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Notes on the reduced web, behaviour and prey of *Arcys nitidiceps* Simon (Araneidae) in south western Australia

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Summary

Observations on the reduced web, associated behaviour and prey of *Arcys nitidiceps* Simon are recorded. The spider is generally nocturnal and builds a non-viscid, single-line "suspension web" which supports the spider while waiting for prey. Dipterans, and one moth, lightly wrapped in silk, constituted the identified prey.

Introduction

Several araneid genera have abandoned the web as a snare for prey. These genera appear to have an essentially Australasian distribution apart from *Taczanowskia* Keyserling in South America. As noted by McKeown (1963), Clyne (1969), Hickman (1971) and Mascord (1970) *Celaenia* Thorell does not make a web. Main (1976, 1981) erroneously inferred that juveniles make a web. Reports indicate that it catches nocturnal moths either in a thomisid fashion while sited on a resting pad on leaves (McKeown, 1963; Hickman, 1971) or while holding onto a leaf with the third and fourth legs (McKeown, 1963). Alternatively, when waiting for prey, a spider may "hang suspended on a thread" with front legs extended (Hickman, 1971). Forster & Forster (1973) also reported that spiders hang on a thread while waiting for prey. Neither Hickman nor the Forsters elaborated on the nature of the supporting threads. However Forster & Forster (1973) figured a spider suspended on a short horizontal thread, which was effectively a bridge, and stated that the spider seizes prey with the front pairs of legs "as it hangs down from a thread of silk". *Archemorus* Simon builds no web and sits on a silk pad on leaves and seizes prey with the heavily spined anterior legs (Clyne, 1969; Mascord, 1970; Robinson, 1980). Drs M. H. and B. Robinson and Y. Lubin have recently been studying the predatory behaviour of *Archemorus* in Papua New Guinea.

Various workers have observed *Arcys* Walckenaer sitting on leaves during daylight, with the two anterior pairs of legs apposed and outstretched in a thomisid-like stance. This posture was interpreted as an ambushing, prey-await stance by Clyne (1969), Mascord (1970), Main (1976, 1981) and Robinson (1980). Robinson (1980) suggested that *Arcys* does not use a web in prey capture.

During three recent summers I observed webs and associated behaviour of *Arcys* and some prey. For want of a more convenient term "web" is used here to denote the silk line (interpreted as a reduced web) made by *Arcys*. It is not a web in the sense of a snare.

Simon (1908) described *Arcys nitidiceps* from a juvenile specimen. Figures of the female epigynum and male palp are therefore presented (Figs. 1-4). Voucher specimens (four males and two females) have been deposited in the Western Australian Museum.

Characteristics of habitat

Observations were made on *Arcys nitidiceps* in a cottage garden on Torbay Head hill near Torbay (west of Albany), the type locality of the species. The garden is sited in an open paddock about 100 metres from uncleared forest dominated by post-fire regenerated karri (*Eucalyptus diversicolor* F. V. Muell.) and marri (*E. calophylla* R.Br.) around surviving senescent trees.

Although *Arcys* is usually observed on shrubs and low-level foliage I believe that in Australia its real habitat is the eucalypt canopy and that low-level specimens are "strays". The spiders I observed at Torbay were on planted eucalypt trees about two and a half to three metres high. The trees are colonised by wind-dispersed, small araneids from the adjacent forest.

Methods and observations

Observations were made on late instar and adult spiders (at various times between dusk and 2200 hours) from mid-December to early February over the three summers 1979-80, 1980-81, 1981-82. The earliest positive (winter/spring) identifications of juveniles were made in early September 1980 and 1981.

