FHP TECHNOLOGY DEVELOPMENT PROPOSAL

PROJECT STATUS: New, not previously funded.

PROJECT NUMBER: R8-99-03

PROJECT TITLE: Development of a mass rearing scheme for the bark beetle natural enemy Roptrocerus xylophagorum.

SUBJECT: Biological control, bark beetles, Dendroctonus, Ips, Roptrocerus xylophagorum.

PROJECT OBJECTIVES: The core objective of this project is the development of a cost-efficient mass rearing procedure for the bark beetle larval/pupal parasitoid, Roptrocerus xylophagorum, capable of producing adequate numbers of insects for possible use in augmentative release programs aimed at controlling bark beetle infestations. No methods currently exist to rear R. xylophagorum in a cost-effective manner on its natural hosts (Ips or Dendroctonus beetles), because large quantities of tree tissue are required to rear the beetles themselves. We propose to develop methods for rearing R. xylophagorum on an artificial diet devoid of insect components. To meet this goal the project must address the following two component objectives:

(1) Identification and synthesis of an oviposition stimulant for R xylophagorum. This parasitoid normally oviposits only on their natural hosts when these are enveloped in tree tissue. Collection and transfer of eggs from such "natural" oviposition sites to artificial media would be prohibitively labor intensive and too costly for large-scale implementation. To overcome this problem, we must identify the natural cues (chemical and physical) involved in oviposition, and then develop a synthetic oviposition stimulant. This stimulant would be used to induce the parasitoids to deposit eggs directly on the diet or onto surfaces where the eggs might be easily recovered and manipulated.

(2) Optimization of an artificial diet for rearing R. xylophagorum. Previous work with Dr. M. Guadalupe Rojas (USDA-ARS) has resulted in a functional artificial diet capable of rearing R. xylophagorum from egg to adult, one that has no insect-derived components. However, further tests are to needed to measure the quality of the individuals produced on the artificial diet. We will compare the fecundity, longevity, size, etc. of adult parasitoids reared on the diet with those reared on natural hosts, and if necessary enrich or modify the diet to obtain similar performance.

BRIEF DESCRIPTION OF PROJECT: Studies will be conducted to meet component objectives 1 and 2 above.

(1) Studies will be undertaken to characterize and then artificially reproduce the chemistry of R. xylophagorum's natural oviposition stimulant(s). Volatile and non-volatile compounds associated with R. xylophagorum oviposition sites in host-infested bark will be isolated by a variety of techniques and identified using coupled gas

chromatography-mass spectrometry. Compounds distinguishing the oviposition sites from other locations will be obtained in pure form, and synthetic blends of candidate oviposition stimulants will be bioassayed to check for oviposition-stimulating activity. Methods for presenting the stimulants to ovipositing parasitoids will be refined in order to maximize the facility with which eggs may be collected and transferred to media. Optimally, it will be possible to present the stimulants in such a way that oviposition occurs directly on media cells (see below), hence eliminating the need for manual or automated transfer.

(2) Studies will be conducted to fully evaluate the fitness of R. xylophagorum reared on artificial diet. Trays with multiple cells will be partially filled with the diet for R. xylophagorum and then eggs will be placed within each cell near the diet, as in our preliminary studies. Survivorship from egg to emerging adult will be recorded, and then measurements made of the fecundity, longevity, and size of the resulting adult wasps. Performance of R. xylophagorum on the diet will then be compared with those reared on natural hosts, and if necessary the diet will be modified/enriched until similar performance is obtained.

FHP PEOPLE WHO WILL LEAD PROJECT: Steve Clarke & Don Duerr, R8

CO-PRINCIPAL INVESTIGATORS:

Dr. Brian T. Sullivan and Dr. C. Wayne Berisford
Department of Entomology
University of Georgia
Athens, Georgia 30602

Contributions: Dr. Sullivan will work on developing a synthetic oviposition stimulant for R. xylophagorum (see Methods, part 1), while Dr. Berisford will provide the necessary analytical equipment, oversight, and salary for Dr. Sullivan's work.

