

SPAWNING AND REARING THE PARSLEY FROG (*PELODYTES PUNCTATUS*) IN CAPTIVITY

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INTRODUCTION

The Parsley Frog, *Pelodytes punctatus*, is native to western Europe, being widely distributed throughout France and Iberia and occurring also in western Belgium and extreme north-west Italy. It is closely related to the *Pelobatidae*, the Spadefoot and Horned Toads, but is now more often placed, together with the very similar Caucasian Parsley Frog, *Pelodytes caucasicus*, which occurs in the north-western Caucasus mountains, in a separate family, *Pelodytidae*.

It is small, reaching a maximum size of 1½-2" (4-5cm), possesses long hind limbs with unusually long toes, which are not webbed, a body covered with small, irregular warts, and a flattened head with prominent eyes, which have a vertical pupil. Colouration, even within one population, is extremely variable, ranging from the drab brown individuals usually illustrated in books, where the green dorsal spots which give the frog its name are often very small and sparse, through specimens with a variety of delicate brown patterns of different shades and red-orange dots along the sides, to others with broad patterns of bright, almost iridescent green on a dark or light background, and with additional dark green markings, the latter types being almost as strikingly coloured as European *Hyla*. Darker individuals often display a lighter X mark across the back, but whatever the dorsal colour, the underside is always a uniform, unmarked cream-white. The sexes are similar in general appearance, but males can be distinguished by their thicker front limbs, slightly broader heads and slimmer build, and also by the presence of nuptial pads on the forelimbs when in breeding condition.

Although Parsleys are extremely agile, and almost compulsive climbers, they are at the same time nocturnal and highly secretive, especially when adult, and while individuals can be heard calling during the day, it is always from cover.

The following is an account of my attempts at breeding and raising *P. punctatus* undertaken in 1988 and 1989. Since the latter produced much more information of interest and value to potential keepers of this species so far as spawning method is concerned than the former, observations made earlier this year will be considered in greater detail than those in the previous one.

As available literature covering Parsley reproduction was inadequate for my purposes, and no accounts of captive breeding could be found, my first efforts were wholly experimental. Tadpoles and froglets, about 1 month metamorphosed, obtained in May 1987 were sexually mature at between half and two-thirds full-grown, by September-October, the first characteristic low-pitched 'krr-ek' calls being heard in August. Partly because no suitable outdoor accommodation was available, partly that Parsleys are recorded as spawning after emerging from aestivation in southern Iberia (Salvador, 1985), the above, 4 males and 3 females, were kept inside at room temperature instead of being hibernated. However, general activity decreased in late November-December, so no attempt to induce breeding was made until the following spring.

BREEDING ACCOMMODATION

The only indication of water depth preferred by spawning Parsley Frogs was that strands of eggs were apparently wrapped around vegetation in similar manner to Spadefoots, so it was decided to start with 10" (25 cm), which could be reduced if required. An aquarium 25" x 12" x 15" was prepared, filled with water to the above depth, to which clumps of *Elodea densa* were added, and a terrestrial area, covered with clumps of grass, moss and stones, was built up in the middle. The tank sides were raised a further 6" (15 cm) by a

temporary glass construction, and the top covered with a combination of curtain netting and plastic aquarium condensation sheets, to prevent escapes. As the frogs were evidently active by day during the spawning period, (Arnold & Burton, 1978), the tank was placed where it could receive strong sunlight from a south-west facing window, and since water temperatures remained in the mid to upper 50sF (c.12C) when the above was first set up, no artificial heating was used initially.

SPAWNING

The first attempt at amplexus, which in this species, as with *Pelobates* and *Bombina*, is inguinal, was observed in the second week of March. On closer examination, the females appeared gravid, and nuptial pads, in the form of dark brown patches extending the length of the front limbs to the arm pits as well as on the thumbs and forefingers, were now clearly visible on the males, so they were all transferred to the breeding tank on the 17th.

