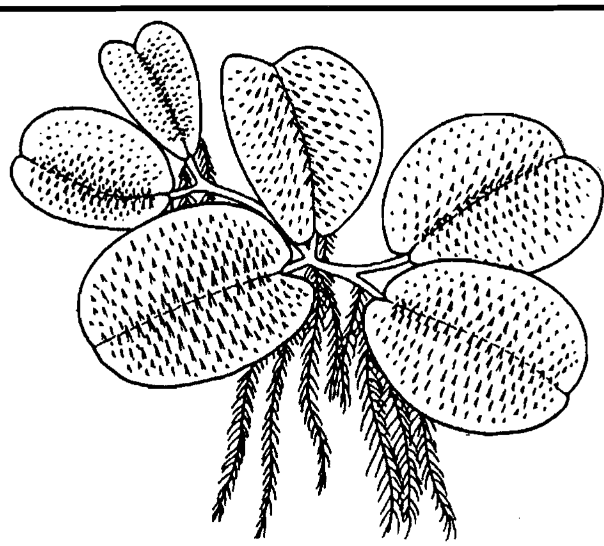
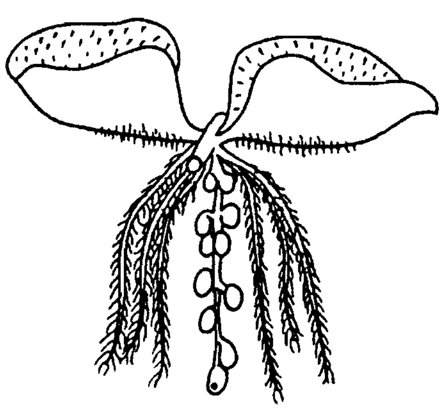
California Plant Pest
&
Disease Report

California Department of Food and Agriculture
Plant Pest Diagnostics Center
3294 Meadowwview Road
Sacramento, CA 95832-1448





HAVE YOU SEEN THESE WEEDS?
SEE PAGES 41-49 FOR MORE DETAILS

What's Inside: Volume 18 Nos. 1-2, January - May, 1999

-Also Included-
Updated article on Redgum Lerp Psyllid
(see pages 6-8)

California Plant Pest & Disease Report

Editor: Raymond J. Gill
Production Assistants: Stacie M. Oswalt & Sean M.Veling

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Correspondence concerning the CPPDR or subscription requests should be addressed to:

Editor, CPPDR
State of California
Department of Food and Agriculture
Plant Pest Diagnostics Center
3294 Meadowview Road
Sacramento, CA 95832-1448

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ENTOMOLOGY HIGHLIGHTS

NAME CHANGES

The following common names were approved by the Entomological Society of America (ESA) Standing Committee on Common Names:

Virginia creeper leafhopper
Erythroneura ziczac (Walsh)
Homoptera: Cicadellidae

rough strawberry root weevil
Otiorhynchus rugosostriatus (Goeze)
Coleoptera: Curculionidae

willow bark beetle
Trypophloeus striatulus (Mannerheim)
Coleoptera: Scolytidae

SIGNIFICANT FINDS

MELON FRUIT FLY, *Bactrocera cucurbitae* -(A)- On April 13, one male melon fruit fly was found in the Rosewood area of **Los Angeles** County. Los Angeles County trapper Ramon Melendez found the fly in a Jackson/cue lure trap located in a loquat. Also on April 13, Los Angeles County trapper Jesus Garcia found a male melon fruit fly in Compton, **Los Angeles** County, in a Jackson/cue lure trap that was placed in an orange tree. No infestations were found in either case.

MEDITERRANEAN FRUIT FLY, *Ceratitis capitata* -(A) - One sexually mature, mated female Mediterranean Fruit Fly (Medfly) was found on April 20, 1999 in El Monte, **Los Angeles** County. CDFA Insect Biosystematist Kevin Hoffman made the determination. The fly was found in a McPhail trap by Los Angeles County trapper Elio Cano and CDFA Identifier Gloria Vargas. Two hundred sterile Medflies were also found in the trap. In addition, the spermatheca were sent to USDA researchers and it was determined that the sperm was sterile.

The find was within the Los Angeles Medfly Preventative release zone. In response, the trap density was increased to 10 Jackson and 10 McPhail traps per square mile in a four square mile area around the find, and sterile Medfly release was increased to 500K per square mile for two life cycle generations in a nine square mile area around the find. A door-to-door fruit survey was initiated by CDFA for all properties within 200m of the find site. No infestations were found.

OLIVE FRUIT FLY, *Bactrocera oleae* -(A) - Eradication efforts continue for this pest in **Los Angeles** County. See pages 9-14 for additional trapping information.

A FRUIT FLY, *Bactrocera scutellata* -(A) - Los Angeles County Department of Agriculture trapper Negash Bahta found one sexually mature male *Bactrocera scutellata* on January 6, 1999, in Wilmington, **Los Angeles** County. The fly was found in a McPhail trap placed in an avocado tree.

The trap density at the time of the find was five McPhail traps per square mile. In response, CDFA increased the trap density to protocol levels around the find. No infestations were found.

CDFA Insect Biosystematists Kevin Hoffman and Eric Fisher made the determination. Kevin Hoffman provides the following information:

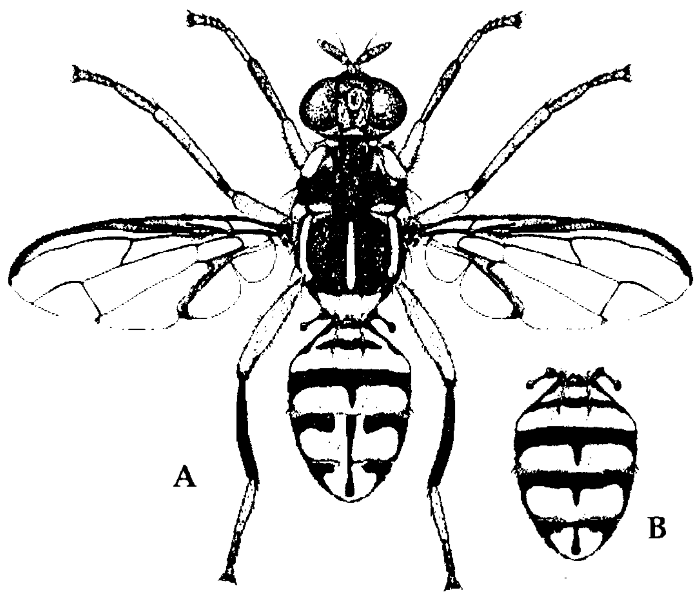

Fig.1. *Bactrocera scutellata*. A: dorsal view of adult; B: abdomen showing variation in color pattern.

The general appearance of *Bactrocera scutellata* resembles an Oriental fruit fly, but *B. scutellata* differs from it by the wing pattern and the coloration pattern on the abdomen (see Fig. 1 at right). The wing has the dark mark along the front edge which is expanded into a small spot at the wing tip, which is similar to but much smaller than that of a melon fruit fly. The abdomen has the usual T-shaped mark, but the front edges of segments 4 and 5 are darkened laterally and may extend completely across the abdomen, causing the abdomen to appear to have three consecutive short T-shaped marks. The size of the captured specimen is slightly larger than a typical Oriental fruit fly. Males are attracted to cue lure, and therefore can be found on melon fly traps. When servicing these traps, trappers should be reminded to submit any specimens which display the typical *Bactrocera* thorax and wing patterns regardless of the pattern on the abdomen.

Bactrocera scutellata occurs in China, Taiwan, Japan, Hong Kong, Thailand, and Malaysia. It has been reared only from a few Cucurbitaceae, specifically from male flower buds of pumpkin (*Cucurbita* sp.), from flower and stem galls on *Melothria liukiuensis*, and from *Trichosanthes cucumeroides*. There is a doubtful record of pear as a host.

AFRICANIZED HONEY BEE (AHB), *Apis* "Africanized" -(B)- AHB was discovered for the first time in **Orange** County on March 1, 1999 in Seal Beach and in California City, **Kern** County on March 22, 1999. Additional finds are listed below.

The new AHB colonized area is 43,240 square miles and includes all of Imperial, Los Angeles, Orange, Riverside, San Bernardino and San Diego Counties, and portions of Kern and Ventura Counties.

CITY	COUNTY	DATE COLLECTED	COLLECTOR
PalmDesert	Riverside County	01/01/99	
Redondo Beach	Los Angeles County	01/05/99	Hurley
Torrance	Los Angeles County	01/05/99	Hurley
Palm Desert	Riverside County	01/05/99	Davis/Kiegl
West Covina	Los Angeles County	01/25/99	Malinzak
San Bernardino	San Bernardino County	02/20/99	Mian
Imperial	Imperial County	02/26/99	Inay/Bolin
Seal Beach	Orange County	03/01/99	Ross
La Palma	Orange County	03/02/99	Ross
Garden Grove	Orange County	03/02/99	Ford
Costa Mesa	Orange County	03/03/99	Bonderov
Calabasas	Los Angeles County	03/05/99	Turner/Phoutinan
Moreno Valley	Riverside County	03/05/99	Durso
Live Oak Park	San Diego County	03/12/99	
San Diego	San Diego County	03/12/99	Kellum
Palmdale	Los Angeles County	03/18/99	Martinez
California City	Kern County	03/22/99	Marlett
Indio	Riverside County	05/18/99	Franklin
Blythe	Riverside County	05/22/99	Elms

REDGUM LERP PSYLLID, *Glycaspis brimblecombei* -(Q) - This pest of eucalyptus has been rapidly extending its range from southern California to the central valley. Due to the extensive problems caused by this psyllid, numerous calls from homeowners and property managers, as well as intense media interest, we are including an updated report by Rosser Garrison, Los Angeles County Entomologist, on pages 6-8. [Note: The California Department of Food and Agriculture, while printing Garrison's report, makes no pesticide recommendations.] Research is currently under way to locate parasitoid natural enemies in Australia. However, it is currently wintertime there and it will not necessarily be easy to locate these natural enemies. The whole biocontrol process will of necessity require a block of time before natural enemies can be released. For additional information on this pest, see CPPDR 17(1-3):7-8.

LOS ANGELES COUNTY AGRICULTURAL COMMISSIONER'S OFFICE

New Agricultural Pest for Southern California

Redgum Lerp Psyllid, *Glycaspis brimblecombei* (Figs. 1-3)

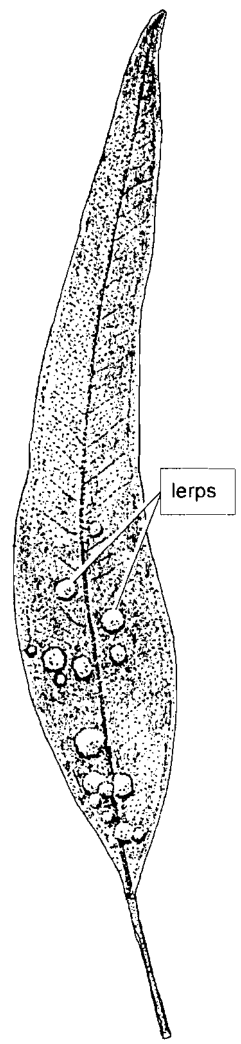

Fig. 1. *Eucalyptus camaldulensis* leaf with lerps of Redgum lerp psyllid (life size)

Introduction: On 17 June 1998, Los Angeles County Agricultural Inspector Cindy Werner gathered some leaves of Red Gum Eucalyptus from three heavily infested trees bordering the Interstate 10 Freeway across the street from the Los Angeles County Agricultural Commissioner's Office in El Monte. The leaves were covered with honeydew and curious, round, white mounds (Fig. 1). Staff Entomologist Rosser Garrison determined that the cones were lerps of a completely new psyllid unlike any known from California or the United States. Examination of various literature sources revealed that this species was one of many lerp-forming psyllids native to Australia. Garrison contacted Biosystematic Entomologist Ray Gill of the California Department of Food and Agriculture who later collected material at the site on 21 June and reported his findings by telephone to Garrison later that week.

Gill identified the psyllid as *Glycaspis brimblecombei*, a species described in 1964 from Brisbane, Australia. Specimens were sent to Daniel Burckhardt, a psyllid specialist in Switzerland, for confirmation. This species, a new North American record, belongs to a large group of lerp-forming psyllids specific to eucalyptus trees.

Economic Importance: Redgum Lerp Psyllid (RLP) is becoming a major ornamental pest of eucalyptus in California. RLP heavily infests **Red Gum Eucalyptus**, *Eucalyptus camaldulensis*, but also occurs on sugar gum (*E. cladocalyx*), blue gum (*E. globulus*), *Eucalyptus rudis*, and three other species. RLP forms a "lerp." This is a mostly excretionary structure of crystallized honeydew produced by the larvae as a protective cover that closely resembles armored scale insects. The psyllids produce large amounts of honeydew, which stains the ground beneath trees. A blackish sooty mold grows on the honeydew-covered surfaces. In severe infestations, thousands of lerps cover the ground and understory, giving the appearance of hail. The lerps and honeydew stick to shoes of pedestrians. Heavy infestations cause severe leaf drop. Honeydew and sooty mold are bothersome to people, but probably do not have a serious adverse effect on tree health. However, extensive defoliation weakens trees and increases tree susceptibility to wood-boring pests such as eucalyptus longhorned beetles. These beetles, if successful in attacking trees weakened by RLP, can kill branches or entire trees. Successfully attacked eucalyptus will turn completely brown.

In Australia RLP is known to feed on a localized population of the redgum eucalyptus (Moore 1970b). According to Moore (1970a), RLP is also known to feed on *Eucalyptus dealbata, E. tereticornis, E. blakelyi, E. bridgesiana,* and *E. nitens*. RLP is implicated in serious outbreaks in native vegetation in Australia.

Distribution: RLP was originally described in 1964 from Brisbane, Australia (Moore 1964) but it has been found in central Queensland and in most of New South Wales (Moore 1970b). Besides the initial findings in El Monte, RLP has been discovered in northern California. Samples were first collected on 24 July 1998 in Alameda County near Fremont, at Stanford University in Santa Clara County, and in San Mateo County. It has also been found in Alameda, Oakland, Hayward, South San Francisco, and San Francisco (Brennan *et al.* 1999)

Although the infestation was first discovered in El Monte it has since spread to most cities in the Los Angeles basin and to Orange, San Diego, western San Bernardino and Riverside Counties.

Identification: The young larvae build a conical lerp by excreting a gelatinous honeydew from their posterior end. The larger larvae are found beneath these lerps and resemble an armored scale insect. The conical lerps reach a size of about 3 mm wide and 2 mm high. The larvae (Fig. 3) are yellow, or yellow and brown. The adults (Fig. 2) are 3 mm long, slender, pale green with areas of orange and yellow. They differ from other California psyllids in having long genal cones on the face.

Comments: If the lerp is removed from the leaf surface, the exposed full-grown larva begins constructing a new lerp. A matrix of new honeydew which will become a new lerp is formed over the larva. It moves in a circular direction in order to add to the cover. Some exposed larvae wither and die soon after their lerp is removed.

Garrison has observed RLP was being attacked by several predators, including the two introduced ladybeetles, the Asian lady beetle (*Harmonia axyridis*) and *Chilocorus bipustulatus*, particularly the former, which occurs in large numbers both in El Monte and Ardenwood. Other predators include spiders, mites, syrphid fly larvae, the lady beetles *Coccinella californica* and *Hippodamia convergens*, and the heteropteran *Zelus renardii*. Predators of other psyllids that might also feed on redgum_lerp psyllid include minute pirate bugs (*Anthocoris* spp.), and larvae of green lacewings (*Chrysoperla* spp.) and brown lacewings (*Hemerobius* spp.). **None of these predators, however, has been shown to be an effective biological control agent.**

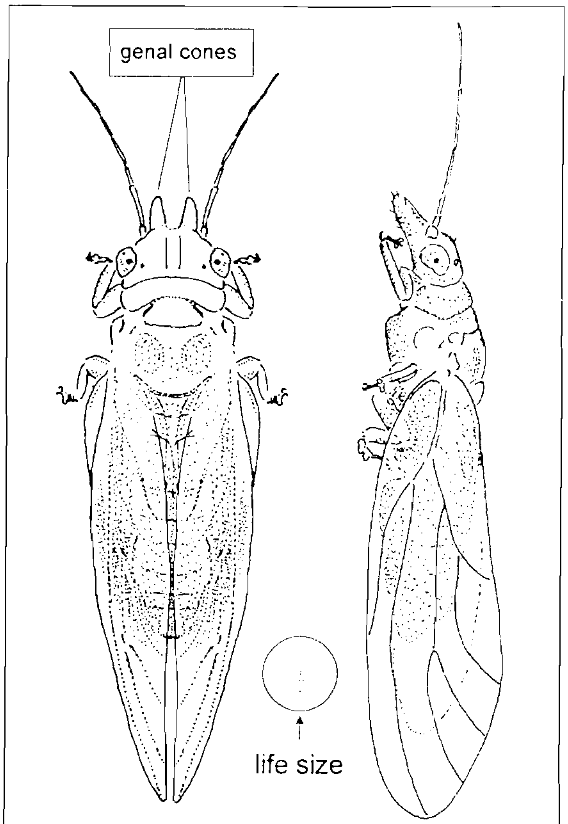

Fig. 2. Redgum lerp psyllid (adults)

Classical biological control for this pest is currently being investigated by entomologists at the University of California, but it will be several years before results of this approach are available. A classical biocontrol program involves studying which predators, parasites, and pathogens help to control a pest in its native habitat. After identifying which natural enemies are expected to be effective, a quarantine screening process is conducted to determine if these natural enemies can be safely introduced into California. Classical biological control has been effective against several other psyllids, including acacia psyllid and blue gum psyllid, and it provides partial control of the eugenia psyllid. Biological control is often influenced by pesticide use and cultural practices: effective biocontrol must be integrated with these activities.

