Cooperative Research Efforts to Develop the Use of a Nematode for Russian Knapweed Biocontrol

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THE PROBLEM

Russian knapweed, *Acroptilon (Centaurea) repens* (L.) DC. is a noxious herbacious weed in the family Compositae. This weed has invaded millions of acres of native rangeland and farmland throughout the western and north-central United States and western prairies of Canada. Russian knapweed is an exotic weed which was imported to the Pacific Northwest

about 1900. The species *Centaurea rothrockii* and *Centaurea americana* are the only two native American species of the closely allied genus *Centaurea* (Reed and Hughes, 1970). Russian knapweed is an extremely aggressive and pernicious invader. It has an extensive, creeping horizontal root system which can penetrate soil to a depth of over eight feet, and is a prolific shoot producer.

Russian knapweed is considered a severe weed pest for several reasons besides its invasiveness. Russian knapweed may be allelopathic (Fletcher and Renney, 1963) because it produces a variety of compounds such as polyacetylenes and sesquiterpene lactones (isolated from roots and shoots, respectively) which are phytotoxic to several important economic crops and native species (Kelsey and Bedunah, 1989). In addition, these toxic compounds inhibit seed germination of many grasses, thereby decreasing forage quality of rangeland. Besides its noxious effect on other plants, Russian knapweed is also toxic to livestock. Sheep, cattle, and horses are sensitive to poisoning, which can occur from grazing or by ingesting contaminated hay (Young *et al.*, 1970). Russian knapweed has invaded several USNPS areas in the western United States. It is especially effective in establishing new populations in disturbed areas. However, the aggressive nature and resistance to control of this species makes it a serious threat even to relatively undisturbed areas such as those found in many western USNPS units.

THE NEMATODE

The endoparasitic nematode *Subanguina* (Paranguina) *picridis* (Brzeski, 1981) forms galls (plant cancers) on Russian knapweed stems, leaves, and root collars. These galls considerably stunt and weaken infected plants. Scientists in the Soviet Union (Kirjanova and Ivanova, 1969) and Canada (Watson, 1986) have shown that *S. picridis* overwinters in galls in plant residue. In early spring, infective nematodes are released from disintegrating galls and penetrate young knapweed shoots as they sprout through wet soil. Watson (1986) has investigated the host range of the knapweed nematode using a large variety of *Centaurea* species and other families containing economically important plants. Russian knapweed is the best host for *S. picridis*, while flax, lettuce, sunflower, onion, kohlrabi, potato, wheat, safflower, carrot, Jerusalem artichoke, and globe artichoke were unaffected by the nematode (Watson and Harris, 1984). In the United States, the host range was again tested by Rosenthal (1989) of the USDA-Agricultural Research Service (ARS) at the request of the USDA-Animal and Plant Health Inspection Service Technical Advisory Group (APHIS-TAG). Her research essentially confirmed the previous results and thus allowed the nematode to be cleared for release in the United States in 1989.

USING THE NEMATODE AS RUSSIAN KNAPWEED BIOCONTROL AGENT

Management strategies to control Russian knapweed have met with little success before the recognition of the biological control potential of *S. picridis*. Several USNPS areas have had marginal success in treating even very small knapweed populations with herbicide where no large-scale invasion has occurred. More often, the proliferation of Russian knapweed in agricultural or rangeland areas contiguous to USNPS units make such treatments futile. In Russia, acres of knapweed are planted as nurseries to propagate the nematode. Crushed gall material is distributed in knapweed fields each spring to initiate infections. The nematode has been introduced

into Canada by Agriculture Canada for knapweed biocontrol, but the use of the nematode for commercial purposes has not been explored. Therefore, no techniques for mass production (and resultant availability in more than experimental quantities) have been developed in the United States or Canada.

Over the past several years, several agencies (including the USNPS) in Wyoming and Montana have carried out separate, uncoordinated, and relatively ineffective efforts to control the spread of Russian knapweed. In an attempt to approach this problem in a more programmatic and effective manner, a coalition of agencies formed an action group consisting of members from several federal, state, and county agencies, e.g., U.S. Department of the Interior (USNPS, Bureau of Land Management, Bureau of Reclamation, Bureau of Indian Affairs), U.S. Department of Agriculture (Forest Service, ARS), Wyoming Game and Fish Department, University of Wyoming, Wyoming State Lands Department, and several county weed and pest supervisors from Wyoming and Montana. This group is actively supporting development of the nematode as a biocontrol agent by funding a project to develop and improve mass rearing techniques for the nematode, and to develop formulations to aid in its long-term preservation and storage. The ARS has been designated as the lead agency to initiate this project. With funding provided by the USNPS and other cooperators, the ARS Rangeland Weed Laboratory has developed a specific cooperative agreement with W.E. Dyer of the Plant and Soil Science Department at Montana State University in Bozeman. Dyer has employed T.C. Ceasar as a visiting assistant professor to conduct this research (now underway) in cooperation with S.S. Rosenthal and P.C. Quimby of the ARS Rangeland Weed Laboratory. Collaboration with a nematologist at the ARS laboratory in Beltsville, Maryland, and scientific exchanges with Canadian experts have been very valuable in the progress of the project.

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