retractor is well developed. Glands are absent from the oesophagus, the mucous coat being composed of transporting and lubricating tissue. Ciliated epithelium is absent from the stomach, transverse muscle being correspondingly strongly developed. A 'muscularis mucosae' is described in this region. In the duodenum and ileum the absorptive lining is amplified by tubular invaginations rather than by folding or evagination. Numerous glands of unknown function occur in the mucous coat of the rectum. A muscularis mucosae is represented in this region by a few fibres. The vertebrae are amphicoelous. The sacral processes are free and not formed from the transverse processes of the ninth vertebra. They appear to represent an original tenth vertebral segment. Bones apparently representing an eleventh vertebral segment are fused with the anterior urostyle. The total number of pairs of spinal nerves is twelve, one pair being associated with each of the modified tenth and eleventh vertebrae. The frontoparietals do not approximate in the middle line, a large fontanelle being covered dorsally only by connective tissue. The vomers and palatines are fused to form a vomeropalatine. Bones associated with a middle ear are absent and a quadratojugal is also lacking. A well developed prepubis is associated with the pelvic girdle.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Notes:** There is only one copy of this thesis in the University of Auckland's library and as such they will not allow it to be interloaned. Two pages were photocopied by the library staff (table of contents and introduction only). The summary page is from a draft copy held by Ben Bell of Victoria University.

**Reference Type:** Journal Article

**Record Number:** 43

**Author:** Turbott, E.G.

**Year:** 1942

**Title:** The distribution of the genus *Leiopelma* in New Zealand with a description of a new species

**Journal:** Transactions and Proceedings of the Royal Society of New Zealand

**Volume:** 71

**Pages:** 247-253

**Label:** 43

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; morphology

**Abstract:** This paper describes discoveries of *Leiopelma hochstetteri* to date and formally describes *L. archeyi* as a new species. Morphology of *L. archeyi* is outlined in detail. Historical notes and habitat are covered for both species.

Turbott also calls for the original spelling of *Leiopelma* (by Fitzinger) to be retained and extended to the family name. The spelling *Liopelma* was apparently first used by Günther in 1868 (ref # 111).

**Reference Type:** Journal Article

**Record Number:** 16

**Author:** Turbott, E.G.

**Year:** 1949

**Title:** Discovery of the breeding habits of *Leiopelma hochstetteri* Fitzinger

**Journal:** Records of the Auckland Institute and Museum

**Volume:** 3

**Pages:** 373-376

**Label:** 16

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; Warkworth; development; Coromandel

**Abstract:** This paper describes the discovery near Warkworth, in the North Auckland district, of eggs and intracapsular embryos of *Leiopelma hochstetteri* Fitzinger. The development is described as being of the direct type, similar to *Leiopelma archeyi*. The eggs were found in holes beneath water-logged clay. The environment of adult and developmental stages of *L. hochstetteri* and *L. archeyi* is discussed briefly with reference to speciation.

This paper is also the first reporting of *L. hochstetteri* and *L. archeyi* occurring in sympatry in the Coromandel ranges. Three groups of eggs were found in wet mud of a seepage above a stream by Mr Gittos in 1948. Three adults were also found under the same stone, but not sitting over the eggs. In November 1949, Turbott found two groups of 10 and 11 eggs in the burrows of the dragonfly (*Uropetala* sp.) nymph, which were subsequently given to N.G. Stephenson (ref # 247).

**Reference Type:** Report

**Record Number:** 268

**Author:** Vial, James L.; Saylor, Lorelei

**Year:** 1993

**Title:** The status of amphibian populations: a compilation and analysis

**Institution:** IUCN/SSC, Declining Amphibian Populations Task Force

**Type:** Working Document No. 1

**Label:** 268

**Keywords:** *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma pakeka*; status

**Abstract:** This reports lists three native and endemic species of frog in New Zealand, which are considered to be Sensitive or Vulnerable.

Major threats to the two mainland species are listed as habitat disturbance and destruction from mining, and introduced mammals. The distribution of *Leiopelma hamiltoni* is listed as both Stephens and Maud Islands (therefore also referring to *L. pakeka*), and is considered 'Endangered' and 'Sensitive' due to low numbers, habitat modification and 'inbreeding depression'.

Information was provided by Alison Cree.

**Notes:** Hardcopy includes pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 162

**Author:** Wagner, D. S.

**Year:** 1934

**Title:** *Liopelma* Studies No. 1. The structure of the inner ear in relation to the reduction of the middle ear in the Liopelmidae (Noble).

**Journal:** Anatomischer Anzeiger

**Volume:** 79

**Pages:** 20-36

**Label:** 162

**Keywords:** physiology; *Leiopelma hochstetteri*; history

**Abstract:** This paper is the first of a series of investigations into the anatomy of *Leiopelma* (as *Liopelma*) undertaken by the Department of Zoology of the University of Stellenbosh (other papers are ref # 112, 113 & 163).

The purpose of this study was to ascertain whether any deviation from the Ranid pattern occurs in the anatomical structure of the inner ear of in the two genera of the Leiopelmatidae (referring to *Leiopelma* and *Ascaphus*), a family lacking the middle ear. The author concluded that the reduction of the middle ear and associated structures has called forth no parallel degeneration of the inner ear.

