

Survival of strandline spiders maintained on a diet of the kelp fly *Thoracochoeta ancudensis* (Sphaeroceridae)

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Abstract

Spiders commonly occur in marine strandlines, although with the exception of a few specialist species little is known of the behaviour and diet of spiders which occur in this habitat. In this study, 48 spiders were collected from strandlines at New Brighton beach, Canterbury, caged in plastic boxes and maintained under laboratory conditions. The spiders belonged to seven species: 15 *Tenuiphantes tenuis*, 10 *Anoteropsis littoralis*, 6 *Anoteropsis hilaris*, 7 *Cryptachaea blattea*, 4 *Steatoda capensis*, 4 *Nyssus coloripes* and 2 *Ostearius melanopygius*. The spiders were maintained for a maximum of 40 days on a diet of adult *Thoracochoeta ancudensis*, a species of sphaerocerid kelp fly, which is often highly abundant in strandlines in this region. Individuals of all spider species were observed attacking, capturing and feeding upon *Thoracochoeta ancudensis*, usually within 5 minutes of the fly being introduced. There were differences in patterns of survival among the spider species, although at least one individual of each species survived for the full duration of the 40 day trial. *Anoteropsis hilaris*, *Cryptachaea blattea*, *Nyssus coloripes* and *Steatoda capensis* exhibited high levels of survival, whereas *Anoteropsis hilaris* and *Tenuiphantes tenuis* did not perform well under these conditions. The results indicate that all the

species of spider we examined will attack and feed on *Thoracochaeta ancudensis*, and we can speculate these behaviours may form a part of food webs in the strandline habitat under natural conditions. However, a diet consisting of just this prey species does not support long-term survival for all spider species we examined.

Key words: Lycosidae; Linyphiidae; Sand dunes; Survival curves; New Zealand; Wrack beds.

Introduction

Marine strandlines or ‘wrack beds’ consist of accumulations of loose seaweed and marine debris washed up on shore. These strandlines can remain in place for several days (and even weeks) when formed beyond the reach of subsequent tides, and are then colonised by a wide range of littoral and terrestrial arthropod detritivores and their associated predators and parasites. The interactions between these invertebrate species, temporal patterns in colonization, seasonal patterns in abundance and spatial distribution of individuals within larger wrack beds have been the subject of much previous ecological study (Lavoie 1985; Hodge & Jessop 1996; Hodge & Arthur 1997; Hodge & Williams 2007). *Thoracochaeta ancudensis* (Richards, 1931) (Sphaeroceridae) is an abundant and fairly ubiquitous fly found in strandlines on beaches near Christchurch. Harrison (1959) named this species as *Leptocera (Limosina) aucklandica* (see Inglis 1989) but this was later synonymized with *Thoracochaeta ancudensis* by Marshall and Roháček (2000).

Spiders have been known to occupy strandlines for some time (Bristowe, 1958; Egglisshaw, 1965; Duffey 1968, 2004; Hodge & Vink 2006) and the small Diptera, Collembola, and other small invertebrates present in the wrack would appear to offer an abundant and varied source of prey. However, we can find no studies that have specifically examined whether

the flies found in strandlines are actually attacked and fed upon by co-occurring spider species.

This study aimed to gain preliminary information on whether *T. ancurdensis* would be accepted as prey by spiders also found amongst this wrack material. The attack and feeding behaviour of spiders offered adult flies under laboratory conditions was observed, and the survival of spiders maintained on an exclusive diet of *T. ancurdensis* was monitored.

Methods

Spiders and flies were obtained from strandlines on the foreshore of New Brighton beach, Christchurch (43.520°S, 172.737°E), by hand searching through stranded seaweed and collecting using a battery-powered aspirator. *Thoracocheata ancurdensis* could be obtained in large numbers by rapidly placing strandline material in a clear plastic bag and collecting the flies as they walked towards the opening.

Fifty-two spiders, belonging to seven species, were originally obtained from the strandlines, of which three specimens died within 24 hours and one specimen was an unidentifiable juvenile. The remaining 48 spiders consisted of: 15 *Tenuiphantes tenuis* (Blackwall, 1852) (Linyphiidae); 10 *Anoteropsis litoralis* Vink, 2002 (Lycosidae); 6 *Anoteropsis hilaris* (L. Koch, 1877) (Lycosidae); 7 *Cryptachaea blattea* (Urquhart, 1886) (Theridiidae); 4 *Steatoda capensis* Hann, 1990 (Theridiidae); 4 *Nyssus coloripes* Walckenaer, 1805 (Corinnidae); 2 *Ostearius melanopygius* (O. Pickard-Cambridge, 1879) (Linyphiidae). Specimens were identified using Millidge (1988), Paquin *et al.* (2010) and Vink (2002). Spiders were also defined in terms of their reproductive status: mature male, mature female or 'not mature'.

