Observations on the spatial distribution and natural history of *Cyrtophora hirta* (L. Koch) (Araneae: Araneidae) in Queensland, Australia

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Summary

The orb-weaving spiders, *Cyrtophora hirta* (L. Koch), are distributed in communities in which the web of the adult female is surrounded by webs of juvenile spiders. The spatial distribution of the community did not appear to be a consequence of attempts by the spiders to reduce competition for resources. Evidence of parasitism on the spider eggs by a moth *Stathmopoda arachnophthora* was discovered. Two theridiids, *Argyrodes incisifrons* and *A. antipodianus*, were present on almost all adult webs. A description of the web is given and aspects of the natural history of *C. hirta* are discussed in relation to other species of *Cyrtophora.*

Introduction

There is some variation in the social behaviour exhibited among species of *Cyrtophora,* ranging from the solitary *C. cylindroides* (Walck.) and *C. cicatrosa* (Stoliczka) to the colonial *C. moluccensis* (Doleschall) and *C. citricola* (Forskal) (Buskirk, 1981; Lubin, 1974; Rypstra, 1979). The colonial species are often highly conspicuous with adjacent webs sharing structural threads (Marples, 1947, and Wheeler, 1926, on *C. moluccensis* and *C. citricola* respectively). Between these extremes of social behaviour is *C. monulfi* Chrysanthus which forms loose aggregations in which individuals occasionally share some structural threads (Lubin, 1974).

This paper presents some observations on the natural history of *C. hirta* (L. Koch) which forms communities consisting of a large web, inhabited by an adult female, surrounded by smaller, but structurally identical, 'satellite' webs, inhabited by juveniles. In addition, the study examined the positions of webs within each community in order to investigate the patterns of its spatial structure.

Web structure, feeding behaviour and interspecific associations

Habitat

Our observations, made from March through May 1978, refer to populations found in Toohey Forest on the Griffith University campus in Brisbane, Australia. The site was in a dry sclerophyll forest, with a canopy of *Eucalyptus* and *Angophora,* an understorey of *Pultenea* and *Acacia* and a ground cover of dry kangaroo grass, *Themeda australis.*

Web and community structure

The web of *C. hirta* is similar to those of other species of *Cyrtophora* (see Lubin, 1974, 1980; Sabath *et al.*, 1974). It is built upon a scaffold which, in the case of the largest webs, may stretch between branches about one metre apart. The scaffold supports a tangle or barrier web, which is between 30 and 40 cm deep, above and below a platform. The platform is a very closely woven horizontal orb-web between 15 and 20 cm in diameter, with a hole cut in the centre. The periphery of this hole is connected by threads to a thimble-shaped silken retreat which is contained within the upper barrier web. These connecting threads are so taut that the platform is slightly drawn up, forming a raised hub. The outer edges of the web are turned up with 'guy ropes' pulling it into a scalloped channel (see Fig. 1). The pale green egg-sacs are attached to the retreat, frequently suspended one above the other, as in other species of this genus (e.g. Lubin, 1980; Marples, 1947). The satellite webs are identical in structure, with the diameter of the platform between 5 and 8 cm and the depth of the barrier web between 5 and 8 cm.

Adult webs were found between 30 and 150 cm above the ground, the average being 77 cm, and were generally built between trees or bushes with little or no foliage. Adult webs were never seen adjacent to

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openings and distance between the outer eyes of the spider were found to be strongly correlated (Pearson product-moment correlation coefficient = 0.976) so that the measurement of the retreat opening enabled us to estimate the relative size of the resident spider without destroying the web.

The positions of the satellite webs in six communities were recorded according to each web's compass bearing, horizontal distance from the adult web, and their height above ground. The direct distance between the retreats of the satellite webs and the adult web and the size of the retreat openings were also measured. Webs further than 150 cm from the adult web were regarded as outside that community.

Results

Analysis of the pooled data from all six communities revealed no linear relationship between juvenile size and the distance between the satellite web and adult web (Pearson product-moment correlation coefficient = 0.093), nor was there a relationship between spider size and height of the web above the ground (Pearson product-moment correlation coefficient = 0.241). In view of the differences in size of the adult spiders, we also examined the relationship between juvenile size and distance from its web to the adult web for each of the six communities; there was considerable variation in the correlation coefficients so obtained (Table 1).

Discussion

Our observations indicate that there was no relationship between the size of an immature *C. hirta* and the distance between its web and that of the adult female. Nevertheless, our hypothesis should not be rejected purely on the basis of these results since they have several inadequacies. The immature spiders had very little variation in size and were, on average, about one third the size of the adult female. There was one exception, community F, which with a correlation coefficient of 0.986 also showed the greatest variation in the size of immature spiders and had the smallest adult female (see Table 1). At this stage the results are ambiguous and alternative hypotheses may be sought. For example, the spatial properties of the habitat may be the major factor governing the spatial distribution of *C. hirta* communities, as Colebourn (1974) found for the distribution of *Araneus diadematus* Clerck. However, both of these hypotheses depend upon the spider density being at a high enough level to make either prey availability or spatial properties of the habitat a limiting factor. Furthermore, these factors may be confounded by the juveniles' attempts to build webs near the centre of the community, rather than on the periphery, where they may be more vulnerable to predation (see Rypstra, 1979).

