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The web of *Paraneus cyrtoscapus* (Pocock, 1899) (Araneae: Araneidae) in Ghana*

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Summary

Paraneus cyrtoscapus was found in Ghana on two types of web. One was a normal, almost vertical, araneid web. The other was basically horizontal, but with the hub pulled up by threads attached to the vegetation above, so that it formed a shallow cone. The latter was smaller both in diameter and mesh size than the normal web, and occurred closer to the ground. It had a defective frame, radii being attached to the vegetation or to very short frame threads. Both types of web were found mainly in grassy, sunny areas. Only mature females were found on vertical webs. Juveniles, mature males and a few mature females were found on horizontal webs. The most likely explanation is that all spiders spin horizontal webs until they are mature, but that shortly after reaching maturity females change to building vertical webs.

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Introduction

Whilst studying the ecology of Araneidae and Tetragnathidae at Legon (near Accra), Ghana, between February 1971 and August 1973, I occasionally saw the webs of what I assumed to be two species of Araneinae, though the spiders were similar in appearance. One type of web was an almost vertical normal araneid web, and the other was an almost horizontal cone-shaped web. Spiders from both types of web have since been identified as *Paraneus cyrtoscapus* by Dr M. Grasshoff (pers. comm.). The vertical web was not common; the horizontal web was easily overlooked as it occurred low in the grass. However, the spider was probably common as one individual of the wasp *Chalybion fuscipenne* Smith stocked 11 cells with 78 *P. cyrtoscapus* out of 93 araneids and a total of 112 spiders. Because of the difficulty in finding the spiders, observations were not as extensive as they would have been if I had realised during the field work that there was a single species building two types of web.

P. cyrtoscapus is an African species (M. Grasshoff, pers. comm.). All individuals were entirely brown with some mottling on the abdomen, especially ventrally; mature specimens were dark reddish brown, juveniles normally yellowish or greyish brown. For three mature females the weight varied from 230-481 mg and measurements were:– total length: 11.0-14.0 mm; carapace length: 5.0-7.0 mm; length of first leg: 18.0-22.5 mm. Males were on average slightly smaller,

though there was some overlap in carapace and leg measurements. As well as being found in the cultivated, but basically savanna, area of Legon, three *P. cyrtoscapus* were found on horizontal webs, at the edge of a path in the forest area of Mount Atewa, Kibi, about 160 km north-west of Accra.

Methods

All observations were made on spiders' webs in the field; a few individuals were collected, weighed and preserved for identification. The angle of the web from the vertical was measured to the nearest 5° with a protractor that had a plumb line fixed to its centre. The longest and shortest diameters of the web were measured to the nearest cm, and the average of the two was taken as the diameter. The mesh of the web was measured by counting the number of sticky spirals that crossed 5 cm of a radius in the centre of the catching zone. The height of the web hub above the ground was measured to the nearest cm. The strength of the sticky spiral was found by hanging small hooks of wire of known weight over five individual spirals, tested consecutively; weights were increased from the maximum that failed to break the spirals, through weights that broke a percentage of the spirals tested, to the minimum weight that broke all spirals tested. The light intensity at midday at the web site was taken using a 'Weston Master III' photographic light meter, converted for measuring direct light; the results are recorded as full sunlight, full-½ sunlight, ½-¼ sunlight, etc.

Results

The two types of web built by *P. cyrtoscapus* will be referred to as vertical and horizontal webs, though vertical webs are usually slightly inclined and horizontal webs are cone-shaped. A vertical web is a normal, fairly large araneid web, with an inclination from the vertical of 0-40° (mean of eight webs = 21.9°). A horizontal web is shown in Fig. 1, though only the outer spirals have been drawn. The most noticeable feature is the approximately horizontal

