PITCHER THIS!

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In October 2005, at a site NW of Albany, Western Australia, a frog was observed climbing in and out of the pitchers of the carnivorous plant *Cephalotus follicularis* Labill. (Figure 1). To my knowledge, movement between pitchers has not been reported before for frogs with *C. follicularis*.

The Albany pitcher plant, *C. follicularis*, is endemic to south-western Western Australia and grows in damp peaty sands in a patchy distribution between Augusta and Wongerup. It is the only genus and species in the Cephalotaceae, not related to other pitcher plants such as those in the Nepenthaceae and Serraseriaceae. In the wild it has a vulnerable conservation status (IUCN 2.3), predominantly due to illegal collection and habitat loss. The Albany pitcher plant is a small herbaceous plant. Normal leaves are produced in rosettes and flowers appear in summer on long stalks to 20-60 cm high (Clarke, 1988). Modified leaves form pitchers to 2.5 cm in length with a lid that partially covers the pitcher, sheltering the digestive enzymatic liquid inside from rain and the lids wilt to cover the pitcher reducing evaporation when conditions are dry (Parkes & Hallam, 1984).

The frog observed climbing out of the *C. follicularis* pitcher was a juvenile and therefore difficult to identify. It may be *Geocrinia*, possibly a juvenile *Geocrinia leai* (pers. comms., Dale Roberts and Marion Anstis). This species occurs in vegetation in swamps and near streams, similar habitats to the Albany pitcher plant. The frog lays its eggs on plant material above the water surface and the tadpoles fall into the water after hatching (Barker *et al*., 1995).

Prey is attracted to *C. follicularis* by nectar exuded from specialised glands around the lid and opening and by the attractive colouration of the pitchers, particularly in the UV spectrum (Parkes & Hallam, 1984; Joel *et al.*, 1985). The sides and lips of the pitchers have multiple adaptations to prevent the escape of animals that find their way inside. These include including modification of microtopography that reduce the adhesion of insect foot pads, disorienting light 'windows' on the lid, downward pointing hooks along the rim and a curved cornice inside the pitcher (Arber, 1941; Parkes & Hallam, 1984). Two types of digestive glands occur inside the pitchers (Parkes & Hallam, 1984) that produce phosphatases (Plachno *et al.*, 2006). The majority of prey drown before being digested rather than being killed by the solution, but frogs, with permeable skin, may be more susceptible. The frog observed in the *C. follicularis* plants appeared to avoid adaptations to prevent prey escape and seemed unaffected by the digestive fluid.

The most common prey of *C. follicularis* include Diptera, Coleoptera, Formicidae and Arachnida and up to 30% of total plant nitrogen can be attributed to carnivory (Schultz *et al.*, 1997), which is low for carnivorous plants. However more than 150 other species also live inside the pitchers including Protozoa, Oligochaeta, Nematoda, Arthropoda, Rotifera, Tardigrada and others (including bacteria, algae and fungi) (Clarke, 1985, in Yeates, 1992). The identity and dependence on *C. follicularis* of the majority of these species is unknown, but the larvae of the stilt fly *Badisis ambulans* is an obligate commensal (Yeates, 1992). It is possible that a frog could feed on these species inside the pitcher of *C. follicularis* plants.

Pitcher plants from the unrelated Nepenthaceae can feed on the faecal material of diverse phytotelmata fauna rather competing with them for food, taking advantage

of the digestive systems of the fauna (Mogi & Yong, 1992; Cresswell, 1998). Some *Nepenthes* species from Borneo are adapted to capture the faeces of shrews and may have very little reliance on trapped invertebrates (Clarke *et al.*, 2009).

There are few examples of frogs living in pitcher plants. The tadpoles of the Asian sticky frog (*Kalophrynus pleurostigma*) develop in the pitchers of *Nepenthes ampullaria*, but do not feed, apparently surviving on their yolk sacs (Lim & Ng, 1991). Other frogs, such as the American green tree frog (*Hyla cinerea*), wait on the lip of North American pitchers and catch prey attracted by the plants (Wray & Brimley, 1943), but in turn probably provide the plant with faecal material (D'Amato, 1998). Some pitcher plants are capable of digesting frogs (Schnell, 2002).

There is one other record of a frog (species unknown) found inside a *C. follicularis* pitcher (Shulze *et al.*, 1997) suggesting the frog-pitcher interactions I observed may not be a unique occurrence. It is possible that a frog, perhaps *G. leai*, completes some of its lifecycle in the Albany pitcher plant, takes food from the phytotelmata and provides faecal material to the plant, or just visits the water body.

Figure 1. A juvenile frog, possibly *Geocrinia leai*, perched on the edge of a *Cephalotus follicularis* pitcher NW of Albany, October 2005. The pitcher was about 2.5 cm high.

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