Euglandina rosea (Stylommatophora: Spiraxidae)

Problem statement:
The rosey wolfsnail, (*Euglandina rosea*), a medium, pink-hued, predatory land snail, is native to the southeast United States. Purposely brought to Hawaiʻi in 1955 to serve as a biocontrol, *E. rosea* failed to reduce populations of its intended target, the giant African snail, *Achatina fulca*. A generalist predator, *E. rosea* proved adept at finding prey in varied habitats, including native forests, where it became associated with the decline and endangerment of endemic snail species. Native snail populations in Maritius and French Polynesia responded similarly to *E. rosea* invasion.

Goals:
Examine the feeding behavior and ecology of *E. rosea* in native Hawaiian forest, assess their impacts on native snails based on population numbers and use results to aid in the development of an effective control program.

Action:
Occasionally, NRS provide funds and field assistance to University of Hawaiʻi at Mānoa (UH) graduate students whose projects achieve OANRP goals. One such project, addressing problems associated with *E. rosea*, has been underway for one year and OANRP has committed to supporting this research through the upcoming year. Research is carried out by Wallace Martin Meyer III (UH, Center for Conservation Research and Training) as part of his PhD thesis. NRS assists in monthly field surveys for *E. rosea* and collect *E. rosea* and (non-native) prey items for use in feeding experiments. Results from year one of this project, written by W. M. Meyer, appear in Appendix 10. Proposed research for the upcoming year includes an investigation of *E. rosea* movement and microhabitat preference (Appendix 9). Results from this work will improve the ability of NRS to protect native tree snails from the depredations of *E. rosea*.

Xylosandrus compactus (Curculionidae: Scolytidae)

Except where noted, data on the life cycle of *X. compactus* and hosts in Hawaiʻi are taken from Hara and Beardsley (1979).

Problem statement:
Native to Asia, the black twig borer *X. compactus* didn't become widely distributed in Hawaiʻi until 1960, nearly 30 years after its initial arrival in plant material from Singapore. In common with other members of the tribe Xyleborini, *X. compactus* depends upon on an ambrosia fungus, farmed in galleries bored into the vascular tissue of the host plant, for its development. Hawaiʻi hosts 21 endemic ambrosia beetles, many of which specialize on a single plant species. While native ambrosia beetles and other naturalized species, like *X. crassicus*, nest and rear young in dead wood, *X. compactus*, readily attacks healthy plants. In Hawaiʻi, active galleries have been found in 108 host plant genera spanning 44 plant families, making *X. compactus* a serious economic pest as well as a threat to native species. With such a wide range of hosts, *X. compactus* is nearly impossible to control through the removal of potentially infected vegetation alone.

The life cycle of *X. compactus* is such that damage to the host plant arises as a result of multiple activities: 1. the hole bored by the beetle upon entry (Figure. 6.2) 2. the formation of a gallery in which eggs are laid (Figure. 6.3), and, according to some researchers (N. Dudley, Hawaiʻi Agriculture Research Center (HARC) *pers. comm.*) 3. disease-causing strains of the *Fusarium* fungus, which is inoculated into the new host plant by a gravid female. Upon reaching maturity, the female *X. compactus* leaves her parental gallery, having already mated with a male sibling, the majority of which die in place, never to emerge. On average, eight eggs are produced by the female at one time. These hatch within seven days, after which, larvae feed on fungus until they pupate and reach maturity. Another two weeks will elapse before these recently pupated females will leave the galley, at which time they will depart via the single hole bored by their mother.