Life History: Like other psyllids, redgum lerp psyllid develops through gradual metamorphosis, which includes egg, several increasingly larger larval stages, and adult. There is no pupal stage. Females lay eggs on succulent leaves and young shoots, so population increases often follow new plant growth. However, all psyllid life stages can occur on both new and mature foliage. In its native Australia the psyllid has 2 to 4 generations a year, and a similar number of generations would be expected in California. Development time from egg to adult varies from several weeks during warm weather to several months during prolonged cool temperatures. In mild coastal areas, all stages can be present throughout the year.

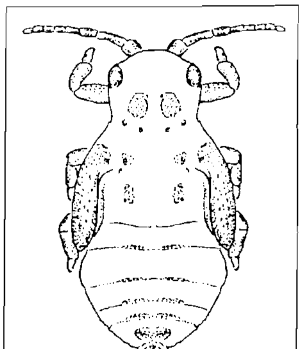
Fig. 3. Redgum lerp psyllid (larva)

Cultural Control [Note: The following is abstracted from Dreistadt *et al.*, 1999.]: Minimize tree stress by providing eucalyptus with proper cultural care and protecting trees from injury. Nitrogen levels in foliage may increase when eucalyptus is stressed. Increased foliar nitrogen increases reproduction and survival of psyllids. To minimize stress, consider providing trees with supplemental water during periods of prolonged drought, such as during summer and fall in much of California when rain is infrequent or nonexistent. Drought stress increases damage to trees from both RLP and eucalyptus longhorned borers. RLP outbreaks may also follow prolonged rain, possibly because excessively wet soil prevents roots from obtaining adequate oxygen, causing small roots to die.

When irrigating trees, apply water beneath the outer canopy, not near trunks. Avoid frequent, shallow watering that is often used for lawns. A general recommendation is to irrigate eucalyptus infrequently (possibly once a month during drought periods) but with sufficient amounts so that the water penetrates deeply into soil. This can be achieved by applying water slowly through drip emitters that run continuously for several days. The specific amount and frequency of water needed varies greatly depending on the site and tree species.

Avoid fertilizing eucalyptus. Use slow-release nutrient formulations if other plants near the drip line of eucalyptus require fertilization. Psyllid larvae and egg-laying females prefer the abundant, succulent new shoot growth stimulated by excess nutrients that occur following the application of quick-release fertilizer formulations. Remember that RLP attacks only certain species of eucalyptus: *some* eucalyptus species are avoided by this psyllid. Eggs laid on certain other eucalyptus species are unable to complete their development, so psyllid populations there do not build to bothersome levels. The number of eucalyptus species attacked may decrease later if this pest is brought at least partly under biological control.

Chemical Control: Pesticide effectiveness against RLP is not known: no controlled studies involving the effectiveness of ANY pesticide application(s) have been conducted . Foliar sprays generally are not recommended and will most likely not be cost effective. There are no selective insecticides that kill *only* psyllids. It is difficult to spray large urban trees without pesticide drift. The lerp covering may provide psyllid larvae with some protection from spray contact.

If honeydew is intolerable and foliar spraying is used, consider using a mixture of insecticidal soap (potassium salts of fatty acids) and horticultural oil (an insecticide labeled narrow-range, superior, or supreme oil). These low-hazard insecticides can be combined at one-half of the labeled rate or the full labeled rate (commonly 1%-2% active ingredient each). Unlike many other insecticides, oil can kill psyllid eggs, in addition to other insect life stages. Insecticidal soap helps to wash-off honeydew and kill psyllids. **Thorough foliar coverage is essential, so effective spraying may be limited to smaller trees.** Soap or oil applications will likely provide only temporary control and application may need to be repeated after about two weeks.

Certain systemic insecticides may control RLP, but this has not been verified. Acephate implants (Orthene Acecaps®) may be the only systemic available to homeowners for treating large trees. These implants are pesticide-containing plastic plugs that are pounded into holes drilled every few inches to encircle the trunk. It can be difficult to drill holes and place these plugs at the proper depth so insecticide is effectively absorbed and translocated to leaves. Proper implant depth varies in part depending on the tree species and trunk diameter.

Implanting or injecting trunks or roots causes undesirable wounds that can serve as entry points for plant pathogens. Wounding trees increases the likelihood of attack by boring insects, such as eucalyptus longhorned borers. Do not implant or inject trees more than once a year.

Several systemic insecticides can be applied to landscape trees by professional pest control operators. These include abamectin (Avid®), azadirachtin (Azatin®, Neemazad®) or neem (Triact®), and imidacloprid (Merit®). Imidacloprid is labeled for application as a soil drench and for injection into soil beneath trees. This application method avoids the tree wounds that result from injecting or implanting trunks or roots. Imidacloprid may be effective if applied to soil during late winter to early spring or before rainfall or irrigation are expected to facilitate root absorbance of the material. **However, no research data are available to verify the effectiveness of these materials against RLP.**

Warning on the Use of Chemicals: Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits and/or vegetables ready to be picked.

Dispose of empty containers carefully. Follow label instructions for disposal. Never reuse containers. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Do not pour down sink or toilet. Consult your county agricultural commissioner for correct ways of disposing of excess pesticides. Never burn pesticide containers.

Acknowledgements: Thanks are due to Ray Gill, CDFA for making the initial identification and sharing information and literature, and Steve Dreistadt, Univ. Calif., Davis for sharing information on pest management of this species.

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Prepared by Rosser W. Garrison, Entomologist, Los Angeles County Agricultural Commissioner's Office, 3400 La Madera Ave., El Monte, CA 91732 ☎ 626-575-5469............ Revised 6/99

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Westwood	01/04	1F	Panel	olive	Ronquillo
Los Angeles	Alta Dena	01/04	1F	McPhail	olive	See
Los Angeles	Redondo Beach	01/05	1F	McPhail	olive	Barrera
Los Angeles	Westwood	01/05	1M/1F	McPhail	olive	Ronquillo
Los Angeles	Westwood	01/05	1F	McPhail	olive	
Los Angeles	West Los Angeles	01/05	1M	Champ	olive	Cordova
Los Angeles	West Hollywood	01/05	1M	Champ	olive	Montoya
Los Angeles	Westwood	01/06	1M/1F	Champ	olive	Hendrickson
Los Angeles	Westwood	01/06	3M	Champ	olive	Lopez
Los Angeles	Westwood	01/06	1F	Champ	olive	Hendrickson
Los Angeles	Westwood	01/06	4M/1F	Champ	olive	Neustadt
Los Angeles	Westwood	01/06	9M/5F	Champ	olive	Lopez
Los Angeles	Westwood	01/06	9M/5F	Champ	olive	Neustadt
Los Angeles	Westwood	01/06	1F	Champ	olive	Hendrickson
Los Angeles	Westwood	01/06	1M	Champ	olive	Neustadt
Los Angeles	Westwood	01/06	6L	N/A	olive	Williams
Los Angeles	Westwood	01/06	1F	Champ	olive	Lopez
Los Angeles	Westwood	01/06	2M	Champ	olive	Lopez
Los Angeles	Westwood	01/06	2M	Champ	olive	Lopez
Los Angeles	Westwood	01/07	1M	Champ	olive	Lopez
Los Angeles	Westwood	01/08	12M/6F	Champ	olive	Lopez
Los Angeles	Westwood	01/08	1M	Champ	olive	Hendrickson
Los Angeles	Westwood	01/13	1F	McPhail	olive	Bullard
Los Angeles	Westwood	01/13	1M	McPhail	olive	Paredes
Los Angeles	Los Angeles	01/13	1M	McPhail	avocado	Haralal/Moreno
Los Angeles	Cheviot Hills	01/13	1M	McPhail	olive	Razo/Harris
Los Angeles	Palms	01/13	1M	McPhail	olive	Enciso
Los Angeles	Westwood	01/13	1F	Champ	olive	Nunez
Los Angeles	Westwood	01/13	1M	Champ	olive	Nunez
Los Angeles	Culver City	01/13	1F	Champ	olive	Gomez
Los Angeles	Westwood	01/14	1M/1L	N/A	olive	Urquieta/Ramirez
Los Angeles	Los Angeles	01/15	1F	Champ	olive	Moreno
Los Angeles	Westwood	01/15	1F	Champ	olive	Ronquillo
Los Angeles	Westwood	01/15	1M	Panel	olive	Ronquillo
Los Angeles	Cheviot Hills	01/15	2L/1P	N/A	olive	Urquieta
Los Angeles	Culver City	01/15	1M	Champ	olive	Montoya
Los Angeles	Los Angeles	01/15	1F	Champ	olive	Razo
Los Angeles	Westwood	01/15	1F	Champ	olive	Perez

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections, continued

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Culver City	01/15	1M	Champ	olive	Montoya
Los Angeles	Westwood	01/19	1M	Champ	olive	Ronquillo
Los Angeles	West Los Angeles	01/21	2L	N/A	olive	Ruiz/Ayala
Los Angeles	West Los Angeles	01/21	1L	N/A	olive	Lupe
Los Angeles	West Los Angeles	01/21	1F	McPhail	olive	Vargas
Los Angeles	Westwood	01/21	1F	Champ	olive	Vargas
Los Angeles	West Los Angeles	01/21	2M	Champ	olive	Cordova
Los Angeles	Cheviot Hills	01/22	2F	Champ	olive	Harris
Los Angeles	Cheviot Hills	01/22	1M	McPhail	olive	Harris
Los Angeles	Westwood	01/26	1F	Champ	olive	Ronquillo
Los Angeles	Westwood	01/26	1F	Champ	olive	Ronquillo
Los Angeles	Bel Air Estates	01/29	1M	Champ	olive	Harris
Los Angeles	Cheviot Hills	01/29	1F	Champ	olive	Harris
Los Angeles	Cheviot Hills	01/29	1F	Champ	olive	Harris
Los Angeles	Santa Monica	01/29	1M/1F	Champ	olive	Gomez
Los Angeles	Westwood	02/01	1M/1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/01	1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/01	1M/1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/01	1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/01	1M	Champ	olive	Ronquillo
Los Angeles	Westwood	02/01	3F	Champ	olive	Ronquillo
Los Angeles	Cheviot Hills	02/02	1F	Champ	olive	Samuels
Los Angeles	Crenshaw	02/05	1M	Champ	olive	Harris
Los Angeles	Crenshaw	02/05	1M	Champ	olive	Harris
Los Angeles	Crenshaw	02/05	1M	Champ	olive	Harris
Los Angeles	Westwood	02/08	3F	Champ	olive	Ronquillo
Los Angeles	West Los Angeles	02/08	1M	Champ	olive	Cordova
Los Angeles	Westwood	02/08	1M/1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/08	1M	Champ	olive	Ronquillo
Los Angeles	Westwood	02/08	1M	Champ	olive	Ronquillo
Los Angeles	Westwood	02/08	1F	Champ	olive	Ronquillo
Los Angeles	Hawthorne	02/09	1F	Champ	olive	Pasillas
Los Angeles	West Los Angeles	02/16	1M	Champ	olive	Moreno
Los Angeles	Los Angeles	02/22	1F	Champ	olive	Ronquillo
Los Angeles	Westwood	02/22	1F	Champ	olive	Rodriguez
Los Angeles	Crenshaw	02/24	1L	N/A	olive	Jara/Segura
Los Angeles	Crenshaw	02/25	4L	N/A	olive	Ramirez/Ruiz

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections, continued

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Crenshaw	02/26	1L	N/A	olive	Morales
Los Angeles	Crenshaw	03/01	1L	N/A	olive	Ramirez
Los Angeles	Cheviot Hills	03/01	1M	Champ	olive	Moreno
Los Angeles	West Los Angeles	03/01	1F	Champ	olive	Samuels
Los Angeles	Crenshaw	03/01	1P	N/A	olive	Segura/Lopez
Los Angeles	Crenshaw	03/02	2M/1F	Champ	olive	Rodriguez
Los Angeles	Brentwood	03/03	1M	Champ	olive	Moreno
Los Angeles	View Park	03/03	1F	Champ	olive	Rodriguez
Los Angeles	Crenshaw	03/03	3L	N/A	olive	Segura/Gonzales
Los Angeles	Athens	03/10	1F	Champ	olive	Pasillas
Los Angeles	Los Angeles	03/26	1M	Champ	olive	Enciso
Los Angeles	Los Angeles	03/29	1F	Champ	olive	Enciso
Los Angeles	Palms	04/07	1M	Champ	olive	De la Cruz
Los Angeles	Athens	04/09	1F	Champ	olive	Nuñez
Los Angeles	Westwood	04/13	1M	Champ	olive	De la Cruz
Los Angeles	View Park	04/13	1M	Champ	olive	Rodriguez
Los Angeles	WoodlandHills	04/20	1M	Champ	orange	Mendoza
Los Angeles	Los Angeles	04/21	7M/2F	Champ	olive	Cordova
Los Angeles	Mar Vista	04/21	1M	Champ	olive	Cordova
Los Angeles	Rancho Palos Verdes	04/21	1M	Champ	ornamental	Ortiz
Los Angeles	Rolling Hills	04/21	2M	Champ	olive	Ortiz
Los Angeles	Encino	04/21	1M	Champ	tangerine	Mendoza
Los Angeles	View Park	04/21	2M	Champ	olive	Rodriguez
Los Angeles	Winnetka	04/22	1M	Champ	olive	Pocasangre
Los Angeles	San Pedro	04/22	1M	Champ	olive	Lopez
Los Angeles	San Pedro	04/23	1F	Champ	olive	Gonzales
Los Angeles	Rolling Hills	04/26	1M	Champ	olive	Vargas
Los Angeles	West Los Angeles	04/26	1M	Champ	olive	Chavez
Los Angeles	Beverly Hills	04/26	1M	Champ	olive	Chavez
Los Angeles	Playa del Rey	04/26	1M	Champ	olive	Liscano
Los Angeles	Sunland	04/26	1M	Champ	olive	Dominguez
Los Angeles	Rancho Palos Verdes	04/26	1M	McPhail	loquat	Lopez
Los Angeles	Sante Fe Springs	04/26	1M	Champ	grapefruit	Matthews
Los Angeles	Rancho Palos Verdes	04/27	1F	Champ	ornamental	Lopez
Los Angeles	Santa Monica	04/27	1M	Champ	olive	Baeza
Los Angeles	Harbor City	04/27	1M	Champ	olive	Rodriguez
Los Angeles	Rancho Palos Verdes	04/27	3M	Champ	olive	Gary/Snyder

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections, continued

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Rancho Palos Verdes	04/27	1M	Champ	olive	Gray/Snyder
Los Angeles	Palos Verdes Estates	04/27	1M	Champ	olive	Gray/Snyder
Los Angeles	Rolling Hills Estates	04/27	1M	Champ	olive	Montoya
Los Angeles	Rancho Palos Verdes	04/27	2M	Champ	olive	Gray/Snyder
Los Angeles	Rancho Palos Verdes	04/27	1F	Champ	olive	Gray/Snyder
Los Angeles	Rolling Hills Estates	04/27	1M	Champ	olive	Montoya
Los Angeles	Rolling Hills Estates	04/27	1M	Champ	olive	Montoya
Los Angeles	Palos Verdes Estates	04/27	2M	Champ	olive	Williams
Los Angeles	Palos Verdes Estates	04/27	1M	Champ	olive	Williams
Los Angeles	Rancho Palos Verdes	04/27	1M	Champ	olive	Williams
Los Angeles	Palos Verdes Estates	04/27	1M/1F	Champ	olive	Williams
Los Angeles	Palos Verdes Estates	04/27	1M	Champ	olive	Williams
Los Angeles	Palos Verdes Estates	04/27	1M	Champ	olive	Williams
Los Angeles	Palos Verdes Estates	04/27	1M	Champ	olive	Gray/Snyder
Los Angeles	La Mirada	04/28	1M	Champ	olive	Barrera
Los Angeles	Los Angeles	04/28	1M	Champ	olive	Samuels/Moore
Los Angeles	Wilmington	04/28	1M	Champ	olive	Enciso
Los Angeles	Torrance	04/28	1M	Champ	olive	De la Cruz/Scott
Los Angeles	Redondo Beach	04/28	1M	Champ	olive	Gomez/Razo
Los Angeles	Los Angeles	04/28	4M	Champ	olive	Gray/Snyder
Los Angeles	Culver City	04/28	1M	Champ	olive	Moreno
Los Angeles	Ladera Heights	04/28	*1 pair wings only	Champ	olive	Vela
Los Angeles	Los Angeles	04/29	2M	Champ	olive	Mendoza
Los Angeles	Sherman Oaks	04/29	1M	Champ	olive	Cordova
Los Angeles	Sawtelle	04/29	1M	Champ	olive	Moore/Samuels
Los Angeles	Palms	04/29	1M	Champ	olive	Cordova
Los Angeles	Hacienda Heights	04/29	1M	Champ	olive	Hickey
Los Angeles	Los Angeles	04/29	1M	Champ	olive	Gray/Snyder
Los Angeles	Rolling Hills Estates	04/30	1M	Champ	olive	Liscano
Los Angeles	Cheviot Hills	05/01	1M	Champ	olive	Cordova
Los Angeles	Los Angeles	05/01	1M	Champ	olive	Vela
Los Angeles	Santa Monica	05/03	1M	Champ	olive	De la Cruz
Los Angeles	Park la Brea	05/03	1F	Champ	olive	Medina
Los Angeles	Carson	05/03	1M	Champ	olive	Baeza
Los Angeles	Los Angeles	05/03	1M	Champ	olive	Mendoza
Los Angeles	San Pedro	05/04	1M	Champ	ornamental	Lopez
Los Angeles	San Marino	05/04	1M	Champ	olive	Scott
Los Angeles	Gardena	05/04	1F	Champ	olive	Moore

