

Out of the frying pan and into the fire: A novel trade-off for Batesian mimics

Running title: Salticids that mimic ants and get eaten by ant specialists

Ximena J. Nelson ^{*†}, Daiqin Li [§] and Robert R. Jackson [†]

^{*}Department of Psychology, Animal Behaviour Laboratory, Macquarie University, Sydney, NSW 2109, Australia

Email: ximena@galliform.bhs.mq.edu.au

Phone: 61-2-98509232

Fax: 61-2-98509231

[§]Department of Biological Sciences, National University of Singapore, Singapore

[†]School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

Key words: Ants, Batesian mimicry, myrmecophagy, predation, spiders, trade-off

Abstract

A mimicry system was investigated in which the models were ants (Formicidae) and both the mimics and the predators were jumping spiders (Salticidae). By using motionless lures in simultaneous-presentation prey-choice tests, how the predators respond specifically to the static appearance of ants and ant mimics was determined. These findings suggest a rarely considered adaptive trade-off for Batesian mimics of ants. Mimicry may be advantageous when it deceives ant-averse potential predators, but disadvantageous in encounters with ant-eating specialists. Nine myrmecophagic (ant-eating) species (from Africa, Asia, Australia and North America) and one araneophagic (spider-eating) species (*Portia fimbriata* from Queensland) were tested with ants (5 species), with myrmecomorphic (ant-like) salticids (6 species of *Myrmarachne*) and with non-ant-like prey (dipterans and ordinary salticids). The araneophagic salticid chose an ordinary salticid and chose flies significantly more often than ants. *P. fimbriata* also chose the ordinary salticid and chose flies significantly more often than myrmecomorphic salticids. However, there was no significant difference in how *P. fimbriata* responded to ants and to myrmecomorphic salticids. The myrmecophagic salticids chose ants and chose myrmecomorphic salticids significantly more often than ordinary salticids and significantly more often than flies, but myrmecophagic salticids did not respond significantly differently to myrmecomorphic salticids and ants.

Introduction

Batesian mimics are palatable prey that resemble unpalatable or dangerous models (Bates 1862; Wickler 1968), with the most thoroughly studied examples being terrestrial arthropods. Here we consider whether, besides deceiving potential predators that are averse to preying on the model, Batesian mimics also deceive predators that specialize on the model (maladaptive for the mimic). This is an especially interesting question because it is adaptive for the mimic to deceive ant-averse predators but maladaptive to deceive predators that specialise on eating ants.

Ants are especially often the models (Edmunds 1974, 1978; Holldobler & Wilson 1990) in Batesian-mimicry systems. Yet many predators, including various spiders and predatory insects (Allan et al. 1996; Jackson et al. 1998, Brandt & Mahsberg 2002; Cushing & Santangelo 2002; Pierce et al. 2002; Elgar & Allan 2004), specialize at preying on ants, suggesting that adaptive tradeoffs might be particularly serious for Batesian mimics of ants because of the prevalence of ant-eating specialists. This is the first study to consider the susceptibility of mimics to predators that specialise on the model.

Jumping spiders (Salticidae) are especially appropriate as a case study. Having large eyes, acute vision and intricate vision-guided predatory behaviour (Land 1969a,b; Forster 1982; Blest et al. 1990; Jackson & Pollard 1996), and being the largest spider family (more than 5000 described species: Coddington & Levi 1991; Proszynski 2003; Platnick 2005), salticids are a dominant and diverse group of predatory arthropods (Jackson & Pollard 1996). Most salticids may be generalist insectivores (Richman & Jackson 1992; Foelix 1996), but most salticids also appear to be averse to preying on ants. However, there is sizeable minority (the myrmecophagic species) within this large family that actively selects ants as preferred prey (Edwards et al. 1974; Cutler 1980; Jackson & van Olphen 1991, 1992; Jackson et al. 1998). Within the Salticidae, a sizeable minority (the myrmecomorphic species) are Batesian mimics of ants (Edmunds 1974, 1993; Cutler 1991; Nelson et al. in press) (Fig. 1). There is

yet another minority within the Salticidae (the araneophagic species) that actively selects other spiders as preferred prey, and the members of one particular population of one of these species (*Portia fimbriata* from Queensland) chooses other salticids in preference to other kinds of spiders (Li & Jackson 1996), yet is averse to ants (Harland & Jackson 2001). When its prey is an ordinary salticid, the Queensland *P. fimbriata* adopts a special tactic, ‘cryptic stalking’: walks in exceptionally slow, choppy gait, pulls palps back beside chelicerae and, if faced, freezes until the prey turns away (Jackson & Blest 1982; Jackson & Hallas 1986). Cryptic stalking appears to be a prey-specific predatory behaviour because it is not adopted when stalking non-salticid prey (Harland & Jackson 2001).

