NOTES ON THE DISTRIBUTION, ACTIVITY AND BREEDING OF THE WHISTLING FROG (*LITORIA EWINGI* ANURA: HYLIDAE) IN THE COASTAL MANAWATU DISTRICT, NEW ZEALAND

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SUMMARY: New records indicate an expanded distribution of *Litoria ewingi* in the Manawatu district. Frogs called in every month of the year, at all air temperatures between 0°C and 21°C. Between February 1973 and July 1976 the following events were seen or inferred: nuptial pads and spawn from April to December, amplexus from April to November, tadpoles throughout the year, and newly-emerged frogs (mean length 12.3 mm) from November to May. In three cases, tadpoles grew and metamorphosed in about four months. High densities of whistling frogs in small ponds may reflect an absence of competition from other species of frog.

INTRODUCTION

Whistling or brown tree frogs, *Litoria ewingi* (Dumeril and Bibron, 1841), apparently obtained from Tasmania, were liberated in Greymouth (South Island) in 1875 (Marriner, 1907) and now occur widely in Westland and Southland (Bell, 1977). The species was not established in the North Island until about 1948, when frogs were transferred from Westland to Lake Kaikokopu, 4.5 km W of Himatangi in the Manawatu (Wilson, 1959; McCann, 1961).

Virtually nothing is known about the life-cycle and breeding of *L. ewingi* in New Zealand, and there are major gaps in knowledge of the species in Australia (see Table 10.4 in Littlejohn and Martin, 1974). This paper provides details, where previously only generalisations were available (Gill, 1973), on the activity and breeding of *L. ewingi* in the Manawatu, and is the first report in New Zealand of the seasonal activities of frogs in one area.

Between February 1973 and July 1976 I made observations on whistling frogs in the vicinity of Foxton (100 km N of Wellington; 6 km E of the coast), particularly at two small garden ponds which I inspected approximately weekly for 23 months. Winter 1974 was unusually wet, winter 1975 was the coldest for many years and summer 1975-76 was wet and unusually cold. Foxton has a mean annual rainfall of 813 mm on 119 rain-days (Cowie *et al.,* 1967).

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RESULTS AND DISCUSSION

Distribution

Since the distribution of *L. ewingi* in the Manawatu-Rangitikei region up to 1971-72 was described (Gill, 1973), new records have confirmed extensions of the frog's range:

1. Santoft (14 km NW of Bulls; M. Butcher, *pers. comm.* 1975); also nearby Raumai (R. H. Taylor, *pers. comm.* 1974).
2. Lake Papaitonga (4 km SW of Levin; P. C. Bull, *pers. comm.* 1974).
3. Awahuri (6.5 km SW of Feilding; J. P. Skip worth, *pers. comm.* 1974).
4. Longburn (3.5 km SW of Palmerston North; *pers. obs.* 1975).

The success of *L. ewingi* in the cold winters and arid summers of the coastal Manawatu is not surprising, since Tasmanian populations of the species occur where the annual rainfall is as low as 480 mm and frogs persist in areas with mean temperatures in July of 0.5°C (Littlejohn and Martin, 1974).

Calling

Whistling frogs called at night, and often by day, in every month of the year (Table 1). To examine the pattern at one locality, I listened for calling in Lady's Mile (Foxton) 6 or 7 evenings a month (n = 78) for a full year (April 1975 to March 1976). I

heard calling in every month, and on every evening except a total of six in December, January, February and June. Thus the frequency of calling diminished in summer and mid-winter.

TABLE 1. *Occurrence of events in the annual cycle of the whistling frog* in *the coastal Manawatu district* (x *observed,* 0 *presumed); data for three years combined.*

	J	F	M	A	M	J	J	A	S	O	N	D
Calling at night	x	x	x	x	x	x	x	x	x	x	x	x
Presence of nuptial pads				x	x	x	x	x	x	x	x	x
Amplexus				o	x	x	x	x	x	x	x	
Spawn				o	x	x	x	x	x	x	x	x
Tadpoles	x	x	x	x	x	x	x	x	x	x	x	x
Newly-metamorphosed frogs	x	x	x	x	x						x	x

At my listening-post calling came from several directions, one of which was a small pond 200 m away where frogs bred. At this pond during 1974-75 calling in chorus, clearly associated with breeding, began in March / April and ended in October / November, with two interruptions (during cold weather in late June, and in late August and early September). Calling from other quarters showed independent patterns, and the relationship between presence or absence of calling at a site, and the activity of frogs there, was not clear. Many frogs have a "calling season" which is longer than the period of spawning, and this is often explicable in terms of a threshold for reproductive behaviour much lower in males than in females (Salthe and Mecham, 1974). Lack of calling in an area at one time cannot always be equated with absence of frogs.

