bly, much of the destruction of benthic chironomid larvae took place during daylight hours.

Planaria reproduction

Although a rapid reproduction rate of 5 to 7 days was obtained with *Dugesia* in the laboratory, our field samples showed a population doubling only about every 30 days in both the chironomid midge and the mosquito experiments.

Conclusions

The results show that *Dugesia dorotocephala* is capable of regulating both *Culex* mosquitoes and several genera of economically important chironomid midges at densities below that attainable with other natural controls in the area. The degree of control attained in these studies falls well within the range usually considered acceptable, although higher planaria inoculation rates would have undoubtedly produced greater control. Unlike pesticide-treated midge and mosquito populations, modest planaria treatments produced a sustained supression with no notable population rebounds and no resistance. This stability might be partially caused by the planarians' ability to utilize several kinds of food, to withstand long periods of starvation, to respond with increased numbers produced by fission to increasing mosquito densities, and their harmlessness to other beneficial insects in the ecosystem (such as notonectids and hydrophylid beetles). Planaria are worthy biological control substitutes for chemical pesticides in some aquatic pest management systems.

E. F. Legner is Professor of Biological Control and Entomologist, Riverside; R. A. Medved and M. E. Badgley are Staff Research Associates, Division of Biological Control, Riverside. H. S. Yu, Research Assistant, is a graduate student in the Division of Biological Control, Riverside. *The authors are grateful for the assistance and partial research funding of the Southeast Mosquito Abatement District and the Los Angeles County Flood Control District.*

Separation of Blank Mechanical

J. C. CRANE • J. J. DUNNING

TABLE 1. DISTRIBUTION OF 'KERMAN' PISTACHIO NUTS HARVESTED FROM INDIVIDUAL TREES BY BOOM-SHAKING, AND STRIPPING BY HAND THOSE REMAINING.

Tree no.	Method of harvest	Yield (lb.) Good nuts	Blank nuts	Total	Percent blanks	Percent of total crop removed
1	Shake	11.0	.7	11.7	6.0	85.4
	Strip	.9	1.1	2.0	55.0	14.6
	Total	11.9	1.8	13.7	13.1	100.0
2	Shake	18.4	.8	19.2	4.2	76.2
	Strip	1.9	4.1	6.0	68.3	23.8
	Total	20.3	4.9	25.2	19.4	100.0
3	Shake	18.9	2.0	20.9	9.6	72.3
	Strip	3.7	4.3	8.0	53.7	27.7
	Total	22.6	6.3	28.9	21.8	100.0
4	Shake	41.8	2.2	44.0	5.0	83.2
	Strip	3.7	5.2	8.9	58.4	16.8
	Total	45.5	7.4	52.9	14.0	100.0
5	Shake	21.1	.7	21.8	3.2	70.6
	Strip	3.3	5.8	9.1	63.7	29.4
	Total	24.4	6.5	30.9	21.0	100.0
6	Shake	22.4	1.3	23.7	5.5	85.9
	Strip	1.5	2.4	3.9	61.5	14.1
	Total	23.9	3.7	27.6	13.4	100.0
Avg.	Shake	22.2	1.3	23.5	5.5	78.9
	Strip	2.5	3.8	6.3	60.3	21.1
	Total	24.7	5.1	29.8	17.1	100.0

The pistachio nut tree (*Pistacia vera* L.), which is native to the Mid-East and Central Asia, was introduced into California in the early part of this century. Commercial plantings were few and small until the last several years, but there are now over 1,000 acres in production and about 23,000 acres will come into bearing in the next 2 to 4 years. The majority of the plantings are in Kern and Kings Counties, with some over 2,000 acres in size.

As with many tree crops, the cost of harvest is a major portion of the total production expenses. Most growers harvest pistachios by vigorously shaking the tree with a mechanical device such as is used to harvest walnuts and almonds. However, to avoid contaminating the nuts with soil organisms, especially those which produce aflotoxins, a catching frame is combined with the shaker. The vigorous shaking usually removes almost 100% of the nuts.

