SHORT COMMUNICATION

Some notes on rearing *Poltys* (Araneae, Araneidae) in captivity

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Abstract. Spiders of sexually dimorphic and nocturnal species, *Poltys grayi* Smith 2006 and *P. laciniosus* Keyserling 1886, were reared from egg sacs. Spiders were kept in small containers and were fed on a non-living food mix based on houseflies, pollen, egg, and moths. Despite setbacks while developing the method, 41% of *P. grayi* spiderlings matured (all males) and 24% of *P. laciniosus* matured (both males and females). Details of the food mix and conditions of rearing are presented. This method of rearing spiders may be useful for taxonomic purposes and for studies of variation, but is probably unsuitable for behavioral studies.

Keywords: Orb-web spiders, captive rearing, pollen, houseflies, moths, variation

The majority of studies that involve rearing orb-web spiders aim to examine web-building behavior, therefore spiders are reared in large cages where they can spin webs and live food is usually placed into the webs. Indeed, a recent publication provides invaluable advice for laboratory rearing (Zschokke & Herberstein 2005). Of studies involving the rearing of spiders for other purposes, many minimize the space and facilities required by enclosing spiders in small vials, at least for younger stages (e.g. Schaefer 1977), and some have successfully used artificial food mixes (Peck & Whitcomb 1968, cited in Nentwig 1987; Amalin et al. 1999, 2001). That spiders will accept non-living food is not surprising as a number of instances of spiders scavenging dead prey or accepting unlikely food items offered in a captive situation can be found in the literature (Nentwig 1987 provides examples). As far as I am aware, however, no studies have reported rearing orb-web species (e.g., Araneidae) to maturity using small containers and entirely fed on non-living food.

The present study involved rearing araneid spiders in the genus *Poltys* C.L. Koch 1843. This was carried out to: 1) confirm the matching of sexes by obtaining males from egg sacs laid by known females; 2) study the development of abdominal shape in females. These results have been previously reported (Smith 2006a, 2003 respectively), but the method of rearing has not. Additional data from this rearing method on clutch sizes and growth rates will be reported in a future publication. The spiders were reared as efficiently as possible in small vials and on non-living food. The rearing methods were developed by trial and error during the course of raising the specimens; hence this work is not presented as a rigorous scientific study. Rather, this short communication is intended to provide some guidance to others who wish to raise spiders in similar conditions, and is focused on methodology rather than results.

Female and juvenile male spiders in the genus *Poltys* catch nocturnal insects, primarily moths, using an orb web snare. During daylight the spiders sit motionless on a dead twig and the females especially are cryptically camouflaged, with irregular abdominal shape and coloration (Smith 2006a). Males mature after 2–4 molts, females after 8–12 molts (Smith 2003, 2006b). Males of several *Poltys* species were reared successfully but the results reported here concentrate on two species for which females were also targeted, *P. grayi* Smith 2006 and *P. laciniosus* Keyserling 1886. *Poltys grayi* is restricted to Lord Howe Island, where the climate is similar to the northern coast of New South Wales; *P. laciniosus* is found over much of mainland Australia, but mostly away from the humid east coast. Eighty spiderlings of *P. grayi* were set up as described below, 40 from each of two egg sacs laid in December 2000 by wild-caught females. The *P. laciniosus* spiderlings were from egg sacs laid by females caught in western New South Wales and South Australia in March 2002. A total of 374 spiderlings from 12 egg sacs were set up. All the females that laid egg sacs (Table 1) and the majority of their offspring are deposited in the collections of the Australian Museum, Sydney, New South Wales. Some reared specimens were distributed to other Australian museums (Smith 2006a).

A few days after their emergence, spiderlings were placed in separate glass vials approximately 1.5 cm diameter $\times$ 5 cm high. Males were reared through to maturity in these, females until about the 5th molt when they were transferred into the next vial size (2.5 $\times$ 5 cm). Large females were again transferred into larger containers, usually plastic specimen pots (4.4 $\times$ 5.8 cm). Plastic caps supplied with the vials were used as stoppers for *P. grayi*; several small holes were punched in each cap. These stoppers were initially used also for *P. laciniosus*, but the spiderlings did not thrive in the humid conditions these lids produced. These were subsequently swapped for caps made of a thin cotton cloth secured with an elastic band. All spiders were provided with an appropriately sized twig with broken side twigs or leaf scars to sit on. The twig was stuck onto the base of the vial in a small ball of ''Blu Tack'' to keep it in position during cleaning and so help minimize disturbance.