Mirroring the success of ants, myrmecomorphic salticids tend to be common in the same habitats in which myrmecophagic salticids are common (Jackson & Willey 1994; Nelson et al. 2004, in press). Myrmecomorphic salticids are also common in the Queensland habitat of *Portia fimbriata*. However, little is known about *P. fimbriata*’s interactions with myrmecomorphic salticids or about interactions between myrmecomorphic and myrmecophagic salticids.

Among spiders, salticids have the unique ability to discriminate by sight alone between different kinds of prey and respond readily to stationary lures made from mounted specimens of prey presented in lifelike posture (Jackson & Tarsitano 1993, Harland & Jackson 2000; Harland & Jackson 2001). Here we consider whether, by sight alone, myrmecophagic and araneophagic salticids can distinguish between myrmecomorphic salticids and ants.

Methods

Study Animals

We used juveniles and adult females of the Queensland *Portia fimbriata* and of nine myrmecophagic species (*Aelurillus aeruginosus* from Israel; *Chalcotropis gulosus*, the

Philippines; *Chrysilla lauta*, Sri Lanka; *Corythalia canosa*, USA; *Habrocestum pulex*, USA; *Natta rufopicta*, Kenya; *Siler semiglaucus*, the Philippines and Sri Lanka; *Xenocytaea* sp., the Philippines; *Zenodorus orbiculatus*, Australia) as test spiders ('predators'). Adult males, being known to be less responsive to prey (Jackson 1982; Li & Jackson 1996; Jackson & Pollard 1997), were not used.

Animal care and Husbandry

All test spiders came from laboratory culture (F2 generation), and standard spider-laboratory procedures were adopted (see Jackson & Hallas 1986; Li & Jackson 1996). Only modifications and critical details concerning these procedures are given here. Salticid maintenance procedures, which were the same as in earlier spider studies (see Jackson & Hallas 1986, Li & Jackson 1997), included 'enriched environments' (spacious cages and meshwork's of twigs within the cages; see Carducci & Jakob 2000). All testing was carried out between 0900 and 1100 hours (laboratory photoperiod 12L:12D, lights at 0800 hours) at the University of Canterbury, New Zealand. Predators had no prior contact with any other salticids (except for conspecific individuals in the eggsac before dispersal) or with ants. Salticids were fed house flies (*Musca domestica*) and vinegar flies (*Drosophila melanogaster*) (from laboratory culture) three times per week. Hunger state was standardized by keeping each predator without prey for 5 days before testing.

Experimental Design and Statistical Analysis

We used simultaneous-presentation testing and all testing was with lures (i.e., each individual predator was given access to two lures at the same time, each lure being made from a different prey type). In earlier studies of salticid prey-choice behaviour (Li & Jackson 1996), three types of testing (alternate-day, simultaneous-presentation and alternative-prey) were adopted, and testing was carried out using both living prey and lures. On the whole,

findings have been comparable across testing methods, but simultaneous presentation testing using lures was advantageous because it ruled out prey behaviour as an influence on test outcome and forced the predator to rely on static cues from appearance alone.

Each lure was made by asphyxiating an insect or a salticid with CO₂ and then placing it in 80% ETOH. One day later, the insect or salticid was mounted in a lifelike posture on the centre of one side of a disc-shaped piece of cork (diameter c. 1.25 X the body length of the spider or insect). The lure and the cork were next sprayed with an aerosol plastic adhesive for preservation (see Jackson & Tarsitano 1993). Arthropods used for making lures were collected from the field, except for house flies and vinegar flies, which came from laboratory cultures (Table 1). All ants were workers. All myrmecomorphic salticids were either adult females or juveniles of species from the genus *Myrmarachne*.

The testing apparatus was a Y-shaped ramp (2 arms) (for details, see Li et al. 1996; Jackson et al. 1998), each arm ending at a perpendicular wooden wall against which the predator viewed a lure. The arm on which each lure was placed was randomised. Before testing started, the test spider was kept in a covered pit near the lower end of the ramp until quiescent. The cover was removed to start a test. The test spider walked up the stem of the ramp and viewed a lure centred 10 mm in front of the wall (facing 45° away from the pit) at the end of each arm. No individual predators and no individual lures were used more than once.

