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BUGS that eat BUGS

Biological control research offers hope for southern pine bark beetle management

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The black turpentine beetle (BTB) is a native pest of pines in the southeastern United States. It is particularly injurious to trees in areas of Georgia and Florida where gum naval stores operations are an important industry. Here, slash pine and longleaf pine are routinely attacked and killed during turpentine operations. Additionally, the BTB quickly attacks trees skinned during logging operations or by construction in urban areas. Normal healthy trees may also be the target of their attack.

For preventing BTB attacks, the same advice applies as that recognized for control of southern pine beetle (SPB). Southern pines should always be kept healthy and vigorously growing through proper forest management including thinning, fertilization (if possible) and protection from bark damage. Additionally, certain insecticides, such as lindane, can be used to prevent an attack on individual trees around houses. In a large infestation, cutting infested trees and removing them from the area is the best method of control.

For many years, this formula of prevention, salvage and chemicals has been the only prescription to solve bark beetle problems. Prevention is the first line of defense and the best method of bark beetle control; however, due to landowner absenteeism, ignorance or depressed timber markets, prevention advice is often unheeded by landowners. Once trees are infested, only rapid salvage can save the day. Chemical treatment is a poor alternative for bark beetle control because of relatively high cost.

Despite considerable knowledge gained and put to use in the last several decades, BTB and SPB problems continue to be as bad or worse than in the past. All the control expertise heretofore developed is still not enough.

What to do?

Obviously, forest managers should closely follow recommendations regarding preventive methods or rapid salvage if trees are under attack. These are proven methods and should be the first line of defense against the beetles.

But judging from losses being incurred, even when direct controls are applied supplementary strategies are needed. Insecticides are usually ruled out because of costs and environmental problems associated with their use. This leaves biological controls.

Applied biological control of bark beetles as an alternative or supplementary control strategy has received little attention over the years. Instances of attempts at applied biological controls using predators and

parasites are few in number, even on a worldwide basis. This lack of interest in the use of such methods may be based on the long-held assumption that importation of exotic natural enemies only works if the pest was originally transplanted without its natural enemy complex. Recent studies by noted authorities on both sides of the Atlantic have disproved this assumption.

Rationale for a Biological Approach

Recently one insect predator that appears to have exciting possibilities to test the "new association" theory of biological control has come to the attention of scientists working in this field. ("New associations" are parasites or predators not from the same native area and natural enemy complex.) This new association approach is based on the ecological principle that natural enemies and their hosts tend to evolve some degree of balance.

The insect we have been observing is the predatory beetle, *Rhizophagus grandis* Gyllenhal, a specific predator of the European spruce bark beetle, which closely resembles BTB in appearance and size. Both host and predator are found from eastern Siberia west to France and Britain, south to Turkey, and to the northern tip of Norway. Large scale programs are presently underway to introduce *R. grandis* in spruce stands in parts of Belgium, Britain, France, Russia and Turkey, where the spruce bark beetle still is epidemic.

As far as is known, *R. grandis* is specific only to the European spruce bark beetle and has never been recorded attacking any other bark beetle. But perhaps this is because no other members of the beetle's family are available within its natural range in Eurasia.

One European researcher, J.C. Gregoire, has suggested that New World beetles might also be attractive to this predator. In fact, a series of bioassays performed by Gregoire in Belgium in February 1985 demonstrated that larval frass of three native North American beetles from the family *Dendroctonus* — black turpentine beetle, southern pine beetle and North American spruce beetle — were highly attractive to both males and females of *R. grandis*.

In 1986, the U.S. Forest Service imported about 300 *R. grandis* into the United States as a predator on the black turpentine beetle. BTB proved to be an ideal candidate because its larvae are gregarious like those of its native prey, the spruce beetle, and because of size similarities.

This success has caused some researchers to ask, might the predator also effect some control on the BTB's near relative, the southern pine beetle, even though SPB larvae do not feed gregariously and are smaller? This hypothesis merits even more emphasis in light of the recent epidemic spread of SPB across the forest lands of Texas, Louisiana and Mississippi.

Of all the pine bark beetles infesting pines in the southern United States, southern pine beetle causes by far the greatest losses. The SPB destroyed 2.5 billion board feet and 8.5 cords of pine in the two decades between 1960-80. From 1971-82, timber value losses were estimated at $334.5 million. Recent damage estimates put the annual figure at about $53 million. Beetle populations have been increasing, and projections are that even greater losses can be expected over the next 20 years.

The black turpentine beetle, though not as aggressive or widespread as the southern pine beetle, shows a preference for weakened trees, such as those damaged by fire, worked for naval stores, or skinned during logging operations. It ranks third in overall damage among ten major forest pests in the 13 southeastern states. According to U.S. Forest Service and university researchers working in Florida, in that state and neighboring south Georgia where the turpentine industry is important, the BTB ranks as the most destructive pest.

Our beetle-eating hero is *Rhizophagus grandis* from Europe.

The Viable Alternative

Up to now applied biological control of bark beetles has been a much ignored and undeveloped technique. Of the many organisms and allied beetle species associated with bark beetles, other insects, mites, nematodes and fungi have received the most attention. Past studies were oriented toward determining specific roles and impacts of these native associates. Control strategies were sought that could capitalize on population suppression by native natural enemies.

This was not biological control! Studies have demonstrated that mites and other associated organisms dependent on the SPB for transport seldom prey upon it and that some associates will even evolve positive relationships with it.

