Tamarisk Coalition Newsletter

April 2007

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Our June newsletter will concentrate on the importance of revegetation

2006 Tamarisk Research Conference

If you were unable to attend please visit the following website to download presentations and abstracts: **http://www.weedcenter.org/tamarisk_conf_06/conference_home.html**

Contact Us

www.tamariskcoalition.org
(970) 256-7400
P.O. Box 1907
Grand Junction, CO 81502

Wishing you a beautiful spring!

We are busy as usual, working hard to provide education, technical assistance, and coordinating support to you and your organization for the restoration of riparian lands.

We recognize that our Newsletter is a bit longer than usual, however we think that the read will be well worth your time. This Newsletter focuses on biological agents as a method for tamarisk control. We feel it is important to understand the history of biocontrol, the research that is currently taking place, and what we can expect in the future in order to effectively address tamarisk control as a whole. Happy reading!

Biocontrol of Tamarisk Using the Leaf Beetle, *Diorhabda elongata*

By: Dr. Dan Bean of the Colorado Department of Agriculture's Palisade Insectary

Biocontrol is the use of natural enemies to help control pests, including weeds. Our worst weeds were imported from other continents, without their natural enemies, which allows these imported weeds to grow unchecked. Tamarisk (*Tamarix* spp.) is one such weed with very few natural enemies in North America. The USDA Agricultural Research Service first identified tamarisk as a weed in need of biocontrol back in the 1970's. In the 1980's Dr. Jack DeLoach and his group with the USDA in Temple, Texas began overseas exploration to locate the natural enemies of tamarisk on the continents and in the countries where the plants are native. These efforts took USDA researchers to China, Kazakhstan, Uzbekistan, Tunisia, Greece and many other places where they were guided by local entomologists to find hundreds of different insect species that feed on tamarisk in its native habitat. Finding the natural enemies of tamarisk was just the first step; next these potential biocontrol agents were carefully evaluated and screened so that only those that feed exclusively on tamarisk remained on the list.

At the top of the list was a tamarisk feeding specialist *Diorhabda elongata*, which belongs to the leaf beetle family, Chrysomelidae. Beetles in the family Chrysomelidae have been responsible for some of the most spectacular weed biocontrol success stories in North America. The first weed biocontrol

Meet the Staff

Tim working hard

John points out the San Juan watershed

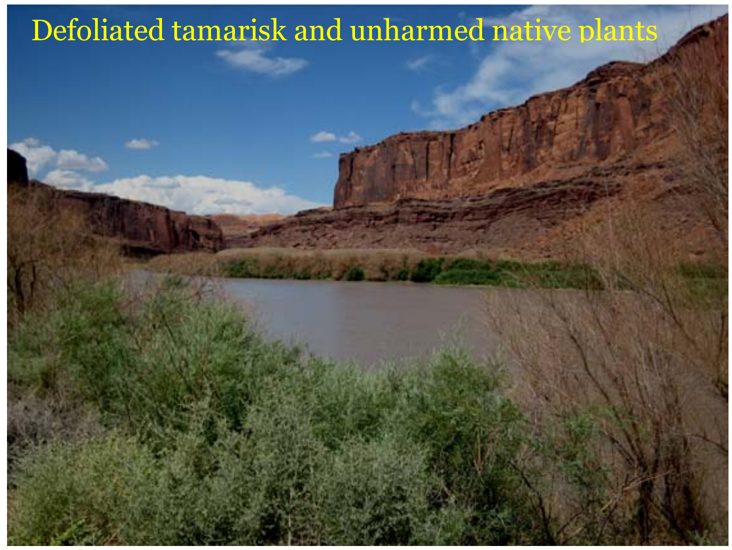
Clark on a tamarisk scouting mission

Christy clicking away

Elyse all smiles at the office

agents used in North America were Chrysomelid beetles that successfully controlled St. Johnswort in Oregon and Northern California. Other very successful agents, such as those used against purple loosestrife and leafy spurge, are also Chrysomelid beetles. The past successes of Chrysomelid beetles, plus the observations of entomologists in China and Kazakhstan that these beetles occasionally defoliate tamarisk plants in their native habitats, indicated a good potential for success. The next big question was safety. Would the beetles harm native plants or crop plants?