Enders (1974) has suggested that, in *Araneus* and *Argiope*, a change in food preferences as spider

Community	Adult web retreat size (cm)	Number of satellite webs in community	Satellite web retreat size (cm)		Distance of satellite webs from adult web (cm)		Correlation coefficient*
			mean	s.d.	mean	s.d.	
A	0.73	7	0.18	0.05	58.1	24.2	−0.329
B	0.83	24	0.17	0.03	129.8	24.8	0.150
C	0.91	23	0.19	0.04	60.2	21.9	−0.106
D	0.77	7	0.23	0.03	119.9	44.6	0.163
E	0.79	8	0.20	0.05	80.1	39.4	−0.013
F	0.68	5	0.27	0.18	32.5	27.4	0.986

Table 1: Relationship between the size of the retreats of the satellite webs and their distance from the retreat of the adult web in six communities of *Cyrtophora hirta.*

*Pearson product-moment correlation coefficient.

size changes may cause a spider to change the stratum in which it builds its web; the data obtained in this study show no conclusive evidence that the size of *C. hirta* has any relationship with the height of its web above the ground.

Comparing our observations with Lubin's (1974, 1980) observations of *Cyrtophora*, we find some interesting behavioural similarities between *C. hirta* and *C. monulfi*. Both form loose aggregations and both have silken retreats, absent in both the solitary and colonial species of *Cyrtophora*. Unlike *C. monulfi*, juvenile *C. hirta* webs were occasionally observed within the framework of the adult web, which Lubin (1980) also observed in the colonial *C. moluccensis* and *C. citricola*. The major difference between the communities of *C. hirta* and those of the social *Cyrtophora* species is the apparent lack of overlapping generations. Whether *C. hirta* forms social aggregations, or whether the communities are simply familial aggregations which will later disperse is still unclear.

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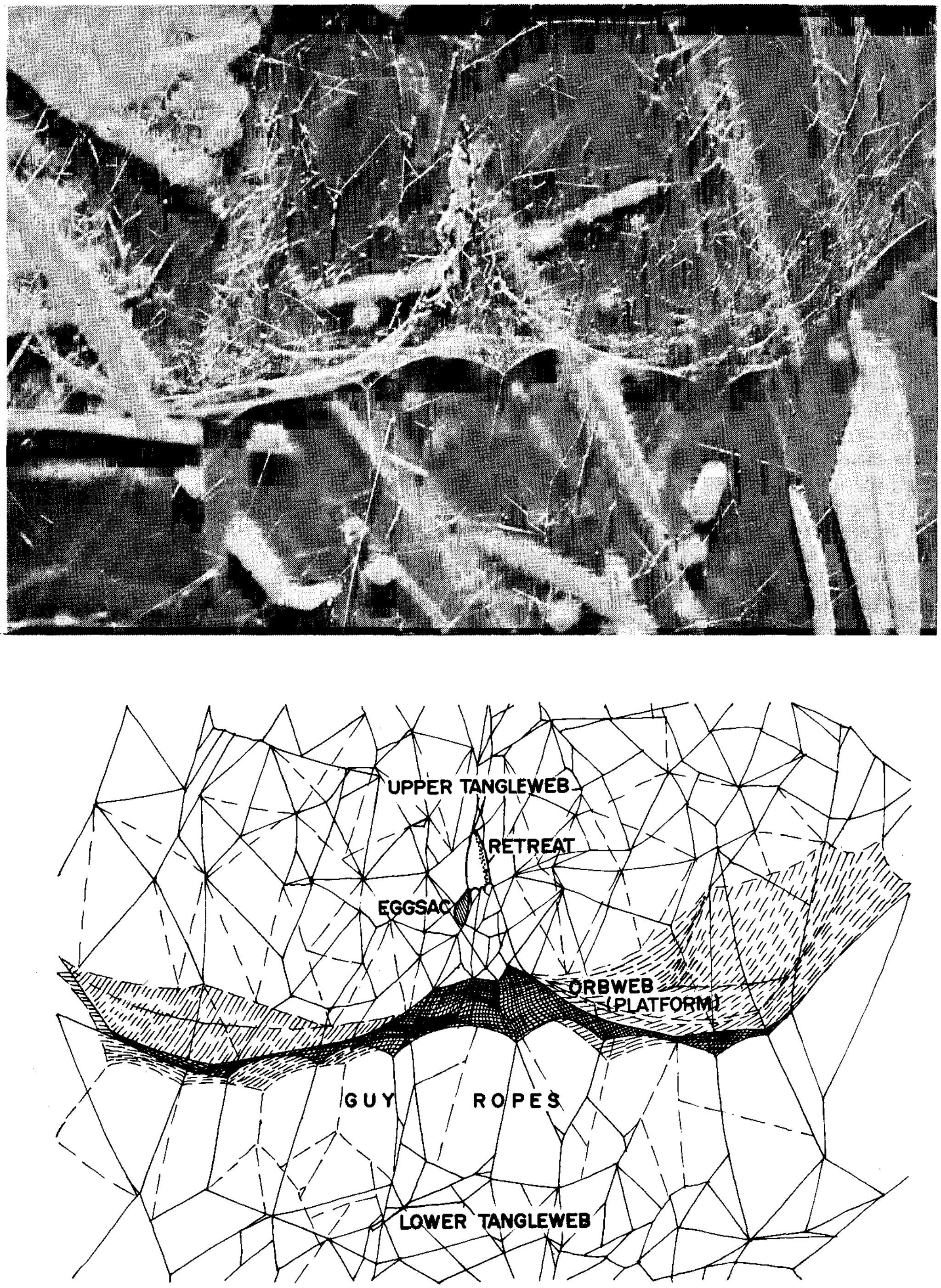