The adult *L. hochstetteri* was provided by Mr Archey of Auckland. At the time of publication, *L. archeyi* was as yet unnamed, and it is not clear whether this work refers to *L. hochstetteri* or *L. archeyi*.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Notes:** This paper also gives a brief outline of the history of the nomenclature of the genus as follows (quoted directly as written, therefore alternative spelling of *Liopelma* maintained): 'The Liopelmidae include only two genera: *Ascaphus* of North America and *Liopelma* of New Zealand. The latter genus is the only amphibian of New Zealand and was first described by Fitzinger (1861) who considered the genus to be closely related to *Telmatobius peruvianus*. Nieden groups *Liopelma* with the *Cystignathidae* in 'Das Tierreich' (1923, S. 510); Boulenger in the 'Catalogue of Batrachia Salientia' (1882, p. 447) places *Liopelma* under the Discoglossidae. Archey (1922) and Noble (1925) accept this classification. Noble (1924) instituted the family Liopelmidae for the reception of the American genus *Ascaphus* and the New Zealand frog *Liopelma*.....Noble considers the Liopelmidae as the most primitive Anura and therefore ancestral to the Discoglossidae and Pelobatidae.'

**Reference Type:** Journal Article

**Record Number:** 163

**Author:** Wagner, D. S.

**Year:** 1934

**Title:** *Liopelma* Studies No. 2. On the cranial characters of *Liopelma hochstetteri*

**Journal:** Anatomischer Anzeiger

**Volume:** 79

**Pages:** 65-77

**Label:** 163

**Keywords:** physiology; *Leiopelma hochstetteri*

**Abstract:** This paper continues the previous study by Wagner (ref # 162) and looks at the olfactory capsule of *Leiopelma hochstetteri* (as *Liopelma*), which, in general, no marked deviation from that of the genus *Rana* was found.

A detailed description of the cranial characters of *Leiopelma* is given and a comparison with *Ascaphus* is made, in which the author finds 'the most striking proof of the affinity of *Ascaphus* and *Liopelma*; they are too striking to be ascribed to parallel evolution'.

At the time of publication, *L. archeyi* was as yet unnamed, and it is not clear whether this work refers to *L. hochstetteri* or *L. archeyi*.

The alternative spelling of *Liopelma* was first used by Günther in 1868 and consequently other authors until Turbott called for the original spelling of *Leiopelma* to be retained, in 1942.

**Reference Type:** Journal Article

**Record Number:** 30

**Author:** Waldman, Bruce

**Year:** 1995

**Title:** Molecular approaches to frog population biology

**Journal:** New Zealand Journal of Zoology

**Volume:** 22

**Pages:** 401

**Label:** 30

**Keywords:** *Leiopelma hochstetteri*; *Leiopelma archeyi*; genetics; population studies

**Abstract:** This is an abstract of paper presented at the 6th Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand held at Manaia, Whangarei, 10-12 February 1995. This presentation discussed work underway to genetically characterise fine-grained population structure within and among populations of *Leiopelma archeyi* and *L. hamiltoni* using polymerase chain reaction (PCR) to amplify DNA extracted from toe clips.

**Reference Type:** Magazine Article

**Record Number:** 125

**Author:** Waldman, Bruce

**Year:** 1996

**Title:** Mixed fortunes of the frog fauna of New Zealand

**Magazine:** Froglog

**Volume:** 18

**Pages:** 6

**Date:** August 1996

**Label:** 125

**Keywords:** agents of decline; recovery plan

**Abstract:** Froglog is the magazine of the Declining Amphibian Populations Task Force (DAPTF) and is available online. This short article refers briefly to



possible agents of decline in *Leiopelma*. The recovery plan for *Leiopelma* spp. is also referred to.

**URL:** <http://www2.open.ac.uk/biology/froglog/FROGLOG-18-6.html>

**Reference Type:** Journal Article

**Record Number:** 238

**Author:** Waldman, Bruce

**Year:** 2000

**Title:** Hamilton's frog, *Leiopelma hamiltoni*

**Journal:** Biodiversity

**Volume:** 1

**Issue:** 3

**Pages:** 30-31

**Label:** 238

**Keywords:** *Leiopelma hamiltoni*; ecology

**Abstract:** This brief article describes *Leiopelma hamiltoni* and gives details of the ecology and life history of the species. The possibility that *L. hamiltoni* has experienced a genetic bottleneck is mentioned. The risks associated with the proposed translocation of the species to a second predator-free island are questioned. This article also points out that the justification of reclassifying *L. pakeka* as a separate species to *L. hamiltoni* is still under debate.

**Reference Type:** Book Section

**Record Number:** 121

**Author:** Waldman, Bruce; Tocher, Mandy D.

**Year:** 1998

**Title:** Behavioral ecology, genetic diversity, and declining amphibian populations

**Editor:** Caro, T.

**Book Title:** Behavioral Ecology and Conservation Biology

**City:** New York

**Publisher:** Oxford University Press Inc.

**Pages:** 394-443

**Label:** 121

**Keywords:** ecology; genetics; agents of decline

**Abstract:** This chapter discusses possible agents of global declining populations of amphibians. These include ultraviolet radiation, climate change, acid rain, pesticides/herbicides/fertilisers, changes in the biotic environment, fragmentation, demographic effects, genetic effects and disease. No single factor or group of factors can account for the declines and causation needs to be analysed on a case-by-case basis. A table showing long-term surveys of amphibian populations, including *Leiopelma*, is included. Behavioural ecology and amphibian conservation are also briefly discussed. Recommendations are made for population surveys, assessing genetic variation and planning conservation strategies.

**Reference Type:** Journal Article

**Record Number:** 193

**Author:** Waldman, Bruce; Wolfshaar, Karen E. van de; Klena, John D.; Andjic, Vera; Bishop, Phil; Norman, Richard J. de B.