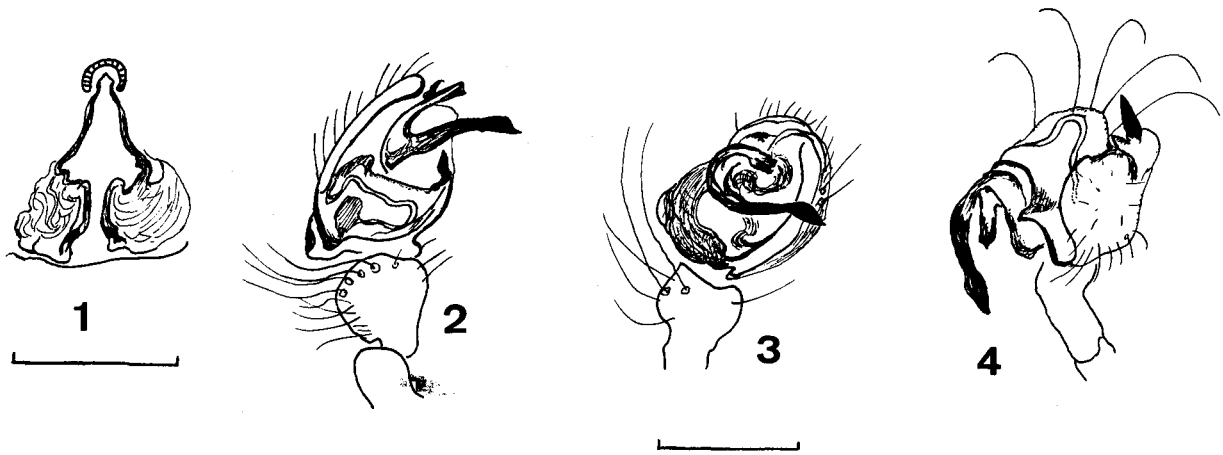
Totals of 15 and 19 spiders were watched regularly

over the first two summers. Occasional observations were made on five spiders during the third summer. Spider numbers declined from late December onwards until all spiders had disappeared by early February. Not all spiders were active on each observation night. One hundred and seventy-two webs made by 34 spiders were observed on 59 nights during the first two summers. When active it appeared that individual spiders maintained an arbitrary "foraging territory" within an area of about 50 cm in any direction. Territory sites of spiders which could not be recognised easily from vegetative features were marked with threads of black sewing cotton tied to leaf stems or twigs. Thus spiders could be found more readily during the day (sitting on leaves), the identity of individuals assured and the extent of their "territories" observed at night. At least some spiders were active on mild and warm (16-25°C), still nights or nights with light to strong, gusty wind. No spiders were active on very cold (i.e. below about 10°C) and few on violently windy nights. Light mist and fog did not deter the spiders but webs were not constructed during rain.

The web and associated behaviour

Web structure and behavioural attitudes

The "web" is made at dusk, or shortly after dark. It consists of a non-viscid, horizontal line attached at each end to a leaf or leaf stalk (Figs. 5, 6). Web spans are usually 10-15 cm but range up to 90 cm. Juveniles sometimes build lines of 5 or 6 cm beneath the long axis of leaves. Flocculent white patches or "tension points" (Fig. 6 b) usually demarcate tension zones (Fig. 6 c) from an elastic segment (Fig. 6 a) on which the spider is suspended when, presumably, it is waiting for prey. Spiders face away from the retreat leaf and about-turn when retreating. When suspended on the web, the spider carries the two anterior pairs of legs apposed and outstretched in a thomisid-like, prey-await attitude, with legs I and II of one side holding the line and those of the other side hanging free usually at a 90-180° angle depending on the plane of the suspension web (Plate 1, Figs. 5, 6). The web is also held by the third and fourth legs of both sides. The third pair sometimes hold a coil of thread, which suggests that in such cases the web is *either* two threads, with the spider forming a bridge between them *or* simply that the third legs are holding some "slack". Spiders occasionally drop and stretch the section of the web between the tension points, and the line then assumes a V configuration (instead of horizontal) implying release of the coiled slack *and* extrusion from the spinnerets. At other times spiders drop on a separate V-thread (attached at two tension points) below the main suspension web (Fig. 7), thus indicating that the line sometimes consists of more than one thread. One spider was seen holding prey while on a V-"drop-thread" (Appendix 1, example 3). When spiders retreat along a V-"drop-thread" it is pulled taut until it apparently



Figs. 1-4: *ps* Simon. **1** Epigynum (uncleared) (Voucher specimen WAM 1982/112); **2** Right male palp (retro- her specimen WAM 1982/116); **3** Ditto (ventral); **4** Ditto (dorsal). Scale lines = 0.5 mm.

