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## EDITORIAL NOTE

In the early 1980's, the Giant Fire Bellied Toad, *Bombina maxima* of Western China, was imported alive into Britain, Europe and North America, for the first time. At that time its natural history, behaviour and captive care were little known. While it was successfully kept and bred for a short time by a few individuals, it never became firmly established in captivity, at least not in Britain or North America. Also, the imported animals were mostly short-lived, succumbing rapidly to unknown infections.

This year, 1998, it has again been commercially exported from China in some numbers. This time, fortunately, the animals appear to have been healthy and have not suffered from disease or unusual levels of mortality. Many people will have had the opportunity to acquire the species. In view of the scant information available, we consider it appropriate and helpful to reprint the following paper, originally published in the British Journal of Herpetology in 1982, by Max Sparreboom and Paul van den Elzen, and revised recently by Max Sparreboom. We hope in the near future to publish further articles with new information on the natural history, care and breeding in captivity of the species.

*This is a partial reprint of a paper published in the British Journal of Herpetology, 1982, Vol. 6, pp. 269-272. Changes to the original text were made by the first author; the recent address of the second author is unknown.*

### A PRELIMINARY NOTE ON THE CARE AND BREEDING OF *BOMBINA MAXIMA* (BOULENGER, 1905) IN CAPTIVITY

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#### SUMMARY

Notes are given on the behaviour of *Bombina maxima* as observed in captivity. The males, and to a lesser extent also the females, display a behaviour pattern which has been provisionally described as territorial. Claspings, making sideways jerking movements and the emitting of the excitement-call, are here explained as serving to maintain or to establish a certain distance between individuals. The toads have been bred in captivity. The development of tadpoles is described and compared to that of the other known species of *Bombina*.

## INTRODUCTION

Very few specimens of *Bombina maxima* (Boulenger, 1905) had been seen alive in Europe until fairly recently, and even major museums failed to have it in their collections. The species was collected for museums in Britain, Germany, Austria and the U.S.A. during the early part of this century (Boulenger, 1905; Mell, 1922; Werner, 1924; Schmidt, 1927; Pope, 1931). Stadtmüller (1931) reports on a specimen examined by him which he bought from a dealer and which originated from Yunnan. Reports that the species has been kept and bred in Hungary cannot be corroborated for lack of further information. Liu (1936, 1945, 1950) was the first to deal with the species in detail and describes its life history.

During the latter part of 1980 hundreds of *B. maxima* suddenly turned up on the European market. They were shipped via Hong Kong to two major herpetile dealers, Van Mourik (Netherlands) and Hoch (Germany). After a short boom the number of specimens kept alive in captivity dwindled rapidly for various reasons, but mainly because of an epidemic caused by a bacterial infection (Diesener, 1981). It is now once more rare in amateur terraria.

The collecting locality of the specimens is unknown. Marked differences occur in dorsal and ventral colouration patterns (Kühnel & Epperlein, 1981).

The aim of this paper is to present information on the care and breeding of the species under captive conditions. All observations are made on captive specimens.

## CARE

Eighteen specimens were kept in glass aquaria. Most bell-toads measure c. 60 mm but some attain at least 75 mm. Six specimens were housed in a 60 x 30 x 30 cm tank, furnished with a ground soil of coarse sand, with stones and pieces of corkbark placed on it. The water level was 7 cm. The toads could find hiding places both under and above the water surface. Twelve specimens were housed in two full-glass aquaria of 60 x 40 x 40 cm, furnished with 10 cm high density foam, stones and pieces of masonite sheeting to afford hiding. In both instances the toads were bred.

In order first to increase the animals' condition, the water temperature was raised until it reached approximately 20°C, and the toads were fed several times weekly on naked mice and big earthworms. In the beginning of February 1981 the temperature was lowered again. The aquarium was standing in an unheated room, where temperatures could sink to about 7°C in winter. Food was still accepted at temperatures of 10°C. In spring the males developed large black nuptial pads on the first three fingers and the forearms, but hardly on the chest.

One of the observation tanks will be dealt with here. Although the aquarium was too small for the six toads, they were left in it for the time being. At that time other keepers of *B. maxima* lost many specimens due to sudden diseases. Our own toads were apparently healthy, so it was decided to maintain the *status quo* for some time. The average temperature of the water rose according to the season; during summer, temperatures sometimes exceeded 25°C. Food was now offered once a week. There was however little mating activity and the mating call was not heard.