Water was provided by wetting a small twist of cotton wool stuck on the side of the vial. *Poltys laciniosus* with cloth caps were provided with additional humidity at night in dry weather by the placement of a damp cloth over each tray of specimens. This cloth was removed in the morning. *Poltys grayi* spiderlings were alternately fed freshly squashed flies (*Drosophila* Fallén or houseflies, *Musca domestica* L.) and a few crushed and dried pollen ''granules'' (Table 2), which were sprinkled onto their lines. Spiderlings did not thrive beyond the first two or three molts on this diet (similar results were reported for a lycosid species fed on a monotypic diet by Uetz et al. 1992) and so a food mix was developed (Table 2). The ingredients were mashed and mixed thoroughly to a sticky consistency using a pestle and mortar. Batches sufficient for one or two weeks were mixed at one time: portions were placed in small vial lids, wrapped in twists of plastic wrap and stored in a freezer until required. Lumps of freshly thawed food mix approximately the size of the spider were stuck to the inside of the vial lid (for those with plastic lids) or to the side of the vial (for *P. laciniosus*). The correct consistency ensured that the food stayed in place high in the vial, as food that fell was not eaten. Food and water were provided every two to three days, the frequency depending on the number of specimens to be fed, their growth rate/voracity and the time of year. In hot weather it was necessary to remove food remains from high-humidity vials on the following day. Spiders were fed shortly before dark and specimens

Table 1.—Specimen data for the female spiders that made egg sacs used in this study.

Australian Museum registration number	Species Locality and date
	Poltys grayi
KS90968, KS90953	New South Wales: Lord Howe Island, along Lagoon Rd, 31°31′S 159°04′E, 6–15 Dec. 2000
	Poltys laciniosus
KS78296	New South Wales: Cocoparra NP, The Woolshed Flat campsite, 34°04′46″S 146°13′23″E, 15 Mar. 2002
KS78300, KS78301	South Australia: Ngarkat Conservation Park, Pertendi Hut campsite, 35°38′17″S 140°46′50″E, 17 Mar. 2002
KS78303, KS78304	South Australia: Millbrook Reservoir, 34°50′S 138°49′E, 19 Mar. 2002
KS78307	South Australia: Mt Remarkable NP, Mambray Creek, 32°50′45″S 138°01′41″E, 20 Mar. 2002
KS78310	South Australia: near entrance to Coffin Bay NP, 34°37′26″S 135°27′04″E, 22 Mar. 2002
KS78311	South Australia: Lincoln NP, Woodcutters Beach camping area., 34°47′11″S 135°55′04″E, 23 Mar. 2002
KS78313	South Australia: Lincoln Hwy, 41km N of Cowell, 33°21′28″S 137°03′58″E, 24 Mar. 2002
KS78314, KS78315, KS78318	South Australia: Arden Vale Rd, 5.1km from outskirts of Quorn, 32°18′08″S 138°00′49″E, 24 Mar. 2002

were kept well lit until feeding was complete to inhibit the onset of nightly activity. This regime minimized stress through disturbance while making fresh food mix available during the nightly active period.

Spiders were reared in a deeply shaded room and supplementary light was provided using a lamp on a timer. Day lengths were maintained as appropriate for the time of year, but were often shifted slightly later during winter to facilitate the late afternoon-early evening feeding regime. Additional heating was used to boost day-time temperatures during the cooler months, when thermal inertia caused indoor temperatures to lag significantly behind those outside. When many specimens were involved, i.e. during the early stages of rearing *P. laciniosus*, the whole room was heated using an electric oil-filled radiator. For fewer specimens the heated area was localized by using pet heating pads and enclosing the specimens in an inverted clear plastic tank.

The date of each molt was recorded on a label. Cast exoskeletons and the label were kept in a separate adjacent vial. On death or maturity, the spider and alcohol were added into the same vial as the exuviae and data. All hatched egg sacs were retained, and later opened and the exuviae counted.

A summary of the spiders raised by this method follows. The *Poltys grayi* spiderlings emerged in mid summer 2001 (early–mid January). Of the 80 spiderlings, sixteen males matured from one egg sac, 17 from the second. No females matured from either, but many grew far enough to establish the abdominal shape (Smith 2003). This is an overall success rate of 41%, or 82% for males if the sex ratio was 1:1 at hatching (Smith 2003). The *Poltys laciniosus* spiderlings hatched in late autumn and early winter 2002. There was high initial mortality over winter and until plastic lids were replaced with porous cloth caps. Few molts occurred until spring. Sixty-three males from these 374 spiderlings matured in total. Twenty-five females were reared through to maturity, five in their first year, and 20 in the second. A further three penultimate females were euthanized at the start of the third winter; these would have matured within the next 6 months. Other juvenile females also grew large enough to develop indicative abdominal shape. This is an overall success rate of 24%, or 34% for males and 15% for females if the sex ratio is 1:1 at hatching. The success rate from individual egg sacs ranged from 0% to 51%. The low percentage of spiders of *P. laciniosus* reared from egg sacs was primarily due to the unsuitable initial rearing conditions of high humidity, combined with the winter emergence, which extended the time until most growth started. Variability of fitness of the spiderlings from different egg sacs may also have been a factor. Some females of *P. grayi* might have survived to maturity using the improved techniques later developed for *P. laciniosus*.

