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Assessment at the end of ecology module

Animals have toilets too!

Modified from : Chin, L., Moran, J. A. and Clarke, C. (2010), Trap geometry in three giant montane pitcher plant species from Borneo is a function of tree shrew body size. New Phytologist, 186: 461–470. doi:10.1111/j.1469-8137.2009.03166.x

Watch the video: https://www.youtube.com/watch?v=TwL7K_loRjM

Most pitcher plants (*Nepenthes*) are carnivorous, they attract insects and ants into the pitcher, where they are then digested by the juices present there.

In Borneo, it was recently discovered that some pitcher plants might be getting their nutrition from a novel source – shrew poop! The pitcher services both the ends of the GI tract – the shrews lick off nectar from the lid while the pitcher itself receives the feces (Figure 1).

Researchers have tried to characterize what differentiates the plants that get this unique 'gift' as compared to those that do not. They measured several physical attributes of 8 different pitcher species. They found feces of the shrew *Tupaia montana* in 3 of these species (*lowii, macrophylla and rajah*) but not in the other 5 (*burbidgeae, reinwardtiana, stenophylla, tentaculata* and *villosa*). Table 1 gives the values for the characteristics that they measured and figure 2 shows the location of these on the pitcher along with images of 'the action'.

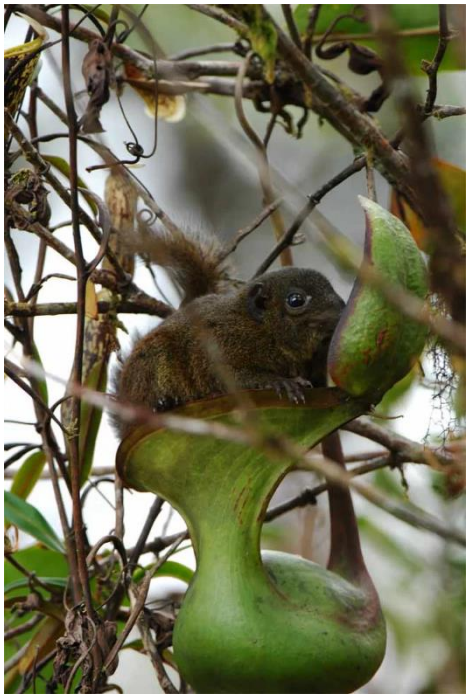


Figure 1: Mountain tree shrews (Tupaia montana), like this one, feed on the nectar coating the undersides of pitcher plant leaves. Conveniently, they can also defecate into the pitcher, leaving nitrogen-rich feces for the plant to consume.
https://www.livescience.com/9666-pitcher-plant-doubles-toilet.html

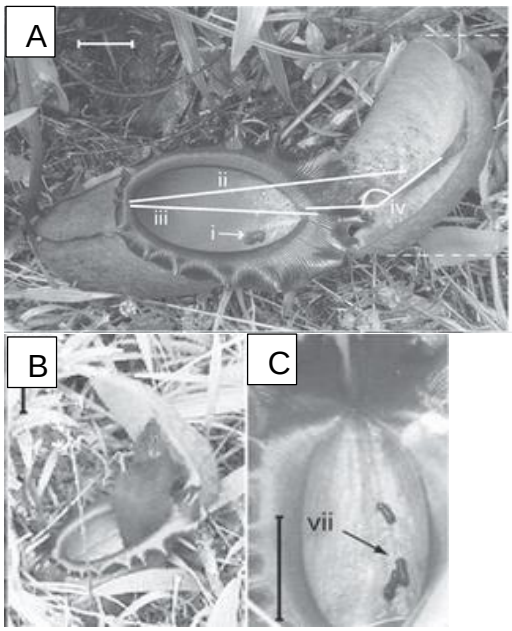
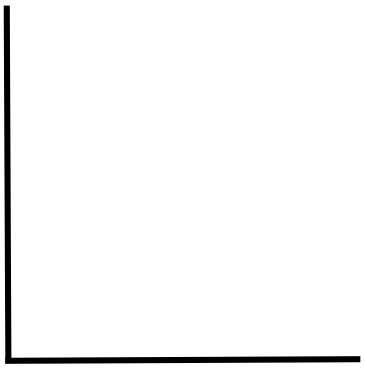


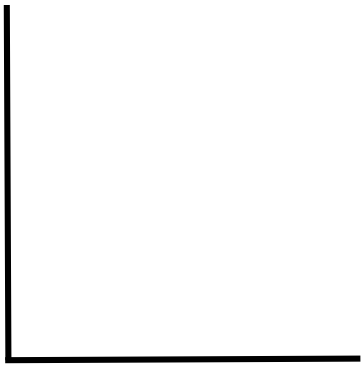
Figure 2: (A) *Nepenthes rajah* pitcher showing (i) *Tupaia montana* faeces on the inner surface, (ii) fmfs (front of the mouth to the food source), (iii) orifice depth, (iv) lid angle; (B) still image taken from a video recording, showing *T. montana* sitting astride the orifice of an *N. rajah* pitcher whilst it feeds on the secretions of the lid glands; note the position of the animal's hindquarters and tail (inside the pitcher); (C) still image taken from a video recording, showing three *T. montana* faecal pellets on the inner surface of an *N. rajah* pitcher. The pellet labelled 'vii' was deposited by *T. montana* during a visit to this pitcher that occurred whilst this recording was being made. Scale bar on all images, 5 cm.