Spiders were caged in transparent plastic boxes (Watkins & Doncaster, UK) appropriate to the size of the spider and mode of prey capture: 73 x

73 x 30 mm for *Tenuiphantes tenuis* and *Ostearius melanopygius*; 150 x 117 x 41 mm for *Anoteropsis litoralis*, *A. hilaris*, *Nyssus coloripes* and *Cryptachaea blattea*; 140 x 79 x 60 mm for *Steatoda capensis*. A thin layer of dried beach sand was placed into the bottom of each box, and a shelter was made out of a piece of folded card. A small amount of damp cotton wool was placed in one corner of each box and replaced every 2–3 days (during feeding). Spiders were maintained at an ambient room temperature of approximately 23°C with a 17:7 hour light:dark cycle.

Two live adult *Thoracochaeta ancudensis* were offered to spiders every 2 to 3 days. The flies were first anaesthetised using carbon dioxide and quickly brushed into the spider containers using a soft artist's paintbrush. For five minutes after the flies were introduced, the spiders were observed to see whether they responded to the introduction of the flies, attacked and/or fed.

The spiders were maintained on the diet of *T. ancudensis* for a maximum of 40 days. The effects of species and reproductive status on survival was assessed using log-rank tests (Genstat v15, VSN International Ltd).

Results

Observations on feeding behaviour

Individuals of all spider species were observed attacking, capturing and feeding upon *Thoracochaeta ancudensis*. Attack and capture of at least one fly usually occurred within 5 minutes of the flies being introduced. On occasions capture could be very rapid, and almost instantaneous attacks and captures (< 5 seconds) were observed by *Tenuiphantes tenuis*, *Anoteropsis hilaris* and *Cryptachaea blattea*. Only on one occasion was a fly captured and then apparently rejected by the spider (*A. hilaris*) without feeding.

Survival

At least one individual of each species survived for the full duration of the 40 day trial (Table 1). However, there were differences in patterns of survival among spider species. Six of the seven *Cryptachaea blattea*, and three of the four *Nyssus coloripes* and *Steotoda capensis*, survived for the full 40 days, whereas only one from six *Anoteropsis hilaris* and three of the fifteen *Tenuiphantes tenuis* survived until the end of the trial.

When trends in survival of the four most replicated spider species were examined there were significant differences among species ($\chi^2 = 10.16$, $df = 3$, $P = 0.017$) but not reproductive status ($\chi^2 = 0.73$, $df = 2$, $P = 0.694$). *Anoteropsis hilaris* and *Tenuiphantes tenuis* died relatively rapidly, with half of the spiders dying by nine days. In contrast, 50% mortality in *Anoteropsis litoralis* was not observed until 35 days, and 50% mortality was not reached in *Cryptachaea blattea* by Day 40 (Figure 1).

Discussion

During the trial, two species of spider, *Anoteropsis hilaris* and *Tenuiphantes tenuis*, died relatively rapidly compared to the other species tested. Although only three of these spiders (from 21) died within five days, 12 died within 10 days. Mortality rates in spiders can be high if they are desiccated, but this should not have been the case in our trial as moist cotton wool was replaced every 2–3 days, and the spiders would have gained fluid from the regular intake of prey. Studies have shown that spiders reared in captivity on a diet solely of one species can be detrimentally affected (Toft & Wise 1999), and it is possible that *A. hilaris* and *T. tenuis* require a more diverse diet, or at least alternative prey other than *Thoracochoaeta ancudensis*, in order to survive for long periods.

Both *A. hilaris* and *Tenuiphantes tenuis* are typically found in grassland in New Zealand (Millidge 1988; Vink 2002; Vink *et al.* 2004) and so are

unlikely to be specifically adapted to a seashore habitat and the prey found there. Their relatively high abundance on the New Brighton shoreline likely reflects the proximity of the marram dominated sand dunes and suburban lawns. In comparison to *A. hilaris*, the seashore specialist wolf spider *A. litoralis* showed much better survival on the diet of *T. ancudensis*. It can be speculated that *A. litoralis* would encounter this species of prey more frequently than the more ‘terrestrial’ *A. hilaris*, and thus might be better equipped to exist on a diet solely consisting of this fly species.

