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MAINTENANCE AND BREEDING OF NEWTS OF THE GENUS *CYNOPS*

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INTRODUCTION

Newts of the genus *Cynops* are distributed in East Asia. Presently seven species are recognised: *C. chenggongensis, C. cyanurus* and *C. wolterstorffi* occur at higher altitudes in the Chinese province of Yunnan; *C. orientalis* occurs in East-central China; *C. orphicus* has been widely described from the Chinese province of Guangdong (Zhao & Adler, 1993). *C. pyrrhogaster* is widely distributed in Japan on the islands Hondo, Shikoku and Kyushu; *C. ensicauda* is found exclusively on the Japanese Ryukyu islands (Thorn, 1968).

These newts have been the subject of study for a number of years: I have studied the sexual behaviour of *C. ensicauda* and *C. orientalis* by staging encounters of males and females in controllable tanks (Sparreboom, 1994; 1996; Sparreboom & Faria, 1997) and by observing *C. ensicauda popei* in the natural habitat (Sparreboom & Ota, 1995). Most animals used for these scientific observations are still in good health (January 1998), showing reproductive behaviour and laying fertilised eggs. They do not only make good subjects for study but are also attractive and hardy animals in our aquariums. Some species of *Cynops* are occasionally imported to Europe through the pet trade. *C. pyrrhogaster* was commonly seen on the markets in the nineteen seventies, *C. ensicauda* in the eighties and *C. orientalis* in the eighties and nineties. There is a substantial body of literature, much of it in German and Dutch, about their maintenance and breeding in indoor aquariums (for instance Gerlach, 1933, 1934; Sparreboom, 1982; Van Leeuwen, 1984; Van Leeuwen & Muddle, 1984; Zaremba, 1993; for further references, see Sparreboom, 1994).

The present paper reports my own experience in breeding the species *C. pyrrhogaster, C. orientalis, C. cyanurus* and *C. ensicauda,* from 1975 onwards. For part of this period, especially since 1989, I kept a diary of events such as onset of courtship, breeding, diseases and deaths, and growth of juveniles. There is not one exclusive method to obtain breeding success, and I do not claim that my way of keeping the animals is better than that of others. My main purpose has been to observe the behaviour of the animals. Consequently I have given visibility of the animals a higher priority than rearing the greatest possible number of offspring. I have paid much individual attention to each of my over 70 animals, taking care to offer them sufficient space, hiding places and a variable diet. I do not have exact data of the numbers of juveniles which I raised successfully and passed on to others, nor can I offer a fool-proof recipe for captive breeding.

GENERAL REQUIREMENTS

Cynops species are basically pond breeders, although they may occasionally also be found in slowly running water. Their life history and reproduction, or what is known of it, resembles that of European species of *Triturus* in various respects: both sexes come to

Plate 1: *Cynops pyrrhogaster sasayamae,* originating from the surroundings of Kyoto, Japan. Male (right), displaying to female.

Plate 2: *Cynops orientalis,* unknown collection locality (China). Female laying an egg, in upside down position.

Plate 3: *Cynops cyanurus,* unknown collecting locality (China).
Close-up of female, showing distinctive orange patch on cheek.

Plate 4: *Cynops ensicauda,* originating from Amami-oshima, Japan.
Male, left, depositing a spermatophore in front of the female.

the pond for breeding and may stay in the water well beyond the breeding period. In nature the animals live on land for at least several months in winter and lead a largely hidden life during that period. In captivity it is mostly possible to keep the animals in water all year round. Whether this affects their readiness to mate or may otherwise influence their behaviour is not entirely clear, but in my experience the timing of their sexual activities under these circumstances is not very different from life in the natural habitat. A positive practical effect of keeping the newts constantly in water is that it enables one to control the animals better and keep an eye on their feeding condition. Furthermore, juveniles grow quicker when reared in water. A floating piece of cork serves as a semi-terrestrial refuge in my aquariums.