**Year:** 2001

**Title:** Chytridiomycosis in New Zealand frogs

**Journal:** Surveillance

**Volume:** 28

**Issue:** 3

**Pages:** 9-11

**Label:** 193

**Keywords:** disease; chytrid fungus

**Abstract:** This article describes the first diagnosis of chytridiomycosis in New Zealand in dead and dying *Litoria raniformis* at an ephemeral pond in Christchurch over the summer of 1999-2000. Transmission and possible sources of incursion are also discussed.

Global amphibian declines are discussed and concerns expressed in relation to *Leiopelma*.

**Reference Type:** Report

**Record Number:** 251

**Author:** Webster, Nadia

**Year:** 2002

**Title:** Frog Ecologist report to the Frog Recovery Group May 2002

**Pages:** 14

**Type:** Unpublished report for the Department of Conservation

**Label:** 251

**Keywords:** *Leiopelma archeyi*; *Leiopelma hochstetteri*; survey; monitoring; artificial cover objects

**Abstract:** This report appears as Appendix 2 in the Native frog Recover Group Annual Report 2002 (ref # 250).

A systematic *L. hochstetteri* distributional survey method was developed and is being trialed. Monitoring trials were undertaken using artificial cover objects (ACO) and nighttime grid searches and are continuing. The Mike Thorsen (1998) random transect method was assessed for its use in *L. archeyi* monitoring on Mt. Moehau. It was decided not to continue using this method and to look for an appropriate nighttime grid site instead. A student study on Great Barrier Island did not find any 'swimming' frogs, but did note large amounts of pig damage to the study stream. Monitoring methods for *L. hochstetteri* will be developed by initially looking at Brenda Greene's Hunua Ranges study site and attempting to assess the variation of numbers of *L. hochstetteri* seen there.

**Reference Type:** Report

**Record Number:** 197

**Author:** Webster, Nadia

**Year:** 'in prep'

**Title:** Native frog captive husbandry manual

**Institution:** Department of Conservation, Waikato Conservancy

**Label:** 197

**Keywords:** captivity; reproduction; husbandry; development; quarantine

**Abstract:** This document will outline the protocols and procedures to be followed when housing *Leiopelma* in a captive situation. Handling, transferring,

quarantine and general husbandry techniques of frogs is discussed. Breeding and rearing protocols are also outlined. This document includes minimum standards and reporting requirements and will form part of the national captive management plan for *Leiopelma* species.

**Notes:** No hardcopy provided

**Reference Type:** Journal Article

**Record Number:** 152

**Author:** Wells, Richard W.; Wellington, C. Ross

**Year:** 1985

**Title:** A synopsis of the Amphibia and Reptilia of New Zealand

**Journal:** Australian Journal of Herpetology

**Volume:** Supplementary Series 1

**Pages:** 62-64

**Label:** 152

**Keywords:** nomenclature; taxonomy

**Abstract:** This paper is a brief review of the extant reptiles and amphibians of New Zealand. The authors considered it appropriate that a number of long overdue changes be proposed to both groups. They reject the traditional view that *Leiopelma* is monophyletic and have erected a new genus to accommodate *L. archeyi* and *L. hamiltoni*. The authors also point out that they consider that the New Zealand herpetofauna is considerably larger than currently recognised. The dichotomy between *L. hochstetteri* and *L. archeyi/L. hamiltoni* leads to the authors naming a new genus - *Leioaspetos archeyi* and *Leioaspetos hamiltoni*. This work was considered by the International Commission on Zoological Nomenclature (Case 2531) and whereas it could not be technically thrown out, it is largely considered not to be authoritative on the subject of nomenclature of NZ herpetofauna.

**Notes:** This work was considered by the International Commission on Zoological Nomenclature (Case 2531) and whereas it could not be technically thrown out, it is largely considered not to be authoritative on the subject of nomenclature of NZ herpetofauna.

**Reference Type:** Book Section

**Record Number:** 206

**Author:** Whitaker, A.H.

**Year:** 1978

**Title:** The effects of rodents of reptiles and amphibians

**Editor:** Dingwall, P. R.; Atkinson, I.A.E.; Hay, C.

**Book Title:** The ecology and control of rodents in New Zealand nature reserves

**City:** Wellington

**Publisher:** Department of Lands and Survey Information Series No. 4

**Pages:** 75-88

**Label:** 206

**Keywords:** predation; *Leiopelma archeyi*; *Leiopelma hochstetteri*

**Abstract:** This is the proceedings of a symposium convened by the Department of Lands and Survey, held in Wellington on 29-30 November 1976. One of the topic headings was the effect of rodents on wildlife and vegetation in New

Zealand.

The possible impacts of introduced rodents on *Leiopelma* were not really known, although it was assumed that frogs might conform to the pattern of vulnerability shown by reptiles. *L. archeyi* and *L. hochstetteri* have probably been exposed to all four rodents. As *L. hochstetteri* is more or less confined to watercourses or very wet ground, the risk of predation may thereby be reduced. Rodents are considered possible agents of decline for extinct *Leiopelma*.

**Notes:** A. H. Whitaker also publishes under Tony Whitaker.

**Reference Type:** Report

**Record Number:** 137

**Author:** Whitaker, A.H.

**Year:** 1996

**Title:** Monitoring of Hochstetter's frog (*Leiopelma hochstetteri*) populations near Golden Cross Mine, Waitekauri Valley, Coromandel.