Dr. John D. Reeve
Southern Research Station
Pineville, Louisiana 71360

Dr. M. Guadalupe Rojas
USDA ARS
New Orleans, LA 71360

Contributions: Dr. Reeve will work on optimizing the diet for R. xylophagorum (see Methods, part 2), in collaboration with Dr. Rojas. All rearing and quality testing will be done at the Southern Research Station, with diet preparation and modification conducted at an ARS facility in New Orleans.

JUSTIFICATION: The proposed project will strengthen FHP program capability by developing a new tool for use in the management of bark beetle infestations. The inundative release of natural enemies of bark beetles offers the possibility of bark beetle control without the environmental hazards and aesthetic damage associated with common bark beetle control procedures requiring insecticides or extensive cutting. For an increasing number of forest settings such as parks, residential areas, and portions of

national forests, cutting and insecticides are no longer acceptable options for control of infestations. In spite of widespread restrictions on cutting and insecticides, however, there are few, if any, reliable and safe alternatives for bringing bark beetle infestations under control. The extreme damage potential posed by bark beetles warrants the development of alternative management tools to prevent possible catastrophic losses. It is increasingly necessary for forest managers to carefully tailor beetle control measures to the dollar value and management goals for the timber stands being protected. Having an abundance of effective tools (to be used singly or in combination) at their disposal will aid forest managers in obtaining the most effective possible control within the site-specific restrictions set by law, environmental and aesthetic demands, and cost. Augmentative releases of R. xylophagorum would blend well with other bark beetle control techniques currently in development, such as pheromone treatments. This method also has the potential to reduce losses control for bark beetle species not normally suppressed due to their infestation dynamics, such as Ips beetles.

URGENCY: Urgency in funding arises from at least two factors. (1) An established colony of R. xylophagorum is currently being maintained at the University of Georgia by Dr. Sullivan, and this colony will serve as the source of insects for the proposed experiments. However, without additional funding of R. xylophagorum research this colony will of necessity be discontinued in 1999. Delaying funding of the proposed experiments to a future year would necessitate the additional costs of re-establishing an R. xylophagorum colony or obtaining experimental insects directly from wild populations. (2) Personnel with the requisite training, experience, and access to needed equipment are available and interested in conducting this research currently. This situation is likely not to exist in future years since some collaborators hold temporary positions.

LINK TO NATIONAL FHP TECHNOLOGY DEVELOPMENT PRIORITIES: The proposed project clearly addresses the steering committee "high priority" objective #1: "Develop or refine biocontrol for established species (native and non-native) and established pest populations." Our project purposes to develop a novel biocontrol technique (i.e., augmentative release of natural enemies) for established, native bark beetle pests.

SCOPE OF APPLICATION: The technology we wish to develop has a very broad potential scope of application because R. xylophagorum, the biocontrol agent we intend for use in inundative releases, is probably indigenous to all pine-forested regions of the continental United States and attacks a broad spectrum of bark beetle pests. R. xylophagorum has been reported as a natural enemy of at least eight economically important species of Dendroctonus and Ips bark beetles throughout North America, including the southern pine beetle, D. frontalis, the western pine beetle, D. brevicomis, the mountain pine beetle, D. ponderosae, the douglas-fir beetle, D. pseudotsugae, the eastern larch beetle, D. simplex, and the engraver beetles, I. pini, and I. confusus (Bushing, 1965; Langor, 1991). Additionally, R. xylophagorum has been reported as the most common parasitoid attacking the southern pine beetle, the western pine beetle, and Ips spp. beetles native to the southeastern United States (Goyer and Finger, 1980;

Stephen and Dahlsten, 1976, Berisford and Franklin, 1972). Hence, inundative releases of mass-reared R. xylophagorum might be employed as a control strategy for any or all of the above listed bark beetle pests. Also of potential relevance, R. xylophagorum is a native parasitoid of bark beetle species in Northern Europe and was introduced into Australia to control the exotic pest Ips grandicollis, hence technology developed here may find utility in other continents as well. We anticipate no particular time limits on the usefulness of the technology we intend to develop.

