

# The tale of a spider and a pitcher plant: Study explains how two predators can benefit from collaboration

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A study conducted by ecologists from the NUS Department of Biological Sciences showed that the crab spider *Thomisus nepenthophilus* lives exclusively in the slender pitcher plant *Nepenthes gracilis*, and provides supplementary nutrients for its host. NUS doctoral student Mr Lam Weng Ngai is a key member of the research team. Credit: National University of Singapore

Two recent studies by ecologists from the National University of Singapore (NUS) have shed light on the relationship between the slender pitcher plant and its 'tenant', the crab spider *Thomisus nepenthophilus*, providing insights into the little known foraging behaviours of the spider.

*Thomisus nepenthophilus* is found only in the slender [pitcher](#) plant *Nepenthes gracilis*, which is native to Singapore and can also be found in Indonesia, Borneo, and Malaysia. Although the pitcher plant is a carnivore that traps and devours insects to supplement its nutrient requirements, the crab spider *Thomisus nepenthophilus* is able to exploit the pitcher plant's sweet-smelling nectar to catch its [prey](#) while at the same time, provide supplementary nutrients for its host.

"Our two studies provide important insights into the circumstances that favour cooperation over parasitism, and the results are pivotal in attaining a better understanding of these interactions," said research supervisor Associate Professor Hugh Tan, who is from the Department of Biological Sciences at the NUS Faculty of Science.

## **The benefit of being 'robbed'**

In the first study, Assoc Prof Tan, together with doctoral student Mr Lam Weng Ngai and former undergraduate student Miss Robyn Lim, found that pitchers that are without any crab spider get more nutrients out of each prey, while those inhabited by 'tenants' trap more prey but get less nutrients from each prey.

Their laboratory experiments found that the crab spider ambushes flies that feed at the pitcher plant and sucks the body fluids of the insect prey. The crab spider subsequently drops the carcasses of the prey, which still contain some nutrients, into the fluids in the pitcher for it to digest. As such, although the crab spider 'steals' from the pitcher plant and gets the first taste of the prey, the net effect of this 'burglary' can still be

beneficial to the pitcher plant as it gets the residual nutrients from the prey.

The findings suggest that when resources are scarce, this partnership between the crab spider and the pitcher plant is beneficial. However, when resources are abundant, this partnership is not favourable. The results of the study were published in the journal *Oecologia* on 14 August 2018.

"A trend that has been observed in recent mutualism research is that under more stressful conditions, the frequency and intensity of mutualism between the different organisms increases. Our findings support this observation. In other words, the age-old adage 'a friend in need is a friend indeed' is true not just for humans, but also for [plants](#) and animals," said Assoc Prof Tan.



Although the crab spider *Thomisus nepenthophilus* ‘steals’ prey from its host, the slender pitcher plant *Nepenthes gracilis*, a study by ecologists from the National University of Singapore found that the net effect of this ‘burglary’ can still be beneficial to the pitcher plant as it gets the residual nutrients from the prey discarded by the crab spider. Credit: Lam Weng Ngai, NUS Department of Biological Sciences

### **Big prey, big gains**

Assoc Prof Tan and Mr Lam also conducted additional experiments in the natural habitat of the plants. Through field surveys, the researchers identified the species of prey that were found to be in greater numbers in pitchers that were inhabited by spiders, and those that were not.

Laboratory experiments were conducted to measure the [nutrient](#) contents of these prey species to estimate how much nutrients the pitchers would obtain if the prey had been trapped with, and without, the help of the crab spiders.

"Our results confirm the findings of our earlier study – the *T. nepenthophilus* crab spider does indeed help the *N. gracilis* pitcher plant catch many different species of prey. More importantly, the net contribution of *T. nepenthophilus* to *N. gracilis*' nutrition appears to be proportional to the size of prey that *T. nepenthophilus* catches," explained Mr Lam.

He elaborated, "If the crab spider only catches small prey, such as mosquitoes or scuttle flies, the net benefit to the pitcher plant will be negative—it will be 'stealing' nutrients from the pitcher plant. However, when the crab spider catches large insects like cockroaches or large bugs, the pitcher plant will benefit, as the 'service charge' paid to the crab spider becomes small compared to the total amount of nutrients gained through the interaction. As such, the residual nutrients that the [pitcher plant](#) receives from the carcasses discarded by the crab [spider](#) is a good trade-off."

The results of this study were published in the *Journal of Animal Ecology* on 10 October 2018.

## **Theoretical model to be constructed**

Based on the insights gained from these two studies, the research team is now constructing a theoretical model on mutualisms that involve the provision of nutrients by one species to another. Such a model will allow scientists to examine the factors that make mutualisms stable, and monitor how changes in the environment, such as global warming or habitat modification, will alter the ecological outcomes.

**More information:** Robyn Jing Ying Lim et al. Novel pitcher plant–spider mutualism is dependent upon environmental resource abundance, *Oecologia* (2018). [DOI: 10.1007/s00442-018-4246-8](https://doi.org/10.1007/s00442-018-4246-8)

Weng Ngai Lam et al. The crab spider-pitcher plant relationship is a nutritional mutualism that is dependent on prey-resource quality, *Journal of Animal Ecology* (2018). [DOI: 10.1111/1365-2656.12915](https://doi.org/10.1111/1365-2656.12915)

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