**City:** Waihi

**Institution:** Coeur Gold, New Zealand

**Pages:** 32

**Type:** Unpublished report

**Label:** 137

**Keywords:** *Leiopelma hochstetteri*; monitoring; Golden Cross Mine; Coromandel; recruitment

**Abstract:** *Leiopelma hochstetteri* populations in five small, forested streams adjacent to the Golden Cross Mine in the Waitekauri Valley, Coromandel, were monitored in January 1996. These streams were the location of a detailed study on the biology of *L. hochstetteri* between 1989-1991 and had been re-surveyed in January 1994. The relative density in the study area in 1996 averaged 21.1 frogs/100 m, the same as in 1994 (21.2/100 m) but significantly higher than reported in January 1991 (11.5/100 m). The proportion of juveniles (<18 mm snout-vent length, < 1 year old) in the population in 1996 (6.5%) was the same as in 1994 (7.8%) but significantly lower than recorded in January 1991 (37.7%). The apparent increase in relative density is interpreted as an artefact of the survey methodology and analysis, and it is more likely the density is little changed. The decline in recruitment is probably real and is further manifest in an ageing population. Possible reasons for the decline in recruitment are considered including impacts from the Golden Cross Mine, habitat changes, and the survey methodology itself. There is no evidence that mine impacts are implicated in the declining recruitment. More likely possibilities relate to changes in vegetation following goat control, disturbance caused by the survey method, or a widespread cyclic (climate) phenomenon. General recommendations arising from this research include: continuing the monitoring programme on a biennial basis; seeking new, more appropriate, control sites; measuring recruitment in undisturbed streams; investigating less disruptive survey methods; and extending the monitoring to include *L. archeyi*.

**Notes:** A. H. Whitaker also publishes under Tony Whitaker.

**Reference Type:** Journal Article

**Record Number:** 74

**Author:** Whitaker, A.H.; Alspach, P.A.

**Year:** 1999

**Title:** Monitoring of Hochstetter's frog (*Leiopelma hochstetteri*) populations near Golden Cross Mine, Waitekauri Valley, Coromandel

**Journal:** Science for Conservation

**Volume:** 130

**Pages:** 36

**Label:** 74

**Keywords:** *Leiopelma hochstetteri*; Golden Cross Mine; monitoring; recruitment

**Abstract:** This report discusses the biennial monitoring of *Leiopelma hochstetteri* populations adjacent to the Golden Cross Mine, in the headwaters of the Waitekauri River, southern Coromandel Range that was undertaken in January 1998. The relative population density of frogs in the study streams (mean 17.7/100 m) was lower than, but comparable to, the density observed in 1994 and 1996 (21/100 m). In 1998 the proportion of sub-adult frogs (1-2 years old) in the population was higher than observed in the earlier monitoring surveys. This difference in the age structure of the population did not appear to be the result of sampling bias and indicated successful recruitment has occurred in the period 1996-1998. There is no evidence that the activities of the Golden Cross Mine have impacted on the frog populations in the study streams.

Continued monitoring was recommended without toe clipping (as the rate of recapture of marked animals between 1994 and 1998 was very low).

**Notes:** A. H. Whitaker also publishes under Tony Whitaker.

**Reference Type:** Journal Article

**Record Number:** 20

**Author:** Whitaker, A.H.; Hardy, G.S.

**Year:** 1985

**Title:** An unusual frog observation

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 15

**Issue:** 3

**Pages:** 289-290

**Label:** 20

**Keywords:** Great Barrier Island; *Leiopelma hochstetteri*; frog swimming

**Abstract:** This is a record of an observation of a frog not obviously *Leiopelma hochstetteri* or *Litoria raniformis* or *Litoria ewingi* during a herpetofauna survey by the New Zealand Wildlife Service on Great Barrier Island. Two frogs were observed active by day in a fast flowing pool. When disturbed they swam down to the depths of the pool, using a strong double leg action. Both frogs were coloured a pale fawn. This observation may represent new or aberrant behaviour in *L. hochstetteri*, a previously unrecorded introduced species on Great Barrier or a new species of indigenous frog.

**Notes:** A. H. Whitaker also publishes under Tony Whitaker.

**Reference Type:** Report

**Record Number:** 48

**Author:** Whitaker, Tony  
**Year:** 2000  
**Title:** Herpetofauna of the Opuiaki Ecological Area, northern Mamaku Plateau  
**City:** Tauranga  
**Institution:** Tauranga Area Office, Bay of Plenty Conservancy, Department of Conservation  
**Pages:** 19  
**Date:** 20 May 2000  
**Type:** Unpublished report  
**Label:** 48

**Keywords:** Opuiaki; *Leiopelma hochstetteri*; survey

**Abstract:** The herpetofauna of the Opuiaki Ecological Area was surveyed in January 2000 using a variety of search techniques. *Leiopelma hochstetteri* were previously known from the central Kaimai Range, to the north, and from Otawa, an isolated peak to the east near Te Puke.

Particular emphasis was given to searching small streams for *L. hochstetteri* (night searches totally 17.3 person hours). No indigenous frogs were found, but the introduced green and golden bell frog (*Litoria aurea*) was found to be widespread.

**Notes:** Tony Whitaker also publishes under A. H. Whitaker.

**Reference Type:** Report

**Record Number:** 49

**Author:** Whitaker, Tony

**Year:** 2001

**Title:** Frogs and lizards of the Bay of Plenty: a field key.

**City:** Rotorua

**Institution:** Bay of Plenty Conservancy, Department of Conservation

**Pages:** 28

**Type:** Unpublished report

**Label:** 49

**Keywords:** identification; *Leiopelma archeyi*; *Leiopelma hochstetteri*; Bay of Plenty

**Abstract:** This provides a field key and description for both *Leiopelma hochstetteri* and *L. archeyi*.

**Notes:** Tony Whitaker also publishes under A. H. Whitaker.

**Reference Type:** Magazine Article

**Record Number:** 144

**Author:** White, Margo

**Year:** 1999

**Title:** Croaking it - apocalypse alert: the frogs of the world are dying

**Magazine:** Listener

**Volume:** 160

**Issue Number:** 3085

**Pages:** 28

**Date:** 26 June 1999

**Label:** 144

**Keywords:** agents of decline; *Leiopelma archeyi*; Coromandel

**Abstract:** This article reports on global amphibian declines (and states that ‘some 35 species of amphibians become extinct each year throughout the world’). Ben Bell is quoted on the apparent decline of *Leiopelma archeyi* in the Coromandel since 1996. Bruce Waldman is quoted re concerns over chemical pollution as an agent of decline.