RESEARCH BASIS: The inundative release of natural enemies has been demonstrated to be an effective tool for controlling insect pest populations, and natural enemy augmentation procedures have become standard management practices for dealing with a broad array of pest species around the globe. The majority of successes involving augmentative releases have been with Trichogramma spp. egg parasitoids against a variety of field crop pests (reviewed by Smith, 1996), however successes have also been reported when inundative release technology was used against forest pests (Sun and Yu, 1986; Hsiao, 1980; Smith et al., 1990) and/or when the control agents were larval or pupal parasitoids (King and Powell, 1992; Proshold et al., 1998; Flinn, 1998; Summy et al. 1997). Although predators and parasitoids of bark beetles can inflict significant levels of mortality and regulate infestation growth (Dahlsten, 1982; Stephen et al., 1989), to date no attempts have made to incorporate native natural enemy augmentation into integrated pest management practices for North American bark beetles.

Roptrocerus xylophagorum (Hymenoptera: Pteromalidae) is a larval/pupal parasitoid that attacks most of the economically important species of pine-infesting bark beetles in North American (see previous section). R. xylophagorum differs from most bark beetle parasitoids in that it enters bark beetle galleries in search of hosts (Bushing, 1965). It has been reported as the most abundant parasitoid associated with the western and southern pine beetles, and it has been successfully established in Australia for the control of the exotic Ips grandicollis (Berisford and Dahlsten, 1989). R. xylophagorum appears to be relatively easy to rear in the laboratory: a colony managed by Dr. Sullivan has been maintained on artificially I. grandicollis-infested bolts for more than twenty generations (Sullivan et al., in prep.).

Oviposition-stimulating compounds have been identified for several species of larval/pupal parasitoids (Henson et al., 1977; Millar and Hare, 1993; Guerra et al., 1994; Ohara et al., 1996), and in at least one instance have been employed in generating eggs for use in parasitoid mass-rearing programs (Rojas et al. 1996; Morales-Ramos et al., 1998). R. xylophagorum have been repeatedly observed attempting oviposition onto paper and glass surfaces apparently contaminated with odors of host frass, and this strongly suggests the presence of a chemical elicitor of oviposition for this species (Sullivan, unpublished). R. xylophagorum also appear to be amenable to behavioral assay in the laboratory: host-infested tree tissues, their extracts, and synthetic mixtures of host-associated compounds are significantly attractive to this species when assayed in a Y-tube olfactometer (Sullivan, in prep.).

There is also a firm research basis for using an artificial diet and other techniques to mass rear R. xylophagorum. Our optimism is based on the success achieved by USDA-ARS researchers with the parasitoid Catolaccus grandis, which attacks the boll weevil. This parasitoid has been successfully reared on an artificial diet for many

generations, producing adults close in quality to those reared on natural hosts (Rojas et al. 1996; Morales-Ramos et al., 1998). It has been reared in sufficient numbers to test augmentation in the field, where it significantly reduces boll weevil damage (Summy et al. 1995). R. xylophagorum is in the same taxonomic family as C. grandis (Pteromalidae) and has a similar life history, and it is likely that methods developed for mass rearing C. grandis could be adapted to R. xylophagorum, with only small investments by the Forest Service in time and resources. Our preliminary studies (with this same group of researchers) already indicate that R. xylophagorum can be successfully reared on an artificial diet using these methods.

METHODS:

(1) Identification and synthesis of a chemical oviposition stimulant for R. xylophagorum. This work will be conducted at the University of Georgia by Dr. Sullivan in the laboratory of Dr. C. Wayne Berisford. Pieces of bark infested with late larval instars of the bark beetle I. grandicollis will be presented to groups of R. xylophagorum females obtained from the colony maintained at the University of Georgia. Parasitoids will be observed for extended periods, and sites on the inner surface of the bark will be marked using insect pins if they either (a) stimulate ovipositor probing or (b) fail to stimulate probing in spite of repeated parasitoid contact with these locations. Parasitoids will be prevented from completing oviposition at probing sites to preclude their possible release of marking pheromones.

