been a factor in retarding the postweaning growth of the late castrates. There was considerable difference in weight gains associated with diethylstilbestrol. Postweaning weight gains of the implanted castrates were 29 lbs greater than the controls.

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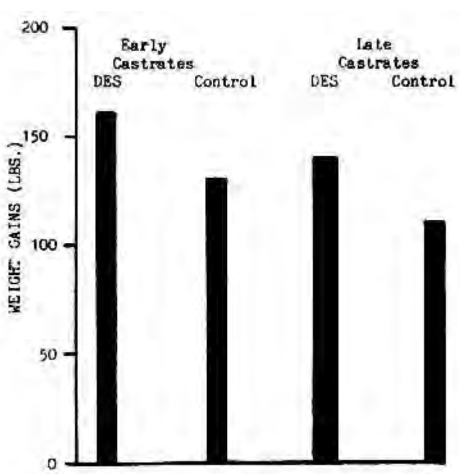
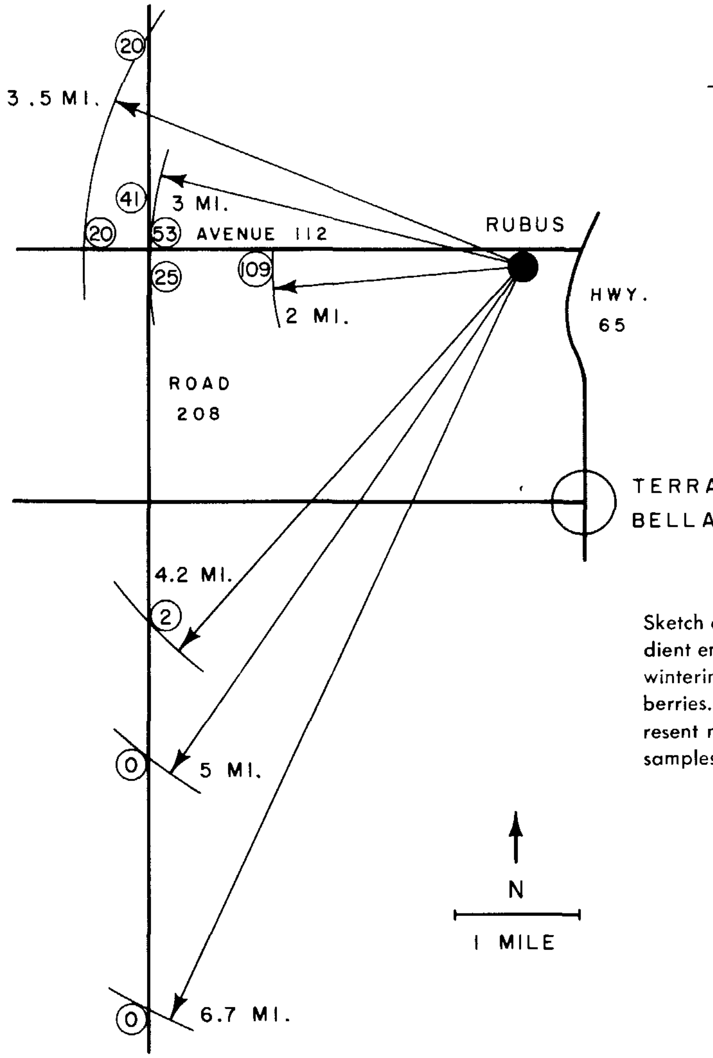
SUMMARY OF PREWEANING GROWTH RATE OF INTACT BULLS VS. CASTRATED CALVES

Tests	Calves in treatment	Initial weight	Gain per calf	Daily gain
	(Number)	(Averages in lbs)		
Test 1. Albaugh Ranch, McArthur—192 days April 24–Nov. 2, 1965				
Bulls	19	129	317	1.65
Early castrates	19	118	304	1.59
Test 2. Strong Ranch, Deep Springs College—153 days May 25–Oct. 22, 1965				
Bulls	9	102	229	1.50
Early castrates	10	84	218	1.42
Test 3. Barnwell Ranch, Bridgeville—May 6–Sept. 15, 1965—131 days				
Bulls	14	184	239	1.82
Early castrates	10	213	219	1.64
Test 4. Beck Ranch, Miranda May 25–Sept. 15, 1965—112 days				
Bulls	16	273	161	1.44
Early castrates	11	276	145	1.30
Test 5. Fearrien Ranch, Loleta June 16–Sept. 15, 1965—90 days				
Bulls	19	387	146	1.62
Early castrates	11	382	146	1.62

EFFECT OF AGE AT CASTRATION AND DIETHYLSTILBESTROL (DES) ON POSTWEANING GROWTH RATE (163) DAYS



Dispersal



Sketch of parasite activity gradient emanating from an overwintering refuge of blackberries. Figures in circles represent numbers of parasites in samples.

An overwintering refuge for egg parasites of grape leafhoppers showed a marked effect in vineyards at a distance of 3.5 miles and its influence could be traced over 4 miles, according to preliminary surveys.

GRAPE GROWERS have planted blackberry thickets near their vineyards in central and southern San Joaquin Valley in an experimental effort to establish seasonal refuges for *Anagrus epos*, an egg parasite of the grape leafhopper. Data reported here, suggesting the dimensions of the area which may be directly and beneficially influenced by such a purposely established overwintering refuge, were obtained in the spring of 1966.

