ISSN 0260-5805

THE BRITISH HERPETOLOGICAL SOCIETY

BULLETIN

No. 53
Autumn 1995

MAINTENANCE AND BREEDING OF THE AUSTRALIAN FROG *NEOBATRACHUS SUDELLI* (LAMB, 1911) IN CAPTIVITY

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INTRODUCTION

Neobatrachus sudelli is a burrowing frog found throughout most of the dry regions of Victoria (Hero et al., 1991), New South Wales and southern Queensland (Tyler, 1989, 1992). Habitats used include woodlands, shrubland, mallee as well as open and disturbed areas (Hero et al., 1991).

In appearance, *N. sudelli*, which grows to a size of about 40 mm (Cogger, 1986), resemble spadefoot toads of the family Pelobatidae: the body is plump, the hind legs are short, with large metatarsal tubercles (an adaptation for burrowing), the pupils are vertical (see front cover). The colour is grey or brown with large dark patches of marbling above and pale cream below; most specimens have a narrow, white or cream vertebral stripe (Cogger, 1986).

Neobatrachus sudelli is active at night, daylight hours are spent in the ground. During dry spells, the frogs remain underground, protected from water loss by a cocoon consisting of a thick layer of dead skin.

Breeding occurs after substantial rainfalls in marshes, dams and roadside ditches. The aquatic larvae metamorphose 4-5 and up to 7 months after spawning (Martin, 1965).

This paper describes the housing, feeding and breeding of *N. sudelli* in captivity.

ORIGIN OF SPECIMENS

Spawn of *N. sudelli* was collected in a farm pond at Yapeen, north of Melbourne in May 1988 for the purpose of comparing the embryonic development with that of other leptodactylid species. Most larvae or metamorphs were released at their site of origin, but six individuals were retained and exported to Austria in June 1989. The only female among them is still alive and well today (August 1995). Specimens used in the experiment described below were offspring of this frog.

HOUSING

The frogs were kept in glass or plastic containers of various sizes (minimum area: 15 x 10 cm for a single frog) filled to about 10 cm with soil and covered by a lid made of fly-wire on a wooden frame. Each tank contained a plastic dish with tap water, which was renewed at weekly intervals. Stones in the corners of the deeper dishes enabled the frogs to get out of the water more easily. Pieces of bark were added to some of the containers, and some stems of *Tradescantia* sp. were planted in one of the glass tanks.

All tanks were put on shelves in the same daylit room. No additional illumination was provided, and temperatures were not controlled (they ranged from about 17° in winter to 28° C in summer).

Soil is, of course, a major factor in the life of a burrowing frog. At the collection site, the soil was loamy and rather heavy (G.F. Watson, personal communication). In captivity, the frogs were at first kept in a mixture of approximately equal parts of commercially available peat and sand. Since it was found to be necessary to either clean or change the soil every three to six months (depending on the size, activity and density of the frogs), after about a year, only sand was used, which had two advantages: first, the moisture could be controlled well; the sand was sprinkled with aged tap water at about weekly intervals, except when the frogs were prepared for breeding (see below). Second, it could easily be cleaned by soaking it for 24 hours and then rinsing it thoroughly (the frogs were in the meantime removed to a spare tank).

Experiment on soil preference of the frogs

Each quarter of a plastic container of 40 x 33 x 25 x cm was filled to about 10 cm with a different type of soil (sand; dark, loose soil from a pine forest on limestone; dense loamy soil; and peat); the four compartments were separated by partitions made of thin (3 mm) wood in which a number of small holes were drilled to allow the exchange of moisture between the compartments. Additionally, removable partitions of the same type reached from the surface of the soil to the lid of the container.

The soil was sprinkled daily, and notes on moisture were taken (four categories were distinguished: dry, slightly moist, moist, very moist). Temperatures were between 17° and 20°C for most of the time, only for two animals they were higher (24° - 27°). The tank was put into a dark corner of the frog-keeping room. Sources of light - albeit little - were the window and, sometimes, a distant lamp.

At the beginning of the experiment, the upper partitions were removed and one frog was placed into a petri dish in the centre of the container, after it had become active at night. In the morning, when the frog had burrowed, the petri dish was removed and the upper partitions were installed; thus, the next emergence of the animal would show which type of soil it had selected. Each frog was kept in the experimental container until four choices of soil type had been protocolled. The tank was rotated three times (90° each) to reduce the influence of differental illumination on the behaviour of the frog. No food was provided during the experiment, except for cases of unusually long duration of the test (the average time needed for one frog was 12.1 days, the maximum 54 days, due to prolonged periods of inactivity by the frog), where prey items were offered in the central petri dish.

None of the twenty frogs tested burrowed in the pine forest soil. Sixteen frogs were consistent in their choice, burrowing in not only the same type of soil, but also in the same spot on each occasion. Eight of these selected loamy soil (under slightly moist to very moist conditions), six chose peat (under slightly moist to moist conditions) and two sand (under dry conditions). Two frogs burrowed in sand for two days and then changed to peat (dry to slightly moist conditions), two others used peat on three days, with a day in sand or loamy soil, respectively, in between. In eight cases, the hole made by the frog was situated in a corner, in four others it was near a wall of the tank.