Volatile and non-volatile compounds at these sites will be isolated by different methods including: (a) Solid Phase MicroextractionTM (SPME). SPME fibers will be either touched directly to the surfaces of marked sites or inserted into small, glass headspace enclosures sealed directly over the marked sites. Fibers will then be desorbed at 200-300 oC in the GC injector, and the desorbed compounds then analyzed. (b) Direct solvent extraction. Marked sites will be dissected from the bark with a clean scalpel, placed into small glass vials, and extracted repeatedly with solvents (methanol, ether, or pentane) to isolate surface compounds and volatiles for later concentration and analysis. Direct extracts will be assayed (see below) to determine whether oviposition stimulants have been successfully isolated.

Chemical isolations will be analyzed by coupled gas chromatography- mass spectrometry using a Hewlett-Packard GCD G1800A with a variety of analytical columns. Chromatographed compounds will be identified by matches of their mass spectra to known spectra and retention time matches with knowns. Quantities of isolated compounds will be determined by comparison with quantitative internal standards added during sampling.

The chemical blends associated with oviposition-stimulating sites will be compared quantitatively to blends associated with inactive sites using either a standard t-test for individual compounds or multivariate methods to identify critical differences in the proportions among blend components. Compounds or combinations found to be uniquely associated with oviposition sites will be considered "candidate" oviposition stimulants and bioassayed for activity. Compounds composing the candidate stimulants will be either obtained commercially, synthesized (when practical), or isolated from natural sources with preparative gas chromatography (using a Varian 3700 gas chromatograph fitted with a fraction collector).

Different candidate oviposition stimulants will be assayed against each other or blank controls by presenting candidates in pairs to groups of 5-20 female parasitoids and counting the number of individuals that attempt oviposition or successfully oviposit on either the candidates or controls. A standard c2 test will be performed to determine if parasitoids oviposit with significantly greater frequency on one or more candidates. A single stimulating blend that maximizes egg deposition will by this means be identified. Modifications to the method of stimulant presentation will be made in order to maximize the efficiency with which eggs can be transferred to media.

(2) Optimization of an artificial diet for R. xylophagorum. This work will be conducted by Dr. John D. Reeve at a Southern Research Station facility in Pineville, Louisiana. It will be done in collaboration with Dr. M. Guadalupe Rojas, USDA ARS, who developed the initial diet for R. xylophagorum. This diet was formulated by performing a detailed chemical analysis using HPLC and gas chromatography of the nutrients in bark beetle hosts (Ips grandicollis larvae), and modifying the diet for C. grandis to more closely match this host type. Our tests will use this initial diet as a starting point. The diet will be mixed with heated 7% ultra pure agar, and then 220 ml dispensed into each well in plastic rearing trays developed for C. grandis (Rojas et al. 1996). The trays will be placed at angle, so that the diet covers only part of the well bottom, and the diet allowed to solidify. Individual R. xylophagorum eggs will then be placed in each well in the area devoid of diet using a small paintbrush. The trays will then be closed with lids and incubated at 28 oC until emergence occurs. The eggs for this procedure will be obtained by confining R. xylophagorum adults with bark pieces infested with I. grandicollis larvae, then dissecting the bark and removing the eggs. Later tests would use the synthetic oviposition stimulant to obtain eggs, when it becomes available.

We will then measure the fecundity and longevity of the adults produced on the diet, using previously published methods (Samson 1984). Male-female pairs will be placed in small containers streaked with honey, and bark squares infested with I. grandicollis larvae supplied daily, until the female parasitoid expires. The bark squares will then be dissected to determine the number of eggs laid per day, with a subset incubated until emergence occurs to determine the sex ratio of the offspring. We will then compare the data for these pairs with control pairs reared on natural hosts, and with previously published data for R. xylophagorum (Samson 1984). If the adults reared on the artificial diet are significantly lower in quality to those reared on natural hosts, the diet will then be modified/enriched by Dr. Rojas and the testing continued.

MEASURE OF SUCCESS: The project will be considered successful if the in vitro rearing methods we develop are found capable of producing adequate numbers of R. xylophagorum for initial field trials of inundative releases into southern pine beetle infestations. Given the typical release numbers reported in the literature for successful augmentative use of parasitoids against larval/pupal hosts (1000-20,000 per ha), the rearing method should be capable of producing at least several thousand parasitoids per day at a reasonable cost.

Success will also be gauged by the cost per parasitoid of the rearing procedure developed, however, the maximum acceptable limit of this cost cannot be known until the control potential of the inundative release procedure has been determined experimentally.