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections, continued

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Brentwood	05/04	2M	Champ	olive	De la Cruz
Los Angeles	Brentwood	05/04	1M	Champ	olive	De la Cruz
Los Angeles	Torrance	05/06	1M	Champ	olive	Scott
Los Angeles	Rolling Hills Estates	05/07	1M	Champ	olive	Garcia
Los Angeles	Rolling Hills	05/07	1M	Champ	olive	Vargas
Los Angeles	Encino	05/07	1M	Champ	olive	Rodriguez
Los Angeles	Mar Vista	05/07	1M	Champ	olive	Medina
Los Angeles	Altadena	05/07	1M	Champ	olive	Montoya
Los Angeles	Cheviot Hills	05/10	1M	Champ	olive	Baeza
Los Angeles	Cheviot Hills	05/10	1F	Champ	olive	Baeza
Los Angeles	Rolling Hills	05/10	1M	Champ	olive	Garcia
Los Angeles	Miraleste	05/10	1F	Champ	olive	Pasillos
Los Angeles	Carson	05/10	1M	Champ	olive	Carlon
Los Angeles	Studio City	05/11	1M	Champ	olive	Rodriguez
Los Angeles	Rolling Hills Estates	05/11	1M	Champ	olive	Vargas
Los Angeles	Portuguese Bend	05/11	2M	Champ	olive	Cordova
Los Angeles	Rolling Hills Estates	05/11	1M	Champ	olive	Garcia
Los Angeles	Hacienda Heights	05/12	1M	Champ	olive	Moreno
Los Angeles	Mount Olympus	05/13	1M	Champ	olive	Mendoza
Los Angeles	Portuguese Bend	05/13	1M	Champ	lemon	Ortiz
Los Angeles	Rolling Hills	05/13	1M	Champ	ornamental	Ortiz
Los Angeles	Winnetka	05/14	1M	Champ	olive	Snyder
Los Angeles	Encino	05/14	1M	Champ	olive	Bell
Los Angeles	Brentwood	05/14	1M	Champ	olive	Baeza
Los Angeles	Studio City	05/14	1M	Champ	olive	Enciso
Los Angeles	Portuguese Bend	05/17	1M	Champ	olive	Bell
Los Angeles	San Pedro	05/17	1F	Champ	olive	Baezo
Los Angeles	Rolling Hills	05/17	1M	Champ	olive	Bell
Los Angeles	Sunland	05/18	1M	Champ	olive	Dominguez
Los Angeles	Bellflower	05/19	1M	Champ	avocado	Medina
Los Angeles	Claremont	05/19	1M	Champ	olive	Garcia
Los Angeles	Chatsworth	05/19	1M	Champ	olive	Pocasangre
Los Angeles	Altadena	05/19	2M	Champ	olive	De la Cruz
Los Angeles	Park la Brea	05/18	1M	Champ	olive	Mendoza
Los Angeles	San Pedro	05/18	1M	Champ	olive	Scott
Los Angeles	Rancho Palos Verdes	05/18	1F	Champ	olive	Moore
Los Angeles	Rolling Hills Estates	05/18	1M	Champ	olive	Tsou
Los Angeles	Rolling Hills Estates	05/18	1M	Champ	olive	Tsou

Olive Fruit Fly, *Bactrocera oleae*, -(A)- January-May, 1999 collections, continued

County	City	Date	#M/F/Stage	Trap	Host	Collector(s)
Los Angeles	Torrance	05/18	1M	Champ	olive	Tsou
Los Angeles	Rolling Hills Estates	05/18	1M	Champ	olive	Tsou
Los Angeles	Rolling Hills Estates	05/18	3M	Champ	olive	Tsou
Los Angeles	Los Feliz	05/19	4M	Champ	olive	Nuñez
Los Angeles	Rancho Palos Verdes	05/19	1M	Champ	olive	Baeza
Los Angeles	Redondo Beach	05/19	1M	Champ	olive	Moreno
Los Angeles	Torrance	05/19	1M	Champ	olive	Gomez
Los Angeles	Torrance	05/19	1M	Champ	olive	Vargas
Los Angeles	Rancho Palos Verdes	05/19	1M	Champ	olive	Moore
Los Angeles	Torrance	05/19	1F	Champ	olive	Gonzales
Los Angeles	Los Angeles	05/19	1M	Champ	olive	Nuñez
Los Angeles	Los Feliz	05/19	1M	Champ	olive	Nuñez
Los Angeles	Silverlake	05/20	1M	Champ	loquat	Carrera
Los Angeles	Palos Verdes Estates	05/21	1M/1F	Champ	olive	Tsou
Los Angeles	Santa Monica	05/21	1M	Champ	olive	Scott
Los Angeles	Los Angeles	05/21	1M	Champ	olive	Baeza
Los Angeles	Brentwood	05/21	1M	Champ	olive	Bell
Los Angeles	Torrance	05/21	2M	Champ	olive	Gomez
Los Angeles	Los Angeles	05/23	1M	Champ	olive	Vargas
Los Angeles	Los Angeles	05/24	1M	Champ	olive	Scott
Los Angeles	Culver City	05/25	1M	Champ	olive	Enciso
Los Angeles	Pasadena	05/25	1F	Champ	olive	Nuñez
Los Angeles	Glendale	05/25	1M	Champ	olive	Kendall
Los Angeles	Los Angeles	05/26	1M	Champ	olive	Vela
Los Angeles	North Hollywood	05/26	1F	Champ	olive	Torres

NEW STATE RECORDS

EUROPEAN CRANE FLY, *Tipula paludosa* -(A) - On April 16, 1999, Humboldt County Agricultural Biologist Dick Spadoni collected suspected European Crane fly (ECF) larvae from garden soil in McKinleyville, **Humboldt** County. These "leatherjackets", so named because of the tough leathery epidermis of the larvae, have been provisionally identified as European crane fly, *Tipula paludosa*, by CDFA Insect Biosystematist Eric Fisher. If correct, this is the first record of this insect from California.

(There is a possibility that this crane fly may prove to be *Tipula oleracea*, which is a very similar and closely related species. Also originally from Europe, *T. oleracea* has recently been found in Washington and northern Oregon. Available taxonomic literature [see fig. 2D & 2E] indicates our species is very probably *T. paludosa*. However, adult specimens [not yet found in California] will have to be examined before identification can be considered absolutely positive.)

Tipula paludosa is native to northwestern Europe and was first detected in North America in 1955 on Cape Brenton Island, Nova Scotia. It was first found on the west coast ten years later at Vancouver, British Columbia, and by 1966 had spread southward into the area around Blaine, Washington. By 1984 ECF had colonized the coastal area around the Puget Sound and isolated infestations were known from three counties in northwestern Oregon. It is not known if the current California find represents an isolated infestation or part of a larger one which extends down the Pacific Coast.

Adult crane flies have very long legs, and look like large mosquitos. Their body is about one inch long, not including the legs. Homeowners are alarmed when thousands of these large flies gather on the sides of homes. Although the crane fly does not bite, sting, or do damage to houses, its large numbers do excite homeowners.

Larvae of ECF feed primarily on grasses and can be damaging to lawns, pastures, and hayfields. In the Pacific Northwest damage by the immatures has been a major economic factor for individual dairy farmers. When feeding below the soil surface, larvae usually attack root hairs or roots and crowns. When above ground, they will feed on grass blades and stems. While grasses are preferred, a variety of plants (especially seedlings) can be attacked. Other recorded hosts include cole crops, clover, vegetables, flowers, and strawberries.

There is one life cycle per year. In the Pacific Northwest adults are active in the summer and fall with peak adult numbers generally occurring the last week of August and the first two weeks of September. Eggs are laid and hatch in September and the first two larval instars are completed by early October. The winter months are spent in the third instar. The third and fourth instars feed rapidly in the spring, and mature fourth instar larvae feed over summer. Pupation begins in early August. Adults emerge from late August through September.

Studies of the relationship between ECF and climate in northern Europe have shown that this species is favored by mild winters, cool summers and annual rainfall amounts averaging at least 24 inches. Given these parameters, only the north coastal strip of California extending as far south as perhaps San Francisco would be at risk for colonization.

References: http://coopext.cahe.wsu.edu

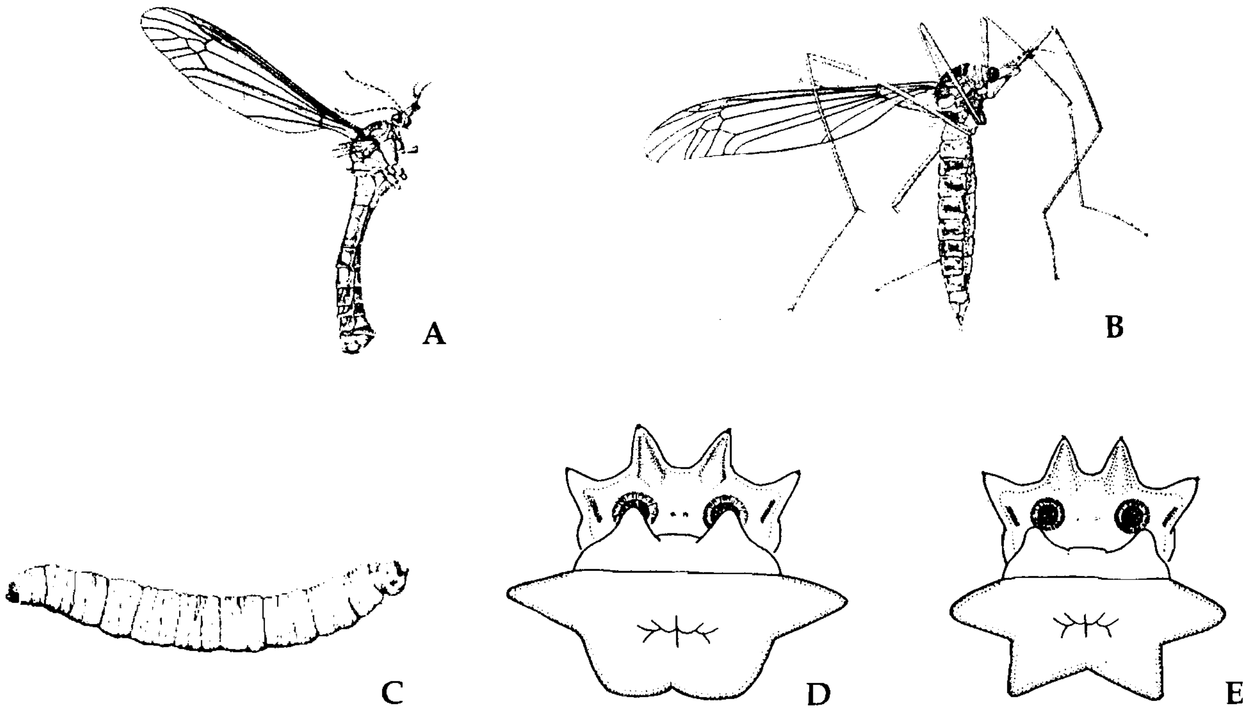

Fig. 2. European Crane Fly, *Tipula paludosa*, A: Male; B. Female; C. Larva,"leatherjacket"; D. posterior *T. paludosa*; E. posterior *T. oleracea*. The four anal papillae of *T. paludosa* larvae consist of one rounded ventral pair and one elongated lateral pair (Fig. 2D). *T. oleracea* is shown for comparison (Fig. 2E).

A GALL WASP, *Epichrysocharis* sp. -(Q)- An undescribed species of gall wasp native to Australia was found by a homeowner in San Pedro, **Los Angeles** County on February 8, 1999. This leaf galling wasp of lemon gum has also become generally distributed throughout **Orange** County on *Eucalyptus citriodora*. Collections have been made in Placentia, on March 31, 1999 and in Brea, on April 22, 1999. These collections were made in nurseries by Brad Sanford. Both *Epichrysocharis* sp. and the vein galling wasp *Aprostocetus* sp. [see CPPDR 14(1-2):5-6] can be found on the same leaves of landscape *Eucalyptus citriodora* in most areas in Orange County. *Epichrysocharis* wasps are tiny, approximately 1mm in length and black in color. Galls of *Epichrysocharis* wasps are about 1mm scattered across on the leaf blades, as opposed to the small tan colored galls on the midvein caused by *Aprostocetus* wasps.

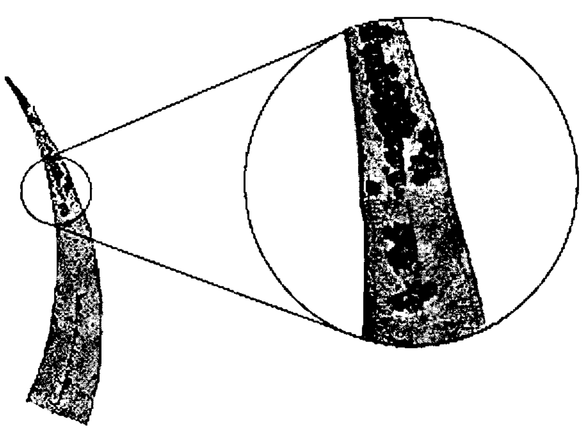

Fig. 3. Picture of leaf damage caused by *Epichrysocharis* sp.

COCONUT ERIOPHYID MITE, *Aceria guerreronis* -(Q)- Recently, a discovery of eriophyid mites attacking queen palm was reported in California. Several specimens were collected from queen palm trees in a nursery in Trabuco Canyon, **Orange** County, and based on a comparison of specimens with types at the USNM collection, were identified by Ronald Ochoa, mite specialist at SEL, as *Aceria guerreronis*. An understanding of the distribution in California and the impact of *Aceria guerreronis* on queen palm and coconut palm is important. This mite is a serious pest. According to Ochoa, the mite can cause from 30 to 60% losses in production of coconuts. This introduction for the state, plus the new host record, is a serious threat for the ornamental palm business in several states in the US such as Texas and Arizona, where ornamental palms are very popular.

Originally described from Cerca Coyuca, Guerrero, Mexico, this mite has since been a serious pest in Central America, namely El Salvador. Other countries include Venezuela, Colombia, and Asia (Phillipines). There is a US record in Florida in 1984.

The coconut eriophyid mite, *Aceria guerreronis,* was first described in 1965 from specimens received from Mexico. It was reported to damage the floral bracts and scar the young developing nuts. In later years it was reported from different parts of the world where coconut is being grown. Prior to this discovery on queen palm, the mite was specific to coconut and had not been reported from any other host.

This mite was reported as a serious pest of coconut in Kerala during 1997-98. Observations made by scientists and coconut farmers of Tamil Nadu revealed the presence of this mite in alarming proportions in Pollachi, Udumalpet, Anaimalai and Vettaikaranpudur areas of Coimbatore District. Hence studies were taken up on the management and control of this eriophyid mite on coconut.

Adults of this mite have a worm like body measuring 200-250 microns length and about 40 micron thickness, having two pairs of legs in the anterior, combined head and thorax portion of the mite, which is called the cephalothorax. The abdominal portion is studded with microtuberels in a series of rings. The anal opening is terminal while the genital opening is anteriorly placed below the leg base.

The mites live below the perianth of the coconut buttons and developing nuts. They pierce the tender tissue there and feed on the sap which causes the death of the cells. The female mites lay about 20 to 100 eggs during their life time. The eggs are glassy, transparent and measure about 35 microns in diameter. Eggs hatch in about 2 days and the first instar nymph emerges. It feeds on the tissue sap and moults after 2 days to become the second stage nymph. The second stage nymph reaches the adult stage in about 2-3 days. The nymphal stages are usually sedentary and do not move much. The adults usually move out of the perianth when populations increase and move over the exposed portions of the developing nuts where from they are blown off by wind and get transported to new coconut buttons where they enter below the perianth and start new colonies.

The earliest symptom of attack on the coconut buttons is a triangular patch, yellow in color emerging out from below the calyx. Later these patches turn brown due to the death of the cells.

As the nut grows, these brown patches lead to warting and longitudinal fissures in mature nuts. Because of the drying of the outer tissues of the coconut, the enlargement of the nut is affected leading to drastic reduction in size of the coconut and copra. Severe infestation in the early button stage leads to heavy button shedding leading to loss in yield of nuts. The affected nuts are usually discarded by the coconut merchants since the oil content in the copra is less and the husk is discarded by the coir fiber industry.

