Bull.Br.arachnol.Soc. (1978) 4 (6), 275-278

The effectiveness of chemical defences against predation by the tarantula *Aphonopelma chalcodes* Chamberlin

E. W. Minch
Department of Zoology,
Arizona State University,
Tempe, Arizona 85281, U.S.A.

Summary

Aphonopelma chalcodes was repelled in varying degrees by prey having repugnatory chemicals as compared with prey lacking such mechanisms. The defensive secretions of tenebrionid beetles appeared to provide them with an opportunity to escape by momentarily startling the tarantula. Secretions of spirostreptid millipedes were more effective in prolonged repulsion of the tarantula.

Introduction

There have been isolated reports in the literature of tarantulas feeding on prey equipped with chemical defences. Petrunkevitch (1926, 1952) found remains of undetermined species of millipedes around tarantula burrows. Williams (1956) reported a tarantula of the genus *Aphonopelma* feeding on a species of tenebrionid beetle with a defensive chemical secretion. However, no one has attempted to compare the degree of feeding by tarantulas on prey with defensive chemicals with feeding on prey lacking these defences. Such data would provide a better understanding of the relative effectiveness of the chemical defences of the prey tested. The tarantula *Aphonopelma chalcodes* Chamberlin occurred in sufficient numbers to favour its use for this investigation.

When disturbed, beetles of the genus *Eleodes* are capable of discharging a complex mixture of chemicals, the main components of which are p-benzoquinones (Eisner & Meinwald, 1966). *E. longicollis* LeConte emits a mixture composed of 2-methyl-1:4 quinone and 2-ethyl-1:4 quinone (Chadha, Eisner & Meinwald, 1961), along with the hydrocarbons 1-tridecene and 1-undecene accompanied by a residue of glucose (Hurst, Meinwald & Eisner, 1964) and caprylic acid (Meinwald & Eisner, 1964). The quinones are the repulsive agents (Eisner & Meinwald, 1966), with the hydrocarbons and caprylic acid serving as spreading factors that get the quinones through the wax layer of the arthropod predator, and the glucose seemingly functionless (Hurst *et al.*, 1964; Meinwald & Eisner, 1964).

Spirostreptid millipedes emit a noxious mixture of p-benzoquinones (Eisner & Meinwald, 1966). *Orthoporus punctilliger* Chamberlin from Portal, Arizona emits 2-methyl-1:4 quinone and 3-methoxy-2-methyl-1:4 quinone (Eisner *et al.*, 1965).

Materials and Methods

The house cricket, *Acheta domestica* (L.), was the regular prey item offered to the tarantulas throughout the time they were maintained within glass gallon jars in the laboratory and also served as a control with which to compare the degree of predation by tarantulas on certain arthropods equipped with chemical defences. Spirostreptid millipedes (Chamberlin & Hoffman, 1958) collected in Portal, Cochise County, Arizona, and the tenebrionid beetles *Eleodes obscura* (Say), taken from the study site at Molino Basin, Pima County, Arizona, and *E. armata* LeConte and *E. longicollis*, taken from the Fort McDowell Indian Reservation, Maricopa County, Arizona, represented prey items capable of emitting chemical irritants. For each prey, 100 trials were performed involving 40 individual tarantulas during the interval of 11 September 1975 to 30 October 1975. Unfortunately, the mixture of the two species *E. armata* and *E. longicollis* was not discovered until after the tests were completed, and it was not possible to separate the results for each. The test procedure consisted of an initial presentation of a prey item with a chemical defence, considered a noxious prey, for 1 hour. If the tarantula fed on this prey item by the end of the hour, it was scored as having preyed upon it. If the prey item was free to move around at this time, the tarantula was scored as having had a negative reaction, and the noxious prey was removed, being replaced by a cricket. The test procedure was then repeated with the cricket for a second 1-hour period. The cricket served mainly to provide the opportunity for the tarantula to feed on a neutral prey item, one not having a chemical defence, which prevented the tarantula from suffering undue starvation that could have influenced future trials. This also indicated that the earlier refusal was due to the chemical rather than to satiation in the spider. However, if uneaten after 2 days, the cricket was removed and the spider was not fed again until the following week. During the testing period, a weekly feeding schedule was followed. In order to obtain a figure with a neutral prey item upon which to base these results, crickets were presented alone in the later weeks, rather than using data from the cricket feedings immediately after removal of the noxious prey items. It was felt that all figures used should represent initial presentations of prey items, thus avoiding the removal of the hungry individuals in the first set of trials.