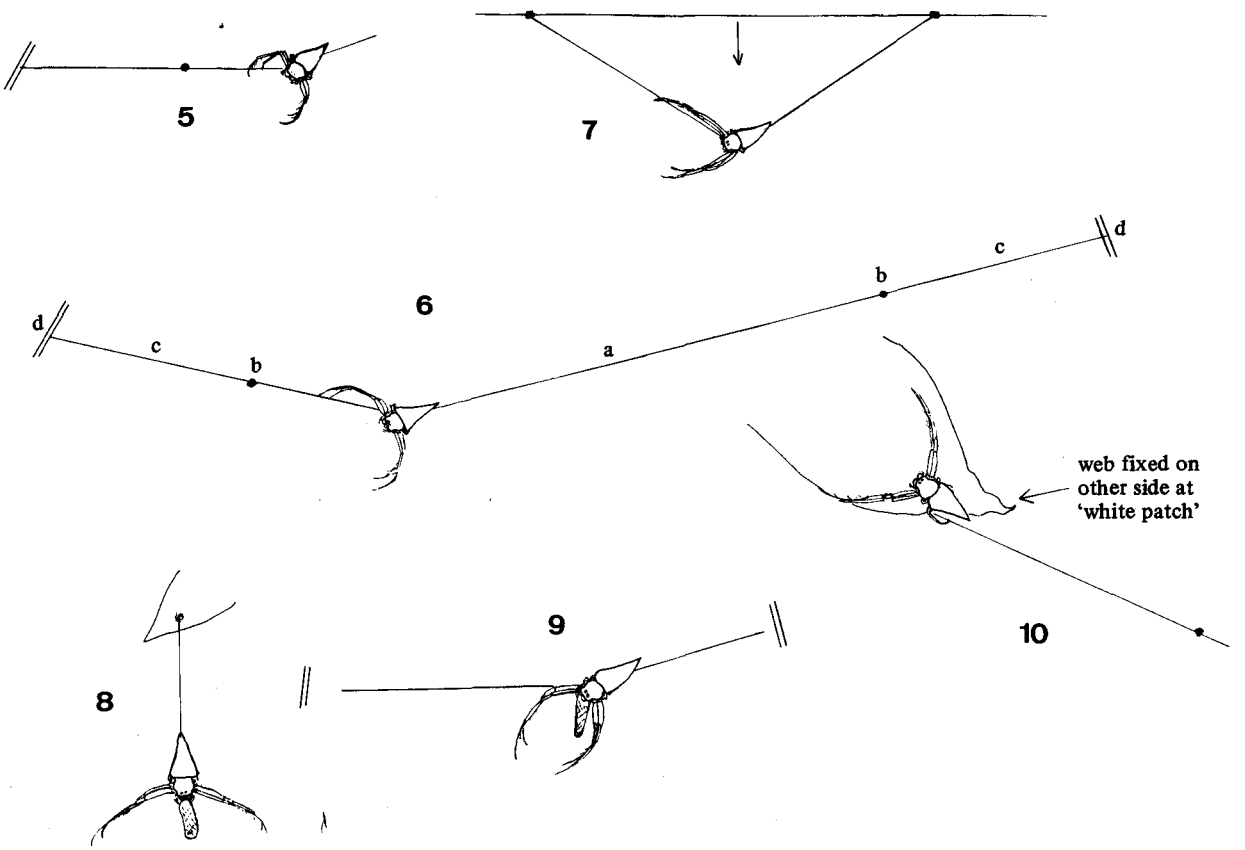
merges with the main line upon the spider reaching a tension point junction. Suspension webs are often left in place after spiders have retreated to leaves.

By being a dry thread the *Arcys* suspension web is functionally quite unlike the single-line sticky spring webs of the uloborid, *Miagrammopes* Cambridge or the theridiid, *Phoroncidia* Westwood. The *Arcys* web possibly represents the initial horizontal frame thread of a typical orb web. It is formed either by a spider swinging on a drag-line below a leaf until the spider grasps another leaf or, more rarely, by a spider carrying a loose thread from one point to another and then affixing it.

Prey captures

Capture of prey has not been observed but three spiders have been observed holding prey while on the web (Appendix 1, examples 1-3, Figs. 8, 9). While feeding, prey is held in the chelicerae and pedipalps and the anterior legs remain outstretched. Spiders have been observed hanging on vertical threads up to about 15 cm below the suspension web with the apposed legs I and II of each side outstretched in thomisid-fashion. It is thus assumed that they seize prey while it is in flight as well as possibly prey that may settle haphazardly on the suspension web.