The primary goal of biocontrol safety testing is to find out if the biocontrol agent is specific for the target plant and does not harm native or crop plants (non-targets). From the beginning we had a big advantage in working on tamarisk. Here in North America there are no native tamarisk. Tamarisk is a botanical newcomer to North America; in its own family Tamaricaceae with no North American members. This means that insects that specialize on tamarisk are not going to find any similar plants among the native flora. Since specialist feeders usually restrict themselves to a single plant species or several close relatives, the likelihood that the beetles would restrict themselves to the tamarisk was very good. Observations made overseas by entomologists from many different countries indicated that the beetles fed exclusively on tamarisk in their native range. After beetles were brought to the US they were maintained in USDA quarantine laboratories in Texas and California where they were subjected to further very extensive host range testing. They were offered a wide selection of native plants and crop plants, either in combination with tamarisk or in the "no choice" tests they were given only the non-target plants. In these tests it was found that the beetles preferred tamarisk to native plants and that in most cases they wouldn't feed at all on non-target plants, but would rather starve while in search of a tamarisk plant. Since then, field tests have shown that when the insects finish feeding on tamarisk they do not move over to the next green thing, but rather they fly or crawl off in search of more tamarisk.



Defoliated tamarisk and unharmed native plants

After host range testing showed that the risks from *D. elongata* were minimal, beetles were released into test cages in 1999, followed by open field releases at test sites in 2001. These open field tests have given us a good preview of what to expect from the beetles which was not uniform success since there were both failures and successes in these first releases. At some locations, such as central Texas, the beetles did not establish field populations. At other locations the beetles did astonishingly well in the open field.

About 1,500 adult beetles were released near the town of Lovelock, Nevada, in 2001. Beetles multiplied to the point where about 2 acres of tamarisk were completely defoliated at the end of the summer, 2002. From then on, the results of biocontrol were evident on a grand scale: hundreds of acres of

Meet the Mascots

Chewbacca

Ghoti

tamarisk defoliated in 2003, thousands of acres defoliated in 2004 and by 2006 tens of thousands of acres had been defoliated over much of western central Nevada. Similar results were seen in Lovell, Wyoming where beetles have defoliated tamarisk along a 51 kilometer stretch of the Big Horn River. At a site near Pueblo, Colorado, tamarisk trees have been defoliated for several years in a row and near Delta, Utah thousands of acres have been defoliated. Getting back to the Lovelock site; about 70% of the plants in the original defoliated area have now been killed by the beetles following multiple defoliations over the course of 5 summers. It is clear that we are seeing a dramatic biological control success story and the emergence of a powerful new tool in the fight against tamarisk invasion.

Diorhabda elongata beetles are not very spectacular as individuals, but rather they gang up on plants and do their best work in great numbers. The adults are yellow and black and a little over a quarter inch long. They don't fly well until temperatures reach the 80s (F°) and even then they rely on wind for long range dispersal. The adults gather together on tamarisk plants; attracted by pheromones released by the males and by the smell of tamarisk foliage. They mate, lay eggs and move on to the next plant, often in large numbers. The eggs hatch into small black larvae that resemble caterpillars. These feed heavily, grow, molt and pass through three larval stages. The last larval stage is distinguished by a conspicuous yellow band running down each side of the otherwise dark larva. When they are mature and stop feeding, the larvae descend from the tamarisk foliage, enter the leaf litter or soil beneath the tamarisk plant and pupate within cocoons made of leaf litter or sand. The pupae within these cocoons are very delicate and bright yellow. After about 10 days the pupae molt to adults, leave the cocoons, crawl up the tamarisk plants and begin feeding. Only after feeding can the females mate and begin to lay eggs. An individual female can live about 2 months and she can lay up to 700 eggs. Life in the field is dangerous and she will probably be eaten by predators or suffer some similar fate before she has reached the 2 month point.

