plete. (A more detailed explanation of the mechanics of how feeding time was controlled can be found in *Progress in Poultry* (PIP), issue No. 11 (August 1978), from Cooperative Extension, University of California, Riverside, CA 92521.) The diet fed to all treatment groups was a standard lay mash formulated to contain 17 percent crude protein and 1260 kilocalories of metabolizable energy per pound of ration.

All controlled feeding groups consumed significantly less feed than the free access control birds (table 1). As expected, the group controlled starting at 22 weeks of age consumed less feed than those birds controlled from 40 weeks on. Regarding total protein and the essential amino acids lysine, methionine, and cystine, more than the required nutrient levels was achieved by birds under each of the controlled feeding programs (table 2). Egg production was depressed by all controlled feeding treatments (by 16 to 19 eggs per hen) over the 40-week experiment. No significant differences in mean eggs per hen housed were observed among controlled feeding methods.

Feed savings as a result of the controlled methods tested were offset by depressed egg production, resulting in no significant improvements in feed efficiency. It follows that the lack of improved efficiency prevented potential economic gain over the free access feeding method.

The experiment was further complicated by what was tentatively diagnosed as late Marek's disease. A characteristic drop in production was first observed at 34 weeks of age in all treatment groups. This was before initiation of the delayed controlled feeding treatments. Hen-housed mortality rose to approximately 2 percent per month. The birds with free access to feed suffered production losses near 12 percent; the losses were only partially regained within 8 weeks.

A drop in egg production was again observed when controlled feeding was implemented at 40 weeks of age. Efforts to minimize this drop by gradually imposing controlled feeding failed. It could not be determined whether the drop in production associated with the delayed treatment resulted from a stress caused by adjustment to the controlled feeding method, stress caused by late Marek's disease, or the combined effects of both. Since the group, placed on controlled feeding starting at 22 weeks, suffered a relatively severe production loss (compared with the free access control group), it appeared the controlled feeding method used imposed some additional "stress" unrelated to nutrient intake.

In summary, the controlled feeding method tested (time-limited feeding) apparently stressed the layers to the point where their ability to resist other stresses, such as disease, was impaired. It is believed that chickens, when subjected to controlled feeding by the time-limited method, tolerate adjustment better at a young age when production rates are low.

Douglas Kuney is Staff Research Associate and Milo Swanson is Extension Avian Scientist, U.C. Cooperative Extension, Riverside.

TABLE 1. Treatment Effects on Feed Consumption and Egg Production during 40 Weeks of Lay.

Treatment	Feed consumption: 1b/100 hens/day	Feed consumption: lb/avg. hen	Egg production: % hen day	Egg production: eggs/hen housed
Free access	25.7a*	71.9*	78.7a*	195a*
22-week sudden	23.2c	64.9c	72.4b	179b
40-week sudden	24.3b	68.1b	74.5b	178b
40-week gradual	23.6bc	66.2bc	74.5b	176b

*Means within a column with different letters are significantly different (P≤0.05).

TABLE 2. Average Nutrient Intakes throughout 40-Week Experiment.

Treatment	Protein	Lysine	Methionine + cystine	Metabolizable energy
	(g)	(mg)*	(mg)*	(Kcal)
Free access	19.9	796	690	324
22-week sudden	17.9	714	620	292
40-week sudden	18.7	748	649	306
40-week gradual	18.2	728	631	297

*Stated nutrient requirements for Leghorn layers are 660 mg lysine per hen per day and 550 mg methionine plus cystine per hen per day. *Nutrient Requirements of Poultry*, 7th ed., 1977. National Academy of Sciences, Washington, D.C.

Spider mites and predators in San Joaquin Valley almond orchards

Marjorie A. Hoy □ R. T. Roush
Katherine B. Smith □ Les W. Barclay

Natural enemies of spider mites can vary from orchard to orchard and from section to section in California.

The naval orangeworm (NOW), *Amyelois transitella* (Walker), is a major insect pest in California almond orchards. Pesticides used to control NOW include Guthion (azinphosmethyl), Imidan (prolate), and Sevin (carbaryl). Growers fear that spider mite increases will occur after these chemical treatments, and Guthion apparently caused increases in European red mite *(Panonychus ulmi* Koch) populations in two almond orchards near Modesto during 1977, but no serious problems occurred after use of Sevin in adjacent blocks in these orchards.