THE AQUARIUMS

My animals are housed in some twenty glass tanks of different sizes. The minimum size for two or three *C. ensicauda,* the largest species, is 60 x 30 x 30 cm. A container of this size can accommodate two couples of *C. pyrrhogaster* or *C. cyanurus,* or three couples of *C. orientalis.* An aquarium of 30 x 20 x 20 cm suffices for two or three *C. orientalis,* the smallest *Cynops* species.

The aquariums are covered by two sheets of glass, one fixed under the light tube, the other removable. Illumination is by one fluorescent light tube of 36 W, covering two aquariums at a time, or through Philips OL electronic/C lamps between 20 and 36 W (1500 lumen). The lamps are placed on the glass sheet and are covered by a simple sheet of aluminium foil. An automatic timer regulates the day-night rhythm, which varies per season: the animals are given some 12 hours light in summer and 18 hours in winter. I do not adhere to this scheme very strictly. Often the lights are also switched on in the evenings. Surprisingly, this appears to activate, rather than to disturb the newts.

PLANTS

Only the strongest plants are used, such as *Sagittaria, Fontinalis, Elodea, Ceratophyllum, Hydrocotyle.* These plants are good hiding places for the newts and are used by the females to attach their eggs. The plants are arranged in such a way that the front window and some space in the middle of the aquarium are left open to allow observation and to allow the light to penetrate.

FLOOR

The floor of the aquarium is covered with gravel, sand or peat only. *Sagittaria* will grow well without additions to the sand, gravel or peat. Coarse gravel creates a larger surface, that gives room to a rich micro-fauna. In aquariums without a filter such as mine, this helps to absorb organic excretory matter. With few plants rooted in the soil, the substrate can be cleaned easily during the routine cleanings which are carried out once a month. During these cleanings, algae and detritus are removed, plants cut back, and one third of the water replenished.

AERATION

The water is only aerated occasionally when tanks temporarily contain a greater number of animals then mentioned above. Small capacity water filters are rarely used. The animals appear to be disturbed by moving water. They become restless and try to swim away from the stream.

FOOD

All species receive the same food items, bigger animals take larger prey than the smaller ones. A favourite food is the earth worm (*Lumbricus terrestris*). The dung earthworm (*Eisenia foetida*), which is frequently offered in pet shops, is taken less readily or

refused. Maggots, mosquito or midge larvae (*Chironomus*), *Mysis* and *Artemia* are regular food items. Many species of water insects are taken such as *Daphnia* and *Cyclops,* as well as small slugs, *Tubifex* and millipedes thrown into the water. Small pieces of lean meat such as heart, liver and fish are taken, but if left uneaten pollute the water rapidly. A great advantage of keeping *Cynops* is that the animals recognise and accept dead food items, even if these do not move. High quality foods such as *Artemia* and *mysis* can be offered in deep-frozen form all year round. I feed juveniles *ad libitum,* the adults are fed about twice per week. If well-fed, the animals can endure at least three weeks without food, without apparent sign of deprivation. Although the newts survive on earthworms or a single other food item, they are best given a variable diet and not too much *Tubifex* as this food is rich in fat, it may contain pollutants and can be the cause of gas in the stomach. Individuals of all species are known to eat their own species' eggs, even shortly after having been fed. *C. ensicauda* is a notorious predator of its own eggs. This behaviour has also been observed in the natural habitat (Sparreboom & Ota, 1995) and does apparently not represent an anomaly of life in captivity or a habit resulting from food deprivation. Frog spawn is eaten as well.

TEMPERATURE

Very probably, a combination of seasonal temperature fluctuations and the changing day-night regime influence or determine the timing of reproduction. In captivity the male newts develop secondary sexual characteristics such as swelling of the cloaca as soon as temperatures drop in Autumn: from October onward, when water temperatures fall from round 20° to 10°-15°C and the light regime is reduced, the first courtship activities can be observed. In my aquariums sexual behaviour can be observed until mid May and in *C. ensicauda* until mid summer. I do not influence the water temperature through a heater. By placing the tanks on top of one another on storage racks, the top aquariums are warmed up by the lighting on the aquariums below. Keeping the tanks in unheated rooms is better than in centrally heated apartments, except for *C. ensicauda* which is used to temperatures well above 20°C and will do fine in centrally heated apartments.