Within 24 hours the males began producing calls which were much louder, and repeated for much longer periods, than those previously described. They did this either resting amongst plants on the surface at the edge of the island, on the island itself, or even from the bottom of the aquarium, where the effects were somewhat 'muffled', but the sound still quite audible. Pairs were seen in amplexus over the next 4 days, sometimes for up to 48 hours, but nothing more happened, cooler temperatures and lack of sun coinciding with less calling, so a heater-thermostat was introduced, raising the water temperature to the mid-60sF (c.18C), and light spraying, simulating rain, was applied to the island in the late evenings. Frogs kept calling and going into amplexus as described, but producing no spawn, for the following 3 days, so the temperature was raised to 75/6F (23-24C) early on the 24th, with a view to turning the heater off at night to simulate a natural fall. Still nothing had happened by then, and as females in amplexus earlier had been released, I decided to give the terrestrial area a much heavier spraying last thing.

The next morning, the 25th, 3 clumps of eggs were found, partly wrapped around roots of grass growing into the water from the island. On examining the frogs, all eggs had clearly been deposited by one female, the smallest, which at only 1" (2.50 cm) was half the size of the others, and apparently the least gravid. Its very dark appearance indicated the spawn had been laid probably a few hours previously, and the temperature at the time of discovery was 68F (c.20C). The clusters, each approximately the same size, c.1½" (3.50cm) long, were all close to the island, two being at a depth of 1-2" (2.50-5cm), the third at 6-7" (15-18 cm), where growth of roots and *Elodea* was thickest. Over the next 24 hours the spawn swelled to approx. 2" (5 cm) in diameter, and as removal would have proved difficult without causing damage, it was left 'in situ', where it could in any case be easily observed, and temperatures were maintained in the lower to mid 70sF.

Vigorous calling by the males, plus further spells of 24-48 hours in amplexus with the other females continued, but though the pattern of higher temperature and heavy evening spraying was maintained, no further eggs were produced. The last loud breeding calls were heard on 1st April; by the 6th all the frogs had left the water, and the males' nuptial pads were clearly disappearing, so they were removed to their former quarters and the island was dismantled, leaving the tank for rearing the tadpoles.

TADPOLE DEVELOPMENT

With temperatures as above, the eggs developed quickly, and with the exception of a small number of infertile ones in the centre of each cluster, began hatching in 48 hours. At this stage the tadpoles resembled many other newly-hatched anurans, dark brown with a lighter underside, short tail and small, feathery external gills, and developed in much the same way, remaining attached to the spawn jelly or surrounding vegetation until they became free-swimming in a further 48 hours. During this period, I removed one of the clusters for closer observation, finding that it contained 104 embryos, including 20-30 which failed to develop, indicating that the total of eggs produced was around 300.

Over the next 10 days, the tadpoles assumed a shape, size and colour very similar to those of *Bombina* at the same stage, and, feeding mostly on algae growing on the tank sides and

plants, plus good quality tropical fish flakes, they progressed very well over the next month, during which time 80-100 were moved to another tank to avoid overcrowding. However, by 28th April it was noticed that although feeding avidly, the majority, especially the smaller ones, were losing their normal rotund shape and becoming thinner, a process observable in both tanks. On 6th May hind leg buds were visible on the largest tadpole, but many of the others were now very thin, and seemed to be stagnating.

Having raised numerous tadpoles of *Rana*, *Bufo* and *Bombina* species in similar densities, straightforward overcrowding seemed unlikely to be the problem, so possible causes and solutions were sought from various herpetological contacts, though none had experience with Parsley tadpoles. Mike Linley suggested the cause might be minute organisms living in the tadpole gut, which, in a confined area, could be passed on to other tadpoles via the droppings, some of which would be eaten by the latter, whose digestive system would be effectively blocked by the multiplying organisms, with results similar to those I was currently witnessing. Trevor Beebee has since told me of just such an organism, which appears to be the key to competition between the tadpoles of Common and Natterjack Toads (*Bufo bufo* and *calamita*). His research suggests it could be a protozoan or yeast, but at the time of writing this article, the precise identity of the organism is still uncertain. Charles Snell told me of his experiences with tadpoles of Green Frogs (*Rana lessonae/esculenta/ridibunda* complex), when a small number of larger individuals kept in restricted space would regularly outgrow the rest, which appeared to stagnate. This adverse competition could be avoided, he suggested, by splitting the tadpoles up according to size and making more frequent water changes, the latter to prevent the build-up of whatever substance was causing the problem. This was duly tried, and while the smallest, approximately one third of the whole batch, which were by now clearly the weakest, failed to recover, the rest improved rapidly, the largest individuals reaching 2½" (6cm). However, though they were now maintained in much lower densities, I still found it necessary to keep those of comparable size together, as a few larger ones would, within 12-14 days, start pulling away while their tank-mates would start to fall back as before.