The project reported here was undertaken to determine the types of spider mites, their predators, and their relative importance in southern San Joaquin Valley almond orchards, and to compare them with northern San Joaquin Valley orchards monitored during 1977. We also evaluated the effect of Sevin on Pacific spider mites and their predators in one of these southern almond orchards during 1978.

In 1978 almond orchards near Bakersfield, Blackwell's Corner, and Chowchilla were monitored for mites every two weeks

TABLE 1. Relative Spider Mite Abundance in California Almond Orchards, 1977 and 1978.

Orchard Location and Year	Relative Abundance* in Each Orchard of: European red mite	Brown mite	Two spotted mite	Pacific mite	Atlantic mite	Citrus red mite
1977						
Yuba City	Med	Hi	Lo	Lo	No	No
Wheatland	Hi	Med	Lo	No	No	No
Stockton-Hwy 132	Lo	Lo	Hi	Lo	No	No
Modesto-Whitmore Ave.	Hi	Lo	Med	Lo	No	No
Modesto-Hwy 99	Hi	Lo	Lo	Lo	No	No
1978						
Chowchilla	No	No	Lo	Hi	No	Lo
Bakersfield-Hwy 99	No	No	Lo	Hi	Med	Med
Blackwell's Corner	No	No	Lo	Hi	No	No

*Hi = most abundant species sampled within orchard over the entire season.
Med = moderate numbers collected.
Lo = few collected.
No = none collected.

TABLE 2. Relative Predator Abundance in California Almond Orchards, 1977 and 1978.

Orchard Location and Year	Relative Abundance* in Each Orchard of: *M. occidentalis*	Other phytoseiids	Sixspotted thrips	Green lacewings	Brown lacewings	*Stethorus* spp.
1977						
Yuba City	No	Lo	No	Hi	Lo	Med
Wheatland	No	Lo	No	Hi	Lo	Med
Stockton-Hwy 132	No	Lo	No	Hi	Lo	No
Modesto-Whitmore Ave.	Lo	Lo	No	Lo	Hi	Lo
Modesto-Hwy 99	Lo	Lo	Lo	Lo	Hi	Lo
1978						
Chowchilla	Hi	Lo	Lo	Med	Lo	Lo
Bakersfield-Hwy 99	Hi	Lo	Lo	Med	No	No
Blackwell's Corner	Hi	Lo	Lo	Med	No	No

*Hi = most abundant predator collected/observed within orchard throughout season, estimated using leaf samples and 10-minute visual assay methods.
Med = moderate numbers collected/observed.
Lo = few collected/observed.
No = none collected/observed.

from early April until early September. Leaf samples consisting of 30 leaves per tree were taken from 18 individually-marked Nonpareil trees in these three orchards in blocks in which no acaricides or insecticides were applied during 1978. Leaf samples consisting of 50 leaves were also taken in June, July, and August from six check and six treated trees in a block where Sevin was applied on July 23 for NOW control in the Blackwell's Corner orchard. Leaf samples were kept cool until the total number of mites per leaf (all stages, including eggs) were counted under a dissecting microscope. Male spider mites collected throughout the season were mounted on slides and identified as to species. General insect predators were assayed by counts of eggs, larvae, nymphs or pupae on the samples, and a 10-minute visual assay was made in each orchard on sample dates.

Results

Spider mite species and their relative abundance varied from orchard to orchard (table 1). Unlike the situation in northern California almond orchards in which European red mite and brown mite *(Bryobia rubioculus* (Scheuten)) were common, these southern San Joaquin Valley orchards had large numbers of Pacific spider mites *(Tetranychus pacificus* McGregor), some twospotted spider mites *(T. urticae* Koch), some Atlantic or "strawberry" mites *(T. turkestani* (Ugarov and Nikolski)), and a few citrus red mites including *P. citri* (McGregor). Only a few peach silver mites (*Aculus cornutus* (Banks)) were found in these more southern orchards.

Natural enemies found also varied from orchard to orchard and presented a different pattern from that observed in the northern orchards (table 2). *Metaseiulus* (= *Typhlodromus*) *occidentalis* (Nesbitt) was the dominant phytoseiid predator in the Chowchilla, Bakersfield, and Blackwell's Corner almond orchards during 1978. Other spider mite predators found included the sixspotted thrips (*Scolothrips sexmaculatus* Pergande), *Stethorus* beetles, and green lacewings. In contrast, *M. occidentalis* was found in two of the northern orchards in 1977, but was much less effective in the northern almond orchards.