Several workers have reported flies and other



Figs. 5-10: *Arcys nitidiceps.* **5** Female on suspension web with left anterior legs partly distended in predatory pose (prey-await stance). Diagrammatic presentation of spider shown in Plate 1; **6** Details of a suspension web with spider in predatory pose (a = elastic section of suspension web, b = flocculent 'white patch', c = tension zone, d = attachment area on leaf); **7** spider on V-thread below suspension web; **8** spider holding prey while dangling on thread (broken suspension web); **9** spider holding prey while on suspension web; **10** *Arcys* holding suspension web with fourth leg while resting on a leaf.

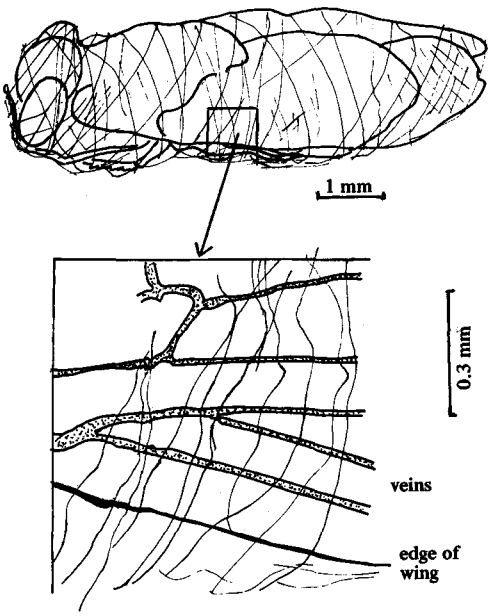


Fig. 11: Prey of *Arcys nitidiceps*; a lightly trussed fly.

insects settling and hanging on spider threads in tropical regions. Robinson & Robinson (1976) and Eberhard (1980) noted insects on threads comprising part of complete webs. Eberhard (1980) and Lahmann & Zuniga (1981) and R. Gagne (in Lahmann & Zuniga, 1981) reported insects hanging on abandoned individual threads. I have also observed small flies on threads at Wau, Papua New Guinea. However I have never observed flies (or any other insects) resting on occasional random threads at the Torbay study site or at other localities in southwest Australia where random spider threads do not persist because of wind.* Clearly the *Arcys* line is stronger and more elastic (?) than an ordinary drag-line.

The sorts of insects present were noted on each night that *Arcys* webs were observed. Flying insects consisted of small dipterans, scorpion flies (Mecoptera), wasps (Ichneumonidae), moths (predominantly Noctuidae about 2 cm long, occasionally small moths) and large flying ants. Crawling insects were mainly ants (small to large, including stinging ants e.g. *Myrmecia*), native cockroaches, small and large chafer beetles (Scarabiidae) and various Curculionidae including large leaf-cutting weevils. During the day the same range of crawling insects was present and flying insects were predominantly small flies (early morning only), ants, various large wasps, sawflies (Tenthrediidae) and honey bees. Both moths and flies were abundant on some nights, sparse or absent on others.

Four spiders were observed feeding on dipterans (flies – not culicids) while sitting on leaves during early and mid-morning. The flies were not pulverised and most were held by the head end, with the body projecting cigar-fashion.