There were two ways in which tests were sometimes unsuccessful: 1) the salticid walked or leapt off the ramp without crossing the threshold (a line, 40 mm from the centre of the pit, at the juncture of the two arms with the stem of the Y-shaped ramp); 2) the salticid remained on the ramp for 30 min, but failed to cross the threshold. Successful tests ended when the predator, after leaving the pit, oriented toward the lure (i.e., aligned its large anterior-medial eyes with the lure) and maintained this orientation while moving past the threshold. The test spider's choice was recorded as the prey type at the top of the arm on to

which it walked when crossing the threshold. There were no instances in which the salticid walked across the threshold without first orienting toward the lure.

Results

All nine myrmecophagic species chose myrmecomorphic salticids significantly more often than they chose flies (Table 2), and they chose ants (Table 3) and myrmecomorphic salticids (Table 4) significantly more often than they chose ordinary salticids. However, there was no significant difference for any myrmecophagic species in how often myrmecomorphic salticids were chosen and how often ants were chosen (Table 5).

The araneophagic salticid, *Portia fimbriata*, always chose the ordinary salticid, *Plexippus paykulli*, instead of the ant (ants used: *Camponotus* sp., *Doleromyrma darwiniana*, *Monomorium antarcticum*, *Oecophylla smaragdina* and *Solenopsis geminata*) (N=20, $\chi^2=20.00$, $P<0.001$, for each) and instead of the myrmecomorphic salticid (*M. assimilis*, *M. lupata*, *M. maxillosa*, *M. naro*, *M. plataleoides*) (N=20, $\chi^2=20.00$, $P<0.001$, N=20, for each), and in all but one instance *P. fimbriata* chose *P. paykulli* instead of *M. kilifi* ($\chi^2=16.2$, $P<0.001$, N=20).

In choice tests in which *Portia fimbriata* was presented with a lure made from a fly and another made from an ant, *P. fimbriata* chose flies significantly more often than they chose ants (Cam-Myc 93%, $\chi^2=11.27$, $P<0.001$; Dol-DM, Mon-DM, Oec-Mus, Sol-DI all 100%, $\chi^2=15.00$, $P<0.001$; N=15 for each combination) (see Table 1 for abbreviations). Furthermore, in choice tests in which *P. fimbriata* was given a choice between flies and myrmecomorphic salticids, *P. fimbriata* always chose flies (Ma-Mus, Mk-DI, MI-DI, Mm-DI, Mn-DI, Mp-Mus all 100%, $\chi^2=15.00$, $P<0.001$; N=15 for each combination). Lures were matched for body length (within 1 mm) in all tests.

Consistently, when *P. fimbriata* chose an ordinary salticid, it adopted cryptic stalking, but *P. fimbriata* never adopted cryptic stalking in conjunction with choosing a fly.

Discussion

By using motionless lures, we tested the responses of salticids specifically to the static appearance of potential prey. Responses of araneophagic and of myrmecophagic salticids to ants and to *Myrmarachne* were comparable. The nine species of myrmecophagic salticids that we tested chose ants and chose myrmecomorphic salticids in preference to ordinary salticids and to flies, but in test series with even larger sample sizes chose ants and myrmecomorphic salticids in similar numbers. These findings suggest that *Myrmarachne*'s ant-like appearance deceived not only araneophagic salticids but also myrmecophagic salticids. Evidently, these predators classify *Myrmarachne* as ants rather than as salticids. Besides corroborating the hypothesis that species in the genus *Myrmarachne* are Batesian mimics of ants, these findings suggest a potential adaptive trade-off to which Batesian mimics may be subject. Adaptations that reduce their attractiveness to ant-averse predators may render Batesian mimics more attractive to predators that specialize on the model. Variation in experience, maternal effects and other indirect genetic effects were minimized (see Roff, 1998; Wade, 1998; Moore et al. 1998) because all individuals tested were laboratory reared to second generation under standardized conditions and had no prior experience with the arthropods used for making mounts. Despite the widespread tendency in the literature on Batesian mimicry to emphasize the role of learning (Brower, 1958; Edmunds, 1974; Berenbaum & Miliczky, 1984; Mappes & Alatalo, 1997; Ritland, 1995, 1998; Uesugi 1996), our findings appear to reveal the innate salience of ants and *Myrmarachne* to araneophagic and myrmecophagic salticids.