Likewise, beetle populations may be reduced somewhat by native natural enemies, though their impact is not enough to control epidemic levels of the southern pine beetle or its destructive relatives.

Recent efforts have concentrated on the search for exotic and extraregional enemies for use as biological agents. It is possible then that the best hope in this area lies with inoculative releases of these exotic new associates such as the aforementioned *R. grandis*.

There is no argument that, based on SPB and BTB population dynamics, the silvicultural approach presently is the best long-term management strategy for this pest. For a multitude of reasons, this approach may never be applied to the extent necessary to prevent recurring bark beetle outbreaks. It is the position of U.S. Forest Service researchers that applied biological control to reduce populations has a potential for supplementing this management strategy, and thus is worthy of further investigation.

The position taken here is that the beetle species to be targeted for initial testing of this approach be the black turpentine beetle. The rationale behind this choice is that species is closely related to the European spruce bark beetle, native host of the predator, and its larval frass is attractive to that predator, thus it is an ideal host in the field. Also the ease of continuous rearing of the BTB has been demonstrated and is well documented. The persistence of BTB populations in readily detectable groups of trees is important in facilitating experimental and operational biological control trials.

Beyond this, a most compelling argument for using the BTB is the fact that investigative procedures would correlate with those of two scientists from Cornell University (Kokkanen and Pimentel) who recently postulated the new associations principle of biological control. Their analyses of biological control programs show that the probability of success is 75 percent greater with new predator-prey associations than when long-evolved associations are used. The inability of some native enemies to limit host numbers is attributed to the balance produced by their long-evolved association.

Selection of potential new association natural enemies must be based on the following criteria: choosing an enemy of a close relative of the pest, ideally from the same genus, one that feeds on related hosts; obtaining natural enemies from climatic regions similar to the pests' natural habitat; and selecting natural enemies that have

good searching ability, are highly host specific, and have a high rate of increase in comparison with the pest.

Use of the rhizophagid predator meets all of these criteria except the climatic aspect. Because much of the South is warmer and more humid than Europe, climatic factors merit consideration. It is the Forest Service's position that climatic problems would not prove critical for this adaptable species. Temperature and humidity for artificial rearing are similar to natural conditions for both SPB and BTB.

The premise of this biological control approach is that, if successful, the agent could spread throughout the host range, affecting widespread, nonpolluting BTB control at relatively little cost. It is further theorized that *R. grandis* might also attack SPB broods acting as a buffer to prevent their explosive population build-ups and thus reducing or limiting the resulting epidemics. In the laboratory at least, *R. grandis* adults have entered SPB galleries through holes made by them, and consumed the larvae in phloem sandwiches. These sandwiches had been previously attacked by SPB in the field. Egg laying, however, was not observed.

Rearing Procedures

Experience in Europe has shown that large numbers of *R. grandis* can be reared on larvae of European spruce beetle in spruce bolts. A substitution of pine for rearing would not seem to be a major problem since spruce beetles occasionally attack pine in the field. Indeed, it has been established in the laboratory that *R. grandis* adults will enter pine bolts and produce larvae, which will feed on the BTB brood.

In 1986 and 1987, three shipments totaling 300 pairs of *R. grandis*, reared by J. C. Gregoire in Belgium, were shipped to the Alexandria Forestry Center in Louisiana for testing methods of rearing the predator on BTB and SPB. Although preliminary tests showed that the predator could be reared on BTB using both the bolt and semiartificial methods, the latter method was chosen because using bolts was too labor intensive.

Field Release Techniques

In both Britain and France, field release methods for the predator take advantage of its extraordinary searching ability. In Britain, single pairs are placed in small plastic cups to which moist sand has been added, and the contents are poured out at the bases of trees under attack by the spruce bark beetle. In France, as many as 50 individuals of each sex are placed at the base of single infested trees where they quickly disappear into the bark or take flight. British workers have shown that predator adults may disperse over at least 220 meters following release. They predict that successful reproduction of even a few predators would result in substantial increases in numbers to form a viable population capable of regulating spruce beetles within two to three years of release.

Currently, researchers are looking for federal approval for field releases of *R. grandis*. So far, problems have been encountered in rearing anexic cultures of the insect that are free of any fatal native European microorganisms. More reserach will be required to overcome this, as well as other rearing problems.

Gregoire and his colleagues in Belgium are currently researching rearing and release practices for *R. grandis* and have already performed studies that confirm its attractiveness to three North American bark beetle species. They are supplying limited number of *R. grandis* populations for shipment to the United States until a rearing program becomes well-established here. Cooperative research is being conducted in Brussels on improving the effectiveness of

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Young and mature larvae of predator *Rhizophagus grandis* feed on pine beetle larva.

BUGS, continued

rearing and dissemination of the predator.

Assessing Success

Initial success of this biological control method will be in recapturing the predator after its inoculative release by returning six months later to the release site and finding evidence of *R. grandis* larvae in brood chambers of the BTB. Ultimate long-term success, of course, will depend on whether the predator is also able to invade and multiply in galleries of the southern pine beetle, and it is hoped, have an impact on potential epidemics of this destructive pest. Plans are to release predators in certain "treated" areas and to leave other "control" areas predator free. Dramatic decreases in the population of either BTB or SPB in treated areas would certainly provide evidence of such impact.

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