We concede that this preliminary investigation has a number of limitations: spiders were offered no other choice of prey, the prey had no means of escape and the conditions under which the animals were maintained were deliberately artificial. However, the results of these feeding trials indicate that *T. ancudensis* can be attacked and consumed by at least seven species of spiders found within marine strandlines in New Zealand. These flies can be highly abundant in strandlines (100s of adults per litre of material) and thus spiders could encounter many individuals within the course of a day. Our laboratory observations provide a series of potential ecological interactions that could occur between these spiders and this fly species under natural conditions, and this in turn allows speculation regarding possible links in strandline food-webs and mechanisms by which nutrients originating in the marine environment can be transferred to terrestrial ecosystems. Hodge & Vink (2007) found that spiders occurred more prevalently in artificial shelters baited with decomposing fruit, as this decomposing resource attracted prey species such as drosophilid and phorid flies and Collembola. The strandline habitat may offer a comparable phenomenon, in that spiders remain proximal to this decomposing marine material because it in turn attracts a variety of arthropods that are suitable prey items for the spiders.

By presenting other species of flies collected from the strandlines at New Brighton to the spiders that had completed our trials, we also observed

other predatory behaviours: *Tethinosoma fulvifrons* (Canaceidae) and predatory *Anabarhynchus* sp. (Therevidae) were both attacked and consumed by *Anoteropsis litoralis*, and a coelopid (*Coelopella curvipes* ?) was attacked by both *Anoteropsis litoralis* and *Cryptachaea blattea*, even though this prey proved too large for the latter spider and the fly eventually escaped. In two previous studies of terrestrial arthropods occurring in strandline material in New Zealand, Inglis (1989) did not list any spiders colonising decomposing seaweed at New Brighton, and Dufour et al. (2012) listed only one arachnid in seaweed on Otago beaches. Our findings emphasize that further work is required to fully describe the diversity and frequency of spiders occurring in marine strandlines in New Zealand and to better characterise the predator-prey interactions in which they participate.

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Table 1. Survival time (days) of spiders fed on a diet of *Thoracocheata ancudensis* under laboratory conditions for a maximum of 40 days.

	N	Survived for 40 d	Survival (d)			
			Mean	Median	Min.	Max.
<i>Anoteropsis hilaris</i>	6	1	17	10	4	40
<i>Anoteropsis litoralis</i>	10	3	34	36	20	40
<i>Cryptachaea blattea</i>	7	6	36	40	10	40
<i>Steatoda capensis</i>	4	3	33	40	13	40
<i>Tenuiphantes tenuis</i>	15	3	16	10	2	40
<i>Ostearius melanopygius</i>	2	1	24	24	7	40
<i>Nyssus coloripes</i>	4	3	37	40	28	40

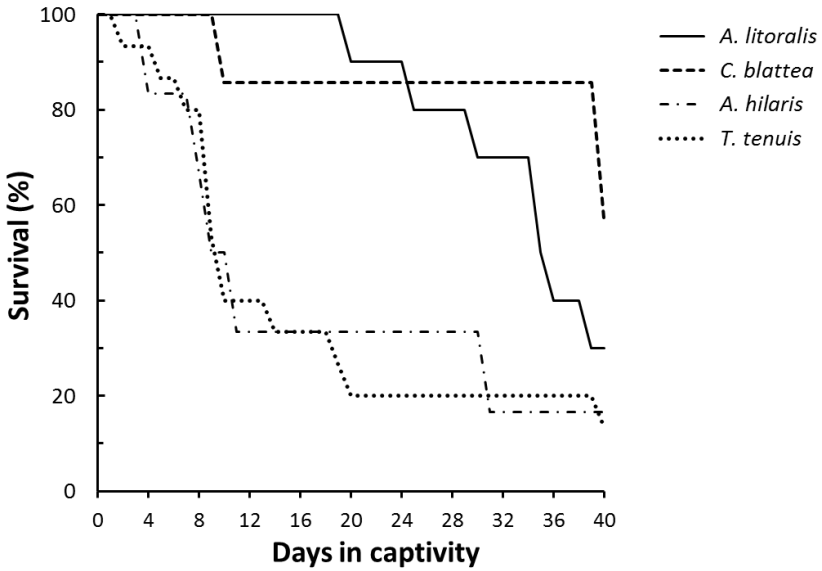


Fig. 1. Temporal trends in survival of spiders fed solely on *Thoracochoaeta ancudensis* in captivity under laboratory conditions for 40 days.