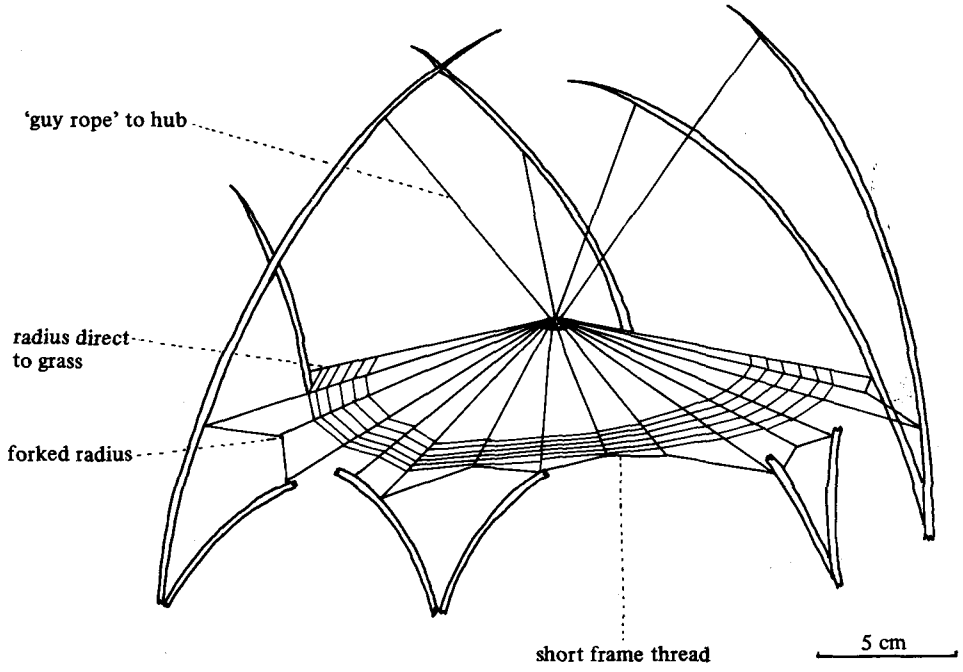

Fig. 1: Horizontal web of *Paraneus cyrtoscapus*, showing the hub pulled up by 'guy ropes', and the defective frame with some radii going straight to the vegetation (only the outer few spirals drawn).

plane of the perimeter. However, the centre of the web is drawn up above the perimeter, making the web into a cone shape, with the sides inclined 60°-80° from the vertical (Fig. 2a) (mean of nine webs: 70.0°). The cone is often fairly symmetrical, though one side, or even a short sector, may be at a different angle from the rest. The hub is pulled up by two to four threads, acting as 'guy ropes', attached to the vegetation above. The hub is strong, finely meshed, and is not perforated, unlike that of some other species with a strongly inclined web, e.g. *Gasteracantha* spp. and *Leucauge* spp. (Eberhard, 1972; pers. obs.). The vertical web is normally in one plane, and though sections may be irregular, the web is never cone-shaped, nor does it have any 'guy ropes' attached to its hub. In the horizontal web the frame is defective, with many radii attached direct to the grass, with some being simply forked, and with a few attached to short pieces of frame threads. Vertical webs have complete, normal frames, in which some threads may be reinforced, and the grass stems nearby may be bound together to further strengthen attachment points.

Further differences between the two types of web are found in the web size, mesh size and in height of the hub from the ground (Fig. 2b, c, d). The horizontal web is smaller, with a mean diameter of 21.7 cm (N = 9) compared with a mean of 37.7 cm (N = 8) for the vertical web (Fig. 2b); if the difference is tested by the median test (Siegel, 1956) it is significant at $p < 0.001$. The horizontal web has a smaller mesh (Fig. 2c) than the vertical (mean of 19.0 spirals in 5 cm compared with 11.5, $p < 0.05$); and it is nearer the ground (the mean height of the hub above the ground is 0.24 m compared with 0.60 m, $p < 0.001$). The height of the web of *P. cyrtoscapus* can be compared with that of other species building in the same habitat (Fig. 2d), e.g. *Argiope trifasciata* (Forskål) with a slightly inclined web, and *Leucauge* sp. with a strongly inclined web, but more or less in one plane. The horizontal web of *P. cyrtoscapus* is lower than that of the other two species, while the vertical web is at a similar height, or possibly slightly higher. Vertical webs are approximately oval in outline, with the part below the hub larger than the part above; horizontal webs are approximately round and symmetrical. The vertical web has a stronger spiral than the horizontal web (Fig. 3). The two vertical webs tested (with spiders weighing 230 mg and 481 mg) were very similar in strength, but one horizontal web, with a spider of similar weight (213 mg) to the lighter one on a vertical web, had a considerably