Fig. 1: Orb-web of *Cyrtophora hirta.* The platform (see diagram) is between 15 and 20 cm wide. Juveniles build structurally identical webs about one third of the size of the adult web.

each other. Each adult web was surrounded by up to about 20 satellite webs. The occupants of the satellite webs were of either sex, which suggests that they were the offspring of the spider in the adult web, rather than males awaiting the opportunity to mate. These satellite webs were sometimes clumped into aggregations and sometimes positioned individually around the adult web. Communities of satellite webs were sometimes found with no adult web present. One of the most striking features of each community was the apparent age, or size structure. It is usual for mortality to be high in early instars, but there were few gradations in size between juveniles and adults. It is not known how many instars there are in this species (V. Davies, pers. comm.), but spiders were found to be in one of two distinct size ranges, corresponding to average retreat sizes of 0.2 and 0.8 cm (see below).

Feeding behaviour

During the day, *C. hirta* is usually found resting in its retreat. At night, *C. hirta* assumes a resting position under the hub, in a manner similar to that described for other species of this genus (Lubin, 1980). Prey caught in the underside of the web were bitten, wrapped in silk and then taken back to the retreat. Those prey caught in the web's upper surface were first bitten and then pulled through a small hole which the spider had cut in the web, before being wrapped and taken to the retreat. A spider with prey in its web showed little further interest in any new prey put into the web. The spiders generally ignored prey in the barrier webs, but reacted very quickly to the prey's vibrations on the platform. It would seem that besides acting as a support for the horizontal orb-web, the barrier web structure arrests the flight of insects so that they are deflected into the platform. Lubin (1980) observed several species of *Cyrtophora* shake the tangleweb structure in order to dislodge prey into the web.

Field observations of the relationship between spider size and prey size were not attempted because of the difficulties in controlling both the projection of prey into the web, and the size and type of prey item. Furthermore, the juvenile spiders were easily disturbed and would return to their retreats, ignoring prey in their webs.

Interspecific associations

Two theridiids, *Argyrodes incisifrons* Keyserling and *A. antipodianus* O. P.-C., were present in almost all adult webs and some satellite webs. No attempt was made to establish experimentally the relationship between these two spiders and *C. hirta. Argyrodes* have been considered as commensals, because it was thought that they cleaned the host web of unwanted prey (e.g. Sabath *et al.,* 1974), but other studies suggest that *Argyrodes* are in fact kleptoparasites because they steal prey from the host spider (Lubin, 1974; Robinson & Robinson, 1973; Vollrath, 1979).

Nine egg-sacs were incubated at 25°C. We found that four of them contained the larvae of a small moth, *Stathmopoda arachnophthora* (Turner) (Fam. Stathmopodidae). There were no surviving spiderlings in the parasitised egg-sacs. Lubin (1980) reported instances of dipteran and hymenopteran parasitism of egg-sacs in several species of *Cyrtophora,* and Robinson (1977) observed kleptoparasitic lepidopteran larvae on a social theridiid, but we have not found any other reports of lepidopteran parasitism in this genus.

Community spatial structure

We examined the positions of webs within each community in order to investigate the patterns of its spatial structure. Assuming prey size was directly related to spider size (see Bristowe, 1958), it seemed possible that as juveniles grow, they come into competition with adults. Hence we predicted that the distance between a juvenile's satellite web and the adult female's web varies directly with the size of the juvenile.

Methods

As it was not known how many instars there are to maturity, nor the age attained by the mature spider (V. Davies, pers. comm.), it was necessary to consider spider size rather than age. The spider retires to the retreat if disturbed and cannot be removed without destroying the web so the following method of sizing the spiders was adopted. Twenty-five occupied webs were selected at random and the openings to the retreats measured with Vernier calipers. The spider occupants were then measured under a microscope. The diameter of the retreat