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SOME OBSERVATIONS ON HOCHSTETTER'S FROG IN THE CATCHMENT OF THE MOTU RIVER, EAST CAPE

Summary: The distribution and abundance of Hochstetter's frog *(Leiopelma hochstetteri* Fitzinger) in part of the catchment of the Motu River was assessed 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 20mm long were bright lime green. Snout to vent lengths ranged from 15-46 mm and weights from 1.0-7.1 g. A cluster of eggs with well developed embryos was found in the catchment in March 1983.

Keywords: Motu River; East Cape; Hochstetter's frog; Leiopelma hochstetteri; Leiopelmidae; abundance; size; breeding.

Introduction

The Motu River rises in the Ruakumara Range and flows northwest through steep, heavily forested hill country before entering the Bay of Plenty at Haupoto. In the late 1970s, the Ministry of Works and Development outlined plans to use the river for the generation of hydro-electric power (Galloway, 1979). As part of feasibility studies, the Ministry commissioned investigations into wildlife of the catchment and how it might be affected by hydro-electric development. The results presented here were collected during two short surveys, aimed mainly at establishing the distribution and abundance of Hochstetter's frog *(Leiopelma hochstetteri)* in some tributaries of the Motu. Little published information currently exists on East Cape populations of this species, and few attempts have been made anywhere to estimate its abundance.

Surveyed Area

The first survey was undertaken in December 1981 in the Takaputahi River (Fig. 1), the largest tributary of the Motu River. The upper parts of the catchment have been cleared for farming, but the lower two-thirds retain an intact cover of forest, dominated by tawa *(Beilschmiedia tawa)* and podocarps (Podocarpaceae). The survey was centred on the interface of the farmland and forest, at the confluence of the Rawea Stream and Takaputahi River.

The second survey was undertaken in March 1983 on the upper Motu River, from Kirks Clearing (NZMS 1, N79: 100970*)* to the confluence of the

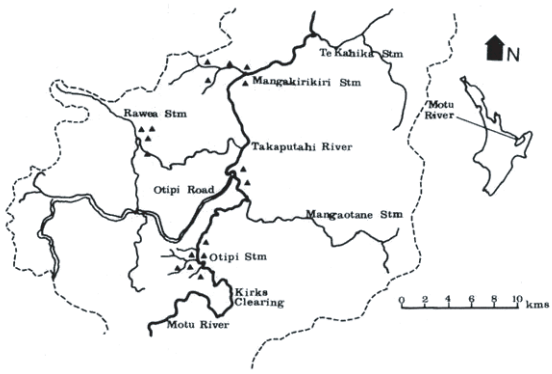

Figure 1: *Locations* (Δ) *of* Leiopelma hochstetteri in *the catchment of the Motu River*.

Mangakirikiri Stream (095174). Four days were spent surveying in forest near Kirks Clearing, Otipi Stream, Otipi road and the Mangakirikiri Stream. In addition, I examined several small tributaries briefly while travelling down the river.

Methods

Searches for Hochstetter's frog were undertaken mainly during daylight, in and along the edges of streams. Records were kept of the time spent searching, the number of stones and logs turned, the number of frogs found, and their distance from the water. Some frogs were weighed and measured. One stream was searched at night with a spotlight, as well as during the day, so that day and night counts

could be compared. The absolute density of frogs was measured in two small streams by positioning 31 quadrats (0.25 m^2) at random points along their banks. All stones and loose debris within each quadrat were turned and the number of frogs found was recorded. The density of frogs in piles of stones at .the foot of slips was also determined by measuring the area of each pile before searching began.

Results

Hochstetter's frog was found in most of the tributaries examined between Kirks Clearing and the Mangakirikiri Stream. It was also found on the banks of the Motu itself, above extreme flood level. The species has been recorded in the lower Motu, below the Mangakirikiri confluence (K. Dolman, pers. comm.), and elsewhere in the Ruakumara Range (Bull and Whitaker, 1975; Bell, 1982).

Distribution in streams

Horizontal: Frogs were found under partially submerged stones in streams, and under rocks and logs up to 4 m from the water. In the Takaputahi catchment, most (59%, n=73) frogs were within 25 cm of the water, whereas in the upper Motu, the majority (61%, n=34) were more than 1.5 m away (Fig. 2). This difference between localities (and years) is highly significant ($X^2 = 47.0$, $p<0.001$). Seventeen frogs found on the banks of the Motu were living in moist seepages, 5-11 m above the river's normal level.

Longitudinal: The frogs were most abundant in areas with coarse, stable, moss-covered substrates, protected from direct sunlight by overhanging vegetation. Conversely, they were seldom found in gorges, where the smooth rock walls offered few hiding places, or in slow-moving parts of streams with fine bed materials. Social attraction may have also contributed to their clumped distribution, since frogs often shared daytime shelters, even in areas with an apparent abundance of sites. Pairs were common, and on four occasions three or four frogs were found under one stone.