The Queensland *Portia fimbriata* showed an especially pronounced preference, choosing an ant only once and never choosing a myrmecomorphic salticid over a fly. Not choosing ants and not choosing *Myrmarachne* might suggest an alternative to the Batesian-

mimicry hypothesis. For *P. fimbriata*, perhaps ants and *Myrmarachne* simply fail to provide prey-capture cues. However, other studies suggest that ants are particularly salient to salticids. Ants sometimes prey on salticids and many salticids appear to be innately predisposed to avoid coming close to these potentially dangerous arthropods (Nelson et al. 2004). This suggests a straightforward Batesian-mimicry explanation for our findings (i.e., that *P. fimbriata* mistakenly identifies salticid species from the genus *Myrmarachne* as being ants).

Batesian mimicry may be particularly risky for prey species that encounter not only predators that are averse to the model but also predators that specialize on the model. For myrmecomorphic salticids, Batesian mimicry may be a successful strategy only so long as deceived ant-eating predators are scarce relative to deceived ant-averse predators.

Acknowledgements

Work in the Philippines was generously assisted by the International Rice Research Institute (IRRI). We are especially grateful to Alberto Barrion, Kong Luen Heong and Tom W. Mew for the numerous ways in which they supported the research and to the following IRRI staff for technical assistance: Elpie Hernández, Errol Rico, Glicerio Javier, Josie Lynn Catindig and Clod Lapis. This research was assisted by a grant to RRJ from the Marsden Fund of the Royal Society of New Zealand (UOC512).

Literature Cited

- Allan, R. A., Elgar, M. A. & Capon, R. J. 1996: Exploitation of an ant chemical alarm signal by the zodariid spider *Habronestes bradleyi* Walckenaer. Proc. Roy. Soc. Lond. B **263**, 69-73.
- Bates, H. W. 1862: Contributions to an insect fauna of the Amazon valley (Lepidoptera: Heliconidae). Trans. Linn. Soc. Lond. **23**, 495-556.
- Berenbaum, M. R. & Miliczky, E. 1984: Mantids and milkweed bugs: efficacy of aposematic coloration against invertebrate predators. Am. Midl. Nat. **111**, 64-68.
- Blest, A. D., O'Carroll, D. C. & Carter, M. 1990: Comparative ultrastructure of layer I receptor mosaics in the principal eyes of jumping spiders: The evolution of regular arrays of light guides. Cell Tissue Res. **262**, 445-460.
- Brandt, M. & Mahsberg, D. 2002: Bugs with a backpack: the function of nymphal camouflage in the West African assassin bugs *Paredocla* and *Acanthaspis* spp. Anim. Behav. **63**, 277-284.
- Brower, J. V. 1958: Experimental studies of mimicry in some North American butterflies. Part I. The monarch, *Danaus plexippus*, and viceroy, *Limenitis archippus archippus*. Evolution **12**, 32-47.
- Carducci, J. P. & Jakob, E. M. 2000: Rearing environment affects behaviour of jumping spiders. Anim. Behav. **59**, 39-46.

- Coddington, J. A. & Levi, H. W. 1991: Systematics and evolution of spiders (Araneae).
Annu. Rev. Ecol. Syst. **22**, 565-592.
- Cushing, P. E. & Santangelo, R. G. 2002: Notes on the natural history and hunting behavior
of an ant eating zodariid spider (Arachnida, Araneae) in Colorado. Journal of
Arachnology **30**, 618-621.
- Cutler, B. 1980: Ant predation by *Habrocestum pulex* (Hentz) (Araneae: Salticidae). Zool.
Anz. **204**, 97-101.
- Cutler, B. 1991: Reduced predation on the antlike jumping spider *Synagelis occidentalis*
(Araneae: Salticidae). J. Insect Behav. **4**, 401-407.
- Edmunds, M. 1974: Defence in animals: A survey of anti-predator defences. Longman,
London, UK.
- Edmunds, M. 1978: On the association between *Myrmarachne* spp. (Salticidae) and ants.
Bull. Br. Arachnol. Soc. **4**, 149-160.
- Edmunds, M. E. 1993: Does mimicry of ants reduce predation by wasps on salticid spiders?
Mem. Queensland Mus. **33**, 507-512.
- Edwards, G. B., Carroll, J. F. & Whitcomb, W. H. 1974: *Stoidis aurata* (Araneae: Salticidae),
a spider predator on ants. Fla. Entomol. **57**, 337-346.
- Elgar, M. A. & Allan, R. A. 2004: Predatory spider mimics acquire colony-specific cuticular

hydrocarbons from their ant model prey. *Naturwissenschaften* **91**, 143-147.