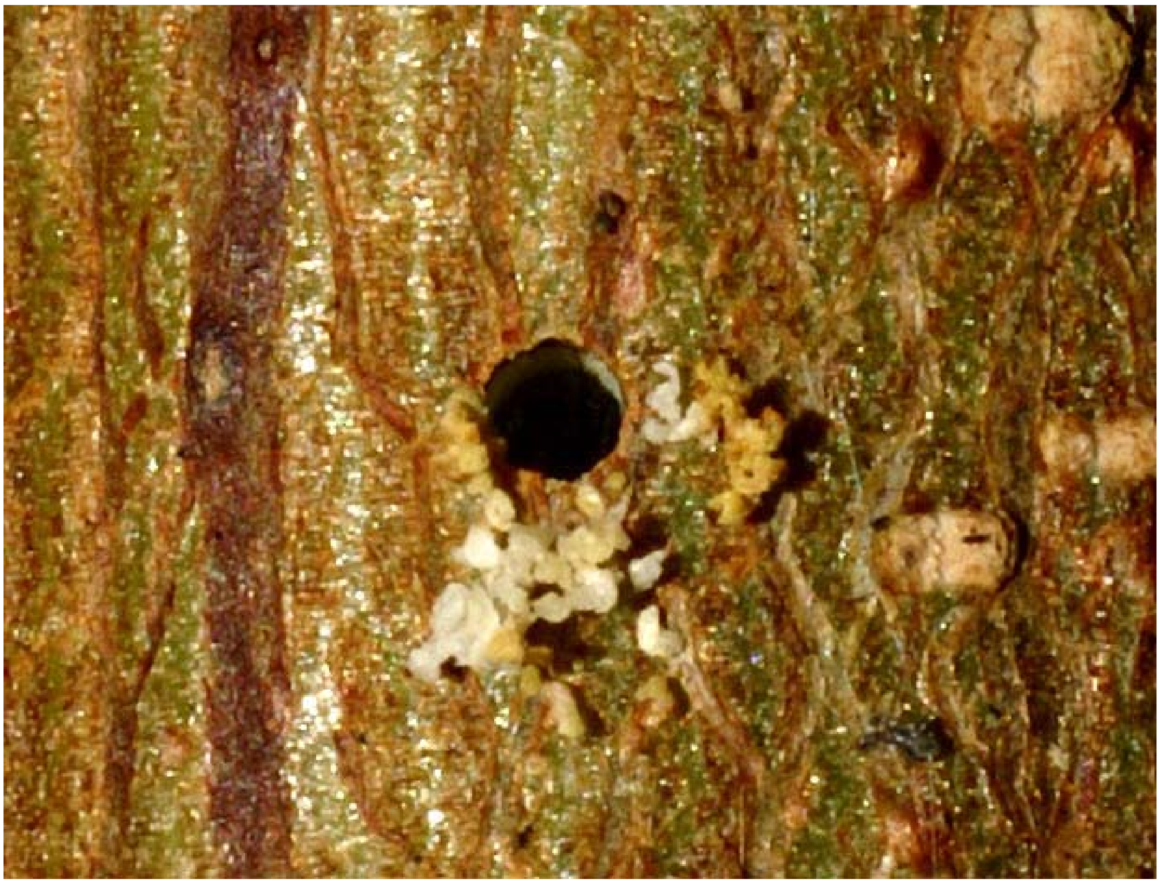

Figure. 6.2: Black twig borer entry hole into *Flueggea neowawraea* stem showing insect frass (photo by S. Joe).

Figure. 6.3: Black twig borer gallery in *Flueggea neowawraea* branch showing mature and recently pupated adult females alongside grubs (photo by H. C. Kuo).

Xylosandrus compactus is a major threat to a number of rare and endangered plants, notably *Caesalpina kavaiensis* (Fabaceae), *Alectryon macrococcus* (Sapindaceae) and *Flueggea neowawraea* (Euphorbiaceae), all of which are observed to suffer high attack rates. Because *X. compactus* resides primarily within the plant pith, chemical control options are limited. Greenhouse collections of *Flueggea neowawraea* are treated with Merit® (Bayer Crop Research, Triangle Park, NC), a systemic insecticide applied as a root drench. The number of entry holes on greenhouse plants differed little from those recorded from untreated, outplanted trees. This suggested treatment with Merit® did not deter *X. compactus* females from nesting and egg laying attempts. Closer inspection of 10 entry holes, however, yielded only three active galleries among the greenhouse individuals compared to eight among the outplanted population.