Indices of abundance

The mean number of frogs found per hour of searching, and the mean number of stones and logs turned per frog found, were calculated to provide crude indices of abundance. These are dependent, so one does not provide a check on the other, and both are very dependant on the skills of the people doing the searching. In one tributary of the Rawea Stream, for example, observer 1 turned 100 stones/hour and found an average of 3.5 frogs/hour. Observer 2, who walked along the other bank at the same speed, turned 172 stones/hour but found only 2.2 frogs/hour. The following year in the upper Motu there was a four-fold difference in the number *of* frogs found by two observers simultaneously searching the same stream. Clearly indices obtained by different workers should be compared with caution, but those obtained by the same observer are useful for comparing abundance in different localities.

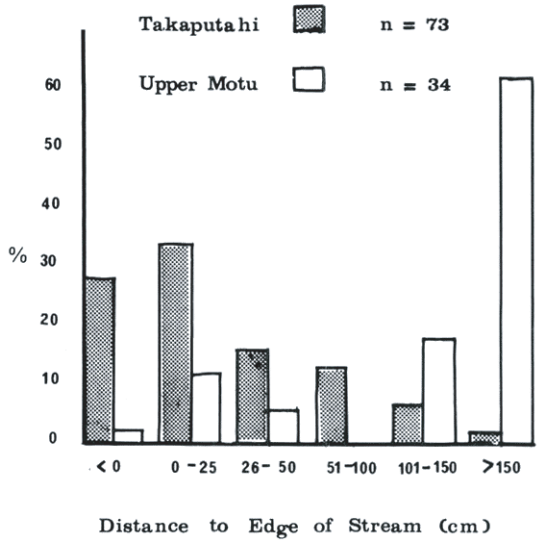

Figure 2: *Distribution of distances at which* Leiopelma hochstetteri *were found from the edge of streams in the catchment of the Motu River.*

The abundance of frogs in the upper Motu River varied markedly between streams but showed no tendency to change systematically with increasing distance downstream. The lowest counts were obtained in the vicinity of Kirks Clearing and Otipi road, and the highest in catchments of the Otipi Stream and the Mangakirikiri Stream. Densities on the banks of the main river were comparable with those in small tributaries. Overall, densities in the upper Motu River in 1983 were lower than those recorded in the Takaputahi in 1981 (Table 1).

Absolute densities of Hochstetter's frog in moist rock piles at the base of screes (a favoured habitat) ranged from 0.4-5.0/m^2 and averaged 2.1/m^2 (no. of sites = 9; mean area sampled per site = 1.8 m^2).

Table 1: *Indices of abundance of* Leiopelma hochstetteri *in various tributaries of the Motu River. All counts were made by the same observer. Tributaries of streams are numbered in order of increasing distance from the confluence with the Motu River.*

Locality	Mean No. frogs/hour	Mean No. stones/frog
Motu River in vicinity of Kirks Clearing	0	—
Otipi stream and tributaries		
Stream 1	8.6	19
Stream 2	4.4	29
Stream 3	3.8	42
Vicinity of Otipi Road	0.9	no counts
Takaputahi catchment		
Stream 1	3.5	28
Stream 2	7.1	9
Mangakirikiri and small tributaries	2.2	30
Motu River in vicinity of Otipi stream confluence	4.0	no counts

Densities in the Mangakirikiri catchment averaged $0.1/m^2$ (n = 31 quadrats).

Searches at night

One frog was found during a night-time search between 2045 hand 2210 h over a 1 km stretch of stream where 13 frogs had been located the previous afternoon. The frog was 3 m from the water in a small depression partially filled with humus and leaf litter. It remained motionless in the beam and its eyes did not reflect light, making it very difficult to detect. Conditions during the search were clear and cool. Native frogs are most active on warm, wet nights (Bell, 1978) and spotlighting in these conditions may give counts which more closely approximate those obtained during daytime searching.

Size and colour

The weights of 32 specimens of *L. hochstetteri* in the Motu River varied from 1.0 to 7.1 g. Snout to vent lengths of 72 specimens ranged from 15 to 46 mm, with the majority falling between 26 and 35 mm (Fig. 3). Frogs were not sexed, but Bell's (1978) measurements of preserved specimens suggest that only females exceed 40 mm. The proportion of frogs exceeding 40 mm was significantly higher ($\chi^2 = 9.0$, $p<0.001$) in the upper Motu River (22%, n=36) than in the Takaputahi (0%, n=36). Some variation between localities is common, presumably because growth rates vary slightly from one place to another (B. D. Bell, pers. comm.), but differences of this magnitude probably result either from a change in sex ratio or an artefact of sampling.