Foelix, R. F. 1996: *Biology of Spiders*. Oxford University Press, New York, USA.

Forster, L. M. 1982: Vision and prey catching strategies in jumping spiders. *Am. Sci.* **70**, 165-175.

Harland, D. P. & Jackson, R. R. 2000: Cues by which *Portia fimbriata*, an araneophagic jumping spider, distinguishes jumping-spider prey from other prey. *J. Exp. Biol.* **203**, 3485-3494.

Harland, D. P. & Jackson, R. R. 2001: Prey classification by *Portia fimbriata*, a salticid spider that specializes at preying on other salticids: Species that elicit cryptic stalking. *J. Zool. Lond.* **255**, 445-460.

Harland, D. P. & Jackson, R. R. 2002: Influence of cues from the anterior medial eyes of virtual prey on *Portia fimbriata*, an araneophagic jumping spider. *J. Exp. Biol.* **205**, 1861-1868.

Hölldobler, B. & Wilson, E. O. 1990: *The ants*. Springer-Verlag, Heidelberg, Germany.

Jackson, R.R. 1982: The behavior of communicating in jumping spiders (Salticidae). Pp. 213-247. In: *Spider communication: Mechanisms and ecological significance* (P.N. Witt & J.S. Rovner, eds.). Princeton University Press, Princeton, NJ, USA

Jackson, R. R. & Blest, A.D. 1982: The biology of *Portia fimbriata*, a web-building jumping

spider (Araneae, Salticidae) from Queensland: Utilization of webs and predatory versatility. *J. Zool. Lond.* **196**, 255-293.

Jackson, R. R. & Hallas, S. E. A. 1986: Comparative studies of *Portia*, araneophagic web-building jumping spiders (Araneae, Salticidae): Predatory versatility, utilisation of silk, and intraspecific interactions of *P. africana*, *P. albimana*, *P. fimbriata*, *P. labiata*, and *P. Schultzi*. *N. Z. J. Zool.* **13**, 423-489.

Jackson, R. R. & Pollard, S. D. 1996: Predatory behavior of jumping spiders. *Ann. Rev. Entomol.* **41**, 287-308.

Jackson, R.R. & Pollard, S.D. 1997: Jumping spider mating strategies: Sex among cannibals in and out of webs. Pp. 340-351. In: *Mating systems in insects and arachnids*. (Choe, J. & B. Crespi, eds.). Cambridge University Press, New York, USA.

Jackson, R. R. & Tarsitano, M. S. 1993: Responses of jumping spiders to motionless prey. *Bull. Br. Arachnol. Soc.* **9**, 105-109.

Jackson, R. R. & van Olphen, A. 1991: Prey-capture techniques and prey preferences of *Corythalia canosa* and *Pystira orbiculata*, ant-eating jumping spiders (Araneae, Salticidae). *J. Zool. Lond.* **223**, 577-591.

Jackson, R. R. & van Olphen, A. 1992: Prey-capture techniques and prey preferences of *Chryzilla*, *Natta* and *Siler*, ant-eating jumping spiders (Araneae, Salticidae) from Kenya and Sri Lanka. *J. Zool. Lond.* **227**, 163-170.

- Jackson, R. R. & Willey, M. B. 1994: The comparative study of the predatory behaviour of *Myrmarachne*, ant-like jumping spiders (Araneae: Salticidae). Zool. J. Linn. Soc. **110**, 77-102.
- Jackson, R. R., Li, D. Q., Barrion, A. T. & Edwards, G. B. 1998: Prey-capture techniques and prey preferences of nine species of ant-eating jumping spiders (Araneae : Salticidae) from the Philippines. N. Z. J. Zool. **25**, 249-272.
- Land, M. F. 1969a: Structure of the retinae of the principal eyes of jumping spiders (Salticidae: Dendryphantinae) in relation to visual optics. J. Exp. Biol. **51**, 443-470.
- Land, M. 1969b: Movements of the retinae of jumping spiders (Salticidae: Dendryphantinae) in relation to visual optics. J. Exp. Biol. **51**, 471-493.
- Li, D. Q. & Jackson, R. R. 1996: Prey preferences of *Portia fimbriata*, an araneophagic, web-building jumping spider (Araneae: Salticidae) from Queensland. J. Insect Behav. **9**, 613-642.
- Li, D. Q. & Jackson, R. R. 1997: Influence of diet on survivorship and growth in *Portia fimbriata*, an araneophagic jumping spider (Araneae: Salticidae). Canadian Journal of Zoology-Revue Canadienne De Zoologie **75**, 1652-1658.
- Li, D. Q., Jackson, R. R. & Cutler, B. 1996: Prey-capture techniques and prey preferences of *Habrocestum pulex*, an ant-eating jumping spider (Araneae, Salticidae) from North America. J. Zool. Lond. **240**, 551-562.

