# Yellow Sticky Traps for Monitoring Males and Two Parasitoids of *Oracella acuta* (Lobdell) (Homoptera: Pseudococcidae)[1,2]

Jianghua Sun, Stephen R. Clarke,[3] Gary L. DeBarr[4] and C. Wayne Berisford[5]

Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, CHINA



J. Entomol. Sci. 37(2): 177-181 (April 2002)

**Abstract** Yellow sticky traps were tested as a method of monitoring populations of males and parasitoids of the mealybug, *Oracella acuta* (Lobdell). Male *O. acuta* were captured even when female populations appeared very low. The parasitoids, *Allotropa* n. sp. and *Zarhopalus debarri* Sun, were trapped less frequently than *O. acuta* males, and more traps or longer trapping periods were required to adequately monitor their populations. Significantly more males than females of *Z. debarri* were trapped, suggesting that yellow traps were more attractive to males, or that males disperse more than females. Yellow sticky traps could be used as part of a biological control program monitoring the establishment and spread of *O. acuta* and its parasitoids in China.

**Key Words** *Oracella acuta*, insecticides, *Allotropa*, *Zarhopalus debarri*, yellow sticky traps, mealybugs

The mealybug, *Oracella acuta* (Lobdell), is found on loblolly pines, *Pinus taeda* L., throughout the southeastern United States, but it is seldom a pest in natural forest stands. Outbreaks may occur after insecticide applications, for example, in seed orchards for control of seed and cone insects, or in young plantations to control the Nantucket pine tip moth, *Rhyacionia frustrana* Comstock. These outbreaks primarily result from the disruption of its natural enemy complex (Clarke et al. 1990, Sun et al. 1996). Pyrethroid insecticides in particular were implicated in reductions of natural enemy populations, leading to outbreaks of *O. acuta* and two scale insects in a loblolly pine seed orchard in Putnam Co., GA (Clarke et al. 1992).

*Oracella acuta* was accidentally introduced into Guangdong Province, China, in 1988, and in the absence of its natural enemies, spread rapidly through stands of introduced slash pine, *Pinus elliottii* Engelm. (Sun et al. 1996). A Sino-United States cooperative biological program was initiated in 1995 to identify and select natural enemies in the southeastern U.S. for export to China to control this exotic pest. A complex of five primary parasitoids was found. A recently described species, *Zarhopalus debarri* Sun (Sun et al. 1998), and *Allotropa* n. sp. accounted for approxi-

[1]Received 22 May 2001; accepted for publication 09 July 2001.

[2]This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement or a recommendation for its use by USDA.

[3]USDA Forest Service, 701 N. 1st Street, Lufkin, TX 75901, and to whom all inquiries are to be addressed (email: sclarke@fs.fed.us).

[4]USDA Forest Service, 320 Green St., Athens, GA 30602-2044.

[5]Department of Entomology, University of Georgia, Athens, GA 30602-2604.

mately 85% of the total parasitism (Sun, unpub. data). Subsequently, these two parasitoids were selected for importation to China, with shipments beginning in 1995.

Monitoring populations of *O. acuta* and its natural enemies is essential to determine optimal collection periods for both the mealybugs and parasitoids. Monitoring also provides valuable insight into the relationships among *O. acuta,* its natural enemies, forest management practices, and environmental conditions that must be considered when planning parasitoid releases. *Oracella acuta* populations in China are seasonal, and the mealybugs are difficult to locate during certain times of the year, particularly in the summer (Xu et al. 1992). Trapping is vital in documenting the establishment and dispersal of released natural enemies when populations of both the host and parasitoid are low.

Sticky traps can be used to monitor pests and natural enemies (Robin and Mitchell 1987, Samways 1988, Grout and Richards 1991, Van Driesche and Bellows 1996). Certain colors, most commonly yellow, visually attract many insects during flight (Jervis and Kidd 1996). Yellow traps work particularly well for sampling of hymenopteran parasitoids belonging to the families Ceraphronidae, Scelionidae, Platygastridae, Diapriidae, Mymaridae, and Encyrtidae (Masner 1976, Noyes 1989).

The main objective of this study was to evaluate yellow sticky traps for monitoring *O. acuta* and its two dominant parasitoids in loblolly pine seed orchards with varying levels of mealybug infestation. Other objectives were to assess the potential utility of the traps in China for documenting dispersal of the mealybug and its parasitoids and for predicting population trends.

