Subanguina picridis Kirj. & Ivan

INVASIVE SPECIES ATTACKED: Russian knapweed (*Acroptilon repens* (L.))
Diffuse knapweed (*Centaurea diffusa* Lam)

PREVIOUSLY KNOWN AS: *Paranguina picridis* Kirj. & Ivan

TYPE OF AGENT: Gall forming nematode

COLLECTABILITY: Not established

ORIGIN: Tajikistan

DESCRIPTION AND LIFE CYCLE

Adult:

Subanquina picridis nematodes are thin white worms, 1.5 mm long and are highly active in water. The first generation nematodes are larger than the second. *S. picridis* nematode males and females are present at the same time in galls, but in variable ratios. The first generation lays eggs for one month, finishing in early June. The second generation is highly productive and lays eggs from the time the first generation dies until gall desiccation, which is usually in July. Females deposit eggs in clusters inside the galls.

Egg:

Eggs are light yellow, oval shaped and measure 0.05 mm long. Eggs from both generations incubate for eight days.

Larva:

After hatching, the larvae develop through five juvenile stages.

First generation juveniles:
The first juvenile stage is ineffective and leaves the galls with the onset of spring moisture and congregate in the top 5 cm of soil. When the soil temperature reaches 1-4^{0}C and plant shoot growth appears, they move to the pubescent leaf axils. They remain in the bud, feeding on it but not penetrating into it, growing from 0.85 mm to 1.0 mm long. When temperatures reach 20^{0}C and the plant shoots are 3-5 cm tall, 5-55 second-stage juveniles penetrate the plant which develops a gall. The gall becomes visible in three to four days. The young nematodes and galls develop in synchronicity. When the galls reach their maximum size, the nematodes are adults. If males and females occupy the same gall, eggs will be laid for one month. This spring generation lays few eggs, but prepares nutrient rich tissue for the next generation.

Second generation juveniles:
Eggs hatch and the second generation juveniles feed on the nutritious tissue created by their parents. These juveniles mature completely within the gall and begin laying eggs near the same time their parents die. This generation will increase the population to 11,500 nematodes/gall by the end of summer. Second generation eggs hatch and larvae develop to the second juvenile stage. At this time the galls will be drying and the young nematode prepares for winter dormancy. They will become active again with the onset of moist weather, which in ideal situations will occur the following spring when they move into the soil. This generation, however, can vary its development when moist conditions occur. In some instances, fall moisture will activate this generation to enter the soil where they will group in clusters near plant roots. Nematode densities can reach 140 larvae/gram of soil. They are vulnerable to drought at this stage and can be killed in four days if the temperature drops to -12^{0}C. Remaining in the galls or deep in the soil can help prevent them from perishing.

Overwintering stage:

Second stage juveniles desiccate and overwinter in dry galls or deep in the soil to avoid low temperatures. They resume activity when moist weather returns and revives them.

Fig. 1. *S. picridis* gall on Russian knapweed (credit Powell et al. 1994)

EFFECTIVENESS ON HOST PLANT

The nematodes are capable of causing gall formation on leaves and stems on diffuse and Russian knapweed. Galls can be observed within one month following application. In Asian plot studies, 100 grams/m^2 of gall infected stems killed over 20% of plants and damaged another 30%, greatly reducing flowering. *S. picridis* requires assisted redistribution as is does not freely self-disperse. The effectiveness of *S. picridis* as an imported biocontrol agent has been less than expected.

HABITAT AND DISTRIBUTION

Native:
Original distribution was once concentrated in Tajikistan and now is widely scattered through central Asia. It is most common on plants growing on south slopes and in poor, coarse soils that become dry during the fall drought.

North America:
S. picridis requirements in North America are highly variable and its establishment is also limited where it has been released. Populations appear to do best in moist areas, particularly those areas that receive some irrigation. It has been recovered in areas with moist winters and springs which coincide with its infection period. It requires two months of moist conditions and then a dry fall. Coarse, poor soils on flat or south slopes are ideal. Plants with high nitrogen are not suitable hosts. *S. picridis* attacks two plant species, however Russian knapweed provides the most nutrition. In the U.S.A., it has established in Colo., Mont., Oreg., Utah, Wash. and Wyo. In Canada, the nematode was reported to be maintaining establishment in Sask. on the South Saskatchewan River.

British Columbia:
All treatments were made in Bunchgrass, Interior Douglas-fir and Ponderosa pine biogeoclimatic zones. Same year, short-term establishment was found only in the Interior Douglas-fir zone near Kamloops.

BRITISH COLUMBIA RECORD

Origin:
The *S. picridis* populations released in B.C. originate in Tajikistan where it existed on Russian knapweed growing in cultivated fields.

History:
S. picridis was first released in B.C. in 1985. In 1985, an unrecorded quantity of *S. picridis* was released into the McQueen Creek area near Kamloops onto Russian knapweed. That same year, nematode inoculum, with an estimated 550,000 nematodes, was applied to Ministry of Agriculture diffuse knapweed research plots in the southern interior near Pritchard in April and supplemented with another application of an unknown quantity in 1986. Same year establishment was maintained for two months and then no further evidence was found. At another study site located at the Agriculture Canada Research Station in Kamloops, *S. picridis* was applied to Russian knapweed plots in 1986, 1987 and 1989. Long term establishment did not occur. In 1991, 117 grams of nematode infested plant material was released in the south Okanagan new Willowbrook.

Field results:
The 1985 and 1986 Pritchard releases were applied to diffuse knapweed in research exclosures. Over the next two months, five galls were located from May 31 to June 19. No further evidence was found to confirm establishment. Since these nematode applications were made, the exclosures have since been removed and other biocontrol agents have freely dispersed onto the site. The Kamloops plots have also been dismantled. The nematode field applications made on Russian knapweed in the McQueen (Kamloops) and the Willowbrook (Okanagan) areas have not shown any establishment. The McQueen release site experienced natural fire the same year of release and the Okanagan site was intentionally burned by the land owner several years later. All three release sites (Pritchard, McQueen and Willowbrook) still have target plants established at varying levels of density and distribution. *Puccinia acroptili* is present at the Russian knapweed release sites. Monitoring is ongoing at this time.

NOTES

- The second generation is the productive generation that guarantees survival. Their continued existence is dependent on the amount of nutritive tissue made available which is produced in greater quantities on Russian knapweed than on diffuse knapweed.
- *S. picridis* galls appear to encourage the increase of *P. acroptili*. The two biocontrol agents co-exist in Saskatchewan.

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