SPECIES ACCOUNTS

Cynops pyrrhogaster

The Japanese Fire-Bellied Newt used to be a common pet among keepers of newts, but is less frequently seen at present. This may partly be caused by the sharp decline of this once common species in the natural habitat (Terutake Hyashi, Hidetoshi Ota, pers. comm.), by saturation of the market, or for unknown reasons. I have kept and bred animals belonging to the subspecies *C. p. sasayamae* for over 10 years since 1975 and have kept them again from 1994 until now. (Typical for the behaviour of the Sasayama race is the leaning of the foot on the female's neck during tail fanning by the male).

The males come into breeding condition every year; courtship can be observed from November to May; egg-laying has been irregular. Other forms than the Sasayama race, the collection locality of which was unknown, have not reproduced in my aquariums. To come into breeding condition, this species requires a period of hibernation, with temperatures falling to about 5°C. If the room or the aquarium cannot be cooled, the animals can be kept in a refrigerator in small plastic boxes filled with moss during the winter. The humidity must then be checked regularly. Eggs are best removed to avoid predation by the parents. Usually a few eggs escape predation and develop well in the parental aquarium. I once reared a few juveniles in a small plastic box furnished with pieces of cork bark and sphagnum for shelter. Food consisted of *Tubifex,* small earthworms and insects, held before the snout of the juveniles. These reached adult size in three years.

The sexual behaviour is described by Tsutsui (1931), Kawamura & Sawada (1959) and Arnold (1972). Accounts of breeding are common and can, for instance, be found in Klingelhöffer (1956), Thorn (1968) and Van Leeuwen (1983).

Cynops orientalis

The Chinese Fire-Bellied Newt is the smallest species of *Cynops*, measuring from 7 to 9 cm. It is imported from time to time, occasionally in large quantities. These shipments usually come from Hong Kong, but the collecting locality of the newts is unknown.. Very little is known about habits and life-history of this species (cf. Chang & Boring, 1936; Thorn, 1968). I kept about six specimens for about five years in the eighties and I have kept them again since the summer of 1994. They are very lively and eat dead prey easily. Their requirements are similar to *C. pyrrhogaster*. They also require a winter break with lower temperatures for good breeding results.

In captivity breeding starts in December and continues until May. Egg laying was observed from March until the end of June. Eggs are laid in a similar way to *C. pyrrhogaster*, between leaves of water plants. I removed the eggs and put some peat in the water to raise the level of acidity to help prevent moulding and infections. The larvae are similar to those of *C. pyrrhogaster*, their rearing is unproblematic until metamorphosis when many larvae die. The first metamorphs were found at the end of July. The juveniles are small, about 33 mm, and have a tendency to go on land, which is only natural but makes them difficult to feed. I have not reared animals to adulthood, but their propagation has been achieved by other breeders, who succeeded in keeping juveniles in the water after metamorphosis. The best results have been obtained in aquariums with a dense vegetation of *Sagittaria* and other plants.

For records of breeding see Freytag (1961) and Koepernik & Herrmann (1991). In aquarium books this species is sometimes mistaken for *C. pyrrhogaster* (Staniszewski, 1995, where *C. orientalis*, not *pyrrhogaster*, is depicted on p. 177 and 264). The sexual behaviour differs in some temporal aspects from that of other *Cynops* species (Sparreboom & Faria, 1997).

Cynops cyanurus

This species has incidentally turned up in the pet trade, but may often go unnoticed, due to its superficial resemblance to other *Cynops* species. Moreover, newts have occasionally been mis-identified as *cyanurus*, when it actually concerned *orientalis* or *pyrrhogaster* (see also Grosse & Laubner, 1988; Grosse & Koepernik, 1993). This species is characterised by a distinct vertebral ridge, a rather rough skin with many small granules, and especially by an orange-red spot at the corner of the mouth, as well as by distinct outer metacarpal and metatarsal tubercles. The male develops a shining bluish tail in the reproductive season (Lieu et al., 1962). Little is known about this species. The courtship repertoire is not entirely known, but seems to follow the pattern of the other *Cynops* species (Fei & Ye, 1988 and personal observations). I hope to study the sexual behaviour of this species in more detail in the coming years.

