A FAUNAL SURVEY OF SPIDERS ASSOCIATED WITH *PINUS RADIATA* IN A SOUTHERN CALIFORNIA FARM

Spiders form an important predatory guild associated with coniferous trees. Their role as predators of lepidopterous pests in such ecosystems has been investigated by several researchers. Eickenbary and Fox (1968) reported spiders as the most abundant predators of the Nantucket pine tip moth (NPTM), *Rhyacionia frustrana* (Comstock), in loblolly pines, *Pinus taeda* L., in South Carolina. They also reported that adult NPTM were captured in webs of *Frontinella communis* (Hentz) and *Argiope aurantia* (Lucas); whereas both NPTM adults and larvae were preyed upon by *Metaphidippus galathea* (Walckenaer), *Misumenops asperatus* (Hentz), and *Peucetia viridans* (Hentz). Bosworth et al. (1970) studied the spiders associated with loblolly pines in Oklahoma. They found NPTM adults trapped in webs of *Cyclosa conica* (Pallas), *Mangora gibberosa* (Hentz), *Neoscona* spp. and *Frontinella pyramitella* (Walckenaer). Juillet (1961) considered spiders the most effective predators of the

European pine shoot moth, *Rhyacionia buoliana* (Schiff), due to their abundance and the different stages they attacked. Ohmart and Voigt (1981) sampled arthropods in natural and planted Monterey pine stands in California. Based on foliage samples, they reported spiders to comprise 33 percent of the total individuals and the most abundant arthropod group.

In California, NPTM is the key insect pest of Monterey pine, *Pinus radiata* D. Don, grown commercially as Christmas trees. Under southern California conditions, NPTM goes through four generations per season. This complicates management efforts and leads to poor control due to improper timing and misapplications of pesticides. Attempts by Scriven and Luck (1978; 1981) have been made to introduce parasites against this pest. This approach was successful in relatively undisturbed landscape settings. However, reliance on parasites for NPTM control in commercial Christmas tree production may not be feasible. This is due to frequent cultural practices and control measures directed toward other pests which may disrupt the host/parasite balance. Spiders, therefore, emerge as potentially valuable biological control agents in such high disturbance settings. Their merits lie in their high mobility, broad carnivorous feeding habits, and relatively high reproductive capability. The study reported herein was conducted to determine the relative seasonal abundance and species diversity of spiders in a commercial Christmas tree farm in southern California.

The study was conducted in 1986 on a 3-year-old stand of Christmas trees in Grand Terrace, San Bernardino County, California. Average tree height was 83 cm. Ground-associated spiders were monitored with pitfall traps similar to the method of Greenslade (1964). Eighteen traps were placed in the ground, spaced approximately 3.66 m (12 ft) apart. Traps were changed once every three weeks between April 24 and October 23. Samples were taken to the laboratory for determination and quantification. Foliage-associated spiders were sampled from 48 trees, utilizing the beat pan method modified from Bosworth et al. (1971). Sampling was conducted on May 30, July 9, September 19, and October 24. Kaston (1978) was used for familial, generic and, when possible, specific determinations. Calculations were made of richness (total number of families) and abundance (total number of individuals). Additionally, calculations were made on familial diversity through modification of the Shannon-Wiener index of species diversity: $H' = -\Sigma(n/N)\log(n/N)$; where "$n$" equals the number of individuals of a family in the sample and "N" equals the total number of individuals of all families in the sample.

Seventeen families, represented by 24 genera, were captured during the study (Table 1). Quantitative measurements of ground- and foliage-associated spiders are shown in Table 2. A larger number of families and a greater abundance of ground-associated spiders were noticed early in the season. As the season progressed, fewer numbers of a lesser amount of families were captured. This trend was reflected by diversity which was highest early in the season, but decreased by approximately 50 percent at the end of the study. The decrease in diversity was likely due to the family Lycosidae which was abundant throughout the season, but dominated in numbers during the latter part. The most commonly encountered genus in that family was the thin-legged wolf spiders, *Pardosa*.

Foliage-associated spiders also were abundant early but declined later in the season. Their diversity also was high at the early part of the study, decreasing by approximately 50 percent as the season progressed. Salticidae was the most

Table 1.—Spiders captured in a southern California Christmas tree farm, 1986.

FAMILY	SCIENTIFIC NAME OF TAXA
Agelenidae	*Agelenopsis aperta* (Gertsch)
Amaurobiidae	(undetermined)
Anyphaenidae	*Aysha* sp.
Clubionidae	*Castianeria* sp.; *Trachelas deceptus* (Banks); *Trachelas* sp.
Dysderidae	*Dysdera crocata* C. L. Koch
Gnaphosidae	*Cessonia classica* Chamberlin; *Drassyllus* sp.; *Sergiolus* sp.; *Zelotes* sp.
Linyphiidae	(undetermined)
Lycosidae	*Alopecosa* sp.; *Lycosa* sp.; *Pardosa* sp.
Oecobiidae	*Oecobius annulipes* Lucas
Oxyopidae	*Oxyopes salticus* Hentz; *O. scalaris* Hentz
Philodromidae	*Ebo* sp.
Pholcidae	*Pholcus phalangioides* (Fuesslin); *Physocyclus californicus* Chamberlin & Gertsch
Pisauridae	(undetermined)
Salticidae	*Habronattus* sp.; *Phidippus johnsoni* G. & E. Peckham
Tetragnathidae	*Tetragnatha laboriosa* Hentz
Theridiidae	*Latrodectus hesperus* Chamberlin & Ivie
Thomisidae	*Misumena vatia* (Clerck); *Tibellus* sp.; *Xysticus* sp.

frequently encountered family on the foliage throughout the season. The terms "ground-" and "foliage-associated," as used in this context, denote the methods by which spiders were captured. They do not necessarily imply specific habitat associations. The latter can be qualified by the facts that salticids were often captured in pitfall traps, and lycosids—especially *Pardosa*—were occasionally encountered on the foliage.

The spider fauna studied in this Christmas tree farm was most abundant and diverse early in the season. Early NPTM generations are considered more damaging than later ones, due to their feeding on young growing tips. It is conceivable that an abundant and diverse spider fauna during that period may result in a significant reduction in NPTM population through predation on several of the life stages consistent with observations by Juillet (1961). This

Table 2.—Quantitative measurements of ground- and foliage-associated spiders based on pitfall trap counts and beat pan samples, respectively, in a commercial Christmas tree farm, Grand Terrace, California, 1986.

DATE	RICHNESS	ABUNDANCE	DIVERSITY
GROUND-ASSOCIATED			
May 8	10	79	0.7493
May 30	11	111	0.6533
June 20	9	143	0.4834
July 11	7	87	0.5132
Aug. 1	6	33	0.5733
Aug. 22	7	63	0.3582
Sept. 12	4	38	0.4169
Oct. 3	6	58	0.3193
Oct. 23	5	46	0.3823
FOLIAGE-ASSOCIATED			
May 30	6	22	0.6921
July 9	2	7	0.2342
Sept. 12	3	4	0.4522
Oct. 24	3	4	0.3469

percentage of biological control may then be supplemented with selective insecticides (insect growth regulators) to attain the desired degree of suppression. Therefore, careful manipulation of several components is needed to enhance the beneficial spider fauna in the highly-disturbed commercial Christmas tree agroecosystems.

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