E. obscura and spirostreptid millipedes were offered to tarantulas at night in the field on three occasions. This was done under a red light to minimize the influence that white light could have on the subjects.

Results

The results obtained from initial presentations of prey and the number of tarantulas accepting at least one or rejecting all of each prey during the test period are given in Table 1. The numbers of tarantulas accepting and rejecting *A. domestica* after prior presentations of each of the noxious prey are given in Table 2.

Eleodes

It can be seen from Table 1 that 63% of the *E. obscura* and 50% of the mixture of *E. armata* and *E. longicollis* were devoured, compared with 83% of the *Acheta.* Eighty per cent of the tarantulas ate at least one *E. obscura* (against 85% for *Acheta*), and 65% of the tarantulas ate at least one of the *E. armata*/*E. longicollis* mixture. Further, Table 2 shows that of the tarantulas rejecting *E. obscura*, 59% ate *Acheta* immediately afterwards, while 80% of the tarantulas that had rejected *E. armata* or *E. longicollis* ate *Acheta.*

Field tests also indicated only partial effectiveness of the chemical defence. Two out of three *E. obscura* were taken by tarantulas near their burrow entrances.

Spirostreptid millipedes

The secretions of spirostreptid millipedes were the most effective against tarantulas of any tested. Only 5% of the millipedes presented were eaten (Table 1), and no individual tarantula ate more than one millipede. Eighty per cent of the tarantulas that had rejected millipedes ate *Acheta* (Table 2).

Tarantulas in the field rejected, upon tarsal contact, three out of three spirostreptid millipedes presented. In each case the millipede was left unharmed.

Acheta domestica

This prey lacked any apparent chemical defence and appeared to depend on jumping ability to avoid predators. The confines of the laboratory containers inhibited jumping to a large extent. In the laboratory tarantulas had the greatest success in capturing this type of prey.

Discussion

Eleodes

The defensive substances exhibited only partial effectiveness in repelling tarantulas as predators, even though tarantulas often held beetles by the abdomen,

	No. of prey		No. of *Aphonopelma*	
Prey	Eaten	Rejected	Eating at least one prey	Rejecting all prey
Eleodes obscura	63	37	32 (80%)	8
E. armata and *E. longicollis*	50	50	26 (65%)	14
Spirostreptid millipedes	5	95	5 (12.5%)	35
Acheta domestica	83	17	34 (85%)	6

Table 1: The prey and number of each prey eaten or rejected by *Aphonopelma chalcodes* from a total of 100 presentations per prey, and the number of individual *Aphonopelma chalcodes*, from a total of 40, eating at least one or rejecting all of a given prey.

No. of presentations	No. *Acheta* eaten	No. *Acheta* rejected	Prey previously rejected
37	22 (59%)	41	*Eleodes obscura*
50	40 (80%)	20	*E. armata* and *E. longicollis*
95	76 (80%)	20	Spirostreptid millipedes

Table 2: The number of presentations of *Acheta domestica*, and numbers of *Acheta domestica* eaten and rejected, after previous rejection of a given noxious prey by *Aphonopelma chalcodes.*

from which the beetle released the secretion and the tarantulas' chelicerae were soaked by quinone secretion. Some tarantulas were not deterred at all by the quinones, while others were repelled throughout the trial period. Repelled tarantulas withdrew from the beetles after tarsal contact.

In the field, the defensive secretion would be important to startle the spider momentarily while the beetle moved outside the limited perceptual range of the tarantula, before the tarantula attacked again. The beetles were hampered in this by the confines of the laboratory containers, and spiders often required a second attempt to capture the beetles after initially releasing them. Since beetles were released before being wounded by the fangs, these tests may underestimate the effectiveness of the defensive substances under natural conditions.

Because *E. longicollis* and *E. armata* were mixed it was not possible to compare each species separately. The data indicated that the mixture of *E. longicollis* and *E. armata* possessed a more effective secretion against the tarantulas tested than *E. obscura.* This may be due to differences in either the repulsive p-benzoquinones or in the associated spreading factors or both.