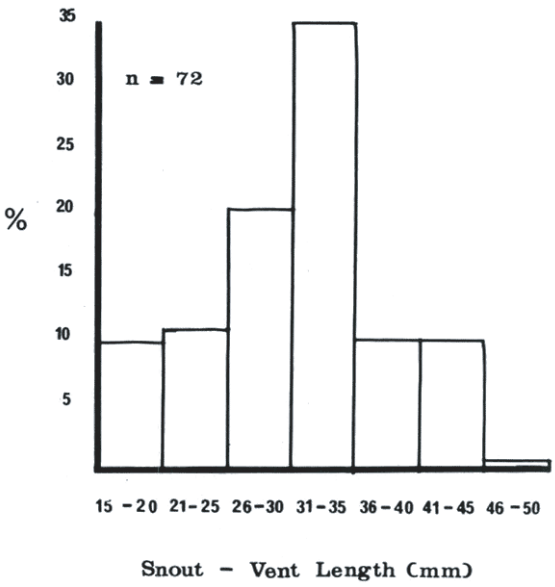

Figure 3: *Snout to vent lengths (mm) of* Leiopelma hochstetteri *found in the catchment of the Motu River.*

The dorsal coloration of *L. hochstetteri* apparently changes as they grow. Frogs less than 20 mm long were bright lime green, with dark olive green bands on their hind legs. Adults were usually a dark grey or dull khaki, but two of the 112 specimens examined were dark brown. Adults had faint bands on their legs and dull orange, rust or brown spotting on their snouts and back. *Leiopelma* spp. apparently cannot change their dorsal coloration to match their surroundings (Stephenson and Stephenson, 1957) and there was no evidence in this study that grey, brown or khaki adults selected different hiding places.

Breeding

No eggs were found in the catchment of the Takaputahi River in December 1981, but a cluster of 10-20 was found in a rocky seepage on the banks of the Otipi Stream on 3 March 83. Four adults, all longer than 40mm, were beside the eggs, so they may have been laid by more than one female. The developing embryos were approximately 1 cm long and had pigmented eyes, which indicated that they

were close to hatching (Bell, 1982). This is apparently the first record of autumn breeding in *L. hochstetteri*.

Discussion

The Ruakumara Range was hit by a severe storm in April 1982 which caused extensive wind-throw in fotests, widespread slipping on steep slopes, and damage to many streams. In some areas, much of the habitat of Hochstetter's frog was scoured out, or buried under silt and gravel. The decline in numbers and the move away from the water observed between 1981 and 1983 may have been caused by the storm. Possibly the survivors moved to shelters above flood level, or frogs on the banks suffered less mortality than those in stream beds. A technique which gives accurate measures of the abundance of Hochstetter's frog is needed to assess population trends, to quantify the species habitat requirements, and to identify catchments and tributaries which are either worthy of special protection or suitable as release sites for populations at risk. Subfossil remains show that native frogs were formerly more widespread in New Zealand than they are at present (Bull and Whitaker, 1975) but there are no basic measures of the abundance of existing populations to determine if the decline is continuing (Bell, 1982).

The indices used in this study measured abundance and the ability of an observer to find frogs, and showed that indices derived by different workers cannot be compared meaningfully. Considerable time and effort is needed to obtain absolute measures of abundance, and they too probably suffer from observer biases. An added disadvantage is that they would not be feasible in streams with boulders and logs too large to move.

Hochstetter's frog is vulnerable to any disturbance that affects the stability of streams (Bell, 1982). Their future well-being in the Motu River was undoubtedly helped recently when the river was protected under the Wild and Scenic Rivers Act, 1983. The main threat to the species in the catchment today may be browsing animals, which have already modified forests there extensively, especially on the eastern bank below the confluence of the Takaputahi and MotU (Clarkson and Wardle, 1983). Geologically, the catchment of the Motu River is inherently unstable and some silting and degredation of stream occurs naturally. With the added burden of high numbers of browsing animals, erosion in the catchment could increase to levels which adversely affects the populations of Hochstetter's frog.

Acknowledgements

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References

Bell, B. D. 1978. Observations on the ecology and reproduction of the New Zealand Leiopelmid frogs. *Herpetologica 34 (4)*: 340-354.

Bell, B. D. 1982. The amphibian fauna of New Zealand. *In:* Newman, D. G. (Editor). *New Zealand herpetology. Proceedings of a symposium held at the Victoria University of Wellington,* 29-31 *January 1980*. pp 27-89. New Zealand Wildlife Service Occasional Publication No.2.

Bull, P. c.; Whitaker, A. H. 1975. The amphibians, reptiles, birds and mammals. *In:* Kuschel, G. (Editor) *Biogeography and ecology* in *New Zealand*. pp 231-276. Junk, The Hague.

Clarkson, B. D.; Wardle, P. 1983 (unpublished). The flora and vegetation of a part of the Motu River. Botany Division, DSIR report. 30p.

Galloway, J. H. H. 1979 (unpublished) Motu River Power investigations. Scope of investigations. Ministry of Works and Development. 4p.

Stephenson, E. M.; Stephenson N. G. 1957. Field observations on the New Zealand frog, *Leiopelma* Fitzinger. *Transactions of the Royal Society of New Zealand* 84 *(4):* 867-882.