WATER-RESISTANT SEX PHEROMONES IN LYCOSID SPIDERS FROM A TROPICAL WET FOREST

The role of female sex pheromones for pre-copulatory communication in lycosid spiders has been studied in Nearctic and Palearctic species that inhabit deciduous forest and grassland biomes (review in Tietjen and Rovner 1982). Substances involved are often bound to the silk dragline secreted by the female as

she wanders (Engelhardt 1964; Tietjen 1977; Tietjen and Rovner 1980), deposited on the substratum (Bristowe and Locket 1926; Richter et al. 1971), or released into the air (Tietjen 1979). The findings on another family of wandering spiders, the Salticidae, recently have been reviewed (Pollard et al. 1987).

In the lycosids studied so far, the substances serving as contact sex pheromones are inactivated (i.e., become ineffective for stimulating males) by water (Dondale and Hegdekar 1973; Tietjen 1977). Consequently, rain or dew can limit the use of such chemical signals in these spiders. On the other hand, *Dolomedes triton* (Walckenaer), a member of the closely related family Pisauridae, produces a sex pheromone that is effective on water, reflecting the special needs of this semi-aquatic spider (Roland and Rovner 1983).

In lycosids that inhabit a tropical wet forest life zone, where there is nightly dew and frequent rainfall, any substrate-deposited or silk-bound pheromone that could be effective for some hours would be expected to resist inactivation by water. We tested this hypothesis in two species of lycosids, *Lycosa tristani* Banks (at one time placed in the genus *Schizocosa*) and *Lycosa longitarsis* F. Pickard-Cambridge (a member of the *Lycosa helluo* species group). (Voucher specimens of both species are deposited at the Biosystematics Research Centre in Ottawa). Both lycosids were abundant when collected at night as they rested waiting for prey in a mown clearing at the Organization for Tropical Studies' La Selva research station near Puerto Viejo de Sarapiqui, Heredia Province, Costa Rica. Research was conducted from mid-November through late December, 1987.

While male spiders placed in vacated female cages usually showed courtship display, those placed in the vacated cages of females which had their spinnerets sealed with paraffin rarely did so (Table 1). Presumably, the female pheromone was bound to the silk, not deposited directly on the substrate by tarsal or body contact. There was little or no courtship response by males to the vacated cages of other males (*L. tristani*, 1/10; *L. longitarsis*, 0/10).

Next, males were tested with female draglines subjected to various treatments. Tethered females were led along a cardboard track, traversing three glass rods (5 mm diameter) placed 7 cm apart and perpendicular to the path of the spider. The dragline began at an attachment disk and was fastened at the other end with adhesive tape. The taut and slightly elevated dragline was then either untreated, allowed to age for 1 day, misted with water and allowed to dry, submerged in water and allowed to dry after removal of the water from the tray, misted with ethanol and allowed to dry, or misted with hexane and allowed to dry. (Drying time was at least 0.5 h in all cases.) Male *L. longitarsis* also were tested with untreated male draglines obtained in a similar manner to those of females. (Male draglines of *L. tristani*, a much smaller lycosid, were not tested because the males did not leave a sufficiently thick dragline as they were led along the track. Female

Table 1.—Occurrences of male courtship behavior in vacated cages of female conspecific lycosid spiders with or without sealed spinnerets. Significance of differences: *G*-test with Yates' correction. $*P < 0.05$; $***P < 0.001$.

Spinnerets	*Lycosa longitarsis*		*Lycosa tristani*
Sealed	2/20		0/10
		$G = 5.820*$	$G = 19.782***$
Not sealed	6/10		10/10

Table 2.—Number of males showing courtship display and dragline-following in response to untreated or treated conspecific lycosid draglines. Values having asterisks are significantly different at the 0.05 (*), 0.01 (**), or 0.001 (***) levels from the within-column value for untreated female draglines (G-test with Yates' correction). N = 10 males of each species/test.

		Lycosa longitarsis		*Lycosa tristani*	
Dragline	Treatment	Court	Follow	Court	Follow
Female	Untreated	7	7	9	10
Female	1-day old	2	3	4	5*
Female	Water spray	5	8	10	7
Female	Underwater	6	8	—	—
Female	Ethanol spray	2	3	7	8
Female	Hexane spray	1*	1*	1**	1***
Male	Untreated	0**	0**	—	—

draglines of *L. tristani* were not tested after being submerged, since they broke too easily when the water was removed from the tray.)

The results of the above-listed tests are given in Table 2. The two lycosids not only responded to the female pheromone by courting, but also showed dragline-following, as in previously studied lycosids. (Neither response occurred when draglines of male *L. longitarsis* were tested.) Loss of stimulatory efficacy with time, perhaps due to volatility of the pheromone, was suggested by lower male responsiveness toward 1-day-old lines, significant in one category. Subjecting the female draglines to water—even submergence—did not reduce the response levels of the males significantly, nor did spraying the lines with ethanol. Male reponsiveness in both species was reduced significantly after the lines were sprayed with hexane, which, unlike water or ethanol, adhered to the silk. Apparently, the dragline-bound pheromones of these lycosids are non-polar compounds (being inactivated by hexane) and probably are not washed off or inactivated by the nightly dew and frequent rain that typifies the tropical wet forest life zone.

Our observations that penultimate male and female *L. longitarsis* constructed dome-shaped nests in their cages before molting led to additional study of this species. (Nest construction also was observed in some adult females with, as well as without, egg sacs, although these nests appeared less dense than those used by penultimate instars for molting.) We tested the nests of penultimate females for possible stimulatory value by placing adult males in the vacated cages of such females. Seven of 20 males tested showed courtship after contacting the nest. This was not significantly different from the response level (6/10) shown by these males to the vacated cages of adult females (G = 0.688). The construction of nests with a sex pheromone bound to the silk is a behavior not reported before in subadult lycosids, although it is well known in other families of wandering spiders (Tietjen and Rovner 1982; Pollard et al. 1987). The presence of female sex pheromone in penultimate female *L. longitarsis* also was suggested by the attempts of four out of ten adult males to copulate with freshly killed penultimate females.

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