Microscopic examination of prey revealed a light

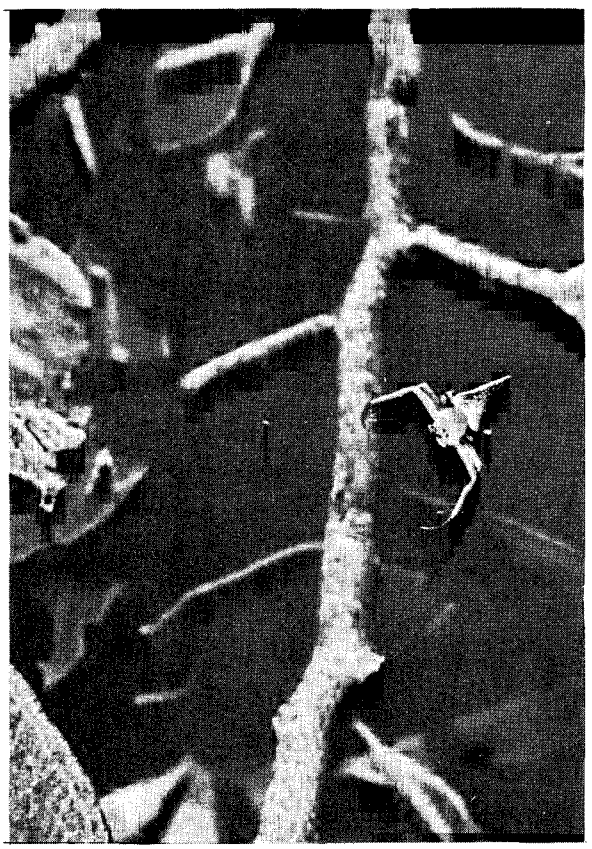


Plate 1: *Arcys nitidiceps* female hanging on suspension web. Viewed obliquely from below. Natural size. (See also Fig. 5).

*Note added in proof: With further fieldwork I have on occasional mild, windless evenings observed flies hanging on abandoned spider threads at several southwest Australian sites, particularly shrub-vegetated swamp habitats.

trussing of silk (Fig. 11). In order to examine prey I collected spiders and prey in vials. The spiders promptly dropped the prey, after which the spiders were released onto leaves. Appendix 1 summarises the data on prey.

The first three observations of day-time feeding on flies while the spiders were sited on leaves suggested that spiders might be feeding on the previous night's web-assisted captures. However, two observations refuted this. On one early morning occasion a spider was observed dropping on a thread below a leaf (Appendix 1, example 8). On another occasion, I noted a spider sitting on a leaf at 0830 hours; half an hour later the spider was holding a fly, cigar-fashion (Appendix 1, example 7).

From the above observations it is concluded that *Arcys* is active both during the day and night. During the day it probably feeds exclusively on flies which alight on the retreat leaf. Presumably such spiders have to drop on a thread to facilitate wrapping prey. Spiders have been observed to ignore ants and beetles crawling on their resting leaves, and it is well known that many spiders reject cockroaches. It is unlikely that bees and wasps (common prey of thomisids) would be caught as they frequent flowers rather than leaves.

Although prey capture has not been witnessed, observations on spiders holding prey while on "webs" (Appendix 1) indicate that the "web" has a role in predatory behaviour. Prey capture from the nocturnal suspension web is indeed probably the primary predatory strategy. The opportunistic ambushing technique combined with a diurnal resting phase while sited on leaves has probably evolved secondarily.

Defensive behaviour

During the day spiders were found with legs and body flattened on leaves, of which they mimic natural blemishes. Transverse threads on the leaves provided footholds. Disturbance elicited a legs-aloft