I have kept three pairs of this species from 1985 to 1989. They were sensitive to diseases, that caused parts of the skin and extremities to rot away. After observing a progressive infection of the tail in some specimen during some weeks, I decided to cut off the rotting part of the tail. The wound then healed within days and the tail almost fully regenerated in a year's time. The fact that these animals proved more difficult to keep in good condition may be due to a greater sensitivity of this species to water quality and temperature, which in the natural mountain habitat might be rather different from what we can offer in an indoor aquarium. The care and maintenance was in my case

similar to that of the other species, which might be an error. Even so, the animals reproduced successfully in 1987. A conspicuous feature was the fact that in larvae the orange spot on the cheeks was already visible well before metamorphosis. Metamorphosis took place in October/November. I did not rear juveniles to adult size.

Fei & Ye (1988) describe a subspecies *C. cyanurus chuxiongensis* from Chuxiong in Yunnan (altitude 2100-2400 m) for which water temperatures of 18° to 27°C in the breeding season are recorded. These authors have bred animals and also report that development from egg to sexual maturity takes about two years. Recently *C. cyanurus* was bred by Dr Jürgen Fleck (Hanau, Germany). In 1997 I acquired three adults and some of his F1 offspring, some hardly 40 mm long juveniles living entirely on land, eating *Drosophila* larvae, springtails and *Chironomus* larvae.

Cynops ensicauda

The attractively coloured Sword-Tailed Newt is imported irregularly and has been bred in captivity many times since Gerlach (1934; and see references in Sparreboom, 1994). With a total length of 11 to 15 cm this is the largest species of *Cynops*. Little is known of its life history. In 1993 I collected a small number of animals in the Ryukyu archipelago in southern Japan (see Sparreboom & Otaa, 1995). All these animals belong to the subspecies *popei*. Fourteen specimens of the nominate race (*C. e. ensicauda)* were sent to me that same year from Amami-oshima. All individuals of the nominate race are uniformly chocolate brown on the dorsum with yellow dorso-lateral stripes in some specimens, whereas all specimens of *popei* have a pattern of more or less bright-coloured spots on the back, which is black (Inger, 1947). One difference between the two subspecies stands out, but has to my knowledge not been reported earlier: in the breeding season, males of *C. e. ensicauda* develop a silver stripe in the tail, similar to but not as clearly demarcated as in European Crested Newts, whereas this has thus far never been observed in *C. e. popei*. Until now I have observed no subspecific variation in behaviour patterns.

In Great Britain this species is apparently less common among breeders (Mattison, 1993, p. 95 depicts a poorly discernible *Pachytriton,* mistaking it for *C. ensicauda).C. ensicauda* occurs at tropical latitudes and in captivity requires temperatures from 20° to 30°C in summer and 12° to 15°C in winter. These temperature requirements probably are a reason why the animal breeds so readily in our homes. No hibernation is therefore required to elicit breeding, the animals are hardy and eat practically all food items mentioned above. I started with two adult pairs purchased in 1983. Presently three of these individuals are still alive (January 1998). I acquired more specimens via the pet trade in 1989 and kept them and their offspring, until 1997. Most of the animals that I caught as adults in 1993 are alive and reproducing yearly until today. This species can reach a respectable age. Thorn (1968) reports an individual of 20 years old. Animals whose origin can be traced back to 1957 and which possibly originated from specimens bred by Gerlach (1934), are still alive in the collection of Wolfgang Mudrack in Berlin (W. Mudrack, pers. comm, October 1997).

Sato (1943) reports that in the natural habitat eggs are laid from March to July/August. In my aquariums breeding and egg laying starts in October, continuing until the end of June. But eggs are laid in practically all parts of the year and larvae can be found at all times. Animals bred in 1992 and kept in water at room temperature after metamorphosis, reached sexual maturity after two years and reproduced in 1994. At metamorphosis the juvenile newts measure between 40-50 mm.