FOOD

Neobatrachus sudelli feed mainly on the ground, but will also attempt to jump after insects climbing the wall of the tank. Metamorphs were fed on non-flying *Drosophila*, small mealworms, crickets and caterpillars of moths; the staple diet for adults was mealworms and crickets, but they were also offered grass-hoppers, caterpillars, flies (immobilised by cooling in the fridge), wood-lice and earthworms.

About every fortnight (more often during the phase of intense growth by the juveniles), the prey items were dusted with a mineral and vitamin powder, or sprinkled with a drop of vitamin solution.

BREEDING

A first attempt of breeding from the imported *N. sudelli* at the age of one year failed when three of the males succumbed to a bacterial infection. When the remaining two males and one female were about three years old, breeding was successful.

The tank housing the frogs had been kept dry for about three months; the frogs had remained burrowed for most of this time. In mid-October, the soil was gradually moistened (especially during rainy periods), and the frogs resumed their activity. Both males were heard to call (mostly underground) on several occasions.

For several consecutive nights, a tape with calls of *Neobatrachus sudelli* (Littlejohn, 1987) was played near the tank. The males were obviously stimulated by these calls: both tried to move towards the source of the calls, and the smaller one was seen in amplexus with the female both in the water and on land.

On November 24th 1991, the frogs were introduced into a breeding tank (the males a few hours before the female), and aquarium of 70 x 35 x 40 cm filled to about 10 cm with aged tap water. Part of the bottom was covered with sand, thus creating a shallow zone at one end of the tank. A small plastic container of about 15 x 10 cm, the rim of which was just above the water level, filled with soil mixture and weighed down with a stone was put into the centre of the tank. A big stone next to it enabled the frogs to reach this island, where they could burrow. A few pieces of aquatic moss were put into the water.

During the next month, periods of calling by the males, who sometimes stayed in the water even at day-time (while the female was underground) and were both seen in amplexus with the female, alternated with periods of reduced activity. After a 5-day period of low atmospheric pressure, during which the tank had frequently been sprayed and the tape had been played every night, spawning occurred on December 23rd while the female was in amplexus with the smaller male. Most of the about 1000 eggs were deposited in a broad layer on the bottom of the deeper part of the tank, about 10% were attached to the moss. The next day, the frogs were removed to their terrarium.

In April 1994, a pair of the offspring of this clutch was induced to breed following basically the same protocol, but combining the playing of the tape and spraying of the tank during a period of low pressure with an increase in the room temperature (about 3°). In this case, spawning occurred about a week after introduction into the breeding tank, and approximately 300 eggs were deposited in the deeper part of the tank.

REARING OF THE LARVAE

In 1991, more than 50% of the embryos failed to develop beyond gastrula stage, many others were retarded in their development. Hatching occurred 6 to 10 days after spawning. About 350 larvae died within their first month, even though they had been distributed to a number of containers. A possible source of this high mortality might have been the Viennese tapwater, the calcium content of which is rather high. The surviving larvae were gradually transferred to 5% Holtfreter's solution, in which they seemed to thrive. Only three tadpoles died after their second month.

Some tadpoles were raised singly in containers of 15 x 10 cm, filled with a gradually increasing amount (400 to 700 ml) of water or, later on, Holtfreter's solution. Larvae also did well at higher densities. The water was changed at approximately weekly intervals. Temperatures in the room were mostly between 18 and 20°C, no illumination except daylight was provided. The tadpoles were fed on parboiled lettuce leaves (stored in the deep freezer and thawed before use) and Tetramin fish food.

Tadpoles grew to a total length of up to 68 mm. Metamorphic climax (foreleg protrusion) was reached 80 to 155 days after spawning. The metamorphs were then transferred to a shallow water container in a terrarium. Sizes after tail resorption, measured from the tip of the snout to the end of the urostyle, ranged from 19 to 24 mm. Altogether, 51 frogs completed metamorphosis successfully. Of these, most developed very well, but a few did not grow at all and eventually died.

In the spawn of 1994 (F2-generation), two size classes could be distinguished: smaller eggs had diameters of 1.5 - 1.6 mm, larger eggs of 1.8 - 1.9 mm. Embryonic and larval mortality was extremely high (more so among the smaller ova), and only 16 animals reached metamorphosis after 62 to 111 days (room temperatures were higher than during the rearing of the previous clutch). Only 11 of these survived their first two weeks on land. They never grew as big as the frogs of the F1-generation. Possibly, inbreeding was responsible for developmental problems in these tetraploid frogs.

ACKNOWLEDGEMENTS

I want to thank Graeme Watson, who collected the *Neobatrachus*-spawn for me (National Parks and Wildlife permit number 87-122) and gave me valuable advice on the maintenance of this species. Vivien Porter and Joanne Wedgewood kindly looked after the frogs during vacations at the University of Melbourne. Helmut Pruscha helped with the transport of the necessary ingredients (mainly, large amounts of deionized water) for Holtfreter's solution. I am greatly indebted to all our animal sitters, especially Peter Pospisil, who took care of the frogs during our absence. Last, but not least, I want to thank Günter Gollmann for help along the way.

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