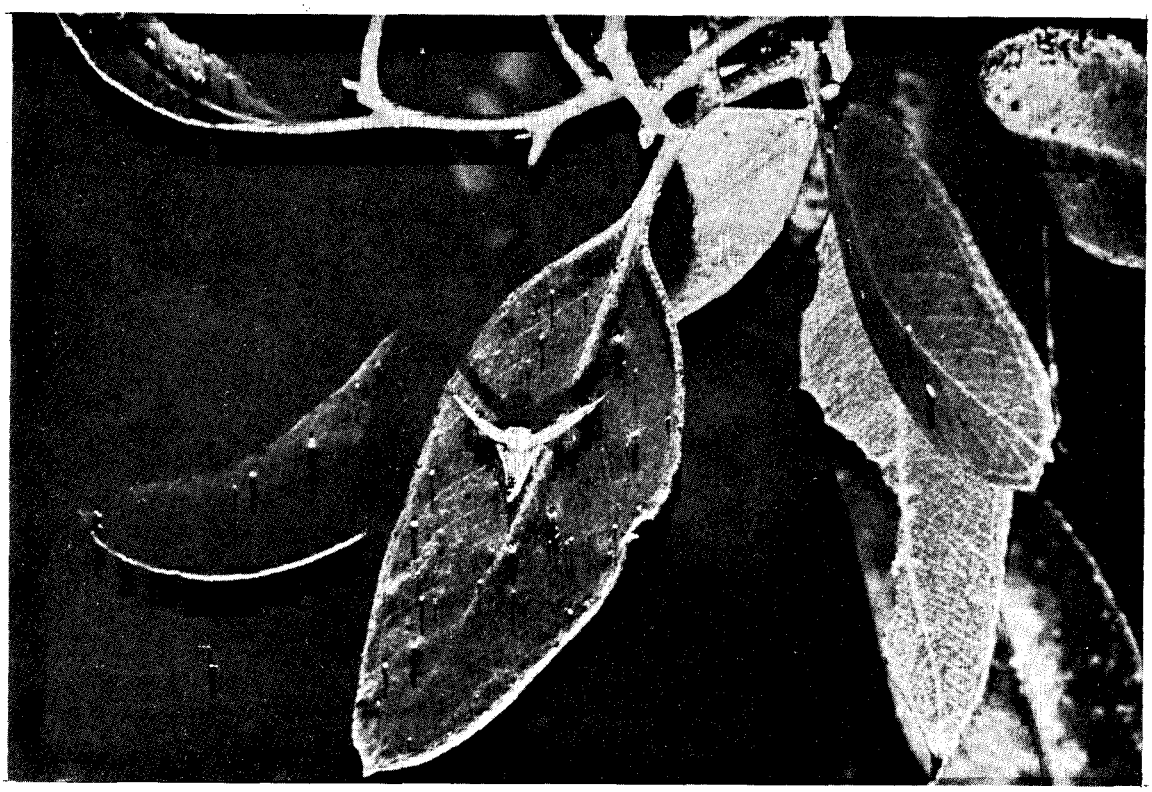


Plate 2: *Arcys nitidiceps* female in stilting pose on leaf. Natural size.

defensive (and secondarily predatory?) posture. Occasionally spiders were noted in a stilted attitude, i.e. with the whole body, supported by legs III and IV, raised slightly above the leaf substrate (Plate 2). This could be a thermoregulatory posture.

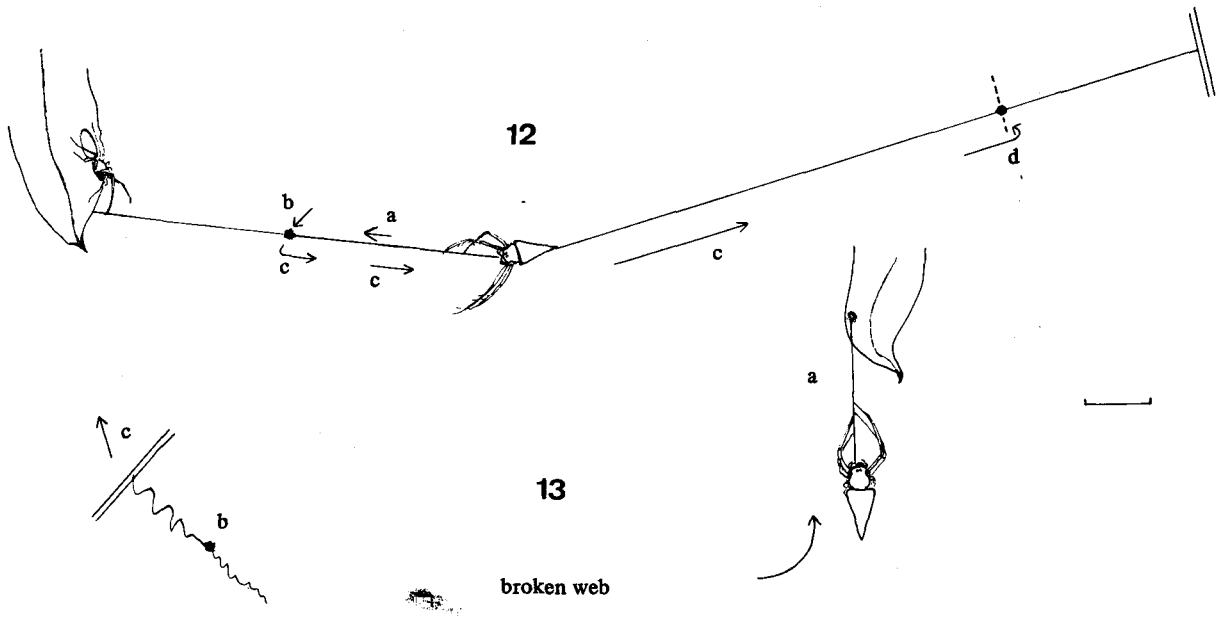
When disturbed on the web at night, a spider either drops on a drag-line or runs to the attachment leaf at one end of the web. Sometimes the suspension web is left in place after retreat and the spider retains contact with it either by a fourth leg (Fig. 10), or it may be held with a second leg with which it tenses or tugs the web. Two spiders broke the thread at a tension point while in retreat, thus letting the opposite end of the web float free. The spider then climbed up the dangling thread, simultaneously spooling it, to the attachment leaf.