Table 1. Comparisons of pitcher dimensions and characteristics.

Pitcher characteristic	*Nepenthes* species							
	Tupaia montana **faeces-trapping species**			**'Typical' species**				
	lowii	*macrophylla*	*rajah*	*burbidgeae*	*reinwardtiana*	*stenophylla*	*tentaculata*	*villosa*
fmfs (mm)	176.9	196.3	177.3	75.4	57.8	64.8	42.5	74.6
Lid angle (deg)	107.1	103.5	83.3	56.6	56.6	57.9	78.7	50.7
fmfs – distance from front of the mouth to the food source.								

1. [6 points] In the space below construct 2 graphs that show the average measurements of 'fmfs' and lid angle for the 2 groups of Nepenthes species: faeces trapping vs typical. Write one concise legend for both the figures.





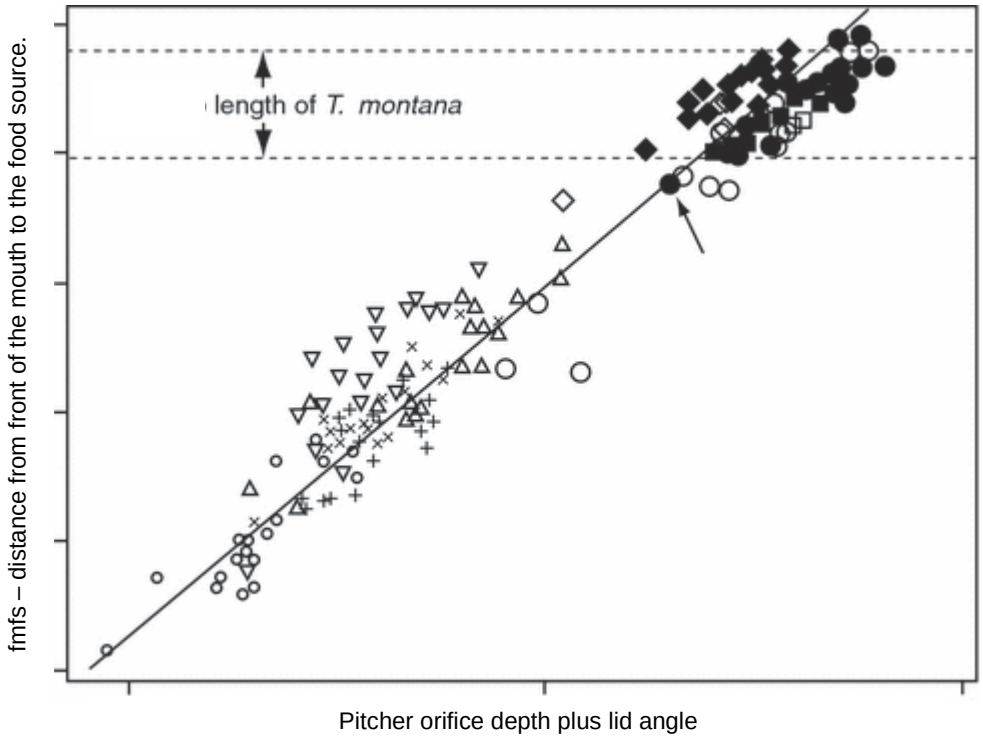


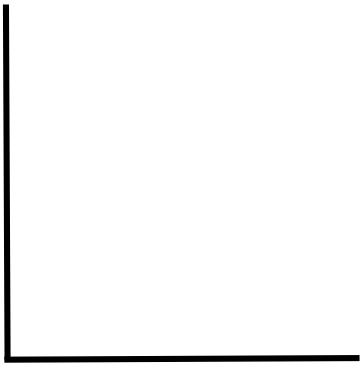
Figure 3: Regression of fmfs (front of the mouth to the food source) vs orifice depth and lid angle for the eight *Nepenthes* species studied. Closed symbols *for N. lowii, N. rajah* and *N. macrophylla* denote pitchers that trapped faeces

2. [4 points] Using figure 3, provide a coherent explanation to show why certain species of the pitcher plants are likely to be 'shrew toilets'. Your explanation has to refer to the evidence that links physical characteristics of both the plant and the shrew

3.[2 points]. List 2 more physical characteristics of the pitcher plant that you think would influence the probability of a 'visitation' followed by a 'deposit'

4.[2 points] Based on one characteristic that you chose, formulate a hypothesis that will explain the effect of variation in that characteristic on the probability of ‘getting a donation’.

5.[2 points] Sketch a simple graph to illustrate your hypothesis.



6. [4 points] With respect to the trait that you chose, discuss the evolutionary trade-offs that could influence the optimum measurement.

Assessment at the end of Plant Ecology Module

Question Number ⇒ **Competency and skill ⇓**	1	2	3	4	5	6
ABILITY TO APPLY THE PROCESS OF SCIENCE		x	x	x		
ABILITY TO USE QUANTITATIVE REASONING	x					
ABILITY TO USE MODELING AND SIMULATION					x	
ABILITY TO TAP INTO THE INTERDISCIPLINARY NATURE OF SCIENCE						x
Modeling					x	
Data Analysis	x					
Argumentation		x	x	x		x