Once its potential for control has been evaluated, the augmentative approach can be further streamlined to increase cost efficiency.

PRODUCTS: A cost-efficient process for mass rearing the parasitoid R. xylophagorum for use in inundative releases against bark beetle pests. We expect this process to be developed by the year 2000.

PUBLICATION: The results of this work will be prepared for submission to refereed journals in relevant fields.

TECHNOLOGY TRANSFER: The transfer of this technology will involve all cooperators on this proposal (University of Georgia, Southern Research Station, and FHP personnel). Once a mass rearing procedure for R. xylophagorum has been developed, the next logical step would be field trials of augmentation in D. frontalis or Ips infestations. After efficacy has been demonstrated at this level, the technology would then be made available to various private companies that rear beneficial insects, who would then provide the parasitoids to federal, state, and private landowners. Landowners would be trained on the use of this method by FHP personnel.

PROJECT DURATION: One (1) year should be required to complete the project. Completion is expected in fiscal year 1999.

LONG TERM BUDGET: No funding requested or expected beyond FY 1999.

FY 1999 BUDGET REQUEST:

Item
Requested FHP STDP Funding
Funding by University of Georgia
Funding by Southern Research Station
Admin items:
Salary
$11,390 (technician-UGA)
$6,750
(¼ postdoc)
$23,000
(1/3 scientist)

Overhead

$4,337
(35% of funds to UGA)

Travel

$1000

Procurements:
Equipment
$5,000
(incubator-SRS)

Supplies
$1,000 (UGA)
$1,000 (SRS)

Total FY 1999 Budget:

$19,390
$11,087
$23,000

Grand Total: $53,477

Items to be funded by FHP STDP:

- ½ time salary and benefits for a Research Tech I (Katja Seltmann) at the University of Georgia
- $1000 for general supplies for research performed at the University of Georgia
- $5000 for a Percival incubator for rearing parasitoids at the Southern Research Station.
- $1000 for general supplies at the Southern Research Station.
- $1000 for travel for FHP and SRS.

Funding by other sources:

- $6,750 for ¼ salary and benefits for a postdoc, Dr. Brian T. Sullivan, University of Georgia.
- $4,337 for 35% overhead of funds provided to University of Georgia.
- $23,000 for 1/3 salary and benefits for a research entomologist, Dr. John D. Reeve, Southern Research Station.

CITATIONS:

Berisford, C.W., and Dahlsten, D.L. 1989. Biological control of Ips grandicollis (Eichoff) (Coleoptera: Scolytidae) in Australia - a preliminary evaluation, pp. 81-93, in D.L. Kulhavy, and M.C. Miller (eds.). Potential for biological control of Dendroctonus and Ips bark beetles. Univ. of Texas Press, Austin, TX.

Berisford, C.W., and Franklin, R.T. 1972. Tree host influence on some parasites of Ips spp. bark beetles (Coleoptera: Scolytidae) on four species of southern pines. J. Ga. Entomol. Soc. 7: 110-115.

Bushing, R.W. 1965. A synoptic list of the parasites of Scolytidae (Coleoptera) in North America north of Mexico. Can. Entomol. 97: 449-492

Dahlsten, D.L. 1982. Relationships between bark beetles and their natural enemies, pp. 140-182 in J.B. Mitton, and K.B. Sturgeon (eds.). Bark beetles in North American conifers. Univ. of Texas Press, Austin, TX.

Flinn, P.W. 1998. Temperature effects on efficacy of Choetospila elegans (Hymenoptera: Pteromalidae) to suppress Rhyzopertha dominica (Coleoptera: Bostrichidae) in stored wheat. J. Econ. Entomol. 91: 320-323.

Goyer, R.A., and Finger, C.K. 1980. Relative abundance and seasonal distributions of the major hymenopterous parasites of the southern pine beetle, Dendroctonus frontalis Zimmerman on loblolly pine. Environ. Entomol. 9: 97-100.

Guerra, A.A., Martinez, S., and Del Rio, H.S. 1994. Natural and synthetic oviposition stimulants for Catolaccus grandis (Burks) females. J. Chem. Ecol. 20: 1583-1594.