That disconnection of the suspension web is a defensive manoeuvre was clearly demonstrated by two spiders which were being ambushed by clubionids. The sequence of retreat moves by one spider is shown in Figs. 12 and 13. A second spider did not break the web when in retreat but ran to the opposite attachment leaf and settled there. When I broke the suspension web the clubionid released its hold and ran off.

Discussion

The non-viscid, horizontal, single-line suspension web of *Arcys* appears to be a previously unrecorded variant in the reduction sequence of the orb web. It may represent the primary horizontal strand of an araneid orb web frame, i.e. the ultimate stage in the reduction of the orb web. If *Arcys* and *Archemorus* are indeed closely related as is generally considered then the *Arcys* web represents a "stage" prior to complete abandonment of the web as an aid to prey capture. It is interesting that both genera, even if only to a limited degree (as in *Arcys*), still wrap their prey.

In accepting that the orb web is a primitive feature of Araneidae (Levi, 1980) it appears that at least three, and possibly four taxonomic groups within the family have evolved reduction sequences of the orb web: (1) the *Gasteracantha* Latreille, *Poecilopachys* Simon, *Pasilobus* Simon line (suggested by Robinson & Robinson, 1975); (2) the bolas spiders, *Mastophora* Holmberg, *Cladomelea* Simon, *Ordgarius*



Figs. 12-13: Sequence of advance and retreat moves by an *Arcys* when a clubionid attempted to ambush it; **12 a** – spider runs along suspension web towards clubionid holding web, **b** – tugs on tension zone, **c** – about-turns and retreats along suspension web, **d** – breaks thread at opposite tension point; **13 a** – spider runs up dangling tension zone to attachment leaf, **b** – broken suspension thread (and opposite tension zone, held by clubionid); **c** – clubionid retreats when tension on web released. Scale line = 1 cm.

Keyserling and *Dicrostichus* Simon; (3) *Celaenia* and *Taczanowskia*, and finally (4) *Arcys* and *Archemorus*. The latter two groups exhibit the most reduced use of web. It is of interest that different elements of the web have been abandoned in the first two and latter two groups. In the first group there is no scaffolding, non-sticky spiral in *Poecilopachys* (Clyne, 1973) and *Pasilobus* (Robinson & Robinson, 1975) as well as the orb being reduced to a sector in *Pasilobus* (Robinson & Robinson, 1975). In the second group only a single viscid element, in the form of a single thread with a terminal sticky globule, remains. In contrast the third and fourth groups have retained non-viscid web to support the spider but construct no sticky threads at all. It would be interesting to investigate the anatomical corollary of this behavioural character, e.g. are the relevant silk glands still present? At least some spiders of the second group and possibly of the third, emit a pheromone, e.g. *Mastophora* (Eberhard, 1977) and probably *Dicrostichus* and *Celaenia* (McKeown, 1963) and *Taczanowskia* (Eberhard, 1981). Those genera of both the second and third groups of which prey has been observed, appear to feed entirely on male moths, e.g. *Dicrostichus* (McKeown, 1963; Clyne, 1969), *Mastophora* (Eberhard, 1977), *Celaenia* (McKeown, 1963; Clyne, 1969; Hickman, 1971; Forster & Forster, 1973) and *Taczanowskia* (Eberhard, 1981). Robinson (1980) states that *Archemorus* feeds on a variety of insects, and from my observations it appears that *Arcys* feeds primarily on dipterans and opportunistically on moths. It is unlikely that these genera emit a pheromone.