Maddison, W. P. & Hedin, M. C. 2003: Jumping spider phylogeny (Araneae: Salticidae).
Invertebr. System. **17**, 529-549.

Mappes, J. & Alatalo, R. V. 1997: Batesian mimicry and signal accuracy. *Evolution* **51**,
2050-2053.

Moore, A. J., Wolf, J. B. & Brodie, E. D. III, 1998: The influence of direct and indirect
genetic effects on the evolution of behavior: social and sexual selection meet maternal
effects. In: *Maternal effects as adaptations* (Mousseau, T. A. & Fox, C. W., eds).
Oxford University Press: Oxford, UK, pp. 22-41.

Nelson, X. J., Jackson, R. R., Pollard, S. D., Edwards, G. B. & Barrion, A. T. 2004:
Predation by ants on jumping spiders (Araneae: Salticidae) in the Philippines. *N. Z.*
J. Zool. **31**, 45-56.

Nelson, X. J., Jackson, R. R., Li, D., Barrion, A. T. & Edwards, G. B. in press: Innate
aversion to ants (Hymenoptera: Formicidae) and ant mimics: experimental findings
from mantises. *Biol. J. Linn. Soc.*

Pierce, N. E., Braby, M. F., Heath, A., Lohman, D. J., Mathew, J., Rand, D. B. & Travassos,
M. A. 2002: The ecology and evolution of ant association in the Lycaenidae
(Lepidoptera). *Annu. Rev. Entomol.* **47**, 733-771.

Platnick, N. I. 2005. The world spider catalog, version 5.5. American Museum of Natural
History, online at <http://research.amnh.org/entomology/spiders/catalog/index.html>

- Proszynski, J. 2003. Salticidae (Araneae) of the world. Online at
<http://salticidae.org/salticid/main.htm>
- Richman, D. B. & Jackson, R. R. 1992: A review of the ethology of jumping spiders (Araneae, Salticidae). *Bull. Br. Arachnol. Soc.* **9**, 33-37.
- Ritland, D. B. 1995: Comparative unpalatability of mimetic Viceroy butterflies (*Limenitis archippus*) from 4 South-Eastern United-States populations. *Oecologia* **103**, 327-336.
- Ritland, D. B. 1998: Mimicry-related predation on two viceroy butterfly (*Limenitis archippus*) phenotypes. *Am. Midl. Nat.* **140**, 1-20.
- Roff, D. A. 1998: The detection and measurement of maternal effects. In: *Maternal effects as adaptations* (Mousseau, T. A. & Fox, C. W., eds). Oxford University Press: Oxford, UK, pp. 83-96.
- Uesugi, K. 1996: The adaptive significance of batesian mimicry in the swallowtail butterfly, *Papilio polytes* (Insecta, Papilionidae): Associative learning in a predator. *Ethology* **102**, 762-775.
- Wade, M. J. 1998: The evolutionary genetics of maternal effects. In: *Maternal effects as adaptations* (Mousseau, T. A. & Fox, C. W., eds). Oxford University Press: Oxford, UK, pp. 5-21
- Wickler, W. 1968: *Mimicry in plants and animals*. Weidenfield & Nicholson, London, UK.



Figure 1: Ant and salticids from the Philippines. a) Myrmrarachne assimilis, a myrmecomorphic salticid, and b) Oecophylla smaragdina. Ant has a non-myrmecomorphic salticid, Phintella piatensis, in its mandibles.

Table 1: Arthropods used in for making lures in simultaneous-presentation tests in laboratory. In each test, the two lures used were of matching (within 1 mm) body length. Ordinary salticid: species that is not known to associate with ants and are neither ant eaters nor ant mimics. Myrmecomorphic salticids: species that resemble ants. Abbreviation for each species provided.