In a recent study, a boom-shaker was used in conjunction with canvas sheets spread on the ground under the trees to harvest nuts from experimental pistachio trees at the University's Wolfskill Experimental Orchards, Winters, California. After the trees had been moderately shaken various amounts of nuts remained, most of which contained no kernel (embryo). Blank nuts primarily result from embryo abortion early in the growth and development of the nut. Unlike most fruits and nuts, which drop from the tree shortly after embryo abortion occurs, aborted pistachio nuts remain on the tree and grow to about the same size and shape as nuts containing fully developed embryos. The blanks mature and drop naturally from the trees somewhat later than the nuts that develop normally. The percentage of blanks produced by the 'Kerman' cultivar, the only one being planted commercially in California, varies from tree to tree and from year to year. Blank production in the Wolfskill Experimental Orchards has averaged about 25% over a 6-year period. If a grower could harvest only the good nuts, leaving the blanks on the trees, he would eliminate needless handling, and bypass the flotation procedure or other technique used to separate out empty nuts after harvesting. This would save time and money. Mechanical harvesting appears to offer a potential solution to a harvesting problem that will become more apparent when the large acreages of young pistachio trees in the San Joaquin Valley come into bearing.

Ten-year-old 'Kerman' trees in the Wolfskill Experimental Orchards were used in the present study. Although the optimum time for harvesting pistachios has not been determined, harvesting was done at what was considered the

Pistachio Nuts by Harvesting

Left, pistachios harvested by boom-shaking and (right) by hand-stripping those remaining after shaking. Nuts with unsplit shells are blanks.

A boom-shaker being used to harvest pistachio nuts from 10-year-old trees.

earliest time possible. At that time, the hulls separated easily from the shells when the nuts were squeezed between the fingers, but no shrivelling of the hulls had occurred. The nuts on each tree were shaken onto canvas in a conventional manner, using a boom-shaker operating with moderate force, and then were put into containers. The canvas was respread under the tree, and the remaining nuts were stripped off by hand or beaten from the tree with poles. The latter operation also removed some leaves, spurs, and small branches, which required separation before the nuts were put into separate containers. The nuts were dehulled and dryed in a dehydrator.

Yield data for six individual trees (see accompanying table) show the variation that occurs from tree to tree in total yield, the distribution of filled and blank nuts in relation to mechanical shaking and hand stripping, and the percentages of the total crop per tree removed by this particular harvest procedure. The data indicate that the percentage of the total crop removed by boom-shaking was closely related to the total percentage of blank nuts produced per tree. For example, trees 1 and 6 produced 13.1 and 13.4% blanks, respectively, and 85.4 and 85.9% of their total crops were removed by boom-shaking. Trees 3 and 5, however, produced 21.8 and 21.0 percent blanks, respectively, and only 72.3 and 70.6 percent of their crops were removed by boom-shaking.

Boom-shaking resulted in an average removal of 23.5 pounds of nuts, or 78.9% of the total crop. Of this yield, 1.3 pounds (5.5%) were blanks. Stripping the remaining nuts by hand resulted in an additional average yield of 6.3 pounds, 21.1% of the total crop, of which 3.8 pounds (60.3%) were blanks. Thus, an average of about 75% of the blank nuts remained on the tree after boom-shaking, but an average of 2.5 pounds (10.1%) of filled nuts also remained on the tree.

This preliminary study indicates that at least a major portion of the blank pistachios produced may be separated from fully developed nuts by a mechanical harvest procedure. However, leaving 10.1% of the good nuts on the trees, as occurred in this particular study, would result in excessive economic loss. The results strongly indicate the desirability of determining the effectiveness and adaptability of different types of harvesters, as well as the optimum stage of nut maturity, in relation to separation of blank nuts.

Julian C. Crane is Professor, Department of Pomology, University of California, Davis; James J. Dunning is Senior Editor, University of California, Davis.

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