## Materials and Methods

**Study sites.** The study was conducted in 1997 in three loblolly pine seed orchards in the coastal plain of the southeastern U.S.: the South Carolina Forestry Commission orchard (SCF) in Jasper Co., SC, and the Weyerhaeuser Company (WEY) and Bowater Newsprint (BOW) orchards, both located in Toombs Co., GA. A 2-ha area in each orchard was used as a trapping site. Trees in the three areas were approximately 10 years old and similar in size.

The three orchards were selected to test the usefulness of sticky traps in areas with different levels of expected mealybug activity: BOW - high, WEY - moderate, and SCF - low. Our predictions of mealybug population levels were based on observations from the previous year, and on the scheduled aerial applications of insecticides. BOW was sprayed with azinphosmethyl five times in 1996 (4/13, 4/29, 6/1, 7/17, 8/30) and six times in 1997 (3/20, 4/3, 5/2, 6/30, 8/17, 10/29). WEY was sprayed four times in 1996 (azinphosmethyl 4/19, 6/1, 7/2, esfenvalerate 8/23) and two times in 1997 (azinphosmethyl 3/20, esfenvalerate, 8/23). SCF was sprayed twice with bifenthrin in 1996 (7/21, 8/23) and once in 1997 (3/17). Registered rates per application were: 3.36 kg azinphosmethyl active ingredient (ai)/ha (Guthion® 2L, Bayer, Kansas City, MO); 0.22 kg bifenthrin ai/ha (Capture®, FMC Corp., Philadelphia, PA); and 0.21 kg esfenvalerate ai/ha (Asana XL®, DuPont, Willimington, DE).

**Trapping protocol.** Three Pherocon® Adult Monitoring Traps (Trece Inc., Salinas, CA) were used at each orchard. Each trap had two yellow sticky surfaces of 14 × 23 cm. Traps were hung approximately 2 m above the ground on low branches at the edge of tree crowns and were spaced about 50 m apart in a triangular pattern. The traps were maintained from 1 April through 30 October 1997, and were changed 10 times at intervals of 14 to 35 d. On each check date, traps were taken to the laboratory

and examined under a dissecting microscope. Numbers of *O. acuta* males, and the number and sex of *Allotropa* n. sp. and *Z. debarri* were recorded. Parasitoids not readily identifiable were removed from the sticky traps using Pure Lemon Extract® (Sysco, Houston, TX) and reexamined to confirm their identities.

Trap catches of *O. acuta* males were calculated as the number per trap per day to compensate for the different trapping intervals. Due to low numbers, parasitoids were separated by sex and reported as total numbers captured on all three traps over the trapping interval.

## Results and Discussion

***Oracella acuta* trap catches.** Yellow sticky traps proved effective for capturing and monitoring male *O. acuta* populations. Catches were highest in the spring, declined during the summer, and then rose in September (Fig. 1). The capture rates at the three orchards corresponded with our predicted levels of infestation: highest at BOW and lowest at SCF. Even when almost no wax cells on the shoots were detected during field observations, such as at the WEY and SCF orchards in the summer, an average of one or more male *O. acuta* per trap was captured each day.

Male *O. acuta* are more mobile than females, as they crawl or fly to find mates; yet trap catches of *O. acuta* males were highest at the BOW orchard, which received the most insecticide applications. These results suggest that males are not heavily impacted by aerial insecticide applications and may benefit from insecticide-caused mortality of natural enemy populations, as has been shown for females (Clarke et al. 1990, 1992).