By 23rd May 3-4 tadpoles had fully-developed hind limbs, with their front ones beginning to come through; within the next 6 days this process was completed, other frog-like features had rapidly developed, and on 1st June they emerged as fully-metamorphosed froglets. The rest continued to come through over the following 6-7 weeks, though many, again possibly as a result of having their development retarded, failed to reach more than 2" (5 cm) as tadpoles, thus metamorphosing at much less than the 15mm attained by the largest individuals, and were evidently not strong enough to survive for long.

REARING THE FROGLET

With the previous year's experience to go by, this proved fairly straightforward. The young Parsleys were housed in various converted aquarium tanks, furnished with a simple substrate of earth and leaves, to which were added clumps of moss, bark and assorted pieces of wood and stones. A water dish was not provided, but I found from unfortunate experience that, even when adult, these frogs easily desiccate if their accommodation becomes too dry, so it was necessary to keep conditions in the tanks damp by means of regular spraying. Fed on a wide variety of insects and other invertebrates collected from grass/hedge sweepings, supplemented by fruit flies (*Drosophila*) and occasionally small crickets (*Acheta domestica*), the froglets made good progress, some of those retained being half-grown by August; calling first heard on 11th of that month, and the largest 6-7 individuals had reached a size comparable with that of their parents at the same stage by the end of November.

1989

The 1988 experiences raised a number of questions, such as why only one of 3 apparently suitable females actually spawned, what really 'triggered' that particular success, and was it more a case of good fortune than providing the correct conditions. Alternatively, in view of the relatively short period of intense breeding activity, there was a possibility that the frogs may have been introduced to the breeding set-up too late, and perhaps the females were not in such prime spawning condition after all. The main task of the 1989 season, therefore, was to try to provide answers to some or all of these.

BREEDING ACCOMODATION

Later in the spring of 1988, Charles Snell obtained a successful spawning from Parsley Frogs (unrelated to mine) in conditions very different to those I had experimented with, i.e. in an outdoor vivarium, with eggs deposited in much shallower water. I thus decided to try a more natural setting for this year's attempt. Also, since another contact, Pat Thorp, had Parsleys (from the same batch as my original ones) produce spawn, which proved to be infertile, apparently 3 weeks before mine had been set up to breed, this in a heated conservatory, I decided to make an earlier start, which of course meant continuing indoors.

This time a vivarium 40" x 20" x 16" was used, with a half aquatic, half terrestrial arrangement in mind, to which end a glass divider 4" (10cm) high was fitted across the tank, sealed by silicone. The basic furniture was similar to that used in '88, except that small logs and more moss were placed in the water and connected with the main terrestrial area by slates overhanging from the latter. The slates, along with clumps of grass positioned so that strands would hang into the water as in the previous set-up, provided cover close to and overhanging the water, giving the frogs greater security and perhaps better 'calling posts' for the males. The water section was filled to a depth of 3½-4" (8-10 cm). *Elodea densa* was added as before, and the tank was this time covered by a strip of plastic greenhouse shade netting, which was fine enough to prevent not only the frogs but also their food, chiefly flies (*Lucilia* and *Calliphora* species) and crickets, from escaping. Since temperatures were unusually mild when this was set up at the beginning of February, and the tank was positioned where it could receive more direct sunlight than last year, it was again decided not to start with any extra heating.

SPAWNING

The frogs, this time consisting of last year's spawning female (now twice the size it was then) and one male, and the largest of the 1988 youngsters, were in excellent condition by early February, most of the males showing nuptial pads and the females clearly plump with eggs. Therefore, 3 of the total 4 females, the other being a small individual which had developed with only one front leg, to be used only if the rest provided unresponsive, and the 7 largest males, were moved to the breeding quarters on 13th of the above month.