Beetles (Coleoptera) form a major part of the tarantulas' diet (Gertsch, 1949), with Baerg (1958) stating that they are essential if a female is to form an egg-sac containing fertile eggs. However, the only other report of tarantulas feeding on tenebrionid beetles was, that by Williams (1956) of an undetermined species of *Aphonopelma* feeding on beetles of the genus *Coniotus* and *Cratidus osculans* (LeConte) in southern California. *Coniotus* spp. lack defensive secretions (C. N. Slobodchikoff, pers.comm. 1977), but Tschinkel (1975) found a defensive secretion present in *Cratidus osculans.*

Spirostreptid millipedes

The p-benzoquinones emitted by spirostreptid millipedes are different from those secreted by *E. longicollis* and this, alone or together with the presence of more potent spreading factors, may be the cause of the greater effectiveness of the millipede secretion. Since these millipedes are slow-moving, compared with the tenebrionid beetles, their chemical defence must be potent, as they could not move beyond the perceptual range of the tarantula or other predator before the predator recovered sufficiently to attack again.

Petrunkevitch (1926) found the remains of numerous large millipedes around the burrows of *Cyrtopholis portoricae* Chamberlin in Puerto Rico, and reported that a species of United States tarantula ate millipedes in the field (Petrunkevitch, 1952). In neither instance did he include any details of prey capture by the tarantulas or of the chemical defences of the millipedes.

Acheta domestica

The tarantula *Sericopelma rubronitens* Ausserer readily accepts normal *A. domestica*, but rejected them when they were provided with an artificial chemical defence (Den Otter, 1974). The rejected *A. domestica* were unharmed, as I found with the prey rejected by *A. chalcodes.*

Acknowledgements

The author wishes to thank a number of individuals who assisted during the course of this work. Dr Willis Gertsch, Portal, Arizona, determined the tarantulas. Dr Charles Triplehorn of the Ohio State University confirmed my identifications of tenebrionid beetles made with the use of the Arizona State University insect collection. Drs Mont Cazier, John Alcock, Gordon Castle, Frank Hasbrouck and Robert Patterson offered helpful criticisms. The final draft of the manuscript was typed by Sherry Cook. In addition, the author wishes to thank the Department of Zoology, Arizona State University, to which this work was presented as part of a Ph.D. dissertation, for providing travel funds to the study area.

References

BAERG, W. J. 1958: *The tarantula.* 1-88. University of Kansas Press, Lawrence, Kan.

CHADHA, M. S., EISNER, T. & MEINWALD, J. 1961: Defense mechanisms of arthropods – IV. para-benzoquinones in the secretion of *Eleodes longicollis* Lec. (Coleoptera: Tenebrionidae). *J.Insect Physiol.* **7**: 46-50.

CHAMBERLIN, R. V. & HOFFMAN, R. L. 1958: Checklist of the millipedes of North America. *Bull. U.S.natn. Mus.* **212**: 1-236.

DEN OTTER, C. J. 1974: Setiform sensilla and prey detection in the bird spider *Sericopelma rubronitens* Ausserer (Araneae, Theraphosidae). *Neth.J.Zool.* **24**: 219-235.

EISNER, T., HURST, J. J., KEETON, W. T. & MEINWALD, Y. 1965: Defense mechanisms of arthropods XVI. para-benzoquinones in the secretion of spirostreptid millipedes. *Ann.ent.Soc.Am.* **58**: 247-248.

EISNER, T. & MEINWALD, J. 1966: Defensive secretions of arthropods. *Science, N.Y.* **153**: 1341-1350.

GERTSCH, W. J. 1949: *American spiders.* 1-285. D. van Nostrand, New York.

HURST, J. J., MEINWALD, J. & EISNER, T. 1964: Defense mechanisms of arthropods – XII. glucose and hydrocarbons in the quinone-containing secretion of *Eleodes longicollis. Ann.ent.Soc.Am.* **57**: 44-46.

MEINWALD, Y. & EISNER, T. 1964: Defense mechanisms of arthropods XIV. caprylic acid: an accessory component of the secretion of *Eleodes longicollis. Ann. ent.Soc.Am.* **57**: 513-514.

PETRUNKEVITCH, A. 1926: Tarantula versus tarantula-hawk: a study in instinct. *J.exp.Zool.* **45**: 367-397.

PETRUNKEVITCH, A. 1952: The spider and the wasp. *Scient.Am.* **187**: 20-23.

TSCHINKEL, W. R. 1975: A comparative study of the chemical defensive system of tenebrionid beetles: chemistry of the secretions. *J.Insect Physiol.* **21**: 753-783.

WILLIAMS, F. X. 1956: Life history studies of *Pepsis* and *Hemipepsis* wasps in California (Hymenoptera: Pompilidae). *Ann.ent.Soc.Am.* **49**: 447-466.