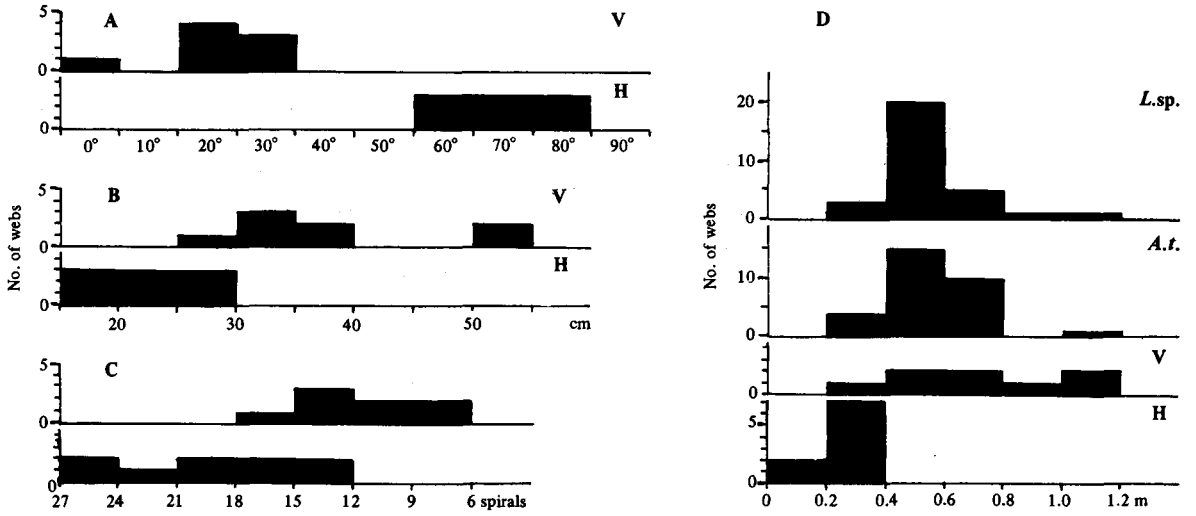

Fig. 2: Differences between the horizontal (H) and vertical (V) webs of *Paraneus cyrtoscapus*. **A**, Inclination of web from vertical; **B**, Diameter of web; **C**, Mesh size, given as the number of spirals crossing 5 cm of radius; **D**, Height of the hub above ground, also compared with *Argiope trifasciata* (*A.t.*) and *Leucauge* sp. (*L*,sp.).

weaker spiral. The differences between the two types of web are summarised in Table 1.

However, both webs were found in mainly grassy, sunny areas (Fig. 4). A few were found amongst weeds, or in the case of the vertical webs, attached to small isolated shrubs in the grass. None were found in areas with less than half sunlight; some other species in the area were found in much shadier places, e.g. *Argiope flavipalpis* Lucas in sites with light intensity at midday as low as 1/128 full sunlight.

In nearly all observations, webs appeared newly built when first seen (at *ca* 07.30) soon after dawn. However, one spider was seen attempting to build a vertical web at 18.30, shortly after sunset, but strong winds kept breaking threads, and a web had not been built by darkness, nor was one present the next day. During the day all spiders rested in retreats. These were shallow, often no more than a few threads on dead vegetation, but the spiders were very cryptic. Spiders with horizontal webs usually had a retreat below the web, in which case there appeared to be no guide line to the hub; however, it was occasionally above the web, when there was normally a guide line. Spiders with vertical webs occasionally had a guide line to the hub. However, during the day I was never able to entice a spider onto a vertical web by means of prey, and only very occasionally onto a horizontal web. At night all spiders rested at the web hub. On some days, horizontal webs were seen with only a few radii, going direct to the grass, or else forked, and a hub with one or two 'guy ropes' giving the outline of a cone shape.