Common name	Species (abbreviation)	Classification	Body length	Origin
Ants	<i>Camponatus</i> sp. (Cam)	Hymneoptera, Formicidae, subfamily Formicinae	5-6 mm	Philippines
	<i>Doleromyrma</i> (formerly <i>Iridomyrmex</i> <i>darwiniana</i> (Dol)	Hymneoptera, Formicidae, subfamily Dolichoderinae	2 mm	New Zealand
	<i>Monomorium</i> <i>antarcticum</i> (Mon)	Hymneoptera, Formicidae, subfamily Myrmicinae	3 mm	New Zealand
	<i>Oecophylla</i> <i>smaragdina</i> (Oec)	Hymneoptera, Formicidae, subfamily Formicinae	7-8 mm	Philippines
	<i>Solenopsis</i> <i>geminata</i> (Sol)	Hymneoptera, Formicidae, subfamily Myrmicinae	4 mm	Philippines

House flies	<i>Musca domestica</i> (Mus)	Diptera, Muscidae	7-8 mm	Laboratory culture
Vinegar flies	<i>Drosophila melanogaster</i> (DM)	Diptera, Drosophilidae	2-3 mm	Laboratory culture
	<i>Drosophila immigrans</i> (DI)	Diptera, Drosophilidae	4 mm	Laboratory culture
Fungus gnats	<i>Mycetophila</i> sp. (Myc)	Diptera, Mycetophilidae	5-6 mm	Philippines
Ordinary salticids	<i>Plexippus paykulli</i> (juveniles) (Plex)	Araneae, Salticidae	7 mm	Philippines
Myrmecomorphic salticids	<i>M. assimilis</i> (Ma)	Araneae, Salticidae	7-8 mm	Philippines
(<i>Myrmarachne</i>)	<i>M. kilifi</i> (Mk)	Araneae, Salticidae	2-4 mm	Kenya
	<i>M. lupata</i> (Ml)	Araneae, Salticidae	5 mm	Australia
	<i>M. maxillosa</i> (Mm)	Araneae, Salticidae	6-7 mm	Philippines
	<i>M. naro</i> (Mn)	Araneae, Salticidae	3-4 mm	Kenya
	<i>M. plataleoides</i> (Mp)	Araneae, Salticidae	7-8 mm	Sri Lanka

Table 2: Percentage of myrmecomorphic salticids (*Myrmarachne*) chosen by myrmecophagic salticids. Tests of vision-based prey choice. Used lures made from myrmecomorphic salticids and from flies. N=30 for each row. Chi-square tests of goodness of fit (null hypothesis: choose each prey type equally often).

Myrmecophagic salticid	Myrmecomorphic salticid	Fly	Chose myrmecomorphic salticid (%)	Test of goodness of fit
<i>Aelurillus aeruginosus</i>	Mp	DM	96.67	$\chi^2= 26.13, P<0.001$
<i>Chalcotropis gulosus</i>	Ma	DI	86.67	$\chi^2= 16.13, P<0.001$
<i>Chalcotropis gulosus</i>	Ma	Mus	83.33	$\chi^2= 13.33, P<0.001$
<i>Chalcotropis gulosus</i>	Ma	Myc	100	$\chi^2= 30.00, P<0.001$
<i>Chalcotropis gulosus</i>	Mm	DI	83.33	$\chi^2= 13.33, P<0.001$
<i>Chrysilla lauta</i>	Mp	DM	100	$\chi^2= 30.00, P<0.001$
<i>Corythalia canosa</i>	Mp	DM	80	$\chi^2= 10.80, P<0.01$
<i>Habrocestum pulex</i>	Mp	DM	86.67	$\chi^2= 16.13, P<0.001$
<i>Natta rufopicta</i>	Mk	DM	93.33	$\chi^2= 22.53, P<0.001$

<i>Natta rufopicta</i>	Mn	DM	80	$\chi^2= 16.133$
<i>Siler semiglaucus</i>	Ma	DM	100	$\chi^2= 30.00, P<0.001$
<i>Siler semiglaucus</i>	Ma	DM	76.67	$\chi^2= 8.53, P<0.01$
<i>Xenocytaea sp</i>	Ma	DM	100	$\chi^2= 30.00, P<0.001$
<i>Zenodorus orbicularis</i>	Ml	DM	100	$\chi^2= 30.00, P<0.001$

Table 3: Percentage of ants chosen by myrmecophagic salticids. Tests of vision-based prey choice. Used lures made from ants (*Monomorium antarcticum*) and from ordinary salticids (*Plexippus paykulli*). N=30 for each row. Chi-square tests of goodness of fit (null hypothesis: choose each prey type equally often). Lures matched for body length (within 1 mm).