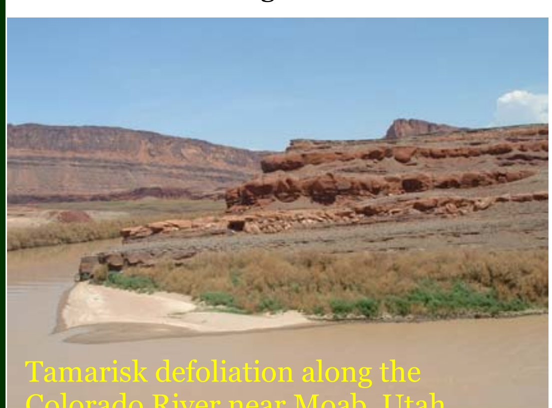
Collecting beetles for redistribution

When day lengths shorten during the summer and reach about 14.5 hours of light the adult beetles cease reproducing and enter a state of dormancy. This dormancy, known as "diapause" in insects, allows the adult beetles to pass through the winter when temperatures are low and there is no foliage available. Diorhabda beetles "know" when to enter dormancy based almost exclusively on day length, which is a very accurate predictor of seasonal weather change. Before they become dormant they first have a huge last meal and become quite fat and lethargic. Toward the end of summer it is possible to see tamarisk branches draped with beetles that don't seem to want to fly and are just hanging out, feeding, and preparing for winter. Eventually these fat beetles descend from the plant and crawl into the leaf litter or under other sheltering materials and spend the winter out of the elements. Even though temperatures may drop to well below freezing the beetles survive, probably due to physiological adaptations such as the accumulation of antifreeze substances in their blood (hemolymph). In the spring, when temperatures climb and tamarisk plants leaf out, the adult beetles emerge and immediately search for a meal of new foliage. With the help of pheromones they again aggregate on individual tamarisk plants, mate and begin laying eggs. A few weeks after the first foliage is evident, the beetles are back at it, defoliating trees and stressing the plants. Beetles may have 2-3 generations during a season and they may defoliate a plant multiple times, clearly a major stress on a tamarisk plant.

Like most stories this one isn't entirely black and white. There are still areas in the west where the beetles have not established well. At one test site in Montana, USDA scientists have released hundreds of thousands of beetles without establishment. In Texas the original population of tamarisk leaf beetles, collected in northwestern China, were not adapted for reproduction at southern latitudes and entered reproductive dormancy prematurely since day lengths are always shorter than 14.5 hours in central Texas. This physiological adaptation to day lengths enables beetles to do well in northern China but limits effectiveness of the China population in areas south of approximately the 38th parallel (which runs through Kansas, southern Colorado, Utah, Nevada and central California). The China population failed to establish in coastal California where the small-flowered tamarisk (*T. parviflora)* is invasive, leading researchers to speculate that our beetles from China may not be effective against that tamarisk species. Even in places where beetles are well suited to the day length and climate it is still difficult to get them established since predators, especially ants, will readily feed on them. Scientists from a number of institutions, including universities and the USDA, continue to work on finding solutions to these problems. Different methods of initial beetle release, including release into cages where predators are less of a problem, are being tested. Populations of *D. elongata* collected from the Mediterranean region and from Uzbekistan are being tested and show promise for the southern range of tamarisk and for *T. parviflora* of coastal California.

Tamarisk biological control has not been attempted in most of New Mexico, all of Arizona and most of southern California. The delay is due to a native endangered bird using tamarisk for nesting on the lower Colorado and stretches of the Rio Grande River, thereby offering the ecologically devastating, nonnative weed a measure of protection under the Endangered Species Act. The bird is the southwestern willow flycatcher and the irony is multilayered. First, that tamarisk should be protected for ecological reasons, second, the name willow flycatcher shows the historic ecological niche of this bird (willows, now lost to tamarisk) and third is that biocontrol scientists, many of whom practice biocontrol because it is an ecologically rational and environmentally sound pest control strategy, are on the defensive over an ecological issue.

