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Defence Mechanisms of the Orb-Weaving Spider *Azilia vachoni* (Araneae:Tetragnathidae)

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ABSTRACT
Azilia vachoni (di Caporiacco) is an orb-weaving spider in the family Tetragnathidae. This species exhibited six secondary defence mechanisms in response to disturbance: walking away from the source of disturbance; dropping off the web; shifting its position in the hub; shaking the web; moving its body in a circular motion while walking in the web; and retaliation. The most frequent of these responses was walking away from the source of disturbance, which was regarded as a moderate response to disturbance by the spider.

Key words: defence mechanisms, *Azilia vachoni, Tetragnathidae,* Trinidad.

INTRODUCTION
The orb-weaver *Azilia vachoni* (di Caporiacco) of the family Tetragnathidae has been observed to occupy a wide variety of microhabitats in the understory vegetation of closed canopy forests. It was observed frequently in discrete patches of microhabitat referred to as buttress notches. This is the semi-open space between two buttress roots of a tree. The frequency of *A. vachoni* in this microhabitat lends itself readily to observation on aspects of its natural history, including secondary defence responses. This category of defence responses is only initiated by the animal when threatened by a predator (Edmunds 1974), noting that sometimes when an animal is disturbed one of its responses is to do nothing.

MATERIALS AND METHODS
This study was carried out in the Arena Forest Reserve, Trinidad, West Indies (10º 34´ and 61º 14´ W). The ground is gently undulating with occasional short, steep slopes and an elevation varying from 22.9 m to 87.5 m (Bell 1980). A headlamp was used to facilitate detection and observation.

Web structure is described on the basis of 100 webs of both adults and juveniles during January – July 2003. Webs were dusted with talcum powder to highlight their structure. Using the terminology given in Zschokke (1999), features of the orb web were described. Some of the features included the placement of sticky and non-sticky silk, the presence of retreats, the use of camouflage and the orientation of the web.

Secondary defence responses of *A. vachoni* were elicited by disturbing subadults and adult individuals of this species in this experiment. A total of 52 *A. vachoni* was disturbed during September – December 2004 and January 2005. Disturbance consisted of two degrees: light followed by heavy. Light disturbance involved gently tapping any of the spider's legs with a thin, dry twig, while heavy disturbance involved striking the spider across the cephalothorax, again using a thin, dry twig. Heavy disturbance was repeated until the spider reached an end point. An end point was reached when the spider either dropped out of the web or walked to the periphery of the sheeting and touched the substrate. The response after each strike was recorded for both light and heavy disturbance. Care was taken not to disturb the web. We recognized that the orb web comprised three sections: (1) the hub; (2) the spiral; and, (3) the anchor threads. These areas of the orb web would be used to specify the location of each spider during the course of the disturbance experiment. *Azilia vachoni* are usually found in the resting position in the hub of their web. The resting position consisted of the first and second pairs of legs stretched above the cephalothorax and the third and fourth pairs of legs angled behind the abdomen (Fig. 1). Therefore, *A. vachoni* found in this position and location on the web was considered to be at the starting point.

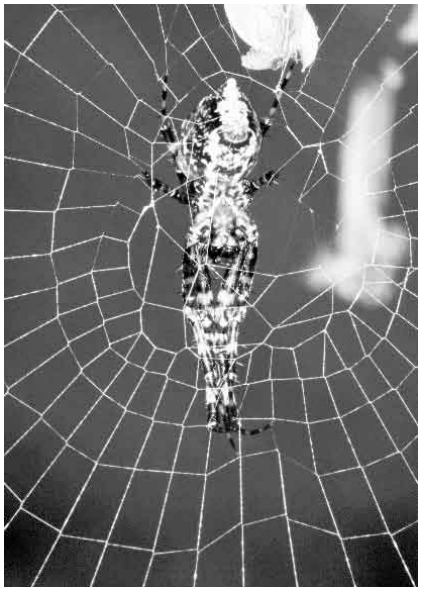

Fig. 1. *Azilia vachoni* in resting position in the hub of its web. Photo: John Abbott.

RESULTS
Webs built by *A. vachoni* can be thought of as consisting of three parts. The first is the hub, which is a roughly circular patch of non-sticky silk, comprising haphazardly arranged rectangles located in the centre of the web. The second part is the spiral, which is a set of concentric circles of sticky silk surrounding the hub. This feature is considered the most distinctive feature of the orb web (Zschokke 1999). Finally, there are the anchor threads which attach the spiral to the substrate. Both juveniles and adults utilize the same web design. Webs were built at angles varying between 0-90º.