Several rearing studies have reported that specimens reared in restrictive containers were smaller at maturity than wild-caught counterparts, at least for normally active hunting species (Schaefer 1977; Miyashita 1988). All specimens that matured in this study, *P. grayi* males and *P. laciniosus* males and females, were within the carapace-length range of wild-caught specimens (Smith 2006a, b).

Table 2.—Ingredients and preparation of food mix used to raise *Poltys* spiders.

Ingredient	Quantity	Availability	Preparation	Notes
Houseflies (*Musca domestica*)	c. 50	As pupae from specialist pet food suppliers	Frozen after eclosion.	Nutritional value low, but provides structure for the mix.
Moths (various species, not identified; those suspected to be distasteful were discarded)	1–5, depending upon size	Caught wild at lights and other sites	Frozen prior to use; prepared by removal of wings, body hairs rubbed off in water.	Moths probably not necessary, especially for non moth-specialist species.
Mealworms (tenebrionid beetle larvae)	2–3	From pet stores or fishing shops; easy to maintain a colony	Frozen to kill; cut into short sections.	Used more when moths not as available. May not be necessary.
Pollen	2–3 'granules'	"Pollen granules" available from health food outlets	Ground into mix. This honeybee product is slightly sticky; if needed as a powder, dried in oven at low temperature and crushed.	Important nutritionally for spiderlings of web-recycling species (Smith & Mommsen 1984)
Egg yolk	2–3 drops	Food stores	Used in small quantity to avoid decay of food mix.	Use demonstrated by Amalin et al. 2001.
Soy 'milk'	A few drops as necessary	Food stores	Used to adjust mix to a sticky consistency.	Use demonstrated by Amalin et al. 2001.

Poltys laciniosus, in particular, mostly fell in the middle of the size range; *P. grayi* males were at the lower end because most matured at the second molt, i.e., at the earliest opportunity. Although some *P. laciniosus* were stunted, it was found that these individuals, which were not responding well to rearing conditions, did not reach maturity. It was previously reported that *P. grayi* juvenile females appeared to be stunted (Smith 2003). Although some of these were distinctly small, comparison with *P. laciniosus* suggests that the size increases typical of the final one to two molts were underestimated, and those *P. grayi* that responded well to rearing conditions were on track to reaching normal sizes.

The method of rearing spiders described above, like others, has advantages and drawbacks. The primary advantage is the relatively small amount of space required. An additional plus is the possibility of feeding spiders through winter when it might be difficult to find natural prey, making it appropriate for species that do not over-winter in the egg stage. The high success rate for males makes it particularly useful for matching sexes for sexually dimorphic species. The primary drawback is the labor-intensive care regime, although for fast growing species (or micro males) this problem is less important. The application of the method is also largely limited to raising spiders for non-experimental purposes, as there is potential for behavioral changes due to lack of mobility and learning cues in a simplified environment. This has been demonstrated for active hunters such as salticids (Carducci & Jakob 2000) but may well apply equally to sedentary web builders. Although *Poltys* species are the only spiders raised all the way through from an egg sac during this study, individuals of other nocturnal araneids, in particular species of *Dolophones* Walckenaer 1837 and *Carepalxis* L. Koch 1872, have been brought to maturity through several molts using the same technique. Undoubtedly this method will not work for all araneid spiders; for instance I was unable to persuade newly hatched spiderlings of *Heurodes* Keyserling 1886 to start feeding and part-grown spiders caught in the wild do not always thrive. Adaptations of the method would be required to match the activity cycle or primary food group of the spiders being raised. Here, due to doubts as to the completeness of the nutrients in the food mix, moths were included because they are the primary prey item of *Poltys* in the wild (Stowe 1986; Smith 2006a) and the importance of a varied diet was stressed by Uetz et al. (1992).

Spiders in natural populations may show marked variation in the development of secondary sexual characters, such as cheliceral parameters (e.g., Levi 1981), and examples of genitalic polymorphisms are occasionally reported (Jocqué 2002). If the occurrence of such variation in spiders is even partially mediated by environmental factors such as space or nutrient intake, it would be likely that polymorphisms might be evident in laboratory reared specimens. Such environmentally controlled variation (or polyphenism) has been studied in some insect species. For instance, the male horn allometry in a scarab beetle (Coleoptera: Scarabaeidae) was shown to be dependent on diet quality (Emlen 1997) and several environmental cues, including crowding, have been shown to influence the behavioral and physical changes in taxa such as aphids (Heteroptera: Aphidae), which switch between dispersive and sedentary adult forms (Braendle et al. 2006). Far from being an undesirable source of error, this exploratory aspect of laboratory rearing of spiders should be viewed as an opportunity. At present it is likely that many variable taxa have been described under multiple species names (Jocqué 2002). These current shortfalls in our understanding and recognition of species boundaries are unlikely to be resolved without the sometimes accidental insights brought by captive rearing.

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