Despite 2-3 attempts at amplexus observed within an hour of being introduced to their new surroundings, disappointingly little happened over the next 3 weeks. Typical non-breeding calls were made by males, usually in the evenings and in response to noise produced by television or radio, but frogs were observed in the water only first thing in the mornings, and none were seen in amplexus. On 25th a heater-thermostat was installed in the water section, bringing the temperature there up to the 1988 spawning level of 68-70F (20-22C), but still the only activity of note was prolonged calling by one of two males, slightly louder than before. However, on 3rd March, one such louder call was answered by a much lower-pitched one, later observations confirming this latter as a call made by a female, something not heard in 1988, though it was reported by Arnold & Burton (1978) and Salvador (1985).

Following the pattern of '88, turning the heater off at night to vary the temperature, and persistent heavy spraying was tried, but made no difference to the frogs' behaviour, so on 11th March the water level, which had previously been topped-up as it evaporated, was allowed to decrease over the next 3 days. At the end of this, fresh cold water was poured into the tank last thing at night, along with a heavy dose of spraying applied to the terrestrial section.

Loud, typical breeding calls were heard early on the morning of the 12th, and upon checking the vivarium at c.7.30, 2 clusters of spawn, one as large as those laid last season around a grass stem, one very small around a leaf of grass, had been deposited. One pair of frogs were also in the water, apparently showing little interest in each other, but it was on this occasion that the female, which by its relatively thin appearance had clearly produced the eggs, was heard answering the male's intermittent vocalisations. The temperature of the water was around 68F (c.19C), and since the weather was overcast, there was no strong sunlight.

Periodic calling by the above pair went on until they were back in amplexus 2 hours later, and I was now able to witness the actual spawning process, descriptions of which appear to be totally absent from relevant literature. Fortunately, the frogs chose to perform close

to the front of the vivarium, which made for perfect viewing. First the female grasped a strand of grass hanging 2-3" (5-8 cm) into the water, from which the pair hung in a vertical position with the female's hind toes just about touching the bottom of the tank, thus pulling the grass a further 2" (5 cm) under the water. After about 10 minutes, the female began pulling itself up the strand 1-2" and a tightly packed string of spawn was quickly ejected while the female made sideways movements which wrapped the eggs around the grass, the male presumably fertilising them as they were produced, in the usual anuran manner. All this was completed, considering it was not just a case of dropping eggs onto the vegetation etc., with surprising speed, in less than 5 minutes, whereupon the male released the female, swam to the opposite side of the water section and resumed calling. The same process was enacted again about 15 minutes later, this time with a much smaller cluster of spawn produced, after which the female had clearly deposited all remaining eggs, and promptly left the water.

The above male continued calling throughout the day and well into the evening, but none of the other females responded, and apart from spells of loud calling, mostly at night, nothing more happened over the next 2 weeks; frogs were seen in the water only briefly in the early mornings or late at night, none in amplexus. Heavy doses of fresh water every 3-4 days, plus equally heavy spraying, had no more effect than the latter had done after the 1988 spawning.

During this period, another contact to whom I had supplied Parsley froglets, Colin Melsom, reported a spawning in a set-up very similar to the above, and noted how quickly his frogs had attempted to go into amplexus whilst being moved into the breeding quarters, as had also been the case with mine. In addition, most of the males seen in the water over the past 2 weeks had actually attempted amplexus on the rare occasions one of the females passed close to them, but never pursued them very far, so I began to wonder whether forcing the gravid females into close contact with males might produce better results. As an experiment, a pair were placed in a small container, and within moments they were in amplexus.

Following this idea, on 24th March I decided to try the remaining 2 gravid females in a much smaller, almost totally aquatic set-up, from which they could not easily escape the attentions of the males. Thus, a tank 14" x 8" x 8" was prepared, with a small island built up with tile and rocks in the centre, from which large clumps of grass hung into water to a depth of 5-5½" (12-15cm). The tank was placed in a back room with no direct sunlight, and 2 pairs of frogs were installed. Within a few hours one male was calling, by evening one pair had gone into amplexus, and ½" (2.2cm) of fresh water was added last thing. Calling was heard after dark.