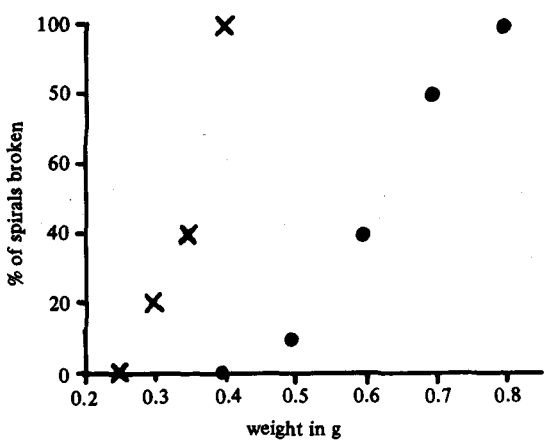

Fig. 3: Strength of the spiral thread in *Paraneus cyrtoscapus* webs. x = results from one horizontal web; ● = results from two vertical webs.

	Vertical web	Horizontal web
Angle of web to vertical	0-40°	60-80°
Plane of web	In one plane	Cone-shaped
Guy ropes supporting hub	Absent	Present
Frame threads	Complete	Defective
Catching area	Oval	Circular
Average diameter	37.7 cm	21.7 cm
Average no. of spirals per 5 cm radius	11.5	19.0
Average height above ground	0.60 m	0.24 m

Table 1: The main differences between the vertical and horizontal webs of *Paraneus cyrtoscapus*.

Spiders collected from vertical webs were all mature females, and those not collected were large. Horizontal webs were built by juveniles, mature males, and occasionally mature females. Mature females and vertical webs were found in February to July, horizontal webs and juveniles from wasp nests were found in all months except August, September and October (there were no or few observations in August and September). As vertical webs were not easily overlooked, it seems likely that mature females only occur in February to July. Mature males were found in January, February, May and June, but as they occur on horizontal webs they could have been overlooked. Nevertheless it appears that mature *P. cyrtoscapus* are only present from January to July, i.e. at the end of the dry season and during the main part of the rainy season. This contrasts with other species of Araneidae found at Legon, most of which seem to be capable of breeding throughout the year. Despite mature spiders being found for only part of the year, it is likely that juveniles occur throughout the year, and in two instances both horizontal and vertical webs were found within a few metres of each other.

Discussion

The shape of the horizontal web of *Paraneus cyrtoscapus* is unusual. I know of no references to a web of this type, though a shallow cone is built low

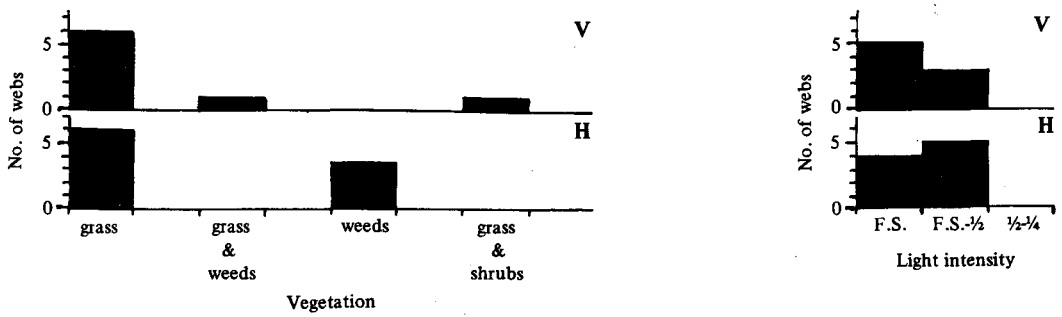

Fig. 4: Vegetation and light intensity at web sites of *Paraneus cyrtoscapus*. H = horizontal web site; V = vertical web site; F.S. = full sunlight.