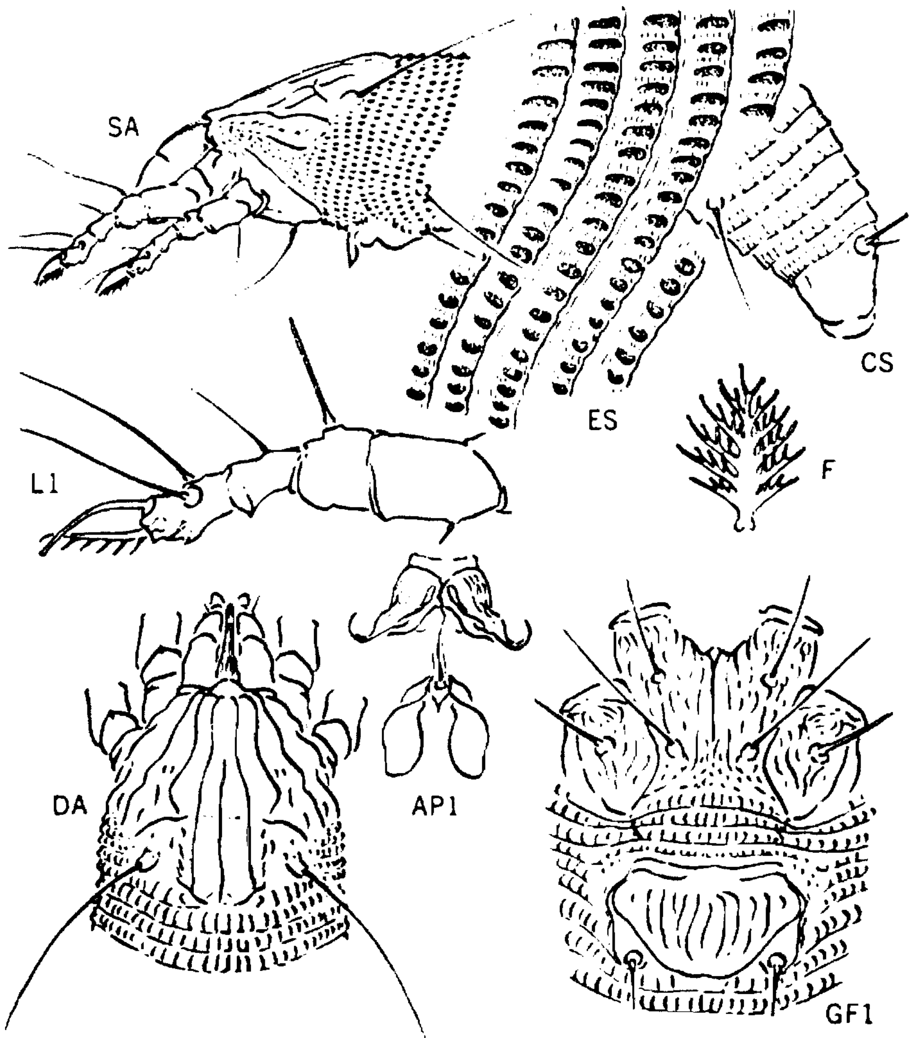

Fig. 4. *Aceria guerreronis.*

SA- Side view of anterior section of mite.
ES- Side skin structures
CS- Side view caudal section of mite
L1- First left leg
F- Featherclaw (empodium)
DA- Dorsal view of mite
AP1- Internal female genital structures
GF1- Female genitalia and coxae

Illustrations by H.H. Keifer, Eriophyid Studies, 1965.

CORIANDER APHID, *Hyadaphis coriandri* -(Q)- This aphid was collected from samples of coriander (cilantro) in March, 1999 in **Ventura**, **Riverside**, and **Imperial** Counties.

Appearance in life: Winged adults are rather small, broadly oval, rather short-legged aphids, mainly dirty greenish in color with dark green dorsal mottling and rust-red patches around the bases of the short, dark brown siphunculi; in life the body is variably dusted with white mealy wax. Winged forms have a pale green abdomen with black dorsal markings, and reddish-brown patches around the siphuncular bases. Apterae and alatae 1.3 - 2.1 mm.

Host plants: Apparently capable of colonizing numerous species of Umbelliferae (*Anethum, Carum, Coriandrum, Cuminum, Daucus, Foeniculum, Pimpinella*); *Coriandrum* is particularly susceptable to attack. It is also occasionally found colonizing plants outside the Umbelliferae (*Mentha longifolia, Amaranthus spinosus, Glycine max*).

Distribution: Portugal, Spain, the Mediterranean region, the Middle East, Central Asia, India, Pakistan, and Africa.

A palaearctic genus of about 15 described species associated with Caprifoliaceae and/or Umbelliferae. The best-known species alternate between *Lonicera* (honey suckle) and the aerial parts of Umbelliferae. Morphologically, *Hyadaphis* are similar to *Lipaphis*, and both these genera were placed in *Rhopalosiphum* in some earlier accounts. There are no keys to the world fauna.

There may be a connection between this aphid and the new virus disease of coriander [see CPPDR vol. 17(4-6):49]. The aphid has been found in some but not all of the areas where the virus occurs.

AN ANT, *Hypoponera gleadowi* -(Q)- This ant was collected in Long Beach, **Los Angeles** County on January 10, 1999 by Michael Martinez.

Workers are characterized as having a total length of about 2.5 mm. Their body color is yellow to yellowish brownish. Scapes do not reach the median posterior border of the head. The eyes of *Hypoponera gleadowi* workers are of 1-3 facets, situated very near the posterior margin of clypeus (the distance from clypeus to anterior margin of eyes is twice the eye diameter). The petiole is thick and 1.5 times as broad as thick, and the subpetiolar process is subtriangular. Ponerines have the gaster, or the large posterior part of the abdomen (excluding the subpetiolar process), appearing to have two distinct sections (see figure 5A below).

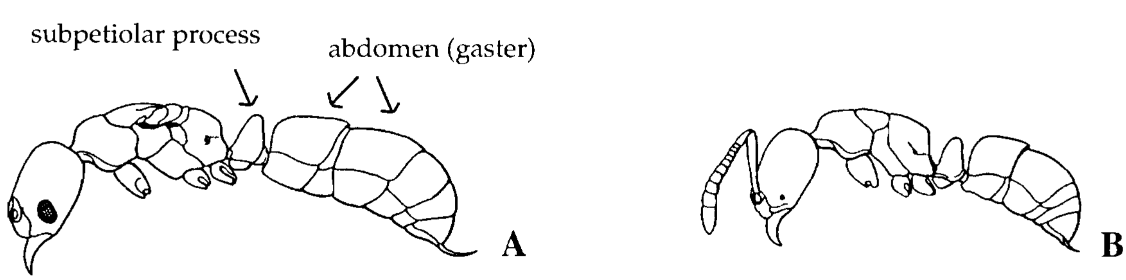

Fig. 5. *Hypoponera gleadowi*. A: queen; B: worker.

NEW COUNTY RECORDS

AFRICANIZED HONEY BEE (AHB), *Apis* "Africanized" -(B)- AHB was found for the first time in **Orange** County on March 1, 1999 in Seal Beach. On March 22, 1999, AHB was found in **Kern** County, in California City. For additional information on AHB, see page 5.

CURRANT-LETTUCE APHID, *Nasonovia ribis-nigri* -(Q)- This recently discovered lettuce pest has been found in three new counties. On January 21, 1999, Mike Lahti found this aphid in Menifee, **Riverside** County. It was discovered in El Centro, **Imperial** County on January 11, 1999. Jerry Davidson collected it in Santa Maria, **Santa Barbara** County on March 22, 1999.

EUCALYPTUS PSYLLID, *Ctenarytaina spatulata* -(Q)- First found as an undescribed species in 1991 at Tustin, Orange County [CPPDR 10(3-4):42]. This species is also expanding its range in California. Collections were made by CDFA Detection Entomologists Dick Penrose and Art Gilbert at San Diego, **San Diego** County on April 22, 1999.

VINE MEALYBUG, *Planococcus ficus* -(B)- This mealybug was found for the first time in **Fresno** County when it was collected in the Del Rey section of Parlier by Walt Bentley on October 15, 1998.

REDGUM LERP PSYLLID, *Glycaspis brimblecombei* -(Q)- First found in North America outside the Ag Commissioner's office in Los Angeles County [CPPDR 17(1-3):7-8], this psyllid pest is proving to be a serious nuisance. Its range is expanding rapidly and is now found in **San Diego** County. The collection was made by Dick Penrose and Art Gilbert in San Diego on April 22, 1999. Additional collections were made in Napa, **Napa** County, on June 4, 1999 by Tim Allen. This psyllid now occurs in Alameda, Los Angeles, Napa, Orange, San Bernardino, San Diego, San Mateo, and Santa Clara counties.

A LYGAEID BUG, *Rhyparochromus saturnius* -(Q)- First found in 1998 in Central California, ths European lygaeid was then found scattered all over the state west of the Sierra. The most recent find was in **San Bernardino** County on November 4, 1998.

EUGENIA PSYLLID, *Trioza eugeniae* -(C)- Found for the first time in **Sacramento** County at a nursery in Carmichael on April 27, 1999. This Australian psyllid was first found in California in 1988 [CPPDR 7(1-4):12-13]. Serious injury to eugenia hedges has been alleviated by introduction of natural enemies.

CITRICOLA SCALE, *Coccus pseudomagnoliarum* -(C)- This soft scale has been in California for many years, mostly in the San Joaquin Valley and Riverside County, where it was an occasional pest of citrus. Pesticides used for California red scale have kept it in check, although with increasing use of biocontrol for red scale, this pest is again becoming important. Also it has become a problem on hackberry (*Celtis* sp.). It was found on hackberry by Jim Xerogeanes in Ukiah, **Mendocino** County on May 6, 1999. Ray Gill found it on hackberry at Independence, **Inyo** County on May 27, 1999.

SIGNIFICANT FINDS IN OTHER STATES

CITRUS LONGHORNED BEETLE, *Anoplophora chinensis*-(Q)- Adults of the citrus longhorned beetle (CLB), *Anoplophora chinensis* (Forster) (Coleoptera: Cerambycidae), were reported the week of April 26, 1999 crawling on crape myrtle *(Lagerstroemia indica)* pen king (bonsai) from China in a greenhouse in Athens, Georgia. CLB is a serious orchard pest, particularly of citrus, and is distributed widely in China. It probably could establish in the United States, especially in southern states. This beetle is basically identical in appearance to the Asian longhorned beetle *(Anoplophora glabripennis)* that is causing serious injury to hardwood trees, and is under eradication in New York and Illinois [see CPPDR 17(1-3):20].

Inspect for this beetle in propagative shipments of trees and shrubs from China. Adults emerge from April to August and are most common in May to July in China, but larvae may be present throughout the year. CLB lays eggs on the lower portion of host trunks or on exposed roots. Females cut T-shaped slits in the bark where they deposit eggs, but at this time, we have no information on how obvious oviposition sites are. Larvae are root and stem borers and are as large as the Asian longhorned beetle larvae, measuring up to 56 mm long and 10 mm wide.

CLB attacks a wide variety of living hardwood trees and possibly some conifers. Primary hosts include citrus, [lime *(Citrus aurantifolia)*, sour orange *(Citrus aurantium)*, mandarin lime *(Citrus limonia)*, pummelo *(Citrus grandis)*, tangor *(Citrus nobilis)*, and *Citrus sinensis* (sweet orange)]. Other reported hosts are pecan *(Carya illinoiensis)*, pear *(Pyrus)*, mulberry *(Morus)*, paper mulberry *(Broussonetia papyrifera)*, pigeon pea *(Cajanus cajan)*, Australian pine or beefwood-tree *(Casuarina equisetifolia)*, willow *(Salix)*, hibiscus *(Hibiscus)*, China-berry or Indian lilac *(Melia azedarach)*, apple *(Malus)*, poplar or aspen *(Populus)*, sycamore or plane tree *(Platanus)*, fig *(Ficus)*, litchi *(Litchi sinensis)*, oval kumquat *(Fortunella margarita)*, and Japanese red cedar *(Cryptomeria japonica)* [CAB International Crop Compendium]. Crape myrtle apparently represents a new host record for this beetle. Other trees or shrubs not formerly recorded as hosts may harbor CLB as well.

PINE SHOOT BEETLE, *Tomicus piniperda* -(Q)- This important pest of conifers has been a problem in several northeastern states. Among these are Indiana, New York, Pennsylvania, West Virginia, Wisconsin, and Vermont. See CPPDR 11(3-4):50-52 for additional information on this pest.

SMALL HIVE BEETLE, *Aethina tumida* -(Q)- This beetle, native to South Africa where it is known as an apiary pest, was first found in Florida in the spring of 1998 [see CPPDR 17(1-3:20)]. It has since been reported in South Carolina, Georgia, and Ohio. Its presence is of concern due to its potential detriment to the apiary industries.

EXCLUSION

Many pest species are collected every year on incoming or newly arrived nursery stock or other similar quarantine situations that are not considered to be established in the state. The following are examples of such rated pests found during the past year up to April.

LARGE COTTONY SCALE, *Pulvinaria mammeae* -(Q)- Found in a nursery in Ventura, **Ventura** County on May 18, 1999 by Charles Gribble and Hope Gerry. The collection was made on litchee nut.

MINING SCALE- *Howardia biclavis* - (A)- This serious pest was found in a nursery in North Hollywood, **Los Angeles** County on August 26, 1998. Warren Dias found the insect on *Ficus benjamina.*

BORDER STATIONS

Several notable pests have been intercepted during the past four months at border stations. Bean leaf beetle, originating in Texas, was found at the Vidal station. Zebra mussel from Ohio was found at Needles and Truckee stations. At Hornbrook, vanda orchid scale from Oregon was found, and red orchid scale from Florida was found at Blythe. For additional information on quarantine and border station interceptions, see pages 23-27.

Border Stations

Important "A", "B", and "Q" Rated Arthropods and Mollusks Intercepted through May 1999

Pest	Station	Date	Origin	Collector	Host
gracillariid moth-*Conopomorpha* sp.	HO	09/05/98	Washington	Martinez	*Euphoria longan*
boll weevil-*Anthonomis grandis*	NE	09/25/98	Texas	Mangin	*Gossypium* sp.
European corn borer-*Ostrinia nubilalis*	YE	09/29/98	Illinois	Tracy	*Zea mays*
an olethreutine moth-*Grapholita* sp.	NE	10/06/98	Maine	Derichsweiler	*Malus* sp.
hickory shuckworm-*Cydia caryana*	LO	10/10/98	Oklahoma	McCollum	*Carya* sp.
boll weevil-*Anthonomus grandis*	BL	10/10/98	Texas	Perez-Argueta	*Gossypium* sp.
an ant-*Ponera* sp.	NE	10/15/98	Arkansas	Derichsweiler	*Citrus* sp.
Oriental scale-*Aonidiella orientalis*	WI	10/16/98	Florida	Berryman	palm tree
carpenter ant-*Camponotus* sp.	BL	10/22/98	Florida	Tennefos	household goods
European corn borer-*Ostrinia nubilalis*	YE	10/24/98	South Dakota	Tracy	*Zea mays*
European corn borer-*Ostrinia nubilalis*	NE	10/29/98	South Dakota	Aragon	*Zea mays*
bean leaf beetle-*Cerotoma trifurcata*	VI	11/01/98	Texas	Dupes	trailer
vanda orchid scale-*Genaparlatoria pseudaspidiotus*	HO	11/02/98	Oregon	Whitman	*Mangifera indica*
garden bagworm-*Apterona helix*	NE	11/06/98	New York	Derichsweiler	RV wheel
whitemarked tussock moth-*Orgyia leucostigma*	WI	11/13/98	Massachusetts	Neuwerk	under trailer/camper
red orchid scale-*Furcaspis biformis*	BL	11/15/98	Florida	Klingenmeier	tee pee palm
a whitefly-*Aleurotulus* sp.	BL	11/15/98	Florida	Klingenmeier	tee pee palm
pickleworm-*Diaphania nitidalis*	VI	11/21/98	Mexico/AZ	Granger	trailer
sweet potato weevil-*Cylas formicarius*	NE	11/25/98	Florida	Burgess	*Ipomoea batatas*
an ant-*Ponera* sp.	BL	12/19/98	Louisiana	Kane	*Quercus* sp.
red imported fire ant-*Solenopsis invicta*	WI	12/22/98	Florida	Vasquez	plants/soil
pink bollworm-*Pectinophora gossypiella*	BL		Arizona	Christy	*Gossypium* sp.
an armored scale-*Melanaspis elaeagni*	BL	12/22/98	Texas	Klingenmeier	*Diospyros* sp.
arrowhead scale-*Unaspis yanonensis*	RE	12/23/98	China	Blakely	*Citrus reticulata*
rufous scale-*Selenaspidus articulatus*	VI	12/27/98	Ecuador/AZ	Granger	*Mangifera indica*
rufous scale-*Selenaspidus articulatus*	VI	12/27/98	Peru/FL	Granger	*Mangifera indica*
a gracillariid moth-*Marmara* sp.	HO	12/28/98	Washington	Bridges	*Citrus paradisi*
a gracillariid moth-*Marmara* sp.	HO	12/28/98	Washington	Bridges	*Citrus paradisi*
arrowhead scale-*Unaspis yanonensis*	RE	01/03/99	China/Canada	Bledsoe	*Citrus reticulata*
a gracillariid moth-*Marmara* sp.	NE	01/08/99	Massachusetts	Brown-Dollins	*Citrus sinensis*
red imported fire ant-*Solenopsis invicta*	WI	01/28/99	Texas	Klingenmeier	bees
sugarcane borer-*Diatraea saccharalis*	BL	01/29/99	Mexico	Villa	*Saccharum officinarum*
zebra mussel-*Dreissena polymorpha*	TR	01/31/99		Baldridge	boat
an ant-*Odontomachus* sp.	WI	02/17/99	Florida	Deleon	nursery stock
a mealybug-*Pseudococcus odermatti*	BL	02/10/99	Florida	Klingenmeier	*Citrus reticulata*
carpenter ant-*Camponotus* sp.	WI	02/19/99	New Jersey	Berryman	*Quercus* sp.
a weevil-*Conotrachelus* sp.	BL	02/13/99	New York	Saldivar	trailer
an ant-*Crematogaster* sp.	BL	02/07/99	Mexico	Klingenmeier	breadfruit