Plate 1: *Bombina maxima*, adult female



Plate 2: *Bombina maxima*, adult male, underside, showing typical body form and colour pattern



Plate 3: *Bombina maxima*, adult female, underside, showing typical body form and colour pattern



Plate 4: *Bombina maxima*, juvenile



In August 1981 the toads were moved to a larger aquarium of 100 x 55 x 50 cm, furnished with big stones, sand on the bottom, a water level of 8 cm and some floating waterplants (*Fontinalis*, *Elodea*, *Ceratophyllum*, *Hydrocotyle*). During the day the tank was illuminated by a 25 W neon light. The water part was not filtered or aerated. In this aquarium most observations on the toads' behaviour were done. Although the thickness and the black colour of the males' nuptial pads clearly decreased in July and August, calling and amplexus were still observed. The toads appeared to be much more active now than earlier in the season in the small aquarium and from now the six toads were observed in the larger aquarium.

Although the toads were often visible and active at daytime, especially when they were fed, they led a mainly nocturnal life. At night they moved about most and could also be seen sitting on land. During the day they sat in the water, hiding under it but also squatting at the water's edge.

Like the other *Bombina* species, these toads actively jump or swim towards prey. Then the tongue is protruded first, but if the prey cannot be caught in that way it is snapped up. Even big prey like naked mice and the biggest worms are eaten. Prey can also be captured under water. *B. maxima* appears to be very voracious but less impetuous in swallowing prey and fighting for it, than the other species of *Bombina*. A few days after feeding the faeces are found in the water; they are of elongate shape and approximately 1.5 cm long.

## REPRODUCTIVE BEHAVIOUR

Any sudden movement in the aquarium by objects approximately the size of a toad immediately provokes two kinds of behaviour. If, for instance, food is offered and one or more toads start moving towards the prey, this frequently induces the males to clasp. If the clasped animal is a male, it usually frees itself with some rapid movements, at the same time uttering the release-call. If the clasped animal is a non-receptive female, she also gives a release-call (at present not distinguished from the male's release-call). She keeps her hindlegs stretched or flabby, flattens her body and keeps the eye membrane closed over the eye. By slow crawling movements of the forelegs she tries to slither away out of the male's grip. These movements look like those on a slow-motion picture. This phenomenon has also been described in *B. variegata* and named "Chamäleonreaktion" by Birkenmeier (1954; see also Savage, 1932). By making too sudden movements the female would possibly stimulate the male to strengthen its grip. While escaping from a male, the female of *B. orientalis* often hammers on the clasping male's forelegs with her forelegs. This behaviour has not been observed in *B. maxima*. The male attempts to prevent the female from climbing ashore and thereby from breaking away from his grip by making rowing movements with his hindlegs and so staying in open water. Other males, attracted to these movements, are knocked off by the amplexing male by fierce thrusts of the hindlegs.

During the amplexus the clasping male makes some remarkable movements. It moves its body to the left, to the right or alternating left and right, with short jerks, quickly succeeding each other. First, these movements appeared to be only connected with the strengthening of the grip but that was not necessarily always the case. The actual grip is often very loose, the male hardly touching the female's back with thorax and throat. The movements were, furthermore, also made without clasping. This behaviour is often provoked when two or more animals come in each other's proximity. In such a case, the

