Prey analysis of four species of tropical orb-weaving spiders (Araneae: Araneidae) and a comparison with araneids of the temperate zone

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Summary. The actual prey in the orb webs of four araneid spiders (Nephila clavipes, Eriophora fuliginosa, Argiope argentata, and A. savignyi) and the relative abundance of their potential prey (pitfall traps, yellow traps, and sweep-netting) was investigated over 1 year at different locations in Panama. The relative abundance of insects and spiders depends on seasonal fluctuations (Fig. 2) which are reflected by corresponding variations in the effectiveness of the webs. The main prey groups are Nematocera (50%-68%), winged Formicoidea (6%-15%) and Hymenoptera, Coleoptera, and Brachycera (4%-10% each) (Fig. 4-6). The remaining 10%-17% of the prey comes from up to 26 other groups (Table 2). Differences in prey size and prey composition between the spider species are small (Fig. 7). Most prey items are 1-2 mm long; only a few insects exceed 30 mm body length (Figs. 9-12). Relative to the available prey, some groups (e.g. Nematocera, Aphidoidea, Psocoptera, Coleoptera, Brachycera, Orthoptera) are underrepresented in the prey spectrum and obviously avoid orb webs (Table 7). The differences in prey composition between araneids of the tropics and of the temperate zone are discussed (Table 8) and compared to those recorded in other studies (Tables 9, 10). Most of these report large numbers of big prey items (Odonata, Lepidoptera, wasps/bees). The size of insects in the tropics has been investigated several times (Williams 1941; Janzen and Schoener 1968; Elton 1973; Janzen 1973a, b; Janzen et al. 1976): the most numerous are small arthropods. Various trapping methods (Smythe 1982; Erwin 1983; Sutton 1983) showed high percentages of Nematocera, Cicadina, Psocoptera, and other small insects in the entomofauna. The question arises: Do tropical Araneidae not catch these small insects? In order to answer this question a 1-year study in Panama was carried out on four araneid species at different locations. The potential prey of the spiders was established by means of extensive trapping using three different methods and was then compared to the actual prey of the spider according to size and composition. The following paper contains a discussion on the differences in prey composition between tropical and temperate-zone araneids.

Material and methods

Study sites. Studies were performed at several locations in the Republic of Panama (Fig. 1). In the following text reference will be made to the locations according to the abbreviations given here.

1) On the access road (approx. 3 km in length) to Cerro Galera (CG), a hill near the Pacific Ocean, 5 subsites (CG 1 to CG 5) were selected, each about 20 m of road length (CG 1 behind the gate to CG, CG 5 at the summit).

2) Cerro Pelado (CP), a hill near Gamboa, with one access road (1 km long) to a transmitting station (CP 1) and another road (500 m long) to the watertank of Gamboa (CP 2).

3) Several study sites were selected on the first 8 km of Pipeline Road (PR), a road leading from Gamboa to the NE end of Lake Gatun.

The composition of the entomofauna (e.g. Nentwig 1982b) and the prey of orb-weaving spiders and their webs (Kajak 1965; Nyffeler and Benz 1978; Nyffeler 1982; Nentwig 1983a), and also the distribution of insect size (e.g. Remmert 1981; Nentwig 1982b) are well known in the temperate zone. The main conclusion to be drawn are that size and prey composition in a spider's web depend on the insects available around the web. Most prey items are very small. The web has the effect of selecting the smaller insects from the available spectrum, while the spider itself selects the larger items from the web catch. In general, phytophagous and detritophagous insects are disproportionately represented in the web, while pollinating, predatory and parasitic insects avoid the web (Nentwig 1982a).

Corresponding data for the actual and potential prey of orb-weaving spiders of tropical countries is scarce and it is not clear whether or not the generalisations which have been derived from temperate-zone studies can be applied to the tropics. A few studies have been conducted on the prey of tropical orb-weaving spiders (Robinson and Robinson 1970, 1973; Shelly 1983), but those of Robinson and Robinson report high percentages of large insects (many wasps, beetles, butterflies, no midges) in the spiders' diet. The size of insects in the tropics has been investigated several times (Williams 1941; Janzen and Schoener 1968; Elton 1973; Janzen 1973a, b; Janzen et al. 1976): the most numerous are small arthropods. Various trapping methods (Smythe 1982; Erwin 1983; Sutton 1983) showed high percentages of Nematocera, Cicadina, Psocoptera, and other small insects in the entomofauna. The question arises: Do tropical Araneidae not catch these small insects? In order to answer this question a 1-year study in Panama was carried out on four araneid species at different locations. The potential prey of the spiders was established by means of extensive trapping using three different methods and was then compared to the actual prey of the spider according to size and composition. The following paper contains a discussion on the differences in prey composition between tropical and temperate-zone araneids.
Fig. 1. The study area in Panama. BCI = Barro Colorado Island; SG = Summit Gardens