**Reference Type:** Report

**Record Number:** 289

**Author:** Wilkinson, A.S.

**Year:** 1925

**Title:** Kapiti Island

**Date:** 31 December 1924

**Type:** Diary entry

**Label:** 289

**Keywords:** *Leiopelma archeyi*; translocation; Kapiti Island; *Leiopelma hochstetteri*

**Abstract:** A journal and a diary entry by A.S. Wilkinson, who ‘took charge of kapiti on 24.11.1924 according to the first entry. The journal entry states that Wilkinson liberated 13 *L. hochstetteri* on 31 December 1924, and again 2 *L. hochstetteri* on 10, 20 or 30 March 1925 (actual date is illegible). The diary entry is of Thursday 1, and has been identified by the person making the original photocopy of the entry (Ben Bell ?) as 1 January 1925. It states that Wilkinson went to see frogs (the date, if correct, means that this must be from his first liberation), but found only 2 dead frogs, which he preserved in spirits to be sent to Museum (not stated which one).

This entry is cited by Bell 1985 (ref. # 97), and by Moon 1994 (ref. # 285). Bell states that the frogs might possibly have been *L. archeyi* (though gives no reason).

**Notes:** Hardcopy from a copy with annotations (by Bell?) and with annotations by A. Holzapfel regarding two possible sources of further information: 1) A.S. Wilkinson & Amy Wilkinson 1952: Kapiti bird sanctuary: a natural history of the island. Masterton. 2) Amy K. Wilkinson 1957: Kapiti Diary. Ed. and pub.: R.H.D. Stidolph. Both references are available in DOC library in Wellington.

**Reference Type:** Book

**Record Number:** 201

**Author:** Williams, Gordon R.; Given, David R.

**Year:** 1981

**Title:** The Red Data Book of New Zealand

**City:** Wellington

**Publisher:** Nature Conservation Council

**Number of Pages:** 175

**ISBN:** ‘(no number)’

**Label:** 201

**Keywords:** status; *Leiopelma archeyi*; *Leiopelma hamiltoni*; *Leiopelma pakeka*; *Leiopelma hochstetteri*

**Abstract:** This publication draws attention to the threats facing the rare and endangered species of endemic terrestrial vertebrates and vascular plants of New Zealand. Species are classed according to degree of threat. A brief description including habitat and ecology, distribution, estimated numbers and threats to survival are given for each species. *Leiopelma archeyi*, *L. hamiltoni* (distribution is given as Stephens and Maud Islands, therefore also referring to *L. pakeka*) and *L. hochstetteri* are all classified as 'rare'.

**Notes:** Hardcopy includes the introduction, explanation of categories and pages relevant to *Leiopelma* only.

**Reference Type:** Manuscript

**Record Number:** 124

**Author:** Wilson, Geoffrey Burns

**Year:** 1967

**Title:** Native frog

**Collection Title:** MS-Papers

**City:** Wellington

**Number:** 1003-37

**Pages:** 4

**Label:** 124

**Keywords:** history;

**Abstract:** This is a small collection of newspaper articles and a letter (dates are 1934 and 1967) held at the Alexander Turnbull Library, originating from Geoffrey Burns Wilson. One newspaper article refers to 'Further Findings of Native Frogs' (Taranaki, 18/11/67) and includes references to letters written to Arthur Parrott, columnist of 'A Naturalist's Notebook'. These report sightings of frogs as follows; in a crater of Mt Edgecumbe, Bay of Plenty; Martinborough (small.. bright green, underneath a fairly large boulder... no streams or pools or breeding places, within miles); the Tararua Ranges (Bald Hill, Tiritea Basin ESE from Palmerston North - found in 'far from running water' but in a seepage and 'one was mainly yellow with faint markings lengthways. The other was dark, near enough the colour of the average freshwater crayfish'. No records have been located as yet verifying these observations.

Another article refers to a lecture given by Gilbert Archey (date unknown), which generally describes *Leiopelma* and another by J. Drummond (Dominion, 19/5/34), which also refers to native and other frog species.

**Reference Type:** Thesis

**Record Number:** 277

**Author:** Worthy, Trevor H.

**Year:** 1986

**Title:** Subfossil bones of the frog *Leiopelma* in New Zealand

**University:** Victoria University of Wellington

**Number of Pages:** 242

**Thesis Type:** MSc.

**Label:** 277

**Keywords:** subfossil;

**Abstract:** The subfossil frog fauna, primarily from cave deposits, was examined



from throughout New Zealand. Frog bones are recorded from 119 sites between Kaitaia and Fiordland, but are most common around Waitomo and northwest Nelson. Three new species of leiopelmid frog are described. *Leiopelma* n.sp. 1 and *Leiopelma* n.sp. 3 are represented by thousands of bones representing a minimum number of 341 and 212 individuals respectively. *Leiopelma* n.sp. 2 is known only from 31 bones of one individual. A minimum number of 107 individuals of *L. hamiltoni* and 33 *L. hochstetteri* were recorded, greatly extending the range of these species so that the former is known to have occurred as far north as Waitomo and the latter as far south as Punakaiki. The distribution of *Leiopelma* n.sp. 1 was New Zealand wide, that for *Leiopelma* n.sp. 2 limited to Fiordland and that for *Leiopelma* n.sp. 3 to the North Island. Subfossil material of *L. archeyi* was not found.