Myrmecophagic salticid	Chose ant (%)	Test of goodness of fit
<i>Aelurillus aeruginosus</i>	80	$\chi^2=10.80$, P<0.01
<i>Chalcotropis gulosus</i>	96.67	$\chi^2=26.13$, P<0.001
<i>Chrysilla lauta</i>	93.33	$\chi^2=22.53$, P<0.001
<i>Corythalia canosa</i>	80	$\chi^2=10.80$, P<0.01
<i>Habrocestum pulex</i>	90	$\chi^2=19.20$, P<0.001
<i>Natta rufopicta</i>	83.33	$\chi^2=13.33$, P<0.001
<i>Siler semiglaucus</i>	96.67	$\chi^2=26.133$, P<0.001
<i>Xenocytaea</i> sp.	80	$\chi^2=10.80$, P<0.01
<i>Zenodorus orbiculatus</i>	90	$\chi^2=19.20$, P<0.001

Table 4: Percentage of myrmecomorphic salticids chosen by myrmecophagic salticids. Tests of vision-based prey choice. Used lures made from myrmecomorphic salticids (*Myrmarachne assimilis*) and from ordinary salticids (*Plexippus paykulli*). N=30 for each row. Chi-square tests of goodness of fit (null hypothesis: choose each prey type equally often). All lures 7 mm in body length.

Myrmecophagic salticid	Chose myrmecomorphic salticid (%)	Test of goodness of fit
<i>Aelurillus aeruginosus</i>	96.67	$\chi^2=26.13$, P<0.001
<i>Chalcotropis gulosus</i>	96.67	$\chi^2=26.13$, P<0.001
<i>Chrysilla lauta</i>	90	$\chi^2=19.20$, P<0.001
<i>Corythalia canosa</i>	80	$\chi^2=10.80$, P<0.01
<i>Habrocestum pulex</i>	76.67	$\chi^2=8.53$, P<0.01
<i>Natta rufopicta</i>	100	$\chi^2=30.00$, P<0.001
<i>Siler semiglaucus</i>	96.67	$\chi^2=26.13$, P<0.001
<i>Xenocytaea</i> sp.	100	$\chi^2=30.00$, P<0.001
<i>Zenodorus orbiculatus</i>	90	$\chi^2=19.20$, P<0.001

Table 5: Percentage of myrmecomorphic salticids chosen by myrmecophagic salticids. Tests of vision-based prey choice. Used lures made from myrmecomorphic salticids and from ants. N=40 for each row. Chi-square tests of goodness of fit (null hypothesis: choose each prey type equally often).

Myrmecophagic salticid	<i>Myrmarachne</i>	Ant	Chose <i>Myrmarachne</i> (%)	Test of goodness of fit
<i>Aelurillus</i>	Mp*	Mon*	45	$\chi^2= 0.40$, NS
<i>aeruginosus</i>				
<i>Chalcotropis</i>	Ma*	Cam*	57.50	$\chi^2=0.90$, NS
<i>gulosus</i>				
<i>Chalcotropis</i>	Ma	Dol	35	$\chi^2= 0.13$, NS
<i>gulosus</i>				
<i>Chalcotropis</i>	Ma	Mon	45	$\chi^2= 0.40$, NS
<i>gulosus</i>				
<i>Chalcotropis</i>	Ma*	Oec*	35	$\chi^2= 0.13$, NS
<i>gulosus</i>				
<i>Chalcotropis</i>	Ma	Sol	35	$\chi^2= 0.03$, NS
<i>gulosus</i>				
<i>Chalcotropis</i>	Mm*	Cam*	50	$\chi^2= 0.00$, NS
<i>gulosus</i>				
<i>Chrysilla lauta</i>	Mp	Dol	32.50	$\chi^2= 0.53$, NS
<i>Corythalia</i>	Mp	Mon	52.50	$\chi^2= 0.10$, NS
<i>canosa</i>				

<i>Habrocestum</i> <i>pulex</i>	Mp	Mon	50	$\chi^2= 0.00$, NS
<i>Natta rufopicta</i>	Mk*	Mon*	32.50	$\chi^2= 0.53$, NS
<i>Natta rufopicta</i>	Mn*	Mon*	37.50	$\chi^2= 0.00$, NS
<i>Siler</i> <i>semiglaucus</i>	Ma	Mon	45	$\chi^2= 1.20$, NS
<i>Siler</i> <i>semiglaucus</i>	Mm	Mon	40	$\chi^2= 0.13$, NS
<i>Zenodorus</i> <i>orbiculatus</i>	MI	Mon	45	$\chi^2= 1.20$, NS
<i>Xenocytaea</i> sp.	Ma	Dol	60	$\chi^2= 1.60$, NS

*Lures matched for body length (within 1 mm).