4) In Summit Gardens (SG), a small zoo and botanical garden located between Gamboa and Panama City, a spider population was chosen for a 4-week study. The habitat can be characterized as tropical rain forest (secondary forest) (CG, CP, PR), locally with lower vegetation (shrubs, herbs) or grass (CG 5, parts of CP 1 and 2, parts of PR). Annual rainfall on Barro Colorado Island (BCI) amounted to 2,520 mm in 1983 with a distinct wet season (May to December) and a dry season (January to April). For temperature and relative humidity of the air in Gamboa see Nentwig (1985).

Spiders. Four larger species of orb-web building spiders (Araneidae) were studied:

Nephila clavipes (L.), the golden silk spider, is one of the largest araneids (20–30 mm body length). This spider is active by day and by night. It sits in the centre of its huge web (diameter up to 1 m) and repairs only the most badly damaged parts of the web. The web is asymmetrical and has a well-developed barrier web. Nephila has no particularly characteristic habitat, but is found primarily between shrubs and trees of forest edges.

Eriophora fuliginea (C.L. Koch), is a large nocturnal spider (20–30 mm body length) which removes its large (diameter 1 m or more) and extremely sticky web at dawn and hides in a retreat of coiled leaves.

Eriophora lives on the edges of forests and builds its web between shrubs.

Argiope argentata (F.) is a diurnal spider with a smaller web; lives in grassland and sits during the day on the hub of the web.

Argiope savignyi Levi was found much less frequently than A. argentata in the habitat of the other three species. The web is similar to that of A. argentata. It may be that the main habitat of A. savignyi is in the canopies of trees (Robinson, pers. comm.) and that the few individuals I found represent only dispersed parts of the main population. Owing to the relative rarity of A. savignyi I present here only the total data for the period of investigation without further subdivision according to location or time of the year.

All four species were found to be more or less sympatric, Nephila and Eriophora in shrubs and trees not higher than a few metres, Argiope in the grass nearby. More background information on these spider species is given by Moore (1977), Robinson (1969), Robinson et al. (1971), Robinson and Mirick (1971), Robinson and Olazarri (1971), and Robinson and Robinson (1970, 1974).

Methods. From March 1983 to February 1984 collections were made of the prey items (= actual prey) of the web-building spiders and also of their potential prey. The practice for prey collections was to gather all prey items (whether dead, alive, partly eaten, chewed up, or even still in the possession of the web resident) from at least 10 webs per species and study site. The prey items were picked up with forceps and preserved in a vial with ethanol. Sometimes less than 10 webs per study site were available, especially before and after the period of a species' main population growth. At CG and CP 1 collections were made throughout the period of investigation (CP 2 see below). At PR studies started in early June 1983; at SG collections were restricted to 4 weeks in January/February 1984. Potential prey was collected at CG and CP in three different ways: pitfall traps, yellow-coloured traps (four of each type per site, both types filled with formaldehyde), and at CG 2 and CP 2 by using a sweepnet (in order to get at least 100–150 insects). For technical details see Nentwig 1980, and in press). Traps at CG were run for the whole investigation period; at CP 2 studies were stopped at the end of September 1983 after road workers had cut back a large amount of the vegetation. All collections were repeated at 10-day intervals in the following sequence: First day CP 2, second day CG, third day CP 1, fourth day PR. Prey collections and trap changes were performed on the same day. On the following days the insects from traps and webs were sorted into taxonomic groups and measured to the nearest mm (body length in 70% ethanol, without antennae or appendages) with the aid of a binocular microscope.

Rainfall data originate from Barro Colorado Island (BCI) in the Gatun Lake, see Fig. 1 (courtesy of the Smithsonian Tropical Research Institute). There may be some variation in the monthly rainfall among the study sites; however, the overall seasonal picture is similar.

The degree of selectivity in prey capture was calculated by means of Ivlev's index of electivity (Ivlev 1961), explained in Nentwig (1980). To this end the percentage results of pitfall traps, yellow traps, and sweepnet catches have been averaged.

Results

General aspects. To judge from the contents of the pitfall traps and yellow traps (quantitative traps) insects are available throughout the year (Fig. 2). There is a major peak after the start of the wet season in May and a second peak