The same pair were still in amplexus the next day, and by mid-morning the other pair had done likewise. As an experiment, a one third change of warm water, pushing the temperature up to 85-90F (30-33C), was tried as an extra stimulus, last thing on 25th. The following morning at about 8.30, spawn was found, attached to the grass as before and very fresh looking, laid perhaps 2-3 hours earlier. This time it consisted of 2 large clusters, around 2"-2½" long, one about half that size, and a very small one of no more than 6-7 eggs. The temperature was then 58F (14C), and the other pair were still in amplexus.

With temperatures in the original vivarium now reaching 70F (22C) in the afternoons and staying at around 60F (15C) at night, it was decided as a further experiment to move the small tank to a position in front of the former, so as to receive maximum sunlight from the window. This was done on 27th, and once again a half change of warm water was tried that night. The remaining pair were in amplexus then, but had separated by the following afternoon, and were only persuaded back together again by means of a half change of cold water last thing at night. Still nothing had happened the following morning, and despite changing half or three quarters of the water for the next three evenings, varying the water depth between 3-5½" (7.5-15cm), and altering the positions of the rocks and grass clumps, the frogs simply went in and out of amplexus periodically for the rest of the week. On 1st April the water level was raised to its original 5½", and no further alterations were made, the pair being in amplexus last thing.

On the morning of the 2nd, nothing had changed, and little attention was paid to the frogs. However, completely without warning, spawning occurred in mid-morning, at a water temperature of 56F (c.13C), the fact that it had taken place being heralded by characteristic

loud calling by the male after it was all over. This proved to be the largest of the three spawnings, consisting of 6 clusters, 2 large, c.3" (7.5cm), 3 medium, c.1-1/2" (2-3.5cm), and one small, and as was the case with all others, the eggs were attached to grass leaves.

Most of the males remained in breeding condition for 2 weeks following the last success, but there was no reason to try the 'reserve' female, if only because there were already more than enough tadpoles to handle.

TADPOLE DEVELOPMENT

As with that in 1988, each of the '89 spawnings had a high fertility rate. Those eggs kept artificially heated developed very quickly as before, those at room temperatures 3-4 days longer. Including the 30-40 infertile eggs in each batch, the first spawning totalled between 450 and 500, the second, produced by the female which bred in '88, 420-30, and the final one 820-30. Though all were substantially bigger than the '88 spawning, even the last was still well short of the 1,000-1,600 reported by various authors Angel, 1946, Fretey, 1975, (Van Den Elzen, 1976, Arnold & Burton, 1978, Lanka & Vit, 1985 and Salvador, 1985), but none of the females, even the one from '88, was then fully-grown. At the time of writing they are all noticeably larger, and can be expected to produce significantly more eggs next season.

Needless to say, without allowing the Parsley tadpoles to monopolise my available facilities, attempting to raise over 1500 of them was neither possible nor desirable, so large numbers were distributed among various herpetological contacts, and any further surplus fed to newts. With lower densities maintained in a selection of aquaria, the problem created by competition in '88 never arose, most tadpoles this time developing extremely well. Those retained from the first batch, which had been kept at 68-70F, first showed hind leg buds on the 16th April, front legs on the 26th, and the first two froglets metamorphosed on the 28th - 46 days from hatching.

Perhaps the most interesting observation concerning the 1989 tadpoles, and one which occurred almost by accident, was that keeping them under different conditions and providing a different diet appeared to have an effect upon the colouration of both tadpoles and froglets. Those reared in the same way as last year, i.e. in tanks indoors, and fed largely on fish flakes, assumed a deep reddish-brown body colour, with no discernable markings until about 2 weeks from metamorphosis. However, others, mainly from the third batch, maintained in a temporary PVC lined pond which was dug in one of my outdoor enclosures to help spread the numbers even further, by contrast developed a lighter, more mottled green-brown appearance. These were still provided with flake food, but also fed on the very considerable growth of algae prompted by the strong sunlight the pond received. I originally put the above down to the fact that the pond liner had a light brown colour, but later it became increasingly clear that not only did the tadpoles here rarely resemble the ones developing elsewhere, but there were also far greater numbers of froglets with bright green markings emerging from this pond than anywhere else. Unfortunately, with so many other breeding amphibians dividing my attention at this time, the significance of the above only occurred to me when, along with those reared indoors, many of the tadpoles and froglets from the pond had gone to contacts as described or been released into outdoor enclosures, so it was too late to make reliable comparisons by monitoring closely the development of large numbers in each area, although among those that were left the differences were quite noticeable. Later in the summer, a similar experience occurred when Yellow-Bellied Toad (*Bombina variegata kolombatovici*) tadpoles were reared in an aquarium situated in a position receiving strong enough sunlight to produce algal growth similar to that in the Parsleys' pond. These developed a green appearance never previously seen in the many hundreds of Yellow-Belly tadpoles handled in recent years, the metamorphosed toadlets retaining green dorsal colouration, of which the parents showed no trace. There may also have been genetic factors involved here, but this further convinced me that the high degree of algae in the diet of Parsley tadpoles in the pond had affected the latter as previously described. Certainly this is a theory I look forward to testing next spring.