*Leiopelma* n.sp. 1 was an extremely stout, medium length frog (50 - 60 mm snout-vent length (SVL)), which was probably a walker, rather than a hopper, that occupied a terrestrial niche on the forest floor. In comparison *Leiopelma* n.sp. 3 was a large species (up to 100 mm SVL), which was relatively the best jumper in the genus, and was probably a streamside inhabitant in forested areas.

The contention that *L. archeyi* is a neotenic form of *L. hamiltoni* (see Stephenson 1960, ref # 66) is found to be false with both species exhibiting similar degrees of ossification. Other than size these species are osteologically identical. Clinal size variation, which has a direct relationship with increasing latitude, was observed in *Leiopelma* n.sp. 3, *L. hochstetteri* and to a lesser extent, *Leiopelma* n.sp. 1 and *L. hamiltoni*. Those species that had more aquatic tendencies had the greatest size variation. It is suggested that larger size is the result of arrested development due to lower temperatures. Terrestrial species by a combination of habitat selection and behavioural adaptations can evade the lower ambient temperatures.

An osteological comparison of all *Leiopelma* species was made and these compared to *Ascaphus*. The recognition of the family Leiopelmatidae as separate to the Ascaphidae is supported. The dichotomy among the extant *Leiopelma* species is mirrored among the extinct forms with *Leiopelma* n.sp. 1 and *Leiopelma* n.sp. 2 being related to *L. hochstetteri* and *Leiopelma* n.sp. 3 to the *L. hamiltoni/archeyi* lineage.

A review of the history of discovery of subfossil frogs in New Zealand is also given.

**Notes:** Hardcopy includes title page, abstract, table of contents, lists of figures, plates and tables

**Reference Type:** Journal Article

**Record Number:** 18

**Author:** Worthy, Trevor H.

**Year:** 1987

**Title:** Osteology of *Leiopelma* (Amphibia: Leiopelmatidae) and description of three new subfossil *Leiopelma* species.

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 17

**Issue:** 3

**Pages:** 201-251

**Label:** 18

**Keywords:** *Leiopelma waitomoensis*; *Leiopelma markhami*; *Leiopelma auroraensis*; osteology; phylogeny; subfossil

**Abstract:** Three new species of leiopelmatid frog are described from cave deposits. *Leiopelma waitomoensis* n.sp., an offshoot of the *L. archeyi*/*L. hamiltoni* lineage, and *Leiopelma markhami* n.sp., and *Leiopelma auroraensis* n.sp., which are more closely related to *L. hochstetteri*. The osteology of the extant species *L. hochstetteri*, *L. hamiltoni* and *L. archeyi* is described in detail. The data do not support the contention of Stephenson (1960, ref # 66), that *L. archeyi* is neotenic in relation to *L. hamiltoni*. This idea was based only on the relative degree of ossification observed in these species; but both were found to exhibit equal degrees of ossification. Detailed osteological studies of the Leiopelmatidae support the distinction of the family from the Ascaphidae.

Snout-vent lengths for adults of each species were given as: *L. hochstetteri* - up to 50 mm; *L. hamiltoni* - up to 50 mm; *L. archeyi* up to 38 mm; *L. markhami* - 50-60 mm; *L. auroraensis* - 60 mm; *L. waitomoensis* - 100 mm. A phenogram based on the data analysed is included.

**Reference Type:** Journal Article

**Record Number:** 21

**Author:** Worthy, Trevor H.

**Year:** 1987

**Title:** Palaeoecological information concerning members of the frog genus *Leiopelma*: Leiopelmatidae in New Zealand.

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 17

**Issue:** 4

**Pages:** 409-420

**Label:** 21

**Keywords:** *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; *Leiopelma waitomoensis*; *Leiopelma markhami*; *Leiopelma pakeka*; distribution; palaeoecology; subfossil

**Abstract:** This paper examines palaeoecological information for the three extant and the three extinct species of *Leiopelma*. The subfossil distribution of the extant *Leiopelma hochstetteri* and *L. hamiltoni* show that until the late Holocene these species ranged from Punakaiki, on the west coast of the South Island, to Waitomo in the North Island. The morphological characters of the frogs, and the characteristics of the subfossil sites, suggest that the presumably extinct *L. waitomoensis* was a strongly hopping, stream or streamside frog, whereas, *L. markhami*, a slightly smaller extinct species, was primarily a walking, terrestrial frog.

The formerly widespread species of *Leiopelma* (*L. markhami*, *L. waitomoensis*, *L. hochstetteri* and *L. hamiltoni*) all tended to become larger in southern populations. Size appears to be negatively correlated with temperature.

The distribution of body sizes among adults of the extant Maud Island popula-

tion of *L. hamiltoni* (therefore referring to *L. pakeka*) is similar to that of the extinct population of the same species previously living in Karamea, northwest Nelson.

The disappearance of the extinct species, and the decline in range of the surviving species, date to the last millennium and is probably correlated with the arrival of the kiore, *Rattus exulans*, in New Zealand.

The study sites were Waitomo, Piopio, Karamea, Martinborough and Lake Te Anau. The age of deposits examined were estimated at 300 to 14,000 B.P. Morphological comparisons of extant species, subfossil and recent are given.