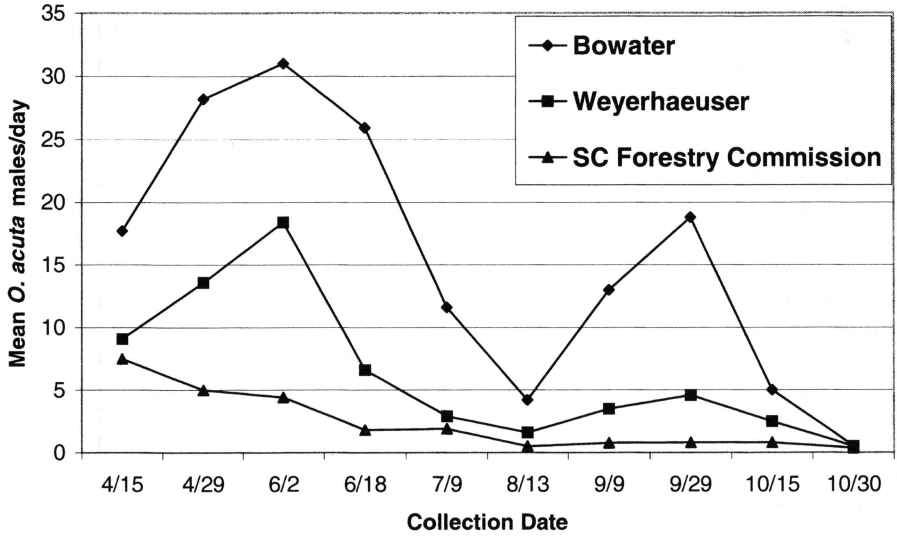


Fig. 1. Mean number of *Oracella acuta* males trapped per trap per day on yellow sticky traps at three southern pine seed orchards, 1997, based on captures between collection dates. Traps deployed April 1, 1997.

**Parasitoid trap catches.** Numbers of parasitoids captured on the traps were much lower than numbers of *O. acuta* males (Table 1, Fig. 1). A majority of the *Z. debarri* caught were males (Table 1). The sex ratio (F/M) previously calculated for emerging *Z. debarri* is 1.43/1 (Sun, unpub. data). The predominance of males captured implies a greater response than females to yellow traps. An alternate explanation may be that males emerge earlier than females (Sun, unpub. data), and disperse searching for emerging females. More female than male *Allotropa* n. sp. were captured (Table 1), which corresponds with the sex ratio (F/M) of 1.11/1 observed by Sun (unpub. data).

A high number of parasitoids was captured at the SCF orchard relative to the captures of *O. acuta* males, particularly in the spring. The *O. acuta* population at this orchard did not increase in the fall. The SCF was the only orchard where azinphos-methyl was not applied. This insecticide has been implicated in previous outbreaks of *O. acuta* (Clarke et al. 1992). The relationship between the numbers of parasitoids and *O. acuta* males captured at the other two orchards was not as well-defined.

Our results indicate that yellow sticky traps could be used year-round to monitor population fluctuations, as they are effective in capturing *O. acuta* males even when populations are low. Traps could also be deployed beyond the established range of *O. acuta* to signal possible new infestations.

**Table 1. Numbers of parasitoids of *O. acuta* collected on yellow sticky traps at three southern pine seed orchards, in 1997. Numbers represent total captured on three traps since previous collection. Traps deployed on 4/1/97. BOW-Bowater Newsprint, Toombs County, GA; WEY-Weyerhaeuser Company, Toombs County, GA; SCF-South Carolina Forestry Commission, Jasper County, SC**

| *Allotropa* n. sp. | | Collection date | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Orchard | Sex | 4/15 | 4/29 | 6/2 | 6/18 | 7/9 | 8/13 | 9/9 | 9/29 | 10/15 | 10/30 | Total |
| BOW | Male | 2 | 8 | 2 | 4 | 11 | 7 | 7 | 1 | 1 | 2 | 45 |
| | Female | 7 | 6 | 3 | 15 | 7 | 5 | 11 | 4 | 2 | 1 | 61 |
| WEY | Male | 0 | 2 | 3 | 2 | 3 | 2 | 5 | 0 | 0 | 0 | 17 |
| | Female | 0 | 10 | 2 | 4 | 8 | 6 | 5 | 1 | 1 | 2 | 39 |
| SCF | Male | 12 | 10 | 11 | 2 | 4 | 5 | 1 | 2 | 2 | 0 | 49 |
| | Female | 20 | 5 | 3 | 3 | 9 | 6 | 4 | 2 | 1 | 1 | 54 |
| *Zarhopalus debarri* | | | | | | | | | | | | |
| BOW | Male | 2 | 5 | 11 | 2 | 3 | 4 | 8 | 15 | 3 | 0 | 53 |
| | Female | 0 | 0 | 2 | 1 | 2 | 4 | 0 | 4 | 1 | 0 | 14 |
| WEY | Male | 0 | 1 | 7 | 1 | 1 | 1 | 2 | 17 | 3 | 0 | 33 |
| | Female | 0 | 2 | 2 | 0 | 1 | 1 | 2 | 2 | 2 | 0 | 12 |
| SCF | Male | 4 | 36 | 61 | 3 | 2 | 2 | 0 | 1 | 1 | 0 | 110 |
| | Female | 6 | 3 | 3 | 4 | 3 | 1 | 1 | 0 | 0 | 0 | 21 |