Goals:

Having found systemic insecticides cumbersome to deploy, slow to act and expensive, with only questionable efficacy, NRS sought out alternatives. NRS entered into a partnership with Nick Dudley, a forester with the HARC and Nancy Gillette, a research entomologist with the U.S. Forestry Service (UFS), to test the anti-aggregation pheromone Verbenone® (Phero Tech, Point Roberts, WA) against *X. compactus* among outplanted *Flueggea neowawraea* in Kahanhāiki Gulch. Verbenone® is currently used on the mainland U.S. to protect pine stands from boring beetles in the genus *Dendroctonus* (Curculionidae: Scolytidae) (Gillette *et al.* 2006). In previous work, Dudley and Gillette demonstrated ethanol effectively attracted *X. compactus* (Gillette *et al.*, *in prep*), presumably because it mimics the odor of rotting wood. When paired with Verbenone, however, they found ethanol attracted significantly fewer *X. compactus* than did ethanol alone or ethanol paired with other potential repellents (Gillette *et al.*, *in prep*). Thus, while Verbenone appears to repel *X. compactus*, our experiment will determine whether this effect is strong enough to protect *F. neowawraea*.

Little is known regarding *X. compactus* densities or population response to seasonal cues. Anecdotal observations suggest *X. compactus* numbers increase starting in late April, peak in August and begin to decline in October (E. Burbano, UH Plant & Environmental Protection Sciences (PEPS) *pers. comm.*). If true, then the deployment of repellents would be most effective at those times when numbers are high and damage to plants most severe. Therefore, NRS needed to devise ways to both monitor *X. compactus* and quantify its damage to *F. neowawraea*. Data from such endeavors are expected to provide information critical to *F. neowawraea* conservation.

Actions:
As in previous studies (Gillette *et al.*, *in prep*; E. Burbano, *unpub. data*), we used counts of *X. compactus* attracted to ethanol-baited traps as an indicator of relative population size. An insecticidal strip (Vaportape® Hercon Environmental, Emigsville, PA) placed in the collecting cup killed any insects entering the trap. On June 15, 2006, six traps were hung at intervals of 20 m around the periphery of the Nike greenhouse (elev: 610 m, Lat: -158.195227096951, Lon: 21.5461005736750). Traps were emptied and re-baited weekly (Figure. 6.4). Samples collected through August yielded only three *X. compactus*. It is too early to say whether our methodology is flawed, or whether the low catch corresponds to actual numbers of *X. compactus* in this area. NRS plan to continue sampling through the end of the year, then re-assess whether the traps are working. Other Scolytidae found, from most to least common, were *Hypothenemus* sp.*; Xyloborinus spp.; Xyloborus spp*.; and *X. crassicus*. These groups are not known to bore living plants (Huang-Chi, *pers. comm*.) and, when opened, entry holes into *Flueggea neowawraea* have yielded only *X. compactus*.

Figure. 6.4: Black twig borer trap with collection cup removed. S. Joe is pictured collecting samples after which, the cup will be reattached to the bottom of the trap (photo by H.C. Kuo).

Counts of new entry holes accumulated over time by individual *Flueggea neowawraea* provide data on the frequency of *X. compactus* attack in the absence of treatments. This method has been used elsewhere (Gillette *et al*. 2006) to evaluate the success of experimental repellents. Using white latex paint, NRS marked all existing holes on outplanted *F. neowawraea* and have started recording new holes on a weekly basis. Preliminary results show trees accumulate one new entry hole per 2.4 inches of bole length every 9 days. An experimental test of Verbenone® efficacy in the field is planned but the design not yet finalized by all cooperators. At present, the experiment is planned to run for 90 days (the duration of efficacy recommended on the label) with some trees receiving Verbenone® and others serving as controls. Upon conclusion, attack rates between the treatment and control will be compared. Until that time, these trees will be resurveyed every 10 days to determine baseline levels of damage.

Solenopsis geminata (Hymenoptera: Formicidae)

Problem statement:

Solenopsis geminata, the tropical fire ant, has been present in Hawaiʻi for over 100 years and, as the name suggests, is capable of delivering repeated, mildly painful stings. Fire ants are notorious for their stinging behavior, and respond rapidly and aggressively to any disturbance. Listed among the top five most invasive ants in Hawaiʻi, *S. geminata* is common in dry, disturbed areas below 450 m elevation (Krushelnycky *et al*. 2005). Thought to be restricted to lowland areas, it was recently discovered at an elevation of 600 m on a ridge top on Army land