

SHORT COMMUNICATION

THE DISTANCES AT WHICH A PRIMITIVE JUMPING SPIDER,
PORTIA FIMBRIATA, MAKES VISUAL DISCRIMINATIONS

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The anterior median (AM) or principal eyes of the primitive jumping spider, *Portia fimbriata* (Doleschall), are miniature telephoto systems (Williams & McIntyre, 1980). Another study on the AM eyes of *Plexippus* suggests that most salticid principal eyes may be of similar design (Blest, Hardie, McIntyre and Williams, 1982). Both studies assumed, from anecdotal evidence (e.g. Forster, 1979), that jumping spiders can make visual discriminations between prey and mates at distances of *ca.* 20 cm. This estimate is necessary to the functional analyses that were essayed; because it is impossible to make sufficiently accurate direct measurements of some of the parameters of these small eyes, their optics can only be modelled with confidence when something is known about what they are designed to see. Land (1969*a, b*), in an elegant optical study, followed Drees (1952) in stating that jumping spiders respond to significant objects some 5-10 body-lengths in front of them. In the case of *Portia*, this would be a distance of no more than 10 cm at most. Recognition of objects is mediated through the AM eyes (Drees, 1952).

Portia allows particularly satisfactory assessment of the distances at which visual discriminations can be made for an unusual reason: in addition to distinguishing conspecifics from various prey, as do all jumping spiders, *Portia* stalks other species of salticid and captures them, adopting a special posture while doing so (Jackson & Blest, 1982). The posture is not employed during the desultory pursuit of flies, which *Portia* is not strongly motivated to stalk and which it often ignores. To conspecifics, *Portia* responds with appropriate displays which are never given to prey of any kind (Jackson, 1982). Thus, an observer can identify when *Portia* decides the nature of an object to which it has orientated with some certainty.

A small number of experiments were performed with *Portia* to determine, firstly, the greatest distance at which they display to a conspecific on the basis of visual cues alone and, secondly, the greatest distances at which they distinguish visually between jumping spiders and flies of similar size.

(1) *Portia* were placed at the lowest point of a ramp with an inclination of 20°, sufficient to ensure that they would always ascend it. At the top of the ramp they were confronted *either* by a mirror in which they could see their own images *or* by a 7 cm

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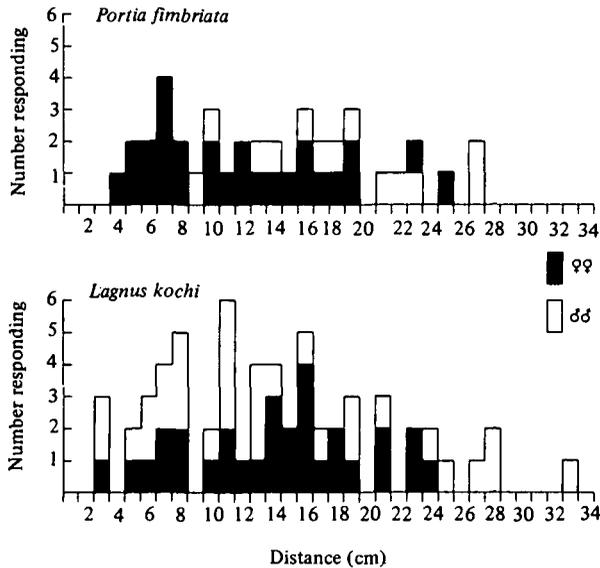


Fig. 1. The number of displays initiated by eight *Portia* (top) at different distances from their virtual images in a mirror. Bottom: data from a similar experiment conducted with 20 *Lagnus*.

diameter glass Petri dish containing two flies of their own size (*Lucilia curprina* Weid). Illumination was provided by two 40 W daylight fluorescent tubes approximately 2 m above and to one side of the ramp. The total irradiance measured with a silicon detector (International Light SEE 100, sensitive to wavelengths greater than 400 nm) was 4×10^{-5} W/cm². The temperature of the room was held at ca. 24°C. Spiders were maintained in the same room on a 13 h light/11 h dark cycle with 'light-on' at 08.00 h. Experiments were performed between 14.00–19.00 h. As *Portia* ascended the ramp they walked over a ruled surface that allowed the distance between the targets and the anterior prosomal margins of the spiders to be measured to within 0.5 cm. The grid was covered with a fresh sheet of transparent plastic before each test. Eight *Portia* were each given successive pairs of tests separated by 1–2 days until each had displayed in the course of five tests. Presentations within pairs were in random order. *Portia* displayed readily to its mirror image, starting to do so at distances from its virtual image in the mirror ranging from 4 to 27 cm (six females) and 9 to 24 cm (two males). No *Portia* stalked the invariably active fly in these tests. The same experiment was conducted with 20 *Lagnus kochi* (Simon), the target salticid spider in the second series of experiments, and closely similar results were obtained. Nine *Lagnus* stalked their flies. Neither *Portia* nor *Lagnus* displayed to flies in error on any occasion. Full data for both species are shown in Fig. 1. AM eyes of *Lagnus* have similar telephoto optics to those of *Portia* (unpublished data).