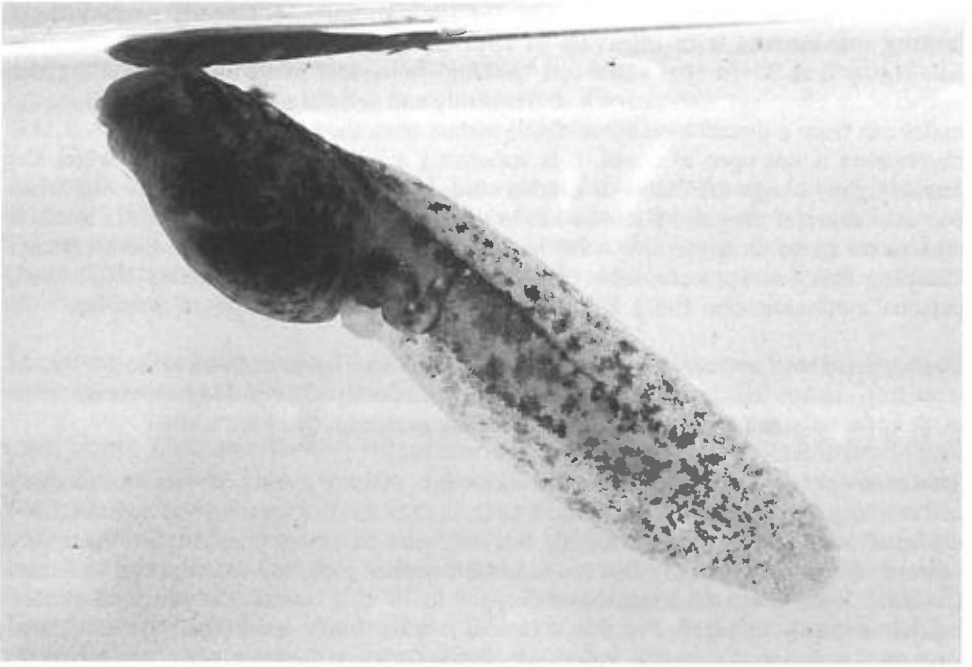


Plate 5: *Bombina maxima*, tadpole

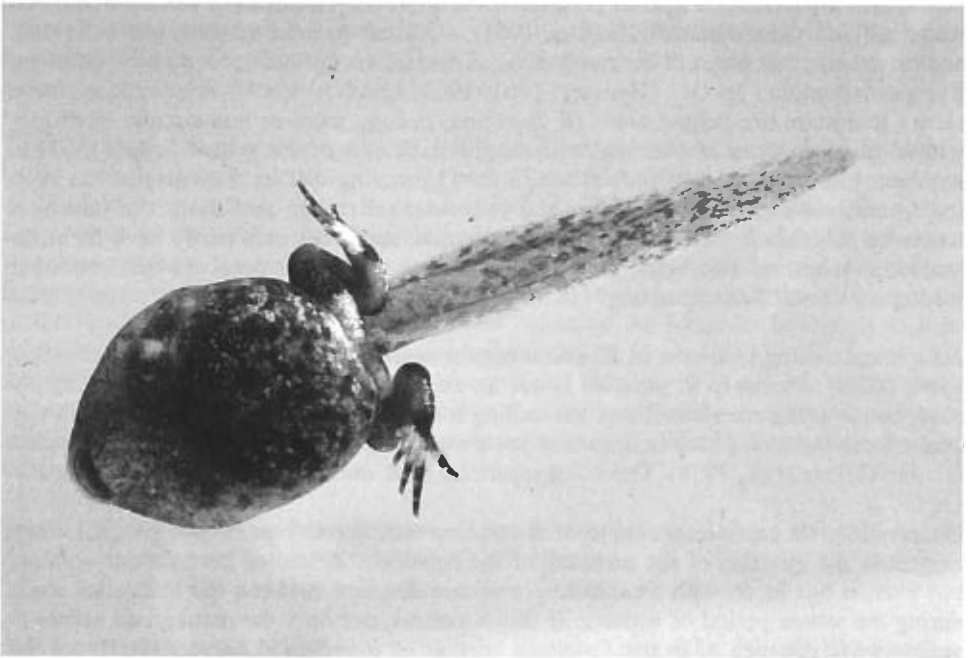


Plate 6: *Bombina maxima*, tadpole

toads sit opposite or next to each other for some minutes, constantly making these jerking movements with intervals of approximately one or a few seconds. It is noteworthy that the females show this "jerking" behaviour too. Moreover, the females also execute clasping, although not so frequently and persistently as the males. Since the males can from a distance easily be distinguished from the females by the observer, this observation is not open to doubt. It is apparently a wilful amplexus during which the female tightly clasps the flanks of another toad. It is often elicited during feeding when one animal seizes prey and a female has to wait till another prey item comes in reach. It thus seems to be an aggressive behaviour and could indicate ranking in the hierarchy. Clasping females were also observed by another keeper of *B. maxima* (Houwaart, personal communication 1981). It is not yet known in the other species of *Bombina*.

During periods of intense activity the toads often swim up to each other and a sort of wrestling ensues during which the toads clasp randomly. The jerking movements are made constantly and both the release-call and the excitement-call are emitted.

This behavioural repertoire: jumping on each other, making jerking movements, clasping and emitting the release- and excitement-calls, is displayed all summer and autumn. Only the "real" mating call, the 'Unkenruf', was not heard any more after August. From July onwards the males gradually lost the big black nuptial pads, but retained the thickened forearms. Even when the temperature dropped to 10°C in winter, the above-mentioned behaviour hardly changed. For this reason, it is most likely not exclusively associated with mating during the mating period but also has a social function which, moreover, is maintained after the reproductive period and could be territorial.