Yellow sticky traps may provide an easy and non-labor-intensive method to monitor parasitoid dispersal from release sites in China. Due to the low numbers of parasitoids collected, three or more sticky traps per site, left in place for at least 2 to 3 wks, may be necessary to effectively track dispersal and sample population trends. Increasing the numbers of traps per site may allow for a decrease in the length of the trapping period. Our results also suggest that the ratio of *O. acuta* males to parasitoids collected on yellow sticky traps might be beneficial in predicting future population levels of *O. acuta* in pine stands in China, where insecticides are normally not applied.

## Acknowledgments

We thank Franklin Brantley, Weyerhaeuser Company; Mike Powell, Bowater Newsprint; and Chris King, South Carolina State Forestry Commission, for access to the seed orchards used in this study. This work is part of a cooperative Sino-U.S. biological control program supported by a cooperative agreement with the USDA Forest Service, Forest Health Technology Enterprise Team, and the State Forestry Administration, People's Republic of China.

## References Cited

**Clarke, S. R., G. L. DeBarr and C. W. Berisford. 1990.** Life history of *Oracella acuta* (Homoptera: Pseudococcidae) in loblolly pine seed orchards in Georgia. Environ. Entomol. 19: 99-103.

**Clarke, S. R., J. F. Negron and G. L. DeBarr. 1992.** Effects of four pyrethroids on scale insects (Homoptera) populations and their natural enemies in loblolly and shortleaf pine seed orchards. J. Econ. Entomol. 85: 1246-1252.

**Grout, T. G. and G. I. Richards. 1991.** Value of pheromone traps for predicting infestations of red scale, *Aonidiella aurantii* (Maskell) (Homoptera: Diaspididae), limited by natural enemy activity and insecticide use to control citrus thrips, *Scirtothrips aurantii* Faure (Thysanoptera: Thripidae). J. Appl. Entomol. 111: 20-27.

**Jervis, M. and N. Kidd. 1996.** Insect Natural Enemies: Practical approaches to their study and evaluation. Chapman & Hall, New York. 539 pp.

**Masner, L. 1976.** Yellow pan traps (Moreicke traps, *Assiettes jaunes*). Proctos. 2: 2.

**Noyes, J. S. 1989.** A study of five methods of sampling Hymenoptera (Insecta) in a tropical forest, with special reference to the Parasitica. J. Natural. Hist. 23: 285-298.

**Robin, M. R. and W. C. Mitchell. 1987.** Sticky trap for monitoring leafminers *Liriomyza sativae* and *L. trifolii* (Diptera: Agromyzidae) and their associated hymenopterous parasites in watermelon. J. Econ. Entomol. 80: 1345-1347.

**Samways, M. J. 1988.** Comparative monitoring of red scale, *Aonidiella aurantii* (Mask.) (Homoptera: Diaspididae) and its *Aphytis* spp. (Hymenoptera: Aphelinidae) parasitoid. J. Appl. Entomol. 105: 483-489.

**Sun, J. H., G. L. DeBarr, T. X. Liu, C. W. Berisford and S. R. Clarke. 1996.** An unwelcome guest in China: a pine feeding mealybug. J. Forestry 94: 27-32.

**Sun, J. H., G. L. DeBarr, C. W. Berisford and M. E. Schauff. 1998.** Description of a new primary parasitoid, *Zarhopalus* Ashmead (Hymenoptera: Encyrtidae), of *Oracella acuta* (Homoptera: Pseudococcidae). Can. Entomol. 130: 793-797.

**Van Driesche, R. G. and T. S. Bellows, Jr. 1996.** Biological control. Chapman & Hall. New York. 539 pp.

**Xu, J. X., K. J. Ding and R. G. Situ. 1992.** Preliminary study on the biology of the loblolly pine mealybug. Guangdong Forest Sci. and Tech. 4: 22-24 (in Chinese).