Henson, R.D., S.B. Vinson, and C.S. Barfield. 1977. Ovipositional behavior of Bracon mellitor Say, a parasitoid of the boll weevil (Anthonomus grandis Boheman) III. Isolation and identification of natural releasers of ovipositor probing. J. Chem. Ecol. 3: 151-158.

Hsiao, K. 1980. The use of biological agents for the control of the pine defoliator, Dendrolimus punctatus (Lep. Lasiocampidae), in China. Prot. Ecol. 2: 297-303.

King, E.G., and J.E. Powell. 1992. Propagation and release of natural enemies for control of cotton insect and mite pests in the United States. Crop Protection 11: 497-506.

Langor, D.W. 1991. Arthropods and nematodes co-occuring with the eastern larch beetle, Dendroctonus simplex (Col.:Scolytidae), in Newfoundland. Entomophaga 36: 303-313.

Millar, J.G., and J.D. Hare. 1993. Identification and synthesis of a kairomone inducing oviposition by parasitoid Aphytus melinus from California red scale covers. J. Chem. Ecol. 19: 1721-1736.

Morales-Ramos, J. A., M. G. Rojas, and E. G. King. 1998. Potential used of in vitro-reared Catolaccus grandis (Hymenoptera: Pteromalidae) for biological control of the boll weevil (Coleoptera: Curculionidae). J. Econ. Entomol. 91: 101-109.

Ohara, Y., J. Takabayashi, and S. Takahashi. 1996. Oviposition kairomones in the cuticular wax of host larvae, Pseudaletia separata, toward its parasitic wasp, Cotesia kariyai. Appl. Entomol. Zool. 31: 271-277.

Proshold, F.I., H.R. Gross, and J.E. Carpenter. 1998. Inundative release of Archytas marmoratus (Diptera: Tachinidae) against the corn earworm and fall armyworm (Lediptera: Noctuidae) in whorl-stage corn. J. Entomol. Sci. 33: 241-255.

Rojas, M. G., J. A. Morales-Ramos, and E. G. King. 1996. In vitro rearing of the boll weevil (Coleoptera: Curculionidae) ectoparasitoid Catolaccus grandis (Hymenoptera: Pteromalidae) on meridic diets. J. Econ. Entomol. 89: 1095-1104.

Samson, P. R. 1984. The biology of Roptrocerus xylophagorum (Hym.: Torymidae), with a note on its taxonomic status. Entomophaga 29: 287-298.

Smith, S.M. 1996. Biological control with Trichogramma: advances, successes, and potential of their use. Annu. Rev. Entomol. 41: 375-406.

Smith, S.M., Carrow, J.R., and Laing, J.E. 1990. Inundative release of the egg parasitoid, Trichogramma minutum (Hymenoptera: Trichogrammatidae), against forest insect pests such as the spruce budworm, Choristoneura fumiferana (Lepidoptera: Tortricidae): The Ontario Project 1982-1986. Mem. Entomol. Soc. Can. no. 153.

Stephen, F.M., and Dahlsten, D.L. 1976. The arrival sequence of the arthropod complex following attack by Dendroctonus brevicomis (Coleoptera: Scolytidae) in ponderosa pine. Can. Entomol. 108: 283-304.

Stephen, F.M., Lih, M.P., and Wallis, G.W. 1989. Impact of arthropod natural enemies on Dendroctonus frontalis (Coleoptera: Scolytidae) mortality and their potential role in infestation growth, pp. 169-185, in D.L. Kulhavy, and M.C. Miller (eds.). Potential for biological control of Dendroctonus and Ips bark beetles. University of Texas Press, Austin.

Sullivan, B.T. Response of the bark beetle parasitoid Roptrocerus xylophagorum (Ratzeburg) in a Y-tube olfactometer to odors associated with the host-tree complex. Manuscript in preparation.

Sullivan. B.T., Seltmann,K., and Berisford, C.W. A simple continuous-rearing technique for the bark beetle parasitoid, Roptrocerus xylophagorum (Ratzeburg). Manuscript in preparation.