Pest	Station	Date	Origin	Collector	Host
hickory shuckworm- *Cydia caryana*	BL	02/12/99	Texas	Villa	*Carya illinoiensis*
woolly whitefly-*Aleurothrixus floccosus*	VI	02/10/99	Florida	Calvery	*Citrus sinensis*
a weevil-*Cylas* sp.	BL	03/30/99	Florida	Klingenmeier	Boniatos
hickory shuckworm-*Cydia caryana*	NE	03/03/99	New Mexico	Guthrie	*Carya illinoiensis*
zebra mussel-*Dreissena polymorpha*	NE		Ohio	Bryant	boat
gypsy moth-*Lymantria dispar*	NE	03/01/99	Michigan	Martinez	patio table
sugarcane borer-*Diatraea saccharalis*	BL	02/03/99	Mexico	Klingenmeier	*Saccharum officinarum*
gypsy moth-*Lymantria dispar*	TR	03/17/99	New York	Anderson	picnic bench
gypsy moth-*Lymantria dispar*	YE	03/04/99	Ohio	Morris	barbeque grill wheel

Important "A", "B", and "Q" Rated Arthropods and Mollusks Intercepted in Quarantine through May 1999

Rating	Species	Common Name	Date	Origin	County	Host	Collector(s)
Q	*Rhizoecus americanus*	soil mealybug	10/21/98	Florida	ORA	*Ravenea rivularis*	Fernandez
Q	*Rhizoecus hibisci*	root mealybug	10/19/98	Florida	SDG	*Ravenea rivularis*	Matsumoto
A	*Hemiberlesia palmae*	tropical palm scale	09/29/98	Florida	SBA	*Aechmea* sp.	Davidson
B	*Diaphania nitidalis*	pickleworm	10/16/98	Dom. Republic	SMT	*Tindora*	Garibaldi
Q	*Drepanococcus chiton*	soft scale	10/20/98		SCL	*Euphoria longan*	Pastalka
A	*Parlatoria blanchardi*	parlatoria date scale	09/25/98	New York	LAX	palm fronds	Matsumoto
Q	*Aleuroclava jasmini*	jasmine whitefly	11/17/98		ALA	curry leaves	Eaton
Q	*Arhopalus* sp.	longhorned beetle	10/21/98	Italy	SFO	wood packing material	Hinton
Q	*Rhizoecus hibisci*	root mealybug	11/13/98	Hawaii	LAX	*Rhapis* sp.	Dias
A	*Pseudococcus cryptus*	a mealybug	11/13/98	Florida	ORA	*Ficus benjamina*	Fernandez
Q	*Lochmaeus bilineata*	a notodontid moth	11/09/98	Florida	SAC	cut plumosus	Bianchi
A	*Parlatoria proteus*	sansevieria scale	11/04/98	Guatemala	SJQ	*Dracaena sanderana*	Curry
Q	*Aleuroplatus* sp.	a whitefly	11/19/98	Costa Rica	SJQ	*Croton* sp.	Curry
Q	*Aleurotrachelus* sp.	a whitefly	11/04/98	Hawaii	SMT	lalop	Loux
Q	*Automeris io lilith*	io moth	11/09/98	Florida	SJQ	ferns	Lanchester
A	*Adoretus sinicus*	Chinese rose beetle	12/30/98	Hawaii	SMT	*Ocimum basilicum*	Loux
A	*Chrysodeixis eriosoma*	green garden looper	11/09/98	Hawaii	ALA	*Ocimum basilicum*	Beauregard
Q	*Hemiberlesia diffinis*	diffinis scale	12/15/98	Florida	ORA	*Ficus benjamina*	Fernandez
A	*Morganella longispina*	plumose scale	12/15/98	Florida	ORA	*Ficus benjamina*	Fernandez
Q	*Coccus acutissimus*	slender soft scale	12/02/98	Hawaii	ORA	*Cycas revoluta*	Barnes
A	*Spodoptera latifascia*	an armyworm	12/04/98	Florida	SCL	*Halepa* "basil"	Nachand
B	*Pseudococcus elisae*	elisa mealybug	12/16/98	Costa Rica	SJQ	*Dracaena marginata*	Lanchester
Q	*Sophonia rufofascia*	a leafhopper	12/10/98	Hawaii	SBA	cut flowers	Davis
Q	*Anoplolepis longipes*	longlegged ant	12/22/98	Hawaii	SFO	*Zingiber* sp.	Albrecht
Q	*Atractomorpha ambigua*	a grasshopper	12/10/98	Hawaii	SCL	*Ocimum basilicum*	Nachand
Q	*Paraleyrodes* sp.	a whitefly	12/29/98	Hawaii	SCL		Nachand
Q	*Phenacoccus emansor*	lily mealybug	12/22/98		SMT	*Ornithogalum* sp.	Garcia
Q	*Pseudococcus odermatti*	a mealybug	12/21/98	Florida	VEN	tangelo	Alamillo
Q	*Gomphadorina* sp.	Madagascar hissing roach	10/27/98		SUT		Furuta
Q	*Veronicella* sp.	a slug	01/08/99	Hawaii	SDG	*Veitchia* sp.	Elliot
Q	*Thysanofiorinia nephelli*	longan scale	10/15/98	Florida	ORA	*Dimocarpus longan*/ *Psidium* sp.	Gibbs
Q	*Pseudococcus odermatti*	a mealybug	12/23/98	Florida	VEN	navel orange/grapefruit	Alamillo
B	*Pulvinaria urbicola*	urban soft scale	10/15/98	Florida	ORA	*Dimocarpus longan*/ *Psidium* sp.	Gibbs

Rating	Species	Common Name	Date	Origin	County	Host	Collector(s)
A	*Selenothrips rubrocinctus*	redbanded thrips	10/15/98	Florida	ORA	*Dimocarpus longan*/ *Psidium* sp.	Gibbs
A	*Phyllocnistis citrella*	citrus leafminer	01/25/99	Thailand	FRE	*Citrus hytrix*	Vasquez
A	*Phyllocnistis citrella*	citrus leafminer	01/25/99	Thailand	FRE	*Citrus hytrix*	Lebarron
Q	*Pseudaonidia trilobitiformis*	trilobe scale	10/15/98	Florida	ORA	*Dimocarpus longan*/ *Psidium* sp.	Gibbs
B	*Pseudococcus elisae*	elisa mealybug	12/30/98	Hawaii	VEN	*Stephanotis* sp.	Alamillo
A	*Parlatoria ziziphi*	black citrus scale	01/26/99	Thailand	FRE	ya nang leaves	Vasquez
A	*Phyllocnistis citrella*	citrus leafminer	01/26/99	Thailand	FRE	ya nang leaves	Vasquez
A	*Ceroplastes rubens*	red wax scale	01/15/99	Florida	ORA	*Aglaonema* sp.	Barnes
A	*Coccus acutissimus*	slender soft scale	10/15/98	Florida	ORA	*Dimocarpus longan*/ *Psidium* sp.	Gibbs
Q	*Anoplolepis longipes*	longlegged ant	01/05/99	Hawaii	SMT	*Zingiber* sp.	Garibaldi
Q	*Rhizoecus hibisci*	root mealybug	01/14/99	Florida	ORA	*Ravenea rivularis*	Kinsella
A	*Saccharicoccus sacchari*	pink sugarcane mealybug	01/26/99	Hawaii	ALA	*Cordyline terminalis*	Peek
A	*Ceroplastes rusci*	fig wax scale	01/26/99	Florida	SCL	*Ficus benjamina*	Irons
Q	*Aspidiotus* sp.	an armored scale	10/19/98		LAX	*Garcinia mangostana*	Cochrane
A	*Bactrocera dorsalis*	Oriental fruit fly	10/19/98		LAX	*Euphoria longan*	
B	*Ferrisia virgata*	striped mealybug	09/29/98	Texas	ALA	*Diospyros* sp.	Wion
Q	*Laminicoccus* sp.	a mealybug	10/19/98		LAX	*Garcinia mangostana*	Keller
Q	*Aceria annonae*	an eriophyid mite	11/19/98	Puerto Rico	ALA	*Annona* sp.	Wion
Q	*Aceria lycopersici*	tomato erineum mite	11/19/98	Puerto Rico	ALA	*Lycopersicon* sp.	Wion
A	*Cylas* sp.	a weevil	10/28/98	Texas	LAX	*Ipomoea batatas*	
A	*Selenothrips rubrocinctus*	redbanded thrips	12/08/98	Texas	ALA	*Averrhoa carambola*	Wion/Slate
B	*Dasineura balsamicola*	balsam fir gall midge	12/08/98	Pennsylvania	LAX	*Pinus* sp.	Dayyani
Q	*Puto mexicanus*	Mexican giant mealybug	12/30/98	Mexico	LAX	*Tejocotes*	Arellano
Q	*Puto mexicanus*	Mexican giant mealybug	12/19/98	Mexico	ORA	*Tejocotes*	Arellano
Q	*Puto mexicanus*	Mexican giant mealybug	12/31/98	Mexico	LAX	*Tejocotes*	Arellano
Q	*Pseudococcus bryberia*	a mealybug	01/07/99		MAD	nursery plants	Brar
A	*Aspidiotus destructor*	coconut scale	01/19/99	Florida	SBA	*Strelitzia* sp./*Phoenix roebelenii*	Davis
Q	*Aleuroclava jasmini*	jasmine whitefly	02/05/99		ALA	curry leaf	Grazzini
Q	*Aleuroclava jasmini*	jasmine whitefly	02/20/99		ALA	curry leaf	Grazzini
Q	*Sophonia rufofascia*	a leafhopper	02/17/99	Hawaii	LAX	cut fowers	Marquez
A	*Ceroplastes rubens*	red wax scale	02/12/99	Hawaii	LAX	wreath	Dias
Q	*Clavaspis* sp.	an armored scale	02/16/99		LAX	*Plumeria* sp.	Ruse
Q	*Ecpantheria muzina*	an arctiid moth	01/29/99	Texas	MER	bee hives	Piper

Rating	Species	Common Name	Date	Origin	County	Host	Collector(s)
Q	*Ecpantheria muzina*	an arctiid moth	01/29/99	Texas	MER	bee hives	Piper
Q	*Amorbia* sp.	a leafroller	02/19/99	Hawaii	LAX	*Cymbidium* sp.	Regis
Q	*Anoplolepis longipes*	longlegged ant	02/05/99	Hawaii	LAX	cut flowers	Marashi
Q	*Rhizoecus hibisci*	root mealybug	02/22/99	Hawaii	ORA	*Prychosperma macarthurii*	Fernandez
Q	*Pinnaspis uniloba*	unilobed scale	02/16/99	Hawaii	SDG		Amador
Q	*Mapsidius* sp.	a scythrid moth	01/28/99	Hawaii	SCL	*Dracaena fragans*	Khokhar
Q	*Orchamoplatus mammaeferus*	croton whitefly	02/26/99	Hawaii	SDG	*Myrtle lei*	Dobbins
Q	*Orchamoplatus mammaeferus*	croton whitefly	01/29/99	Hawaii	SMT	*Alyxia olivaeformis*	Garibaldi
A	*Ceroplastes rubens*	red wax scale	02/26/99	Hawaii	SDG	*Myrtle lei*	Dobbins
A	*Ceroplastes rusci*	fig wax scale	02/08/99	Florida	SCL	*Ravenea rivularis*	Fairbanks
Q	*Chloridolum* sp.	a longhorned beetle	02/16/99	Singapore	SMT	wooden pallets	Loux
Q	*Aleurotulus anthuricola*	anthurium whitefly	02/12/99	Hawaii	RIV	*Anthurium* sp.	Chandler
A	*Phyllocnistis citrella*	citrus leafminer	02/18/99	Thailand	YUB	*Citrus* sp.	Storm
A	*Parlatoria ziziphi*	black citrus scale	02/18/99	Thailand	YUB	*Citrus* sp.	Storm
Q	*Greenidia formosana*	an aphid	02/24/99		VEN	myrtle	Gerry
A	*Gymnaspis aechmeae*	aechmea scale	02/05/99	Florida	SLO	bromeliad	Focha
Q	*Hypothenemus* sp.	a scolytid beetle	03/24/99	Hawaii	SCL		Khokhar
Q	*Coccus acutissimus*	slender soft scale	02/01/99	Hawaii	SMT	sago palm	Loux
A	*Coccus viridis*	green scale	02/02/99	Hawaii	SMT	*Zingiber* sp.	Swanson
Q	*Coptosoma xanthogramma*	black stink bug	03/22/99	Hawaii	SMT	*Ananas comosus*	Thomas
Q	*Rhizoecus hibisci*	root mealybug	02/21/99		LAX	*Phoenix roebelenii*	Dias
B	*Diaphania nitidalis*	pickleworm	03/03/99	Florida	ALA	*Tindora*	Gonsalves
B	*Diaphania nitidalis*	pickleworm	02/04/99	Florida	ALA	*Tindora*	Gonsalves
Q	*Rhizoecus americanus*	soil mealybug	02/21/99		LAX	*Phoenix roebelenii*	Dias
Q	*Aleurocerus* sp.	palm whitefly	03/08/99	Florida	SAC	tea leaves	Hightower
Q	*Aleuroclava jasmini*	jasmine whitefly	03/06/99		ALA	curry leaf	Grazzini
Q	*Aleuroclava anthuricola*	anthurium whitefly	02/24/99	Hawaii	RIV	*Anthurium* sp.	Lahti
A	*Ceroplastes rubens*	red wax scale	03/16/99	Florida	LAX	*Euphoria longan*	Sium
Q	*Coccus acutissimus*	slender soft scale	03/16/99	Florida	LAX	*Euphoria longan*	Sium
A	*Ceroplastes floridensis*	Florida wax scale	03/15/99	Florida	SCL	*Ficus benjamina*	Fairbanks
A	*Ceroplastes rusci*	fig wax scale	03/16/99	Florida	ORA	*Phoenix roebelenii*	Kinsella
A	*Furchaspis biformis*	red orchid scale	05/29/99	Hawaii	SON	orchid leaves	Bryant

NEMATOLOGY HIGHLIGHTS

The White-Tip of Rice Nematode in California*

John J. Chitambar,
Senior Plant Nematologist, California Department of Food and Agriculture
*(Presented at the 31st California Nematology Workshop, March 29, 1999, Yuba City, California)

The White-tip of Rice Nematode is an economic pest of rice in many countries. Recent detections of this nematode in California have sparked interest and concern by California's rice industry. A detailed overview of the nematode's biology, disease development, detection and impact on rice production are discussed here.

Introduction
The disease of rice which is now called "White- tip" was originally described 1915 in Japan, and in 1935 USA under different names. In Japan it was first called "black grain disease" caused by a nematode that was similar to another nematode that caused "ear blight" on Italian millet. Later, a disease of rice was described as "heart blight" caused by a nematode, *Aphelenchoides oryzae*. It was determined that *A. oryzae* was also responsible for black grain and ear blight disease of rice and millet respectively.

In the USA, white-tip symptoms on rice was first attributed to iron or magnesium deficiency, and/or an imbalance in the magnesium/calcium ratio. In 1949, Cralley established that the disease symptoms on rice were caused by a nematode, and similar to those symptoms on rice reported from Japan. *Aphelenchoides oryzae* was found to be identical to *A. besseyi*, a parasite of strawberry described by Christie in 1942 (Allen, 1952). This latter name has since prevailed.

Distribution
White-tip Nematode has been reported from most rice-growing countries throughout the world. It has been discovered on rice and other hosts in the following locations:

Africa: It has been found in several countries, such as, Cameroon, Central African Empire, Kenya, Madagascar, Malawi, Mali, Nigeria, Rhodesia, Senegal, Sierra Leone, Tanzania, Eastern Uganda, Upper Volta, and Zambia.
Middle East: it has been found in Egypt and Israel.
Eastern and southern Asia: India (Cuttack, Tamil Nadu, Kerala, Madras, Orissa), Bangladesh, Sri Lanka, Malaysia, Thailand, Philippines, Japan, Korea,Taiwan, China, Vietnam.
Europe: USSR (Krasnodar region), Central Asia, Uzbekistan and finally from all rice growing areas. Also from Hungary, Bulgaria, Italy (Bari).
The Americas: White-tip nematode was first discovered on strawberry in the USA. All the rice-growing areas, namely, Louisiana, Texas, and Arkansas. Also found on ornamental plants in Florida. Brazil (on rice in Bahia, Minas Gerais State, Sao Paulo, and Guadeloupe), Mexico, Cuba, Dominican Republic (Santa Domingo), El Salvador, French West Indies (yams).
The Pacific islands: on strawberry in Queensland, Australia, Fiji, New Guinea, Hawaii (numerous hosts other than rice).

Hosts

Aphelenchoides besseyi attacks a wide range of plants. While rice is an important economic host worldwide, others include: strawberry (*Fragaria chiloensis* var. *ananassa*: USA), onion (Thailand), garlic (Brazil), sweet corn (Thailand), sweet potato (Pakistan), soybean, yam (Guadeloupe), chinese cabbage (Philippines), sugar cane (Cuba), horse radish, lettuce (Brazil), millet (*Setaria italica, S. viridis*: Japan), Grasses: *P. maximum* var. *trichoglume* (Queensland, Australia), *Panicum crus-galli, P. bisulcatum, Digitaria adscendens, D. sanguinalis* (Japan), *Sporobolus poiretti* (Florida), *Pennisetum typhoides*, Ornamentals: orchids (*Dendrobium* sp. Lady Fay, *Phalenopsis* spp., *Cattleya* spp., *Vanda* spp.: Hawaii), *Jasminum volubile* (Florida), *Hibiscus brachenridgii, Hydrangea macrophylla, Impatiens blasamina, Dahlia variabilis, Coleus blumei, Chrysanthemum maximum, C. morifolium*, marigold (*Tagetes* sp.), wishbone (*Torenia fournieri*), mexican sunflower (*Tithonia diversifolia*), *Pluchea odorata, Zinnia elegans*, tuberose (*Polianthes tuberosa*: Hawaii), african violets (*Saintpaulia ionantha*), rubber plant (*Ficus elastica* var. *decora*: USA).