Some sort of territorial behaviour is known in different anuran families (Heusser, 1969) and in a number of species it is assumed that they "carry" their territory with them, *i.e.* they do not occupy a territory in the sense of a small marked-off area of which the boundaries are defended against potential rivals, but they maintain a certain individual distance ("Individualdistanz", Heusser, 1961), a critical distance between one individual and the others, that may not be transgressed. This has, for instance, been observed in the European *Bombina* species (Heusser, 1961, 1969; Lörcher, 1969). Investigations have shown that male fire-bellied toads (*B. bombina*) occupy more or less circular territories with a radial distance of 1-1.5 m, whereas the territories of the yellow-bellied toad (*B. variegata*) have a radius of only 0.5-0.75 m. The mating call in both species has been interpreted as serving to maintain the individual distance and therefore having a territorial function (Lörcher, 1969). In our opinion, amplexus may partly have the same territorial function. The behaviour of *B. variegata* which has received the somewhat inadequate name "Scheinpaarung" (sham-mating, Birkenmeier, 1954) could point to this.

Antiphonal calling is known in *Bombina* but the males do not necessarily form choruses when calling. Probably *B. maxima* is not an exclusive chorister either. The possibility may, however, be mentioned that the calling may serve to synchronize mating activity and to keep the males clustered, as it is known of certain typical chorus-forming species (cf. van Gelder *et al.*, 1978). The vocal repertoire of *B. maxima* has not been described.

Observations on captive specimens of *B. maxima* during one year cannot give a definite answer to the question of the meaning of the behaviour described here. In our opinion, however, it has to do with establishing a certain distance between the individual toads during the whole period of activity. If this is correct, not only the mating call serves to maintain the distance as in the European species of *Bombina* (Lörcher, 1969), but the clasping behaviour, the jerking movements and the excitement-call do so as well.



## BREEDING

While the toads were still housed in the smaller aquarium, spawn was produced on 20 June 1981. The spawning itself was not observed. The eggs were deposited in small clusters among the vegetation (*Fontinalis*) and loose on the bottom.

According to Liu (1950), the eggs are laid in masses, which mostly sink to the bottom of the pools. If there is any vegetation floating on the surface, the egg-mass is attached to it and suspended from it. It has also been recorded (Anon, 1977) that the eggs are laid in small clusters that can also be deposited in marshy areas in stagnant water, between grasses and reeds.

The larvae were hatching on 25 June. There were about 40 hatching larvae. The eggs could not be counted. Half the number of larvae were kept in an aquarium of 70 x 40 x 40 cm, which had previously accommodated newts. The aquarium was furnished with sand, stones and some floating waterplants, moreover it contained much debris and algae. The rest of the larvae was put in a small aquarium (30 x 20 x 20 cm) containing waterplants. Anuran larvae, when kept in larger tanks, generally grow bigger than in smaller containers, but this was not the case here. In both aquaria the tadpoles grew alike and completed metamorphosis at the same time, having reached about equal size. Rearing the tadpoles presented no difficulties. Water temperature varied from 17-23°C. They were fed on bruised lettuce, algae, Tetramin and now and then a tablet of beer yeast. Development until the completion of metamorphosis took 5-6 weeks and proceeded as follows:

25 June: hatching. 28 June: larvae hanging at glass and plants. 6 July: ± 20 mm, grazing algae and lettuce leaves. 16 July: ± 35 mm, beginning of hindlegs. 29 July: first forelegs broke through. Dorsum became rough and warty and showed vague light spots on shoulder region. 3 August: biggest tadpole 42 mm. 5 August: first metamorphosis, all the other tadpoles underwent metamorphosis during the following week. Young toads measured 14 mm. They were fed on *Tubifex*, *Chironomus* larvae and *Drosophila*. A few months later, dew worms and flies were taken.

Twenty-three of the tadpoles grew up well and 22 reached metamorphosis. The young toads resembled their parents in colour and appearance. Some had light green spots, distributed irregularly over the back and hindlegs. The green colour was somewhat lighter than in the adults. One juvenile had a completely green back. Unlike the other *Bombina* species, the yellow coloured vent becomes apparent before metamorphosis. Before the forelegs break through, two light spots can be distinguished: the yellow palms of the hands. On the hindlegs too, the yellow colour of the footsoles is already visible when the legs are still very small. The development of the larvae was found to agree with the account of Liu (1950). It can finally be noted that tadpoles of *B. maxima* do not grow as big as those of other *Bombina* species and accordingly reach metamorphosis at a smaller size. The following maxima have been measured of larvae bred and reared in captivity:

<i>B. maxima</i>	larva 42 mm	juv. 14 mm
<i>B. variegata</i>	larva 50 mm	juv. 19 mm
<i>B. orientalis</i>	larva 47 mm	juv. 17 mm

The young toads were reared in small plastic aquaria (30 x 20 x 20 cm) filled with a shallow layer of water and a piece of cork bark serving as hiding place and terrestrial part. In this way the animals could easily pick up food from the water. Almost one year

old, the young toads now measure  $\pm 4$  cm and grow well on a diet consisting mainly of earthworms.

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