Summy, K.R., S.M. Greenberg, J.A. Morales-Ramos, and E.G. King. 1997. Suppression of boll weevil infestations (Coleoptera: Curculionidae) occurring on fallow-season cotton in southern Texas by augmentative releases of Catolaccus grandis (Hymenoptera: Pteromalidae). Biological Control 9: 209-215.

Sun, X. and Yu, E. 1988. Use of Trichogramma dendrolimi in forest pest control in China, pp. 591-596, in J. Voegelé, J. Waage, and J.C. Van Lenteren (eds.). Trichogramma and Other Egg Parasites. Int. Symp. on Trichogramma, 2nd, Guangzhou, PR China, Paris: Les Colloques de l'INRA No. 43.

PRODUCTION FUNCTION

PROJECT NUMBER: R8-99-03

PROJECT COST:

STDP	Other	Total
$19,390	$34,087	$53,477

PROJECT OBJECTIVES: The project will develop a cost-effective procedure for mass-rearing of Roptrocerus xylophagorum, a bark beetle parasitoid. First, an ovipositional stimulant for R. xylophagorum will be identified and synthesized. An artificial diet for rearing the parasitoid from egg to adult will be modified and improved. The stimulant will be used to induce oviposition by the parasitoid either directly on the diet or onto surfaces where the eggs can be collect easily. With the development of a mass-rearing program, the parasitoids could be released, either by themselves or in combination with other treatments, to suppress bark beetle infestations. Releases would initially be made in high-value areas such as RCW clusters, wildernesses, or recreation areas which are often difficult to treat, as usually tree-felling or pesticide use is not allowed and/or desirable. Releases of parasitoids to augment natural populations will increase bark beetle mortality, reducing tree loss. This parasitoid attacks a wide variety of bark beetle pests, so releases would be effective in situations where treatments which are more specific to a particular species of bark beetle, such as pheromone applications, may fail. Without a mass-rearing scheme for R. xylophagorum, bark beetles will kill more trees in these sensitive areas. Benefits of this project 1) avoid tree removal/replacement costs, and 2) protect threatened/endangered species habitat. Other benefits not quantified include enhancing visual quality and recreation, maintaining wildlife habitat, and avoiding pesticide-related costs.

ASSUMPTIONS:

A mass-rearing scheme will allow augmentative releases of parasitoids, resulting in a reduction of tree loss in high-value areas.

Benefits of this project will accrue for 5 years.

Releases will only be made in areas where current suppression techniques cannot currently be used, so there are no treatment costs without the project.

The current value of the high-value trees protected for scenic, wildlife, and other purposes is twice the timber value of the trees at harvest, a conservative estimate.

The number of infestations in high-value areas which are not now treated but could be using parasitoid release = 1% of infestations infestations requiring treatment.

20 trees per infestation will be treated, and 20 trees per infestation protected.

No additional labor costs for treatment, as infestations would be monitored anyway.

BACKGROUND:

Production costs of mass-rearing 1000 parasitoids = $29 (cost to produce 1000 Catolaccus grandis, another parasitoid).

1000 parasitoids will be released per infested tree.

Value of pine tree at harvest = $82.50 (TX timber prices).

Average number of spots requiring treatment per year = 3600 (SPBIS data).

EXPENDITURE AND OUTPUT VALUES (EOV) WITHOUT PROJECT
Value of trees lost: 3600 infestations * 1% = 36 infestations untreated per year * 20 trees lost/infestation = 720 trees * $165/tree = $118,800* 5 years=$594,000 discounted to $550,032.12

EXPENDITURE AND OUTPUT VALUES (EOV) WITH PROJECT
Treatment costs: 3600 infestations * 1% = 36 infestations treated/year * 20 trees = 720 trees treated/year * $29/tree = $20,880 * 5 years =$104,400 discounted to $96,672.31

BENEFIT ATTRIBUTABLE TO PROJECT
$550,032.12 - $96,672.31 = $453,359.81

BENEFIT/COST RATIO
$453,359.81/$150,149.31 = 3.0

BENEFIT ATTRIBUTABLE TO STDP
3.0 * $53,477 = $160,431

PNV OF PROJECT
$453,359.81 - $150,149.31 = $303,210.50

PNV OF STDP

$160,431 - $53,477 = $106,954