The reason for encouraging these tiny parasitic wasps is that they attack and kill the eggs of the grape leafhopper, resulting in a substantial decrease in numbers of this grape pest during the growing season. Unlike their host leafhopper, which normally overwinters in the vineyards, these tiny egg parasites survive the winter only by breeding in the eggs of a different leafhopper species—a noneconomic form, *Dikrella cruentata*, which lives throughout the year only on blackberries (*Rubus* spp.). If such a blackberry refuge is not available near a vineyard, the parasites must first overcome a barrier of time and space before they can reach the grape leafhopper populations in the spring. The resulting delay in reaching a distant vineyard by early April often precludes the parasite's attack on the first eggs deposited on the vines by the overwintering adult grape leafhoppers. This seriously handicaps the parasites that would otherwise have measurably reduced the first leafhopper generation by killing a proportion of the eggs. An early appearance of the parasites in a vineyard is particularly important since each egg attacked by *Anagrus* results in another parasite instead of a leafhopper nymph. The increase of the parasite population is thereby accelerated, permitting

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of GRAPE LEAFHOPPER PARASITES *from a blackberry refuge*

the parasites to achieve their maximum effectiveness in suppressing grape leafhoppers.

The plan for intentionally planting blackberries to serve as refuges for *Anagrus* is based on an ancient ecological system discovered in the course of research on integrated control of grape pests (Agricultural Experiment Station Project 2013). It is now believed that the grape leafhopper and its egg parasite are native insects evolving from prehistoric times along the stream and river areas in northern and central California.

The wild grape *(Vitis californica)* and wild blackberries (*Rubus* spp.) occurred naturally together and in very close association. The grape leafhopper was present but not abundant and was commonly attacked by *Anagrus* which overwintered on the alternative leafhopper host found on the wild blackberries. Thus, the grower practice of planting the blackberries is a deliberate attempt to reestablish this naturally functioning *grape-Rubus-parasite-leafhopper* system near commercial plantings and, through this manipulation of the vineyard environment, to achieve suppression of a serious grape pest. This utilization of parasite refuges is an appropriate part of the concept of integrated control, and is an excellent example of an ecologically based control technique being applied to manage an agricultural pest.

The distance over which such a functioning refuge is effective was the first question to be considered in testing this procedure. To measure the area of influence of a refuge the following environmental conditions were needed: (1) a deliberately established and functioning refuge of blackberries containing interacting populations of *Dikrella* and *Anagrus* through the winter in proximity to a large vineyard area, but at a considerable distance from any other blackberry thicket; (2) a sampling technique for parasitized leafhopper eggs repeated at increasing distances from the refuge and conducted only at the brief period of the year between the date when the overwintering grape leafhoppers deposit their first eggs and the date of emergence of the first *Anagrus* from such leafhopper eggs; and (3) the absence of any disturbing insecticidal application to the vineyard or surrounding area. (Fortunately, the applications of sulfur for mildew control apparently do not disturb *Anagrus*.)

These experimental requirements existed in the spring of 1966 at a refuge of blackberries, roughly one-fifth of an acre in area, planted at the edge of the Merzoian Vineyards near Terra Bella, Tulare County. A 1963 survey of the area showed there were no *Anagrus* present in these vineyards. Subsequently, the blackberries were planted and properly irrigated and fertilized to force growth. They were then inoculated with *Dikrella* to establish the alternate host. Later, at the proper time, they were inoculated with the parasite to establish the functioning system of interacting host-parasite populations described above. The parasite bred on *Dikrella* throughout the winter of 1965–1966 and exhibited its characteristic annual pattern of enormous increase in population during the early spring on this host on blackberries. A synchrony of development exists in these large parasite numbers on blackberries with the development of eggs and first oviposition by the overwintering grape leafhoppers in the vineyards. This results in a dispersal of parasites from blackberries at the precise time that grape leafhopper eggs first appear in the vineyard. This first oviposition by grape leafhopper occurred on April 4, 1966, at Terra Bella, and the parasite at that time was dispersing from the refuge. It moved into the vineyards and parasitized the newly laid leafhopper eggs. These parasitized leafhopper eggs soon turned red, providing the characteristic field index for evaluating parasite activity in vineyards. The samples were taken on April 20 and 21 when these red eggs were abundant, but before any *Anagrus* had emerged or any leafhopper nymphs had hatched.

The vineyards adjacent to the refuge showed heavy parasite activity throughout, and a series of samples (each consisting of 30 leaves taken from 30 separate vines in a block) were repeated at increased distances from the refuge. The numbers of parasites found in each such sample are shown in the circles in the sketch. The distances from the refuge are also shown, and these data indicate a gradient of parasite activity decreasing as the distance from the refuge increased.

These data suggest that this particular refuge was very effective for a distance of 3.5 miles, and that its influence could be traced as far as 4.2 miles in a direct line from the refuge. A similar result was found by measuring parasite activity from another refuge near Edison in Kern County. If these distances are considered as radii, then the area influenced by this single refuge is theoretically calculated as being over 38 square miles. While the figures are promising they should not be accepted as necessarily representing the actual influence of the refuge system until they are fully substantiated by results of repeated surveys in future years.

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