**Reference Type:** Book

**Record Number:** 200

**Author:** Worthy, Trevor H.

**Year:** 1993

**Title:** Fossils of Honeycomb Hill

**City:** Wellington

**Publisher:** Museum of New Zealand/Te Papa Tongarewa

**Number of Pages:** 56

**ISBN:** 0908953046

**Label:** 200

**Keywords:** subfossil; Honeycomb Hill; *Leiopelma markhami*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*

**Abstract:** This publication describes the Honeycomb Hill Cave complex (north of Karamea), which is 13.7 km of interconnected passages in a small area of 800 by 1000 m. The significant cave fossil deposits found in the system make it of national and international importance. In Eagles Roost, subfossils of non-avian fauna found were dominated by leiopelmatid frogs, with the extinct *Leiopelma markhami* being most abundant. Minimum number of individuals represented are *L. markhami* = 74; *L. hamiltoni* = 4; *L. hochstetteri* = 3; indeterminate = 44. Current estimates suggest that deposition has been occurring at this site since 16,000 years ago. Subfossils of frogs were also found in Site AR144 (the fauna of which is accepted to be from the Holocene). Minimum number of individuals represented are *L. markhami* = 58; *L. hamiltoni* = 6; *L. hochstetteri* = 2; indeterminate = 24.

**Notes:** Hardcopy includes introduction and pages relevant to *Leiopelma* only.

**Reference Type:** Journal Article

**Record Number:** 42

**Author:** Worthy, Trevor H.

**Year:** 1998

**Title:** The Quaternary fossil avifauna of Southland, South Island, New Zealand

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 28

**Issue:** 4

**Pages:** 537-589

**Label:** 42

**Keywords:** Quaternary; Southland; *Leiopelma auroraenis*; *Leiopelma markhami*; subfossil

**Abstract:** All known Late Quaternary fossil avifauna derived at various times during the last century, from cave, swamp and dune deposits in Southland are described. A few leiopelmatid and sphenodontid bones were found and are also listed. This paper includes descriptions of the present environment and history of vegetation. The systematic palaeontology shows one femur found at Forest Hill identified as either *Leiopelma auroraenesis* or *L. markhami*.

**Reference Type:** Journal Article

**Record Number:** 24

**Author:** Worthy, Trevor H.; Holdaway, R.N.

**Year:** 1993

**Title:** Quaternary fossil faunas from caves in the Punakaiki area, West Coast, South Island, New Zealand

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 23

**Issue:** 3

**Pages:** 147-254

**Label:** 24

**Keywords:** palaeoecology; Quaternary; West Coast; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*; subfossil; *Leiopelma markhami*

**Abstract:** The late Quaternary fossil vertebrate faunas from 42 caves in Oligocene limestones of the Barrytown Syncline, Westland, are described and discussed. Radiocarbon dating shows that the faunas were laid down at various times during the past 25,000 years. A date of 25,070 years is the oldest so far obtained from any cave deposit in New Zealand. The fossil fauna consisted of 50 species of bird, three frogs, one skink, one gecko, one tuatara, and two or possibly three bats.

This paper includes a description of the present climate, current vegetation and present fauna of the study site. A description of all caves surveyed is also provided as well as a systematic palaeontology of all finds. *Leiopelma* finds were: *L. markhami* - 259 bones representing a minimum of 22 individuals from seven caves; *L. hamiltoni* - 424 bones representing a minimum of 33 individuals from five caves; *L. hochstetteri* - 19 bones representing a minimum of four individuals from three caves. There were also 12 bones representing a minimum of seven individuals from four caves of indeterminate *Leiopelma* extant species.

This paper also refers to a Hamilton's type frog found in Whareorino Forest that had recently been discovered; this would later be confirmed to be *L. archeyi* (c.f. Bell *et al.* 1998, ref # 5).

**Reference Type:** Journal Article

**Record Number:** 10

**Author:** Worthy, Trevor H.; Holdaway, R.N.

**Year:** 1994

**Title:** Quaternary fossil faunas from caves in Takaka Valley and on Takaka Hill, northwest Nelson, South Island, New Zealand

**Journal:** Journal of the Royal Society of New Zealand

**Volume:** 24

**Issue:** 3

**Pages:** 297-391

**Label:** 10

**Keywords:** subfossil; Nelson; Quaternary; *Leiopelma markhami*; *Leiopelma hamiltoni*; *Leiopelma hochstetteri*

**Abstract:** The late Quaternary fossil vertebrate faunas from 43 caves in Oligocene limestones and Ordovician marbles in the Takaka Valley and on Takaka Hill, northwest Nelson, are described and discussed. The fossil faunas included 42 species of land snails, three species of leiopelmatid frog, a tuatara, three species of gecko, one or more species of skink, at least 58 (including two introduced) species of bird, three species of bats, two rats and the house mouse. Radiocarbon dates indicate that the faunas found were laid down during the past 30,000 years and demonstrate that there has been no interchange of North and South Island terrestrial vertebrates over this time. This suggests that there was no Cook Strait land bridge at any time during the Otira (last) Glaciation. Leiopelmatidae species found: *Leiopelma markhami* - 753 bones representing 49 individuals, *L. hamiltoni* - 129 bones representing a minimum of 21 individuals, *L. hochstetteri* - 7 bones representing a minimum of three individuals. Fifty-four bones representing a minimum of 11 individuals of indeterminate *Leiopelma* extant species were also recorded. Locations of all finds and catalogue numbers are recorded.

**Reference Type:** Journal Article

**Record Number:** 78

**Author:** Worthy, Trevor H.; Holdaway, R.N.

**Year:** 1994

**Title:** Scraps from an owl's table - predator activity as a significant taphonomic process newly recognised from New Zealand Quaternary deposits

**Journal:** Alcheringa

**Volume:** 18

**Issue:** 3-4

**Pages:** 229-245

**Label:** 78

**Keywords:** Quaternary; subfossil; predation; *Leiopelma hamiltoni*

**Abstract:** This paper describes a fossil bone deposit from a cliff flanking the Tiropahi River, Westland and was dated  $17,340 \pm 140$  radiocarbon years BP. This deposit is assumed to be a result of predation by the laughing owl (*Sceloglaux albifacies*), which is described as an opportunist predator on birds, bats, frogs, skinks, geckos and fish.