Symptoms

During early growth, the most conspicuous and characteristic symptom of *A. besseyi* infestation is the emergence of new leaves with chlorotic or white tips which extend a distance up to 5 cm from the tip. Hence the name. White tip symptoms usually become more evident when the plants begin to elongate. Later, these chlorotic areas become brownish and tattered, or the tips may dry and curl while the remaining leaf appears normal. Infected leaves are darker green than healthy leaves. Leaf margins may be distorted and wrinkled. In severely diseased plants, the upper leaves and the panicle or flag leaf are the most affected. The flag leaf becomes twisted thereby hindering full emergence of the tightly bound panicle.

The length of the panicle and number of spikelets are reduced. At the terminal portion of infected panicles, lemmas and paleas are often absent. Affected panicles have sterile flowers, and many fertile flowers produce distorted glumes and empty grains or small distorted grains. Distorted grains germinate later than normal ones, and have a low germination potential. Black spots and longitudinal cracks have been observed on affected rice kernels. These have been attributed to secondary infection by saprophytic organisms (such as *Enterobacter agglomerans*) in Japan (Nishizawa, 1976).

Diseased plants are stunted, and have low vigor. Tillers are produced abnormally from the upper nodes. Stems which appear first are most severely affected. Diseased panicles mature later than healthy, normal ones. Tillers with severely affected panicles remain vegetative and produce new growth before healthy, normal plants mature.

Symptoms of attack are not exhibited by all plants although infested by the nematode. On the other hand, white tip symptoms may also be caused by certain insects. The detection of the nematode associated with rice seed would give a correct diagnosis.

Yield Losses

The severity of the disease varies with region, country, year, etc. as influenced by rice variety and cultural practices. The degree of damage in susceptible varieties depends largely on the number of infested seeds sown, as well as the number of *A. besseyi* infested seed. While the number of infested seeds sown is not always known, yield losses have been determined on the basis of numbers of nematodes per number or weight of seeds. The economic threshold of

A. besseyi on rice is not known for many countries. A level of 300 nematodes/100 seeds was determined in Japan (Fukano, 1962).

In **Japan**, in the 1950s, yield losses of 10-30% were reported (Yoshii & Yamamoto, 1951). Losses up to 60% in susceptible varieties and 20% in resistant varieties were reported by 1959 (Tamura & Kagasawa), and Komori et al. (1963) reported losses from 19-74% even after seed treatment. Once considered disappeared from Japan, this disease was reported to reoccur in 1985 (Inagaki, 1985).

In **Bangladesh**, damage has occurred to deep water rice. Light infections of 5-25 nematodes/100 seeds, as well as, severe infections of 273-1,031 nematodes/100 seeds of a local susceptible variety "Rajbowalia" has been reported (Rahman & Miah, 1989).

In **India**, yield losses from 10-20% were reported from some western, southern and eastern states, and up to 60% for some varieties grown in southern India (Thakar et al. 1987; Prasad et al. 1987; Rajendran et al. 1977).

Up to 50% yield loss of upland rice was caused in **Brazil** (Silva, 1992), and 10-140 nematodes/100 stored rice grains were found (Huang et al. 1977).

In Huanggang county, **China,** 7-17% loss of rice (Zhang, 1987).

In **Africa**, 3,000-10,000 nematodes/100 seeds of susceptible cultivars in **Sierra Leone** (Fomba, 1984). Nematode levels have been 2-400/100 seeds (usually <100 nematodes/100 seeds) in **Nigeria**, but typical symptoms were not observed.

54% yield loss occurred in the **USSR**. 80% infested seeds sown resulted in 31% damaged plants in the field (Popova, 1984).

Yield losses in the **USA** ranged from 17-54% in 1954 on susceptible varieties and 0-24% on resistant varieties. By 1956, losses were 7% or susceptible varieties. A regimen of seed treatments and resistant varieties was attributed to the reason for eliminating *A. besseyi* as a threat (Hollis & Keoboonrueng, 1984). The current status on yield losses due to the nematode in rice growing areas of the Country has not been reported.

The Causal Agent

Morphology: *Aphelenchoides besseyi*, the causal agent of White-tip Disease of rice, is morphologically distinguished by a slender, vermiform body less than 1 mm in length. In both females and males, the cuticle is marked with four longitudinal lines or incisures in the lateral field. Anteriorly, the lip region is expanded and wider at it's base than the "neck" region. The stylet is 10μm long with moderately developed knobs. Median bulb is well developed, large, almost filling inner body space. The esophageal basal lobe overlaps the anterior end of the intestine on its ventral side. The excretory pore is located slightly anterior to the nerve ring. The female reproductive system is characterized by a vulva located at 65-75% of the body length, a large ovary with oocytes in several rows, and a short and narrow post uterine branch. In males, the spicule is ventrally curved and lacks a dorsal process. Three pairs of ventro-submedian papillae are present on the male tail, and for both sexes, tail terminus is armed with four mucronate points, usually appearing star-shaped.

There may be two or more races of *A. besseyi* although the evidence for this is sparse. Strawberry plants are not attacked by the nematode when grown amidst infested chrysanthemum plants (Noegel & Ferry, 1963).

Biology

Feeding behavior: *Aphelenchoides besseyi* is an ectoparasitic nematode that can feed on the young vegetative shoot tissue of rice without entering them. Also, they can feed on other host plants, as well as a number of different fungi. The nematode does not attack the roots of seedlings (Tamura & Kegasawa, 1958). All larval stages must feed in order to develop. Development ceases after two to three days when the nematodes are present in pure water alone.

Reproduction and life-history: *A. besseyi* is bisexual, and both males and females are found in equal numbers in rice. In laboratory fungal-nematode cultures, a single female *A. besseyi* reproduced parthenogenetically at 23-30°C (Sudakova & Stoykov, 1967; Gokte & Mathur 1989). However, Huang et al. (1979) failed to demonstrate that a single larva could reproduce parthenogenetically. In culture at 30°C, the male ratio increased with the age of the fungal culture, and poor food supply may have favored male differentiation and/or shorten female life span (Huang et al. 1979). The life cycle of the nematode is greatly influenced by temperature. In vitro *Fusarium solani* culture, *A. besseyi* had a life cycle of 24±4 days at 16°C, 15±2.9 days at 20°C, 9±2 days at 23°C, 10±2 days at 25°C, and 8±2 days at 30°C. The optimum temperature for oviposition and hatch is 30°C. At 35°C, the nematode failed to increase in numbers, although oviposition, hatching and molting occurred. In nature, the life cycle is 3 and 6 days at 31.8°C and 25°C, and 9 and 29 days at 20.6°C and 14.7°C respectively (Tikhnova, 1966). Lethal temperatures are 42°C for 16 hours, or 44°C for 4 hours. Development does not occur below 13°C.

Effects of temperature: The nematodes remain active between 13-42°C (Tikhonova, 1966). In China, Qui et al. (1991) determined that 4°C was the minimum temperature for nematode activity, and the thermal death point is 49°C for 10 min. Nematodes died in 1 hour at 41-44°C in water. In USA, Adamo et al., (1977) reported that 47.5°C was the thermal death point. The LD50 was 46.8°C for 10 min. Vertical migration was greatest at 25-28°C, and at 35-37°C the nematodes tend to curl up.

Effects of moisture: *A. besseyi* depends on water for its movement. The nematode requires an atmospheric humidity of at least 70% for normal development. In laboratory experiments, the vertical migration of *A. besseyi* was favored by rough textured surfaces that were continuously supplied with, or had the ability to hold moisture. The nematode migrated downwards or upwards equally indicating that movement was not affected by gravity (geotaxis was not involved). The nematode could effectively migrate on stems of rice seedlings provided the latter was continuously supplied with moisture (Adamo, et al., 1976). In the soil, infectivity is less in damp soil than in the water of paddy fields. Paddy fields flooded before sowing are less susceptible than those flooded at sprouting or later (Cralley, 1949).

Effects of fertilizers: Early studies of the disease proved that its severity was influenced by the content of iron, magnesium and calcium in the soil. In the 1950's in Japan, no difference was found in the total residual amounts of nitrogen in soil around healthy and diseased plants. However, in Sierra Leone, (Terry & Das Gupta,1977) differences in nematode population levels occurred between two varieties as a result of nitrogen fertilization. Ammonium nitrate alone, or with superphosphate, increased the development of plant and nematode. All fertilized plants were infected 24.3% greater than non-fertilized control plants (Sudkova et al., 1964). Applications of potassium tend to decrease nematode populations on rice varieties. Ammonium sulphate, calcium superphosphate and potassium chloride increased the severity of the disease without affecting the numbers of nematode in rice grain. In laboratory tests, high concentrations (0.4-0.1 M) of copper sulphate, potassium chloride, urea, ammonium chloride were more toxic to the nematode than lower concentrations of 0.05-0.025M (Swain & Das, 1979).

Disease development: At the end of the growing season, *A. besseyi* is present spirally coiled and in a state of anabiosis under the hull of paddy seed. When infested seed is sown, on receiving moisture, the nematodes are reactivated and invade the plant within ten days after sowing (Hashioka, 1964) and first feed on the tender primordium of germinating seeds (Nandkumar et al., 1976). They are attracted to the aerial meristematic areas of young plants. [Gotke & Mathur (1989) determined that it takes the nematode 1-5 days after inoculation to reach the growing point of rice seedlings.] Susceptible varieties are more attractive to the nematode than resistant ones. At the start of tillering, they are found in low numbers within the leaf sheath feeding ectoparasitically on the still-folded young inner leaf (Goto & Fukatsu, 1952, Todd & Atkins, 1958). They do not move toward older plant parts or roots (Goto & Fukatsu, 1956). As the nematodes feed, they cause a reduction or absence of plant chloroplasts, retarded cell growth, gumming, and disintegration of phloem cells in the white tip region of plant leaves.

As the plant grows, nematodes increase in numbers and continue to feed ectoparasitically on growing tips of stems and younger larger leaves. The main stem is affected more than subsequent tillers. The nematodes migrate to the developing panicle and penetrate the spikelet before anthesis, while the green florescence is still within the boot leaf. Penetration takes place through a natural opening formed at the apices of the lemma and palea. They feed ectoparasitically on the ovary, stamens, lodicules and embryo (Huang & Huang, 1972). At the time of heading, most nematodes are present on the outside of the glumes, however, during flowering, fewer nematodes are present on the outside of the glumes and most have entered them. As the grain matures, nematode reproduction ceases, but 3rd-stage larvae continue to develop to adults until the hard dough stage of rice seeds. If the humidity of the grain drops to 15-18%, all stages of the nematode except 2nd-stage larvae coil in a state of anabiosis (Tikhonova, 1966). However, adult females form the most predominant anabiotic stage of the nematode, and aggregate in the glume axis. More nematodes are found in plants with white tips, however, apparently healthy green-tipped plants may also bear *A. besseyi*. More nematodes tend to occur in filled than in sterile spikelets. More nematodes tend to occur in the middle of an infested panicle than at the terminal portion.

Survival: *A. besseyi* is able to survive in unhulled rice grains for extended periods of time.

reports exist on survival periods of eight months to three years in stored grains (Cralley, 1949; Yoshi & Yamamoto, 1950). Todd & Atkins (1958) found that viable nematodes were able to survive 23 months on dry, stored rice grains. Survival up to 8 years occurred in stored rice grain in Brazil (Zem & Momteiro, 1977).

Survival in rice seeds is greatly influenced by moisture and temperature conditions, as well as the rate of dehydration. The survival of *A. besseyi* was better at low moisture content (8.1%) than at higher moisture content (15.9%).

Tenente et al. (1994) determined that the nematode was able to survive in seeds stored under low temperatures of 10°C and -18°C up to 30 months. Furthermore, the nematodes were not affected by fumigation with aluminum phosphate. Huang & Chiang (1975) found that the nematodes were unable to survive dehydration occurring at temperatures below 15°C, as opposed to surviving dehydration at 20-33°C. However, once dehydrated for a while at room temperature, the nematodes were no longer sensitive to subsequent dehydration at low temperatures.

Large aggregations of nematodes enhance survival, as does a slow rate of dehydration. The nematode is able to survive on several fungi species on rice stubble in the field (*Fusarium*, *Curvularia*), and starvation adversely affects the nematode's ability to withstand dehydration. Larvae and adults are able to withstand dehydration (Sivakumar, 1987; Huang & Huang, 1974). Sivakumar (1987) determined that the number of nematodes is reduced as the age of stored grain increases (25 months). Good rice grain storage conditions may prolong nematode survival.

In the field, anabiotic nematodes may survive on rice husks and debris and weeds in paddy fields. There are few reports of the nematode surviving in soil between rice crops, however, it is believed that the nematode cannot do so for extended periods of time (Yoshii & Yamamoto, 1950).

Means of spread: The main means by which *A. besseyi* is spread worldwide is by seed. Locally, and within fields, the nematodes may also be spread by irrigation water, rain water, flood water, contaminated plant debris and cultural practices that favor the movement of contaminated plant material (such as, high seeding rates).

Disease complex: have not been studied in extent, however, a few known complexes are:
1. *A. besseyi* and *Curvularia lunata* (*Cochliobolus lunatus* sexual stage) in rice seed. *C. lunatus* caused increased populations of *A. besseyi* and grain deformation compared to effects of the nematode alone. *A. besseyi* at 10 and 100 nemas per seedling increased grain discoloration and fungal infection in grain (Rao, et al., 1994).
2. *A. besseyi* and *Sclerotium oryzae* on rice cv. melrose. In greenhouse tests, weights of melrose plants were reduced significantly by treatments with *A. besseyi* alone and *A. besseyi* and *S. oryzae*, but not *S. oryzae* alone (McGawley, et al., 1984).
3. *A. besseyi* and *Pyricularia oryzae*. The effects of the fungus were enhanced by the nematode species which reproduced in the blast lesions on leaves (Tikhanova & Ivanchenko, 1968).
4. *A. besseyi* and *Enterobacter agglomerans*. The nematode predisposes rice kernels to secondary infection by the bacteria which causes the production of black, wedge-shaped spots on grains

(Uebayashi et al., 1976).
5. *A. besseyi* and *Ditylenchus angustus*. In Bangladesh both nematodes occur together but not much is known about this association (Timm, 1955).
6. *A. besseyi* and *Meloidogyne graminicola*. In pot tests, the effects of both nematodes together was greater than singly, on the yield of flooded rice (Plowright, 1986).

Disease management

Seed Treatment

1. Hot water treatment of infested rice seed has been successfully used all over the world to control WTN. While different combinations of temperature and time durations have been used experimentally, the most feasible combination is one that does not affect seed germination and health while eradicating the nematode. Eradication has been reported at 52°C for 15 min (with shaking) [Tenente & Manso, 1994]. Presoaking seed for 16-18 hr at 26-28°C, or in cold water for 18-24 hr, followed by immersing in water at 52°C for 10 min (51-53°C for 15 min) has proven most effective (ICAR, 1973; Bridge et al., 1990). Higher temperatures 55-61°C for 15 min were used when seed was not presoaked (Pinherio et al., 1997).

2. Various chemical seed treatments have given effective control: presoaking seed in water, then 1% potassium or sodium chloride for 20 min. followed by sun drying at 40-41°C for 6 hr disinfested seeds 95-98% (Sivakumar, 1987). Carbofuran, methomyl, thiabendazole, benomyl, fenitrothion, dasuzin, have been effectively controlled and/or eradicated WTN from seed (Cho et al., 1987; Ribiero, 1977; Martins et al., 1976; Ishiy, 1975; Silviera et al., 1978; Popova & Shesteperov, 1978). Thiabendazole was more effective than Carbofuran in seed treatments [Tenente & Manso, 1994]. In India, seeds soaked in mancozeb and monocroptophos followed by vacuum fumigation with methyl bromide for 2 h at 30°C, or atmospheric fumigation with aluminum phosphide (Phostoxin) was effective in eliminating the nematode (Prasad & Varaprasad, 1992).

3. Phostoxin, an insecticide commonly used against grain insects in stored rice, has been shown to have nematicidal properties as well (McGawley et al, 1984).

4. Field applications of nematicides have given varying results depending on time on application. Effective control has been obtained with combinations of seed and field treatments of paddy rice. In screenhouse tests, when WTN was inoculated at transplanting, Benomyl effectively controlled it when applied as a seed treatment and sprayed 1 or 15 days after transplanting. Control was increased when benomyl was applied during the nematode infestation stage as opposed to later in their development when the nematode was feeding in the apical meristem. Benomyl failed to protect the plants when applied as a seed treatment and/or sprayed 5 days after WTN was inoculated at transplanting, maximum tillering, and/or panicle initiation. Carbofuran broadcast in floodwater 1 or 30 days after WTN inoculated at transplanting failed to control the nematode (Gergon & Prot, 1993). In Brazil, Carbofuran 3F effectively controlled WTN in field application trials (Oliveira & Ribiero, 1980).

Resistant Varieties

Rice varieties differ in susceptibility to *A. besseyi*. Variations in varietal response may demonstrate the influences of environment of the nematodes development and damage. The use of resistant varieties has rendered effective control of the nematode, especially in the USA. USA resistant varieties reported include: Arkansas, Fortuna, Asahi, Nira 43, Bluebonnet, Bluebonnet 50, Improved Bluebonnet, Century 231, Hill long grain, Nira, Rexoro, Sunbonnet, Texas Patna, Toro, TP-49, Pecos'rice, and Labelle.

Cultural

In the USA, early planting in cool conditions (in April) reduced damage caused by the nematode (Cralley, 1949).

Irrigating seed beds, or direct seeding in water reduces infection as the nematodes emerge and lose vigor before germination. When rice is sown dry and flooded after germination, when plants are 7.5-10 cm high, nematode damage appears in 60% of all cases (Cralley, 1956; Yamada et al., 1953).