(2) *Portia fimbriata* build webs from which they make excursions for two purposes: to invade adjacent webs belonging to other species of spider and lure and eat their occupants, and to stalk and capture other species of salticids (Jackson & Blest, 1982)

Table 1

	Out of 12 <i>Portia</i> tested		
	Left web	Assumed cryptic posture	Reached prey cage, pressed face against glass
<i>Lagnus</i>	10*	6	6*
Flies	3	0	0

* N.B. Four out of the ten *Portia* to leave their webs in response to *Lagnus* failed to follow through by maintaining course towards them, and they did not assume the cryptic posture. The remaining six *Portia* both assumed the cryptic posture and maintained course towards the *Lagnus*.

During the latter activity alone, *Portia* conceals its conspicuous palps; this posture is adopted neither in response to a fly, even when the spider is motivated to stalk it, nor during the enticement of web-spiders by plucking their webs.

Twelve *Portia* were allowed to build webs on individual constructions of vertical sticks projecting from a platform. 'Prey' was presented in cages made from two panes of glass 2.5 cm apart, the closest glass surface of the cage being 20 cm from the nearest and 32 cm from the farthest edge of the platform. Prey consisted of either (a) a pair of female *Lagnus* interacting with each other; or (b) ten flies of comparable size, some of which were always in motion during the course of each experiment. The duration of exposure of *Portia* to prey was controlled by a screen between this platform and the cage that was removed during a presentation. Each of 12 *Portia* was tested once with *Lagnus* and once with flies. Observation was continued either for 60 min, until *Portia* had reached the glass of the prey cage, or until it had wandered more than 40 cm from its web.

The results of this experiment are summarized in Table 1. Confronted with the more effective stimulus, 6 out of 12 *Portia* responded unequivocally to it at an initial distance > 20 cm, a proportion rather larger than the data in Fig. 1 would lead one to expect. Although three *Portia* left their webs on seeing flies, none assumed the cryptic posture, and none maintained a steady course towards the prey cage containing them. This confirms the conclusion from qualitative observations in field and laboratory that the cryptic posture is employed only *after* a prey object has been identified as a salticid, and not as a precautionary measure in response to any small moving object.

Taken together, the results of the two experiments show that *Portia* can make visual discriminations between classes of prey and conspecifics at distances up to 27 cm. That most individuals fail to do so at such large distances probably reflects motivational factors rather than absence of visual capacity.

Williams & McIntyre (1980) found that the best solution, for the AM dioptric system of *Portia*, based on a discrimination distance of 20 cm, gave a total depth of field for the receptors of retinal Layer I (Land, 1969a) from 9 cm to infinity when $\lambda = 520$ nm. This does not mean that *Portia* would be unable to make use of images of nearer objects, but merely that they would be less well focused, a deficiency that subsequent neural processing might make relatively unimportant. The resolution of

the receptor mosaic of Layer I in the central retina was estimated to be a visual angle of 2.4 arc min, corresponding to 0.12 mm at 20 cm in front of the spider, or 0.18 mm at 30 cm.

Drees (1952) showed that the legs of jumping spiders are important visual stimuli for conspecific recognitions. Those of *Portia* are decorated with hair-tufts so that their typical outlines are disguised.

Throughout the stalking of other species of salticids, *Portia* employs slow, jerky movements which seem to prevent the prey from recognizing *Portia* as another spider (Jackson & Blest, 1982). More normal locomotion is only employed during intra-specific display bouts, and the displays themselves are of the usual salticid type (Jackson, 1982).

Experiments in which dead, mounted *Lagnus* with various potential visual signals obliterated are presented to *Portia* nevertheless implicate the large anterior median eyes as a key feature by which *Portia* recognizes salticid prey (Jackson, in preparation). Those of *Lagnus* are 0.7 mm in diameter. The stationary image of one such eye covers roughly 24 receptors in the central retina at a distance of 20 cm, and 16 receptors at 30 cm (determined by construction from an electron micrograph of the distal ends of the Layer I receptors). If both eyes constitute the releasing stimulus for cryptic stalking, the ensemble will cover ~ 48 and ~ 32 receptors. Clearly, at the distances at which *Portia* can be shown by behavioural criteria to decide the nature of its prey, the relevant images are adequately represented on the retinal mosaics of the principal eyes.

We have argued elsewhere (Jackson & Blest, 1982) that predation upon other species of spiders exposes *Portia* to risks. High visual acuity may help to minimize them. It is achieved by the long focal length of the corneal lens, the telephoto construction of the eye, and small, closely spaced receptors (Williams & McIntyre 1980). Optimization of all these features has produced a spatial resolution of *ca.* 2.4 arc min compared to the 11 arc min calculated by Land (1969*a*) for more conventional jumping spiders in which the telephoto effects must be assumed to be minimal.

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