This species does not construct retreats but utilize camouflage in their webs. The camouflage most likely consisted of material that had fallen or blown into the web. Some of the material that made

up this web feature included tiny pieces of bark held together by sticky silk. Smaller pieces of bark were held together by greater density of silk than larger pieces of bark or detritus. Other material found included tiny yellow flowers, dried leaflets of *Pentaclethra macroloba* (Willd.) and twigs. The material is approximately linearly placed starting from the hub and extending to the periphery of the spiral. Any material on the spiral was confined to this line which suggests that it was arranged by the spider. However, the use of camouflage by this species was not consistent since only 4 out of 31 webs sampled utilised it.

Azilia vachoni displayed six secondary defence mechanisms: (a) walking away from the source of disturbance; (b) shifting its position in the hub; (c) shaking the web; (d) moving its body in a circular motion while walking in the web; (e) retaliation; and (f) dropping off the web. Retaliation occurred when the spider bit the probe. The circular motion of the body and retaliation were observed by one of us (LD) during continuous heavy disturbance. Two of the spiders tested were holding a prey item when disturbed. Both individuals responded by abandoning their prey item in the hub, retreating to the end point and returning to it a few seconds later.

The secondary defence responses displayed by the spider (Table 1) can be classified as being: (a) non-threatening; (b) slight; (c) moderate; (d) severe; and (e) extreme. Utilizing this classification, a non-threatening response by this spider to disturbance is remaining stationary when touched with the twig. Shifting position in the hub of the web was regarded as a slight response by the spider. Walking away from the source of the disturbance is considered a moderate response, while dropping from the web is a severe response. Finally, retaliation, shaking the web and swirling circularly while moving in the web are extreme responses by the spider.

Table 1. The number of times each secondary defence response is exhibited by *Azilia vachoni* when exposed to both light and heavy degrees of disturbance.

Degree of Disturbance	Secondary Defence Response							Total
	Nothing	Shift position in hub	Walk	Drop from web	Retaliate	Shake web	Swirling circularly while moving in web	
Light	3	3	42	4	0	0	0	52
Heavy	5	4	77	16	1	2	3	108

5.8% of the spiders that were lightly disturbed did nothing in response; 5.8% shifted their position on the hub; 80.8% walked toward another part of the web; 7.7% dropped out of the web; and none retaliated, shook or swirled in response to light disturbance. 4.6% of the spiders that were heavily disturbed did nothing in response; 3.7% shifted their position on the hub; 71.3% walked; 14.8% dropped from the web; 0.9% retaliated; 1.8% shook the web; and 2.8% swirled.

Regardless of whether the disturbance was light or heavy, a majority of the time *A. vachoni* walked away from the source of disturbance. However, it preferred to drop out of its web more often in response to heavy disturbance rather than light disturbance. No significant difference in the behaviours of *A. vachoni* was recorded when subjected to either light or heavy disturbance (÷2=5.2; df=4; P=0.32).

DISCUSSION

Spiders like most animals cannot totally rely on the features of their microhabitat to protect them from predators and have developed defence mechanisms. Animals display two types of defence mechanisms: primary and secondary. In this paper we are concerned with the secondary defence mechanisms exhibited by *Azilia vachoni*. As mentioned earlier, secondary defence mechanisms are only exhibited when the animal is disturbed. These mechanisms can range from the very simple and obvious, such as running away from the source of the disturbance, to displaying a specialised sequence of actions, for example, whirling. Based on a description of *Pholcus phalangioides* (Fuesslin), whirling involves the spider keeping its legs stationary on the web and swinging its body around (Lambright 1979; Jackson 1990; Jackson *et al*.1990; Jackson 1992; Jackson *et al*.1992). Whirling has so far only been described in species belonging to Pholcidae. One pholcid species that displays whirling in Trinidad is *Mesabolivar aurantiacus* (Mello-Leitão) (Sewlal 2005).

Some species may exhibit the same defence mechanisms, as seen with whirling in pholcids. Some species may also exhibit these defence mechanisms to a lesser extent or depending on how severe the animal rates the disturbance. Based on the data *Azilia vachoni* appears to utilize different defence mechanisms most likely depending on how it rates the severity of the disturbance (Table1).

Some defence mechanisms may be taken as being straightforward, such as walking away from the source of the disturbance. However, variations such as walking away from the hub and then returning to it or erratic movement while walking, were displayed by the spiders. *Azilia vachoni* also displayed what we interpreted to be specialised defences such as shaking the web and, moving their bodies in a circular motion while walking on the web, the latter behaviour is similar to whirling. These defence mechanisms could be attempts to confuse the predator. The use of such defence mechanisms indicates that the predators of *A. vachoni* rely on their vision to catch prey.

Orb webs constructed by *Azilia vachoni* did not contain any special modifications to aid in the capture of prey. Their main function appeared to be the capture of prey via entanglement in the sticky silk of the spiral. The construction of a camouflage in the form of material incorporated into the web by some individuals, could be the result of recent disturbances or attacks by predators. However, the relationship between disturbance and construction of a camouflage by *A. vachoni* was not tested.

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