Field sanitation in order to provide freedom from weeds, rice debris and new growth.

Biological Control: Plant and fungal extracts

Laboratory trials using plant and fungal extracts have shown degrees of nematicidal activity:

1. Natural filtrates of the cultural fluid of *Aspergillus niger* killed 100% of *A. besseyi* in 24 hrs (Kurt, 1975).
2. 80-95% nematicidal activity was obtained with 1 and 10 ppm benzene extracts from flowers and roots of *Carthamus tinctorius.*
3. Odaracin, a nematicidal constituent from *Daphne odora* gave 70% activity against *A. besseyi* at 1 ppm (Kogiso et al., 1976).
4. Combined neutral or alkaline fractions of ethanol extracts of *Daphne odora* and *Carthamus tinctorius* at 30 ppm for 48 hrs (Ogiso et al., 1972).

Detection in California

From 1959 to 1996, *A. besseyi* had been detected only twice in California by CDFA Nematologists: once in 1959, in a quarantine strawberry sample which originated in Canby, Oregon and sent to a nursery in Modesto, Stanislaus county. State action would have resulted in the rejection and/or destruction of the shipment. Second, in 1963, *A. besseyi* was detected in a fungal culture of *Sclerotium oryzae.* The fungus had been collected from a rice field in Butte county. The rice field was used by a research facility that exchanged seed with areas in the southeastern United States where this nematode occurs on rice. In 1975, the species was identified as *A. besseyi* by two nematologists: Drs. M. T. Franklin and D. J. Hooper at Rothamsted Experimental Station. Few attempts made to find the nematode from the same field proved unsuccessful.

A proposal for CDFA to survey the state for the presence or absence of *Aphelenhoides besseyi* in California paddy rice was initiated by the Executive Director for the Associated Rice Marketing Cooperative, on April 11, 1997. It was intended that this survey would provide a sound basis for possibly certifying California paddy rice free of the White-tip of rice nematode, and thereby, put a stop to the requirements, cost and technical inconvenience of fumigating paddy rice shipments to Turkey. In order to accept paddy rice from California, by requirement of the Turkish ministry of Agriculture, shipments needed to be fumigated with methyl bromide. However, the maintenance of buffer zones in treatments with mbr rendered such fumigations impossible at the ports of Sacramento and Stockton. As a result, ships were loaded with the commodity and fumigation pipelines, etc, and fumigated in Puerto Rico under the direction of a USDA Inspector.

In 1997, in an initial effort to obtain some preliminary information on the presence or absence of *A. besseyi*, and at the request of USDA/APHIS/PPQ, CDFA collected random samples of paddy rice already present in certain rice storage warehouses in Northern California. In April - May 1997, a total of seventy-nine samples were collected from 29 county warehouses mainly in Butte, Colusa, Sutter, and Yolo counties, and to a lesser extent, Yuba and Kern counties. These samples were taken from samples routinely collected by warehouses for purity analyses, etc, directly from trucks as they come in from rice fields bearing harvested grain. Samples often comprised commingled collections of a locally grown variety from different seed lots, growers and growing areas. All samples tested negative for *A. besseyi.*

In October 1997, at the request of the Rice Industry, USDA-PPQ and CDFA found the need to conduct a more comprehensive, statistically sound statewide sampling scheme before any statement/certification establishing the absence of *A. besseyi* in paddy rice in California could be issued with absolute certainty. A fresh survey of 1997 crop was deemed necessary as the previous years seed had been in storage for a long period of time. A sampling protocol was proposed by USDA/PPQ that had been used earlier in USDA/CDFA's Karnal Bunt sampling program. The sampling scheme represented 490,000 acres of California rice production area spread over 13 counties: Butte, Colusa, Fresno, Madera, Glenn, Tehama, Placer, Merced, San Joaquin, Sacramento, Yolo, Yuba and Sutter. Sampling was designed to detect the presence of the nematode at the county or region level of resolution. Sampling was done at county driers instead of mill driers as the former usually draw product from regions within 25-30 miles, and are, therefore, more familiar with the geographic location of production. The number of samples collected was dependent on the rice acreage for that county or region. One sample represented anywhere from 1,875 to 4,000 acres, or 11 metric tons seed. One pound samples were collected from at least 10 trucks (10 fields or lots) as they arrived at county rice driers. These ten, one pound samples were thoroughly mixed together and from the mixture a one pound minimum sample was sent to the Laboratory for processing and evaluation. Lot identity was maintained. Hence, 170 paddy samples collected were processed and analyzed.

[*Extraction*: Individual one pound samples were presoaked in aerated distilled water for 24 hours at room temperature (24-26°C). After 24 hrs the soak water was passed through a 500 mesh sieve, and the residue on the sieve was back-washed with a few ml of water into the presoaked seed mass. The seeds were spooned into six Baerman funnel apparati. After 5-6 days, when germination had occurred, all water contained in each funnel was withdrawn and passed through a 500 mesh sieve. The sieve residue was back-washed and microscopically examined.]

As a result, one confirmed and three suspect finds of *A. besseyi* were made from four samples collected from two counties. Remaining portions of the original four positive/suspect samples that were sent in amounts >1 pound, were processed and analyzed in order to confirm the earlier suspect finds. However, those samples tested negative the second time. The original four positive/suspect composite samples represented 33 lots.

Regulatory action

Due to the inconsistent results, CDFA was unable to certify paddy rice to Turkey based upon area freedom from *A. besseyi*. As an alternative, CDFA in compliance with USDA-PPQ, agreed to certify paddy rice for export based on sampling and laboratory testing of each potential shipment for the rice white-tip nematode. Phytosanitary Certification would be given only for those shipments analytically determined to be negative for *A. besseyi*. Any lots found positive for the White-Tip Nematode will not be eligible for certification to Turkey or other destinations having quarantine concerns. Such lots may be diverted to milling or other markets where White-Tip Nematode is not a concern. CDFA has not implemented any formal quarantine regulations against this nematode. Paddy rice shipments are kept on hold in the USA until the results of sample analysis are released.

A more sensitive sampling procedure was proposed for the detection of absolute presence or absence in a shipment of California paddy rice, however, in the end, USDA-PPQ complied with Turkey's Ministry of Agriculture in advocating a procedure that allows a more timely and cost efficient approach to collecting and analyzing samples. The sampling protocol is equivalent to that used by the Turkish government for their incoming paddy rice shipments. Briefly, the current sampling protocol advocates that:
a) Advance notice is given by the exporter to the County Agricultural Commissioner's office regarding the volume of rice, number of silos and/or flat storage areas to be sampled for each shipment. b) The number and collection of samples is done by the agricultural commissioner's office. c) For the first 1,000 metric tons of paddy rice, 3 x 1 kg samples are obtained from a total of 15 x 1 kg composite samples collected from the top, middle and bottom locations in a silo or flathouse. 3 x 10 gm subsamples are sent to the laboratory for processing. For each additional 1,000 metric ton, one kg sample is taken first from the top, then the lower locations. Hence, an additional 10 gm subsample will be collected for analysis with the 3 collected for the first 1,000 metric tons. d) Once a shipment or facility has been sampled with negative results, the identity of that sampled rice must be maintained. Other non-sampled rice shall not be added, mixed or blended with the sampled rice. e) Records pertaining to the shipment shall be maintained and provided to the County, ensuring them that the rice being shipped is the same rice that was sampled with negative results.

Extraction from paddy seed conducted in CDFA's Nematology Laboratory is based on blender-maceration and Baerman funnel-water technique used by McGawley et al., (1984) in Louisiana.

Probability of Establishment
The detection of *A. besseyi* in California raises some interesting questions: has the nematode species always been present in California, or was it introduced into the state? 2) if it was introduced, then how did the nematode gain entrance into the state? 3) how long has it been in California? and, 4) what is the probability of its widespread establishment within California?

While it may be difficult to answer these questions with absolute certainty, our current knowledge of the nematode species, and rice production in California provides sound reasoning for consideration. *Aphelenchoides besseyi* was first discovered on rice in the eastern states of the USA. Whether it has been present on wild, non-cultivated plants in California is not known or reported; however, given its low rate of detection on rice, lack of detection on any other California-grown plant, as well as a lack of any known economic damage in cultivated rice fields in California, it is more likely that this nematode species gained entrance into the state through cultivated crop materials, mainly rice. There are at least three possible means for its introduction: 1) on strawberry plants bearing summer dwarf disease caused by *A. besseyi*, from Arkansas and Tennessee (Thomas & Darrow, 1931; Plakidas, 1964). Summer dwarf disease occurred sporadically in California in the 1930s up to 1959, but is currently unknown in California; 2) on infested paddy rice imported to the rice research facility at Biggs in the 1950s and thereafter; 3) through illegal importation of infested paddy rice from other countries. Federal regulations have prohibited the import of rice (seed, paddy, straw and hull) into the USA since November 23, 1933. However, there are no prohibitions for the import of rice seed to California from other states within the country.

It is not known how long the nematode species has been present in California. If it was introduced historically, as suggested, then its low rate of detection in cultivated rice clearly indicates its inability to become established to damaging levels in cultivated fields over a period of time. On the other hand, if its introduction was recent, then it may yet be endeavoring to establish itself significantly.

The limited presence and low detection rate of *A. besseyi* in California rice may well indicate the nematode species' struggle to widely establish itself within the state. There are certain biological and ecological considerations which may be working against the nematode's ability for increase.

Moisture: *A. besseyi* needs a continuous supply of moisture on rice seedlings in order to migrate to, and feed on growing tips of plant stems, leaves, and panicles. Atmospheric humidity of at least 70% is required for nematode development. California rice is grown under low relative humidity through its growing season from April/May to September/October. Average rainfall during this season ranges 0-1 inch, being lowest during elongation and heading. On the other hand, the relative humidity within the dense top growth of rice plants will be greater than atmospheric humidity, but is it sufficient to favor nematode development? Rice seed is planted at about 150 lbs/acre (dry weight), resulting in 45-60 seeds/square foot.

Cultivation: Paddy fields flooded before sowing rice are less susceptible to *A. besseyi* than those flooded at sprouting or later. California rice is planted, by airplane, directly into flooded field basins. Moreover, before sowing, rice seed is soaked in water for 24-36 hours, and then drained for 18-24 hrs, to initiate germination and enable seeds to sink to the soil surface when sown. Presoaking may not only reactivate anabiotic nematodes, but also expel some into the soak water. Some rice fields are flooded from November to February, when rice is not present.

Resistant Varieties: Although low numbers of *A. besseyi* have been found worldwide in resistant rice varieties, the latter does present a barrier to effective nematode increase. While resistance in California rice varieties specifically to *A. besseyi* has not been reported, it may be present. Medium grain rice varieties are most commonly produced in California, increasing *from 79% of the total rice production acreage in 1968 to 96% in 1996 (California Rice Industry* Association Rice Statistics for 1997: CRIARS).

Damage impact potential/Consequences of establishment
Currently, there is no record of rice yield losses caused by *A. besseyi* in California that would indicate that the nematode species is a direct threat to rice production. While an economic damage threshold density has not been established for many countries as it would vary from region to region, low degrees of infection, as detected in California, have been found to be relatively harmless to crop yields (Huang, 1978). Given the current known status of the nematode species in California, a predicted estimate of significant loss in rice yields based on the successful wide-spread establishment of the nematode may not be possible or relevant at this point.

There is no threat to California's strawberry and garlic industry due to *A. besseyi*. CDFA's certification programs for those hosts would detect the nematode species if it were present. Since 1989, *A. besseyi* has never been detected in 20,861 strawberry samples and 16,275 garlic samples processed by CDFA's Nematology Laboratory.

One can only wonder what impact certain changes in cultivation or climate may have on the development of the White-tip nematode. For instance, by the year 2000, burning of rice straw will be phased down. Alternative means for disposing of straw will include soil incorporation and commercial uses for straw, including mulch. Will this provide a means for the nematode to survive and/or spread?

The detection of *A. besseyi* within the state may have its greatest economic impact on California's international trade market. There are over eleven countries that require phytosanitary certification for freedom of *A. besseyi* from paddy rice. Furthermore, some countries, such as Turkey, opt to conduct their own milling of imported California paddy rice instead of purchasing milled rice, thereby increasing the need for certification and the consequential costs involved. Such developments may impact the export value of California rice, which was $144.4 million in 1997 and $145.9 million in 1996 (CRIARS).

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BOTANY HIGHLIGHTS

An aquatic fern native to South America, giant salvinia, was introduced recently into Texas and Louisiana, where it is rapidly becoming a serious pest of waterways and ponds, much like the water hyacinth and hydrilla. Because of these finds, the USDA has requested that intensive surveys be conducted to see if it occurs in other states. The following two articles, by Jeff Hillard and Fred Hrusa, provide information that will aid in our ongoing survey for this weed and another aquatic weed, *Limnobium spongia.*

Giant Salvinia *(Salvinia auriculata* complex), and frogbit or sponge plant *(Limnobium spongia* ssp. *laevigatum)*

by Jeff Hillard CDFA, Pest Exclusion Branch

Live specimens of two species of plants that are both Q-rated in California, the federal noxious weed, **"giant salvinia"** (a common name that refers to several species of floating, aquatic ferns: *Salvinia auriculata, S. bilboa, S. herzogii, and S. molesta),* and "South American frogbit" or "sponge plant" (referred to as the *laevigatum* subspecies of *Limnobium spongia),* have been found offered for sale as water garden plants in California. Both originate in South America, and have become weedy pests in several countries including Australia, South Africa, India, Indonesia, and several southeast Asian countries. Just since 1997, when giant salvinia was first reported in Texas and later in Louisiana, it has become a weedy pest in both states.

Salvinia species in general are characterized by oblong, floating leaves, 1/2, to 1 1/2 inches long. Young plants have smaller leaves that lie flat on the water's surface. As plants mature and aggregate into mats, leaves are folded and compressed into upright chains. Chains of spore-bearing structures ("sporocarps") can often be found on the underside of mature plants. **An important identifying characteristic, found only in this complex of federal noxious *Salvinia* species, is on their leaf surfaces, where cylindrical hairs in rows are each topped with four branches joined at the tips to form a "cage- or egg beater-like" structure (visible with a hand lens).** Common salvinia, *Salvinia minima,* a closely-related aquatic that is allowed for sale in the nursery trade in this state, has leaf hairs that are always free at the tips.

A plant of *Limnobium* species can display both floating and upright small, thick, leathery, heart-shaped leaves, and have small, white flowers with narrow petals on short stems. Plants can be interconnected via underwater stems. **A highly visible characteristic on the underside of young leaves is a central disk of spongy cells, often red in color (hence the common name "sponge plant").** Possible alternative scientific names that sponge plant may be labeled as include *Hyromystria laevigata* and *H. stolonifera,* as well as *Hydrocharis spongia.*

Both giant salvinia and sponge plant are aggressive invaders of freshwater lakes, ponds, slow moving streams, rice fields, ditches, swamps and marshlands, with the potential to rapidly cover the water's surface, spreading by vegetative fragments that are able to develop into more floating plants. Mats of these plants can shade and crowd out important native plants, reduce oxygen content, degrade water quality for fish and other aquatic organisms, impede boating, fishing, and recreation and clog water intakes for irrigation and electrical generation. Many freshwater settings in California provide the conditions that could potentially allow giant salvinia and sponge plant to become major problems in this state.

In order to better understand the nature of the problem in California, CDFA is asking county inspectors to determine as soon as is expedient, both the presence and extent of this plant in the nursery trade. This can involve visual inspections at nurseries, both retail and wholesale, particularly those that specialize in aquatic plants. In some counties, there may be fish or aquarium stores that also offer these plants for sale. **Particularly in the case of giant salvinia, the names and addresses of all sources of this plant, those offering it for sale, propagating it or ordering it from in or out of state sources, should be reported to this office.**

Revised shipping guidelines:

Samples of *Salvinia* and *Limnobium* should be sent to the state lab for identification. Specimens should be sent fresh, either in water within a plastic watertight container or in a sealed plastic bag without or with a minimum of free liquid. Mailing should be addressed to the Plant Pest Diagnostics Branch, attention: Botany Lab, and should not be done on Thursday or Friday to avoid weekend delays in hot post office facilities. Be sure to protect the PDR slips from water leakage by placing them in a separate plastic bag. It would also be useful to mark the package "Rush - *Salvinia/Limnobium*."

Billing for all costs incurred during these Salvinia surveys should be charged to the High Risk Pest Exclusion contract.

Any questions about this advisory can be directed to Jeff Hillard (jhillard@cdfa.ca.gov) at (916) 653-1440.

The *Salvinia auriculata* Aubl. complex (Salviniaceae)

G. Fred Hrusa, Ph.D.
Senior Plant Systematist
CDFA, Plant Pest Diagnostics Center
Botany Laboratory/Herbarium CDA

The genus *Salvinia* Séquier comprises approximately 10 species of heterosporous, aquatic, floating ferns native mostly to South America with vicariant species in Europe, Asia and N. Africa (Mabberley 1997). Most are grown as ornamentals and via anthropogenic introductions into wild areas have become naturalized on all continents except Antarctica.