Calling often began with the onset or approach of rain, but there was no simple relationship. I listened for, and heard, calling in Lady's Mile on 198 evenings (March 1973 to May 1976). On only 9 % of these was it raining at the time of listening, although on one occasion in four the ground was wet (cf. dry on 21 % of evenings; otherwise damp, dew-covered or frosted). I recorded calling at every air temperature from 21 °C to 0°C (mean 11.8°C, mode 12 °C, n = 213). In Tasmania, Littlejohn and Martin (1974) recorded calling or spawning between 3.5∞C and 15.0 °C (air, wet bulb and water tempera tures).

The call of the male whistling frog comprises an initial drawn-out "creee" followed by a variable number of similar, but shortened, and rapidly repeated pulses. The total number of pulses (including the first) in 109 individual calls at a pond varied between 4 and 14 (mean 7.7, mode 8) when the air temperature was 10.5-14.5 ° C. The number of shortened "creee's" and the speed of repetition diminished noticeably on cold evenings; for example, on an evening in July 1975 there were only 3-5 pulses per call (air temperature O.5 °C, water tem- perature 5 °C). The number of pulses per call at 10 °C was 14.0 in Tasmania (Littlejohn, 1965).

Breeding

The occurrence by months of amplexus and developmental stages of the whistling frog, repre- senting the sum of all records (February 1973 to July 1976), is shown in Table 1. As the frogsê activity varied from year to year, especially with recent large fluctuations in weather, the table indicates extremes, and during a single year at one locality events were more restricted.

Nuptial pads on the "thumbs" of male frogs first developed in April and regressed from October to December. I first saw amplexus and spawn in May, but as newly-hatched tadpoles were seen in April 1976, spawning must also have occurred that month. Spawn seen in December was laid in late November. During the main periods of spawning, eggs were laid in clumps of about 25-50, but late in the season (November and December) clumps contained only 7-14 eggs.

The interval between the laying of spawn and hatching of half the tadpoles was 7-9 days under natural conditions in spring (September to Decem- ber; air temperature not below 6 ° C). In colde months hatching took longer. At a pond in May and June 1975 the interval between deposition of spawn and the first appearance of tadpoles was about 23 days. The time from laying to hatching was 29 days for spawn in an aquarium outdoors in July and August 1975 (evening air temperatures 0.3-13.5 °C). Concurrently, spawn took 12 days to hatch at room temperature.

The presence of tadpoles in every month is accounted for by the long breeding season, and survival of larvae from one year to the next during wet summers. Newly-emerged frogs were first seen in November, and after May all had dispersed from ponds. They often basked in full sunlight, and climbed in vegetation to 1 m above ground. The average snout-vent length of 33 newly-emerged frogs measured in March 1976 at the stage of complete absorption of the tail was 12.3 mm (range 11.0-13.5 mm). However, tadpoles reared artificially on limited food metamorphosed at 10 mm. Three newly-hatched tadpoles took about 4 months (129, 124 and 112 days) to grow and metamorphose. In Tasmania, the approximate larval life-span of the frog is 4-5 months (Littlejohn and Martin, 1974).

The slow development of larvae (4 months, plus up to a month for eggs to hatch) suggests that the whistling frog is adapted to breeding in relatively permanent water which never dries up. Yet in the Manawatu during winter the species breeds also in temporarily flooded farmland (Gill, 1973), although there are no details of larval growth under these conditions. That starvation and physiological effects of crowding may' inhibit the growth of tadpoles and lead to delayed metamorphosis (Salthe and Mecham, 1974) is relevant here, as the data relate to tadpoles in very small ponds.

Density

At one small pond (surface area 1.3 m2; depth 0.4 m) on two evenings (2 June and 17 August 1975) I caught all adult frogs by repeated visits until calling ceased and no more individuals were seen. The density was 71.4 frogs per m^2 of surface (95 collected) in June, and 24.8 per m^2 (33 frogs) in August. At another pond (surface area 0.8 m^2; maximum depth 0.15 m), in March 1976, metamorphosing froglets were emerging at a density of about 40 per m of the pond's periphery. In its native Australian habitat the whistling frog shares breeding sites with numerous similar-sized species. In the Manawatu there is only one other frog-the much larger *Litoria raniformis* (for current nomenclature see Bell, 1977)-which does not breed in very small ponds. If the densities I noted are high (and I can find no comparative data) then the cause may be an absence of competition.

CONCLUSION

Activity of the whistling frog, the seasonality of which is here described in detail for the first time, apparently has a similar pattern in New Zealand to that occurring in its native Tasmania, where breeding is year-round (Littlejohn and Martin, 1974).

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