The positive side of this controversy is that it has brought into better focus the ultimate goal of tamarisk biocontrol, which is the restoration of riparian health. This is common ground where biocontrol researchers and scientists dedicated to the preservation of the southwestern willow flycatcher can readily agree. Clearly, any control measures that remove tamarisk, including biological control, must be followed up with an evaluation of riparian health and, if necessary, remediation efforts. Biocontrol must leave us in a more desirable situation, from an ecological perspective, than when tamarisk was


Tamarisk defoliation along the Colorado River near Moab, Utah

a dominant plant. We need to know what our restoration goals are, including habitat requirements of the flycatcher and other native species, compared to what a post-biocontrol riparian area will look like. It could well be that biological control will make riparian areas better flycatcher habitat. We know, for instance, that general avian abundance increases at biocontrol sites and that a number of bird species may feed heavily on the tamarisk leaf beetles. We also know that biological control has never eradicated a target weed and most certainly won't completely eliminate tamarisk. The most likely outcome of biocontrol is a reduction in tamarisk abundance, an increase in arthropod density and diversity, and an increased opportunity for restoration of native vegetation, either naturally or as part of a revegetation program. These are all positive outcomes from an ecological perspective.

A large scale biocontrol implementation program was initiated for tamarisk infestations north of the 38^{th} parallel in August of 2005. The effort was directed by USDA APHIS in cooperation with the Colorado Department of Agriculture, Biological Pest Control program in Palisade, Colorado. The goal of the release program was to establish beetles within each state where they can then be freely moved to secondary sites within the state and finally made available to landowners. In the first year 60,000 beetles were collected from Lovelock, NV and were distributed through cooperators to sites in 6 states, Colorado, Wyoming, Idaho, Kansas, Montana and Oregon. In 2006 over 100,000 beetles were collected from Lovelock and distributed to the original 6 states plus Nebraska and Washington. The fate of these biocontrol releases remains unknown although there are initial reports that many sites now have expanding beetle populations.

Beetles released at the experimental field site near Delta, Utah were originally collected from a site near the town of Chilik, Kazakhstan, instead of from China. These beetles have done very well and have been distributed to numerous sites within Utah. The most spectacular successes for these Kazak beetles have occurred on the Colorado River, near the town of Moab, Utah. In 2006 beetles defoliated at least 18 river miles of dense tamarisk stands both upstream and downstream from Moab, after having defoliated only 2-3 total acres in 2005. It looks as if they will continue to move along the river, expanding both upstream and downstream. They will probably enter Colorado in either 2007 or 2008. Since the China beetles have been released in Colorado there is some concern that when populations meet there could be some genetic incompatibility. This possibility has been investigated through laboratory studies conducted at New Mexico State University and the USDA ARS facility in Albany, California. It was found that these two populations were completely compatible and cross bred freely. All indications are that crossing will not harm, and may benefit the two populations.


Diorhabda elongata eggs, larvae, and beetle

In Texas there have been experimental releases of *Diorhabda* beetles collected from Tunisia, Crete, Greece and Uzbekistan. These releases have been coordinated by USDA ARS scientists seeking a beetle better adapted to southern climates and day lengths. There have been some very successful release sites and it looks like the problem of latitude limitations will be overcome by using other beetle populations. This is especially important since some of the worst tamarisk infestations in the US are located in more southern areas along the Rio Grande River. Finally, beetles from Crete have now been established in California and are defoliating *Tamarix parviflora*.