All *Salvinia* species have a dense covering of water-repellent composite trichomes ("hairs") on the adaxial leaf surface. In the *Salvinia auriculata* complex, a group composed of three morphologically similar species native to subtropical and tropical South America (*S. biloba* Raddi, *S. herzogii* de la Sota, and *S. auriculata* Aubl. sensu stricto) plus one widely naturalized and aggressive hybrid (*S. molesta* D.S. Mitch.), these composite trichomes are distinctive and serve to identify the group (Thomas & Mitchell, 1972). Fortunately, when completely developed, this characteristic trichome form is easily visible under even low magnification (10x). The composite trichomes have a "lantern-like" structure formed from four slender simple connate trichomes raised above the leaf surface with the upper half of each simple trichome diverging then again converging and uniting with the other three at its distal tip. Each composite trichome may be three or four mm. tall and completely cover the lamina adaxial surface. However, if the individual plant is growing in shade or if the leaves are aged or deteriorated, the composite trichomes may develop as, or be reduced to, no more than small papillae-like structures less than 1 mm. tall. On somewhat younger or less deteriorated leaves of the same or different plants in the same (or different) colony, the composite trichomes may develop into a relatively stout 2-4 branched structure as short as 1 mm. or up to 2-3 mm. in length, but without the simple trichome branches converging at their distal tip. This reaction by species of the *S. auriculata* complex may be due to stressful growing conditions or incipient leaf senescence, and is seen in both wild and cultivated specimens. Vigorous, newly developed leaves on these same plants form the typical slender 4-branched "lantern-like" trichomes described above. More complex trichome patterns have also been observed in specimens submitted to this herbarium. Rare individuals, so far always those with relatively small lamina sizes, display all the forms described above — but on a single leaf. The pattern on these plants transitions from minute papillae on the leaf outer 1-2 mm. to 2-4 branched non-connate trichomes inward, to typical "lantern-like" trichomes of the *S. auriculata* complex present only near the midrib — or occasionally scattered among the non-connate, but still branched, forms. Whether genetic or environmental, the source or cause of this pattern is not known.

Leaf venation comparisons have also been proposed as a method of distinguishing among these four species (Forno, 1983). However, the discontinuities among the venation forms are not well-marked, and thus without multiple comparisons, considerable experience, or both, determinations based solely on these criteria are not highly reliable.

The most discontinuous feature among the species is chromosome number. However, numbers range from 2n = 36 to 2n = ca. 60-63 (Schneller, 1981) and technical difficulties associated with obtaining reliable counts on numbers this high make routine identification using chromosomal data infeasible.

Leaf shapes within and among most species of *Salvinia*, particularly the *Salvinia auriculata* complex, are highly variable and the leaf lamina may be as little as 1 cm. in width (or less) or up to 3-4 cm. wide (or more). Leaf shape may vary from ovate or orbicular with a ± cordate base and acute tip, to obovate with a cuneate base and obtuse tip. Plants with leaves on the smaller end of the size range and with concurrently reduced trichomes as described above, could be easily confused with the relatively non-invasive *Salvinia minima* Baker or possibly even *Salvinia natans* (L.) All. non Pursh, depending upon the individual leaf observed. Thus leaf shape and size are also of little help in distinguishing either among the component taxa of *S. auriculata* sensu lato or between them and the sometimes superficially similar but unrelated and relatively benign species listed above.

Species of the *S. auriculata* complex are variably fertile; observation of meiotic chromosome pairing revealed completely normal bivalent formation and essentially complete fertility in *S. auriculata* s.s. (hexaploid with 2n = 54) (Schneller, 1981) to highly irregular pairing in *Salvinia herzogii* (heptaploid with 2n = ca. 60-63) where numerous univalents and multivalents result in near complete sterility (Schneller, 1980). *Salvinia molesta* (pentaploid with 2n = 45) is likewise sterile (Schneller, 1980). These latter two species are apparently of hybrid origin and reproduction is restricted to clonal division. In all *Salvinia* species sporocarp clusters are produced only sporadically in cultivation and the clusters vary greatly in form and arrangement, with the variation patterns overlapping broadly among the species.

The result of this wide phenotypic plasticity in trichome development, leaf venation, leaf shape, and sporocarp arrangement is that the different species often appear so much like each other that even specialist determinations based on cultivated material may be equivocal. Determinations of wild specimens may be less problematic as at least the South American species are largely allopatric and knowledge of originating locality can aid in the interpretation of phenotypic variability. Unfortunately, when determining weedy or cultivated populations one does not have this advantage.

Under favorable conditions *Salvinia molesta* has been reported capable of doubling its biomass in under two days (Cross, 1999), four days (Thomas & Mitchell 1972), or a week (Mitchell & Tur 1975) and following fragmentation can spread rapidly via wind, anthropogenic or other biotic dispersal mechanisms. In any case the consequences for slow-moving warm-water rivers, artificial ponds, or even large lakes (Mitchell 1972) are potentially dire. Colonies can form solid mats up to two feet or more thick. These exclude surface-utilizing organisms, shade out other aquatic vegetation and dead or dying *Salvinia* plant material can raise the biological oxygen demand (BOD) to levels critical to the survival of all other aquatic organisms (Thomas & Room 1986)Although among these species *Salvinia molesta* has the most notorious reputation as an invasive weed, all are considered potentially pestiferous, and because of the difficulty distinguishing among them using external morphological characteristics, the entire complex is considered, and treated as, a threat to California wetlands.

At present, no plants referable to the complex are known to be growing outside of cultivation anywhere in California. A lack of vegetative perennation structures or, in the rare instance that a sexual species may become established in the wild, dormancy-capable spores, makes *Salvinia* survival essentially dependent upon meristem protection. Shoot meristems in *Salvinia* are generally situated in surface plants within 2 cm. of the water surface (Whiteman and Room, op. cit.) and are thus protected to some extent according to the thermal mass of the habitat, that is, larger, deeper, bodies of water will be more likely to protect the meristems during winter cold. Tests have shown that the meristems are capable of surviving prolonged minimum temperatures of –3°C (~27°F) but the taxon apparently does not survive if frozen in ice (Whiteman and Room, op. cit.). Surface air temperature of 40°C (104°F) caused dieback of the leaves, but regrowth rapidly occurred when temperatures declined (Whiteman and Room, op. cit.). The species is thus capable of surviving, growing or rapidly increasing in California wetlands depending on the minimum and to a lesser extent the maximum water surface temperature of a given site. According to USGS data (C. Jacono pers. comm.) *Salvinia molesta* may be expected to persist wherever *Eichhornia crassipes* (Mart.) Solms (water hyacinth) has become established.

Additional information on *Salvinia molesta* may be found on-line via the following:

http://www.toledo-bend.com/alliance/docs/salvinia2.html
http://nas.er.usgs.gov/ferns/ferns.htm
http://nas.er.usgs.gov/ferns/sa_mol.html
http://nas.er.usgs.gov/ferns/

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Limnobium spongia L. sensu lato

The *Limnobium spongia* L. group (spongeplants, frogbit) (Hydrocharitaceae) are monocotyledonous aquatic floating or semi-terrestrial plants with a highly complex classification history; only the combinations likely to be encountered in modern literature or on nursery specimens are provided here. For full synonymy see the reference following this article. Depending on the generic or species concepts and taste of the particular taxonomist (Cook & Urmi-Konig 1983) these two taxa have been classified as 2 monotypic genera, *Hydromystria laevigata* (Humb. & Bonpl. ex Willd.) Hunziker[1] [= *Limnobium laevigatum*] and *Limnobium spongia* (Bosc) Steud.[2]; 2 species in *Limnobium* [*L. spongia*, *L. laevigatum* (Humb. & Bonpl. ex Willd.) Heine]; or 1 species with 2 subspecies in *Limnobium spongia* sensu lato [*L. spongia* ssp. *laevigatum* (Humb. & Bonpl. ex Willd.) Lowden, *L. s.* ssp. *spongia*]. For typographic and nomenclatural simplicity in this discussion, we will consider *Limnobium* to consist of two species, *Limnobium spongia* (Bosc) Steud. sensu stricto and *L. laevigatum* (Humb. & Bonpl. ex Willd.) Heine. Although literature sources other than the one listed at the end of this article may use any of the above, or other, alternative classifications and nomenclature, it should be kept in mind that no matter what name is applied, each taxon discussed here displays the same ecological behavior. This is true whether, for example, the organism is called *Hydromystria laevigata* or *Limnobium spongia* ssp. *laevigatum*.

Limnobium spongia sensu stricto is native to the southeastern United States where it is found along the eastern seaboard as far north as Delaware. Along the Gulf Coast it extends west to eastern Texas and inland up the Mississippi River to extreme southern Illinois. *Limnobium laevigatum* is found from Central Mexico and Cuba south to Argentina, and has been introduced into Puerto Rico, Australia, Java and now California. It ranges widely in elevation, occurring from sea level where it is most common, to 2000 meters in central Mexico and to 2800 meters in Colombia (Cook & Urmi-Konig op. cit.).

In habit these taxa are similar to the floating aquatic species *Hydrocharis morsus-ranae* L. (also often called frogbit). These two genera can be difficult to distinguish when in vegetative condition and this difficulty probably has been responsible for both the sometimes shared common name and the labeling for sale of *Limnobium* as *Hydrocharis morsus-ranae*. Although not often grown in California, *Hydrocharis morsus-ranae* is itself an aggressive invader of northern lakes and other wetlands, being well-established in Ontario (Canada) and also found in New York State. It is listed on the noxious weeds lists of several additional northern states. Although it won't be discussed further here it is a clear threat to high elevation Sierra Nevada, Cascade, and Klamath Range lakes, plus the more limited wetlands of the higher Southern California mountains.

Careful attention to a few easily seen differences can distinguish *H. morsus-ranae* from *L. spongia* or *L. laevigatum*. Flowers of both *Hydrocharis* and *Limnobium* are unisexual and the plants monoecious with staminate and pistillate flowers formed on the same or different rosettes, and staminate flowers of both genera have sepals and petals although the pistillate flowers may or may not have petals. In *Hydrocharis* the petals are showy and generally at least 1.5 times the length of the sepals while *Limnobium* petals are generally no longer than the sepals and not showy. In *Limnobium* the leaf form changes according to growth stage from floating and horizontal with a slightly cordate base and petiole shorter than to a little longer than the leaf lamina, to vertical with a tapered base and long petiole often 5 times or more the length of the lamina, while *Hydrocharis* leaves remain always of the floating type. When in horizontal floating condition *Limnobium* can be distinguished from *Hydrocharis morsus-ranae* by the distinct and often thick aerenchymatous pad on the leaf abaxial surface which serves as a float. On aerial leaves the lamina is not or only slightly aerenchymatous; instead the elongated petiole has its own variably developed aerenchymatous tissue, thus providing the necessary buoyancy. In addition, the roots of *Limnobium* are dimorphic (branched), while those of *Hydrocharis* are monomorphic (unbranched).

Limnobium spongia and *L. laevigatum* are a bit more difficult to distinguish. The most reliable characteristic is stamen number. Generally there are six in *L. laevigatum* and 9-12 in *L. spongia*. In the absence of flowering material, which appears in spring, leaf tip shape is useful; the leaf tip is more or less acute in *L. spongia* but decidedly rounded in *L. laevigatum*. Otherwise these two species are quite similar appearing and both have the same aggressive habit when introduced into areas without natural controls.

Limnobium taxa are perennial herbs with habit, growth rate and morphological plasticity similar to those of *Eichhornia crassipes* (Mart.) Solms (water hyacinth). They may ultimately form large colonies and develop into dense floating mats or root in mud on wetland edges. The flowers are held above water and pollination is probably via wind currents, allowing fertilization and seed to be set in the absence of co-evolved pollinators. Individual mature seeds are covered with small spinules and when shed are contained in a many-seeded gelatinous mass; both forms readily attach to watercraft, waterfowl or even the containers in which they may be cultivated. The seeds are shed above water, but germinate submerged and the seedlings float to the surface where they grow rapidly (Cook & Urmi-Konig op. cit.). Although in its native range the species occurs at up to 2800 meters in elevation, *Limnobium laevigatum* is marginally hardy in California. Nevertheless, naturalized populations survived temperatures to at least –4°C (25°F) in the San Francisco Bay Area in the 1998-1999 winter. *Limnobium spongia* is hardy to temperatures well below those known in low elevation California. Both reproduce rapidly by both seed and stolons, quickly filling newly colonized sites with both clones and new individuals, and both are often considered pestiferous even in their native ranges. *Limnobium spongia* has become established in several states west of its native range, although at present only *Limnobium laevigatum* has been found introduced into the wild in California, likely because it is the only one currently sold as an ornamental.

These two taxa are a threat to California wild wetlands, irrigation ditches, canals, sloughs, farm ponds or private lakes, and should they become established in navigable waterways they are especially likely to spread rapidly and widely. Currently only two established and reproducing colonies, both in non-navigable waters, are known in California: Jordan Pond(s) at Garin Park in Alameda County from where it was first reported in 1996 (as *L. spongia*), and at a commercial cemetery pond near Calimesa in Riverside County from where it was reported in July 1999.

Particularly problematic in regards to the continued or potential spread of these taxa in California is their close vegetative similarity to numerous exotic aquatic species sold randomly in the California nursery trade. These are often sold unlabeled or with inaccurate labeling; *Limnobium* is commonly sold only as "frogbit". It should also be noted that any number of these unidentified taxa could display the same degree of aggressiveness as does *Limnobium* should they be introduced into aquatic habitats where there are no natural controls.

[1] The basionym is *Salvinia laevigata* Humb. & Bonpl. ex Willd. This should not be taken to suggest any more than habital similarity, as there is no relationship between these plants and the genus *Salvinia* Sequier.

[2] The basionym is *Hydrocharis spongia* Bosc. The combination in *Limnobium* is sometimes, and apparently incorrectly, attributed to L.C. Richard and the combination is cited as L.C. Rich. ex Steud.

References

Cook, Christopher D.K. & Katharina Urmi-Konig, 1983. "A Revision of the Genus *Limnobium* including *Hydromystria* (Hydrocharitaceae). Aquatic Botany 17: 1-27.

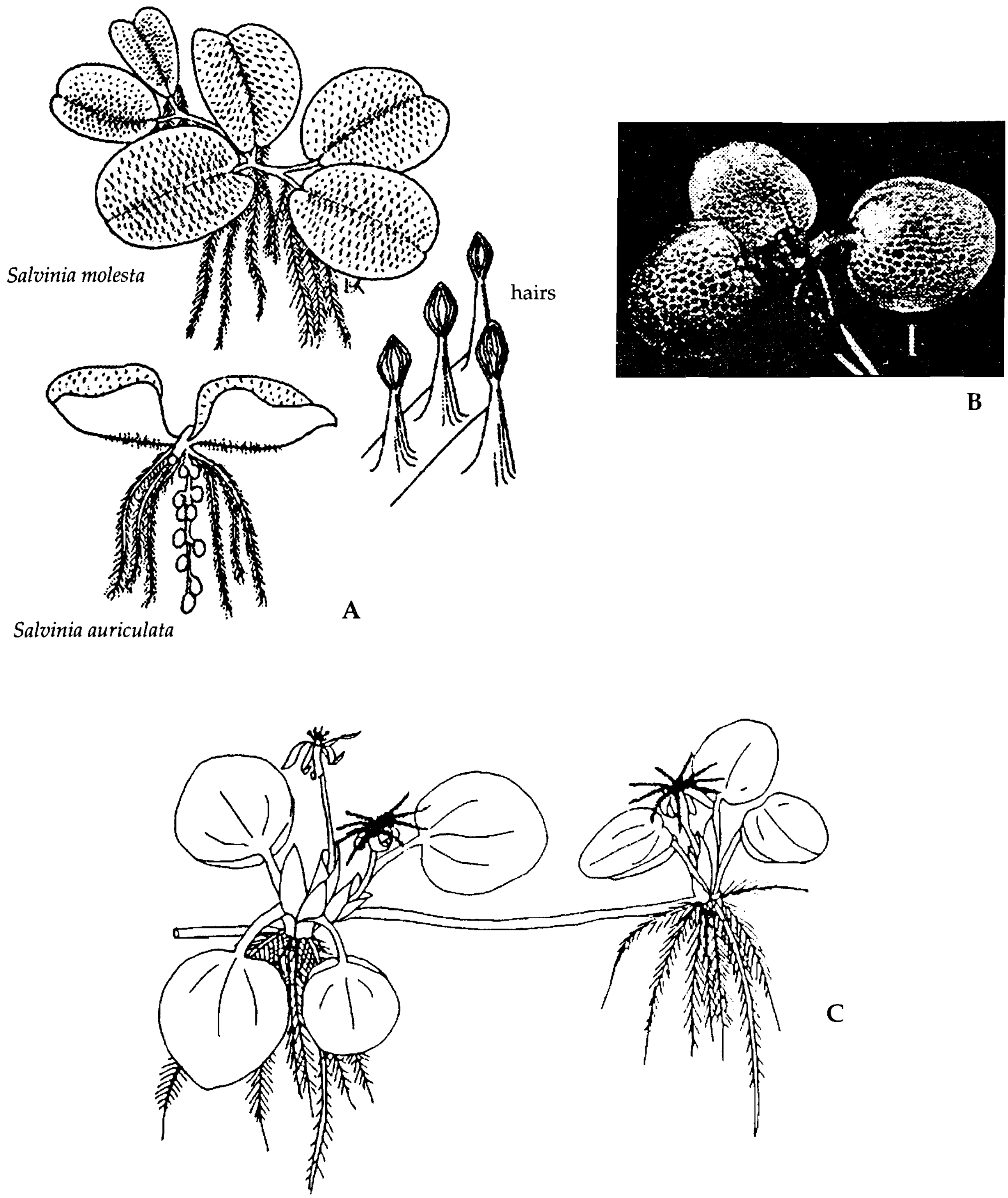

Fig. 6. A: Two of the four species in the "giant salvinia" complex, showing cage-like surface hairs and a dangling chain of sporocarps among roots; B: "Sponge plant" (aka "Frogbit"), *Limnobium* sp., underside of leaves showing spongy tissue; C: Whole *Limnobium* plant with floating and upright leaves and flower.