One can only speculate on the advantages of such araneids abandoning the orb and finally viscid silk. *Archemorus* possibly fills the role of foliage-dwelling spiders with ambushing behaviour, such as thomisids, in an environment which is perhaps saturated with orb weavers. It is my contention that the reduced web of *Arcys* is an adaptation to wind. If *Arcys* is indeed usually a canopy spider, the suspension web has many advantages. Wind and instability of the leaf canopy would combine to make construction of a fragile orb web hazardous and time consuming. The spiders appear to be predominantly dipteran feeders and are generally dependent on catching prey in the first few hours of the night (or occasionally during the early morning) when small dipterans are flying. Construction of an orb web prior to darkness or exposure of the spiders in webs during the early morning would render them conspicuous to predatory birds. New Holland honey eaters *Phylidonyris novaehollandiae* (Latham) and western spinebills *Acanthorhynchus superciliosus* Gould have been seen searching through the eucalypts. In conclusion, the suspension web, combined with a grasping prey capture technique, would seem to be an extremely economical predatory method. The web has structural reliability in an unstable habitat, i.e. wind disturbed foliage, where it is also less costly in terms of time, energy and material (silk) than a conventional temporary orb web.

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Appendix 1. Records of *Arcys nitidiceps* observed with prey.

Nocturnal captures

Example 1:

1/1/80. 2100 hours. No wind, following hot (over 25°C) day, moonlight. Legs IV only (?) supporting spider on "dangling" thread from leaf (broken suspension web), both pairs of legs I & II apposed and outstretched, prey projecting "cigar-fashion" from chelicerae and pedipalps (Fig. 8). Prey, probably a fly (mosquito or midge), not collected.

Example 2:

8/11/80. 1900 hours. Dusk, almost dark. Cool (12-15°C), no wind, but slight movement of leaves. Spider on suspension web but with both pairs of legs I and II apposed and outstretched (not on web) in slightly crooked position, prey projecting cigar-fashion between legs (Fig. 9). Prey, oblong shape no appendages projecting but wrapping threads not discernible. After five minutes, torchlight disturbed spider, retreated (backwards?) along web to leaf, sat flat, front legs raised then flattened on leaf still holding prey. Prey probably a mosquito, not collected. 2130 hours. Spider on suspension web again in prey-await stance.

Example 3:

5/1/81. 2115 hours. Warm (20-25°C) (after hot sunny day with maximum T of 30°C at noon). Light wind. Spider sited on V drop thread below tension points on suspension web; legs I and II (both pairs) holding prey while projecting cigar-fashion from chelicerae and pedipalps. A few minutes later spider on suspension web between tension points, holding head end of moth, legs I & II (both pairs) apposed and outstretched, not on web; spider supported by legs III & IV and spinnerets. Spider about-turned, retreated to edge of leaf, sat with anterior legs hanging free while feeding, suspension web remained intact. Prey, a moth (collected).

Diurnal feeding and captures

Example 4:

2/12/80. 1100 hours. Warm, no wind, sunshine through broken clouds. Spider sited on leaf with midge held cigar-fashion with chelicerae and palps, legs I and II apposed and outstretched. Prey hanging head down (?), wings tight against body but wrapping threads not discernible (Family: Therevidae).

Example 5:

28/12/80. 0915 hours. Warm, sunny, southeast wind. Spider sited on leaf feeding on fly, projecting cigar-fashion from cheliceral/palpal hold, held by head end (?), wrapping threads faintly distinguishable holding wings against body. Spider with legs I and II apposed and outstretched slightly aloft; body and posterior legs pressed flat on leaf. Prey (Family: Dolichopodidae).

Example 6:

2/1/81. 0800 hours. Almost overcast after sunny dawn. No wind. Spider sited on leaf, with prey, a fly (collected). Attitude similar to above records.

Example 7:

6/1/81. 0900 hours. Clear, sunny, following earlier sea fret, becoming hot. Spider on leaf with bushfly (Family: Muscidae – *Musca vetustissima* Walk.) – (not with prey at 0830 hours). Legs I, II apposed, outstretched, prey held cigar-fashion by head end (?) (collected).

Predatory attempt

Example 8:

9/11/80. 0800 hours. Partly overcast, intermittent sunshine. Tiny green flies swarming around tree and settling on leaves. Spider dropped 5 cm from leaf, legs I & II apposed and outstretched, dangled about 30 seconds, recoiled to leaf tip. No prey capture.