Apart from the colouration element discussed above, 1989 produced no information on raising the froglets worth adding to the relevant 1988 section, so there is no need to describe this aspect again.

CONCLUSIONS

As a result of the preceding survey, a set of conditions required in order to reproduce Parsley Frogs successfully using indoor vivaria can now be summarized, with the addition of a few suggestions (some possibly rather speculative!) as to how my experiences may relate to their behaviour in the natural state. However, this is in no way intended to be definitive, merely what has worked for me, and information on any alternative methods offered by readers of this article would be welcomed.

(1) The evidence of the 1989 season in particular strongly suggests that sudden changes in the frogs' environment will trigger spawning. In contrast to the males, females always seemed much more reluctant to enter the water, which suggests that perhaps in their natural habitat sudden heavy rainfall stimulates them into activity near the breeding sites, where they then come into close contact with males. Thus, a small aquarium-vivarium set-up, i.e. one which keeps the sexes in continual contact, and with frequent water level changes etc. as described, is most likely to produce the required results.

(2) A water depth of no more than 3-5" (7.5-12cm) is necessary, as none of the spawn clusters were deposited at more than 6" below the surface. It is highly probable that the frogs prefer spawning in shallow water near the edge of ponds, ditches etc. because of (a) the greater abundance of suitable overhanging vegetation, and (b) in view of what was observed during the first spawning of '89, the actual spawning method seems better adapted to shallow, thickly vegetated surroundings. This also suggests one possible reason why the two larger females failed to breed in '88 was that the much greater water depth, combined with much thinner density of grass etc., meant they lacked the extra support the above conditions would have provided, and so were unable to balance properly in order to deposit the eggs. Although I had no way of knowing which male was involved in the '88 spawning, it may well have been one of the smaller individuals, as the pair would then probably have been light enough to gain sufficient support from the grass hanging from the island.

(3) As regards temperature and light, spawning conditions were extremely variable, so success can be expected at anything between the mid-50s and upper-70sF (12-25C). Though it is quite probable that increasing day-length helps bring the frogs into breeding condition, and they are certainly less nocturnal when spawning, on the evidence above strong sunlight is not essential.

(4) Tadpoles may be reared in much the same manner as those of most other anurans, and no problems should occur so long as overcrowding is avoided. Suitably accommodated and fed as described, the young frogs can be ready to breed in as little as 7-8 months.

However reliable the foregoing prove to be in the future, I have no doubt that the Parsley Frog, with its small size, simple requirements and fascinating colour variations, is to be recommended as a highly interesting and rewarding subject for the amphibian enthusiast.

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REFERENCES

- Angel, F. (1946). *Faune de France. Reptiles et Amphibiens*. Lechavalier, Paris.
- Arnold, E.N. & Burton, J.A. (1978). *A Field Guide to the Reptiles & Amphibians of Britain & Europe*. Collins, London & Glasgow.
- Fretey, J. (1975). *Guide des reptiles et batraciens de France*. Hatier, Paris.
- Lanka, V. & Vit, Z. (1985). *Amphibians & Reptiles*. Hamlyn, Feltham, Middlesex.
- Salvador, A. (1985). *Guia de los Anfibios y Reptiles de la Peninsula Iberica, Islas Baleares y Canarias*. Leon, Spain.
- Van Den Elzen, P. (1976). *Remarques sur la biologie de Pelodytes punctatus*, Daudin 1802 (Amphibia, Pelobatidae), en Camargue'. *Revue Francaise Aquariologique et Herpetologique*, 3.