A total number of 124 bones representing a minimum of eight individuals of *Leiopelma hamiltoni* were found.

**Reference Type:** Thesis

**Record Number:** 262

**Author:** Zeyl, Clifford W.

**Year:** 1991

**Title:** Genome evolution in the primitive frog *Leiopelma hochstetteri*

**Academic Department:** Department of Biology

**City:** Montreal

**University:** McGill University

**Number of Pages:** 138

**Thesis Type:** MSc.

**Label:** 262

**Keywords:** *Leiopelma hochstetteri*; genetics

**Abstract:** *Leiopelma hochstetteri* shows exceptional karyotypic variation. On the North Island, females carry a univalent W chromosome and both sexes have 0 to 15 supernumerary chromosomes. Frogs from Great Barrier Island have a conventional  $2n=22$  karyotype, with no sex chromosome differentiation in C-banded mitotic chromosomes. However, the lampbrush chromosomes of a Great Barrier Island female show evidence of heterogamety. This suggests that presumed ancestral female heterogamety has persisted on Great Barrier Island and given rise to a WZZ-female/ZZ-male sex chromosome system on the North Island.

A repeated sequence, Lh1, varies greatly within populations in copy number and distribution on genomic EcoRI fragments. *In situ* hybridisation revealed the variable presence of large Lh1 arrays on supernumerary chromosomes and two autosomes. The extensive Lh1 variability implies that, like the supernumeraries, it is more selfish than functional in the *L. hochstetteri* genome.

**Notes:** Hardcopy is from microfiche and includes title page, abstract, preface, table of contents and lists of tables and figures only.

**Reference Type:** Journal Article

**Record Number:** 79

**Author:** Zeyl, Clifford W.; Green, David M.

**Year:** 1992

**Title:** Heteromorphism for a highly repeated sequence in the New Zealand frog *Leiopelma hochstetteri*

**Journal:** Evolution

**Volume:** 46

**Issue:** 6

**Pages:** 1891-1899

**Label:** 79

**Keywords:** *Leiopelma hochstetteri*; evolution; genetics

**Abstract:** This paper describes a satellite DNA sequence, Lh1, which was cloned from *Leiopelma hochstetteri*. Large tandem arrays of Lh1 were localised by *in situ* hybridisation to the long arm of a small telocentric autosome in some individuals, but these arrays were absent from other individuals. Lh1 is also present in varying amounts on some supernumerary chromosomes in some individuals. Heteromorphism for the presence of Lh1 exists in two populations that have been separated by a sea channel since the end of the Pleistocene (Great Barrier Island and the North Island), indicating that the heteromorphism either has arisen repeatedly or has persisted for at least 10,000 years. Individuals lacking Lh1 thus appear to be at no significant selective disadvantage. The variation in Lh1 copy number probably results from its interstitial chromosomal location, which exposes it to more frequent unequal crossovers than the pericentromeric or telocentric locations of most satellite DNA. Lh1 may be parasitic or simply

inert junk, but in either case it may be deleted or dispersed throughout the rest of the genome through unequal crossing over.

Specimens used for analysis where as follows: a male and two females from Great Barrier Island, two females from Toatoa, two females from Waitakere, two males from Tokatea, a female from Whanarua, a male from Tapu, a male from Mangatangi, a male from Mt Moechau and a male from Big Omaha.

**Reference Type:** Thesis

**Record Number:** 130

**Author:** Ziegler, Stephanie

**Year:** 1999

**Title:** Distribution, abundance and habitat preferences of Hochstetter's frog in the Waitakere Ranges, Auckland

**Academic Department:** Environmental and Marine Sciences

**University:** University of Auckland

**Number of Pages:** 117 + app

**Thesis Type:** MSc.

**Label:** 130

**Keywords:** *Leiopelma hochstetteri*; distribution; habitat; Waitakere; diet

**Abstract:** This study aimed to determine the distribution of *Leiopelma hochstetteri* in the Waitakere Ranges Regional Park, and the abundance of those populations discovered. Populations of this species are often cited as being disjunctive, and the aggregation of animals within a small area has been suggested to be linked to the available food supply. Hence, this study also investigated the diet of *L. hochstetteri* (via faecal analysis), and related this to the surrounding invertebrate (terrestrial and aquatic) community. Percentage composition of material in faecal samples from all *L. hochstetteri* sampled in the short-term study showed a high presence of Coleoptera (22%), Araneae (23%) and Hymenoptera (18%).

Populations of *L. hochstetteri* were found throughout the Waitakere Ranges Parkland, most being discovered in the southern area of the park. Habitat preferences of *L. hochstetteri* were identified at all inhabited sites. Populations measured appeared stable, and there was evidence of recruitment occurring. Associations between various age classes was recognised and may be a reflection of habitat differentiation between different age classes. *L. hochstetteri* appeared to be opportunistic, generalist feeders, and it is unlikely that their distribution in a stream was related to the available food supply.

Sampling techniques for *L. hochstetteri* have been recommended, as has a monitoring programme for populations within the Waitakere Ranges, Auckland. Despite the apparent abundance of this species in this area, declines and local extinctions of amphibian species can occur rapidly, thus, a structured monitoring programme is necessary to detect any population changes as early as possible.

**Notes:** Hardcopy includes title page, abstract, table of contents, lists of figures, tables, plates and maps. A map showing the sites where frogs were found is also included.