In the Bakersfield and Blackwell's Corner orchards, *M. occidentalis* was found early in April feeding on Pacific spider mite females and eggs which were on newly-expanded foliage. This suggests that either *M. occidentalis* overwintered on the almond trees (as it does on apple trees), perhaps in bark crevices, or that *M. occidentalis* was able to enter the tree early in the season. Thus, in these unsprayed almond orchards, *M. occidentalis* was present on the trees early in the season along with its prey and remained numerous through the season (figures 1, 2, 3, and 4).

M. occidentalis was an effective predator of spider mites in the Blackwell's Corner and Bakersfield almond orchards The abrupt decline of Pacific spider mites in July and their subsequent increase in August (figures 1, 3 and 4) at the Blackwell's Corner orchard is probably because of the predation of *M. occidentalis* as no insect predators were observed at this time in sufficient quantities to account for the decline in Pacific mites.

Sevin was applied for NOW control in one block at the Blackwell's Corner orchard and it killed many *M. occidentalis.* An outbreak of Pacific spider mites subsequently occurred (figure 4), causing appreciable leaf fall. Trees untreated in the same block (figure 3) had low levels of Pacific mite, and *M. occidentalis* was their control agent. None of these trees were treated with an acaricide. The Pacific mite outbreak can be attributed to the lethal effects of Sevin on *M. occidentalis,* but the possible physiological stimulation of Pacific mite reproduction by Sevin cannot be excluded as a contributing factor as well.

Conclusions

The combination of spider mites and predators found in southern San Joaquin Valley almond orchards differs from that found in the northern part of the valley. From Yuba City to Bakersfield there is a gradual change in species composition, and integrated pest management programs or sampling schemes for mites in almonds must take this into account. For example, brown mites, which move from leaves to twigs, must be sampled differently than species that remain on leaves. The effect of these different spider mite species upon almonds is not known.

Predators such as green lacewings, *Stethorus* beetles, and sixspotted thrips were common in most of these unsprayed orchards. Such predators, no doubt, affect spider mite populations, although this is difficult to assess because of difficulties in sampling these insects. The predatory mite *M. occidentalis,* was found in four of the eight orchards monitored in 1977 and 1978. In two of these orchards (Bakersfield and Blackwell's Corner), *M. occidentalis* dramatically reduced Pacific spider mite populations. In the other orchards, European red mite was the dominant spider mite and *M. occidentalis* appeared to be less effective against this pest. The importance of *M. occidentalis* in other almond orchards is

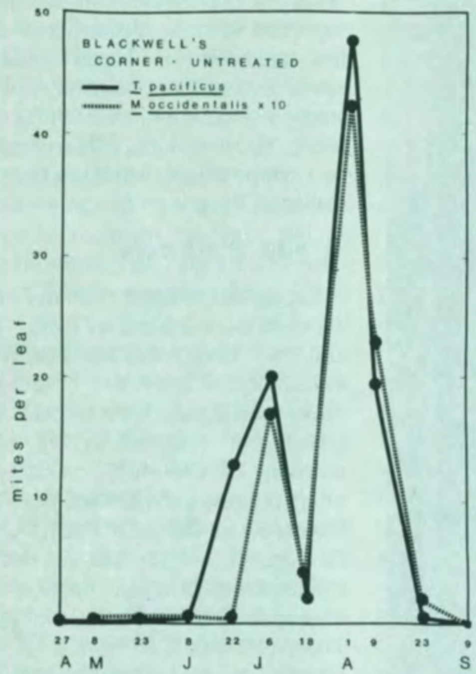

Figure 1. Mean numbers of Pacific spider mites per leaf and mean numbers of *M. occidentalis* per leaf x 10 in an untreated almond orchard, 1978. All stages, including eggs, are counted.