REARING THE LARVAE

I have reared the larvae of all *Cynops* species in a similar way, by raising them in aquariums filled with tap water and furnished with some water plants. Food consists of *Cyclops, Daphnia, Artemia, Chironomus, Tubifex* and occasionally *Mysis.* The larvae prefer living food but will also take deep-frozen *Artemia* and *Mysis.* Larvae grow bigger in larger (for instance 35 litre) than in small (for instance one litre) containers. The best results I obtained were by leaving a number of larvae in the 60 x 30 x 30 cm aquariums with the adults and catching them upon metamorphosis. Once the larvae are in the free-swimming stage, they manage to escape from the adults who occasionally snap at them. The larva spurts away if an adult newt comes in the close vicinity of the larva. It is unclear if eye-sight or lateral line senses alert the larva to the approach of a predator.

Rearing the larvae is unproblematic, but raising metamorphosed juveniles is more difficult and requires much individual attention. The metamorphs normally creep on land and look for moist places where they can keep their feet and rest of the body dry. Food given on land consists of springtails, mosquito larvae, *Drosophila* larvae and *Tubifex.* Even so, it is hard to control growth and who is eating what; the small containers in which the animals are kept can easily turn into rotting newt cemeteries within a day. I get the best results if I manage to keep juveniles in water. They are housed in small plastic shoe boxes with 2 cm water and some peat, moss and water plants, allowing them to sit in water with their heads raised out of the water. Food given in water consists mostly of mosquito larvae. Growth is usually slow, even when the animals are kept at room temperature all year. The young reach maturity in two to three years time. I have kept juveniles of *C. ensicauda popei* and *C. e. ensicauda* in this way, others have reared *C. orientalis* in this manner. For juvenile *C. pyrrhogaster* and *C. cyanurus,* which I only managed to keep on land, I am not aware of any results with aquatic rearing. For *C. ensicauda* it has been emphasised by many breeders from Gerlach (1934) onward, that the larvae and young must be kept warm (20° to 30°C), an observation that I can confirm. There is still much room for experimentation in finding out the best methods of raising the young to adulthood.

Captive bred newts occasionally have yellow or orange belly colours, instead of the bright red ventral coloration often found in the wild animals. Most probably, this is due to carotene deficiencies in their diet during the larval and early post-metamorphic stages of development. Feeding insects rich in carotene such as *Daphnia* and *Artemia* usually results in young animals with brighter colours. Animals with a bleaker coloration are apparently not weaker than the bright-coloured ones and show the same behaviour in captivity. In natural populations of *Cynops ensicauda* the belly colours are very variable, with red and yellow coloured individuals occurring in the same population. One juvenile *C. ensicauda popei* which by accident spent a year in the soil of my (fenced) garden in Strasbourg (1992) showed deep red colours when I found her, 85 mm long, but I don't know what she had eaten. In my experience, red belly colours – especially in *Cynops pyrrhogaster* – may fade a little after some years of captivity. This is probably also the result of nutritional deficiencies.

DISEASES

Over the years a number of animals have been affected by diseases, many of which proved fatal in the end. All the well-known disorders of amphibians can also be found in *Cynops.* The disease that occurs most frequently among my animals is the rotting away of toes and extremities and the occurrence of holes in the skin on head, neck and other body parts. This disorder can sometimes be cured by baths of Pottasium permanganate

and may then disappear temporarily, but can be very resistant. The wounds may heal and do not necessarily lead to the death of the animal. The cause may be a bacterial infection.

Other diseases are deformities in the hands and feet, slow emaciation and refusal of food, swellings around the joints of the legs and under the skin and the disease commonly known as 'Molch-pest'.

It is not possible to identify specific causes for each disease, let alone a reliable cure. Among breeders in Germany a drug called Baytril has proved to be a good remedy against various sorts of infection, but I have no experience with it myself. For a recent survey on amphibian diseases the reader may be referred to Jarofke & Herrmann (1997).

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