The tamarisk biocontrol project is over 20 years old and we are at the point where *D. elongata* are becoming available for widespread use throughout most of the range of tamarisk in the US. It is critical that biological control be properly viewed as a powerful, inexpensive and environmentally sound control method but not the ultimate answer to the tamarisk invasion. First, biocontrol is a way to suppress tamarisk populations and to decrease the invasive nature of tamarisk by stressing plants and decreasing seed production. Biocontrol will result in some percentage of mortality and in lesser canopy cover and possibly smaller plants, but not in eradication. Biocontrol can and will help, but we still have to learn more about using biocontrol in conjunction with other control methods as well as with revegetation and restoration efforts. This includes being vigilant so that we don't end up knocking back tamarisk only to have other invasive species take advantage of newly available resources. The ultimate goal is to restore the health of riparian ecosystems.

Tamarisk Leaf Beetle Life Cycle

(*Diorhabda elongata*)

Below is an outline of the various stages in the Tamarisk Leaf Beetle's life cycle.

STAGE 1:
Eggs of the Tamarisk Leaf Beetle

- Female lays 10-20 eggs per day
- Production ranges from 300-500 eggs per female
- Eggs hatch in 7 days

STAGE 2:
1st and 2nd Instar Larval Stages

- 1st instar larvae (lower) lasts 4-7 days, 1-2mm in length
- 2nd instar larvae (upper) lasts 4-6 days, ~4mm in length

STAGE 3:
3rd Instar Larval Stage

- Feeds for 3-7 days
- Then drops or crawls from tree into leaf litter
- Enters inactive pre-pupal stage (3-7 days)
- 5-9mm in length

STAGE 4:
Pupal Stage

- 3rd instar forms a pupal case
- Made of loose silk cells and plant debris
- Pupal stage lasts 7-10 days

STAGE 5:
Adult Leaf Beetle
Active Stage

- Newly emerged adults feed and mate immediately and are 5-6 mm long and 2.5mm wide
- Active adults move to nearby tamarisk trees to leave food for offspring
- All life stages eat ONLY tamarisk leaves
- Adults secrete pheromones to promote aggregation and mating
- Female lays eggs on tamarisk foliage every day after mature
- Adults live 2-4 weeks after emerging in either late spring or early fall (2 life cycles per year)

STAGE 6:
Adult Leaf Beetle in Diapause Stage

- In late fall adults become less active and gorge on tamarisk leaves
- Develop 'antifreeze' body fluid
- Drop to the ground and burrow deep into the leaf litter
- Overwinter in diapause phase (insect version of hibernation in mammals)

Life Cycle Sources:
Bean, D. 2006. Personal Correspondence. Manager of Palisade Insectary & *D. elongata* extraordinaire!

Lewis, P.A., C.J. DeLoach, A.E. Knutson, J.L. Tracy and T.O. Robbins. 2003. Biology of *Diorhabda elongata deserticola* (Coleoptera:Chrysomelidae), an Asian leaf beetle for biological control of saltcedars (*Tamarix* spp.) in the United States. Biological Control 27:101-116.

Hansen, R. *Saltcedar leaf beetle, Diorhabda elongata ssp. Deserticola (Coleoptera:Chrysomelidae) Biology and Identification* [Brochure]. (2005). Fort Collins, CO: USDA-APHIS-PPQ-CPHST.

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For information on the Tamarisk Coalition's brochure on biological control, contact Tim Carlson at tcarlson@tamariskcoalition.org

Stay Tuned

Our June Newsletter will concentrate on the importance of revegetation.

Funding the Tamarisk Coalition

As a non-profit, the Tamarisk Coalition continuously strives to fund its efforts to restore western river ways. We are hitting our stride and need **YOUR help** to continue our efforts. Please take the time to send in your membership dues if you haven't already. Membership forms are available on our website (www.tamariskcoalition.org) under the "Join Us" heading. Your continued membership is essential for the **Tamarisk Coalition** ***to facilitate tamarisk control efforts and the long-term reestablishment of native vegetation along the West's rivers and streams.***

Happy trails,

Tim Carlson

Tim Carlson, Executive Director
Tamarisk Coalition
P.O. Box 1907
Grand Junction, CO 81502
(970) 256-7400
tcarlson@tamariskcoalition.org