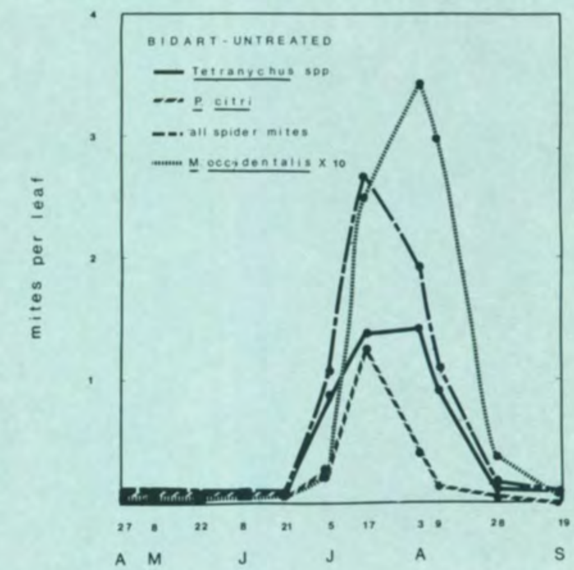

Figure 2. Mean numbers of citrus red mite, all *Tetranychus* spp., and *M. occidentalis* (x 10) per leaf in the untreated Bakersfield (= Bidart) orchard, 1978. "All spider mites" are pooled counts of *P. citri* and *Tetranychus* spp.

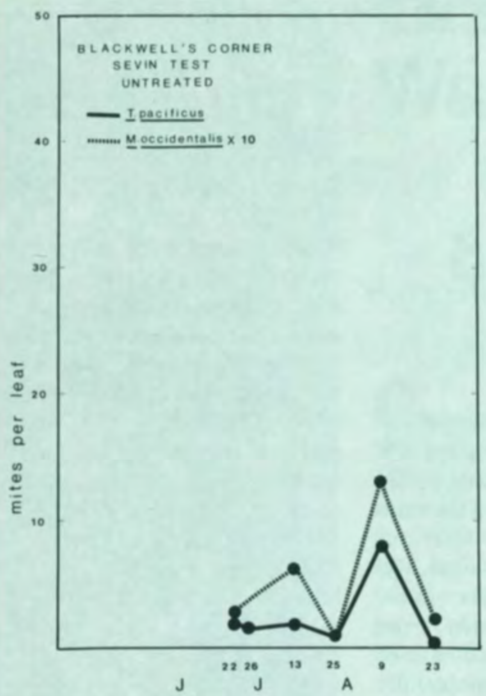

Figure 3. Mean numbers of Pacific spider mites per leaf and mean numbers of *M. occidentalis* x 10 on untreated check trees, 1978. All stages, including eggs, are counted.

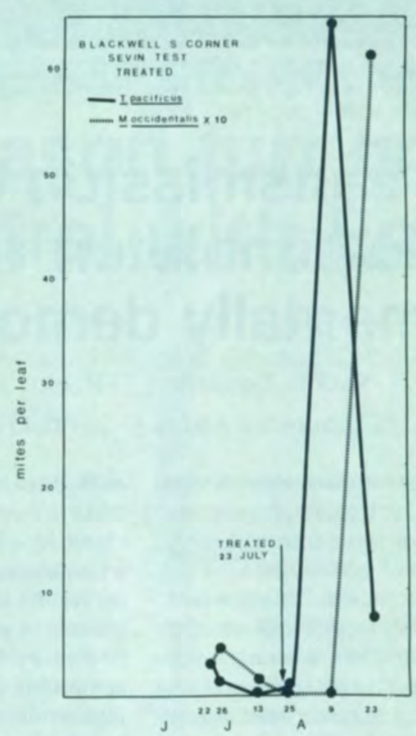

Figure 4. Mean numbers of Pacific mites per leaf and mean numbers of *M. occidentalis* x 10 after Sevin treatment, 1978. No acaricide was applied and defoliation caused a Pacific mite decline. All stages, including eggs, are counted.

not known, but the effects of Sevin in the Blackwell's Corner orchard indicate that insecticide treatments for NOW can disrupt *M. occidentalis* control of spider mites and therefore necessitate treatments with acaricides.

This is the first time that *M. occidentalis* has been shown to be an important predator of spider mites in almonds, although its importance as a spider mite predator is well known in grapes, apples, pears, peaches, and walnuts in California.

Marjorie A. Hoy is Assistant Professor and Assistant Entomologist, Department of Entomological Sciences, U.C., Berkeley. R. T. Roush and Katherine B. Smith are Graduate Students there. Les W. Barclay is Staff Research Associate, U.C. Cooperative Extension, Bakersfield. *This research was supported in part by a grant from the Almond Board of California. The authors wish to thank the almond growers for use of their orchards, and C. S. Davis, Wilbur O. Reil and Toynette W. Johnson for assistance in the project.*