in the vegetation by *P. spectator* (Karsch) in East Africa (M. Grasshoff, pers. comm.). Webs differing in shape from the oval web that is typical for araneids are being reported with increasing frequency, e.g. Nephilinae with partial orbs (Bonnet, 1930), or the more divergent long narrow ladder webs of an unidentified Metinae (Robinson & Robinson, 1972), the inverted ladder of *Scoloderus* sp., the intermediate ladder of *Eustala* (?) sp. (Eberhard, 1975), and the very asymmetrical orbs and sectors of orbs, that function by breaking in *Poecilopachys australasia* (Griffith & Pidgeon) (Clyne, 1973) and *Pasilobus* sp. (Robinson & Robinson, 1975). Such webs have probably been overlooked earlier as they occur mainly in tropical species. Nevertheless one would expect a greater diversity in the tropics than in temperate areas. *Paraneus cyrtoscapus* is also a tropical species. However, unlike the species mentioned above its web does not differ from the typical orb-web in its outline, but in its inclination. Strongly inclined webs are found in *Gasteracantha* spp. and especially *Leucauge* spp., and horizontal webs occur in the Uloboridae (Eberhard, 1972; pers. obs.), and are built by some individuals of *Neoscona nautica* (L. Koch) in Ghana; though in this species webs built by the same spider can vary from vertical to horizontal on different days (pers. obs.). In all these species the web is in more or less one plane and there are no supporting threads attached to the hub. In *P. cyrtoscapus* the web is cone-shaped, with threads pulling the hub out of the plane of the frame. This shape is reminiscent of the orbs of *Cyrtophora* spp., though the latter have an extensive barrier, and the spiral thread is equivalent to the temporary orb of most Araneidae; however if *Cyrtophora* evolved from a more typical araneid (Blanke, 1972; Lubin, 1973), it might have gone through a stage with a web similar to the horizontal web of *Paraneus*.

The horizontal web of *P. cyrtoscapus* has a defective frame thread. Most orb-web spiders do not fix radii direct to the substrate, but to a frame thread, so that there are relatively few attachment points between the web and the substrate. However, the tetragnathid *Eucta kaestneri* Crome (Crome, 1954), and the uloborid *Uloborus diversus* Marx may attach some radii direct to the substrate (Eberhard, 1972). Eberhard points out that too many attachment points between a flexible web and a more rigid substrate could be a mechanical disadvantage if the web or the substrate were moved. The grass in which *P. cyrtoscapus* built is a relatively flexible substrate, so both it and the web would 'give' together. Moreover, the web was built low in the grass, where wind disturbance would be minimal, and the 'guy ropes' from the hub to the grass above would decrease the 'give' of the web in the centre. An unidentified species of *Neoscona* that built in the grass at Legon, also had some radii direct to the grass, though fewer than in *P. cyrtoscapus* (pers. obs.). The web was higher above the ground, was nearly vertical and had no 'guy ropes', so would be more subject to wind disturbance. However, it was only present during approximately 12 hours of darkness, and the rather broken web was entirely eaten by the spider at dawn, a completely new one being spun at dusk.

The most interesting aspect of the web of *P. cyrtoscapus* is the production of both a typical araneid

web and the atypical cone-shaped one. The two types cannot be seasonal or environmental variants, as in two instances both types were found on the same day within a few metres of each other, and both normally occurred in grass. The lack of small spiders on vertical webs, which are less easily overlooked, also argues against their being environmental or genetic variants. Juveniles, mature males and a few mature females are found on horizontal webs. Only mature females are found on vertical webs. Therefore, it seems likely that all spiders build horizontal webs as juveniles, and males continue to do so after maturity. However, either a few females continue on horizontal webs, while the majority change to vertical webs at maturity, or else all females change shortly after reaching maturity.

Two types of web are produced in some other Araneidae. The young *Nephilengys cruentata* (Fabricius) build complete orbs (pers. obs.), but after a few weeks, as they grow, the upper part of the web is reduced compared with the lower, until the hub is at the top of the web, but this development is gradual. A gradual transformation from the normal orb-web to the inverted ladder probably occurs in *Scoloderus* sp. (Eberhard, 1975). However, I found no intermediate between the horizontal and vertical webs in *P. cyrtoscapus*, though because of the paucity of data they may have been overlooked. In the cases of the other species it is assumed that the adult web is a divergence from the typical orb-web built by the young, though some workers think the partial, somewhat irregular, orb-web of adult Nephilinae is the prototype of araneid webs (Kaston, 1964; Kullmann, 1972). However, if the typical vertical orb-web is considered to be more primitive, then in *Paraneus cyrtoscapus* the more primitive web is found in the adult, and not the juvenile. It would be interesting to follow the development as this would be the only way to check if and when the spider does change the type of web spun.

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