Recovery Plan for Rathayibacter poisoning

R. toxicus: a cross-domain pathogen

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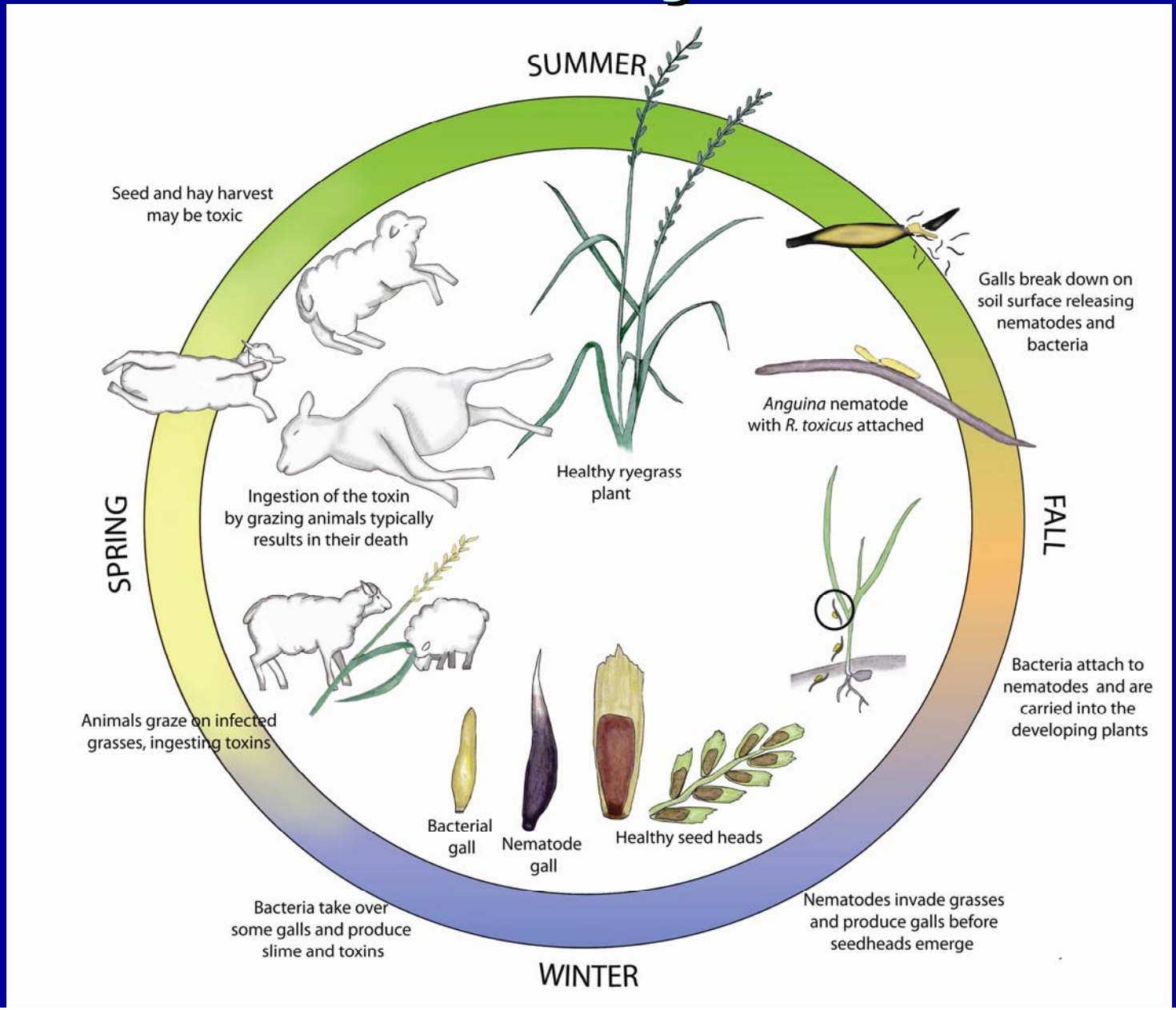
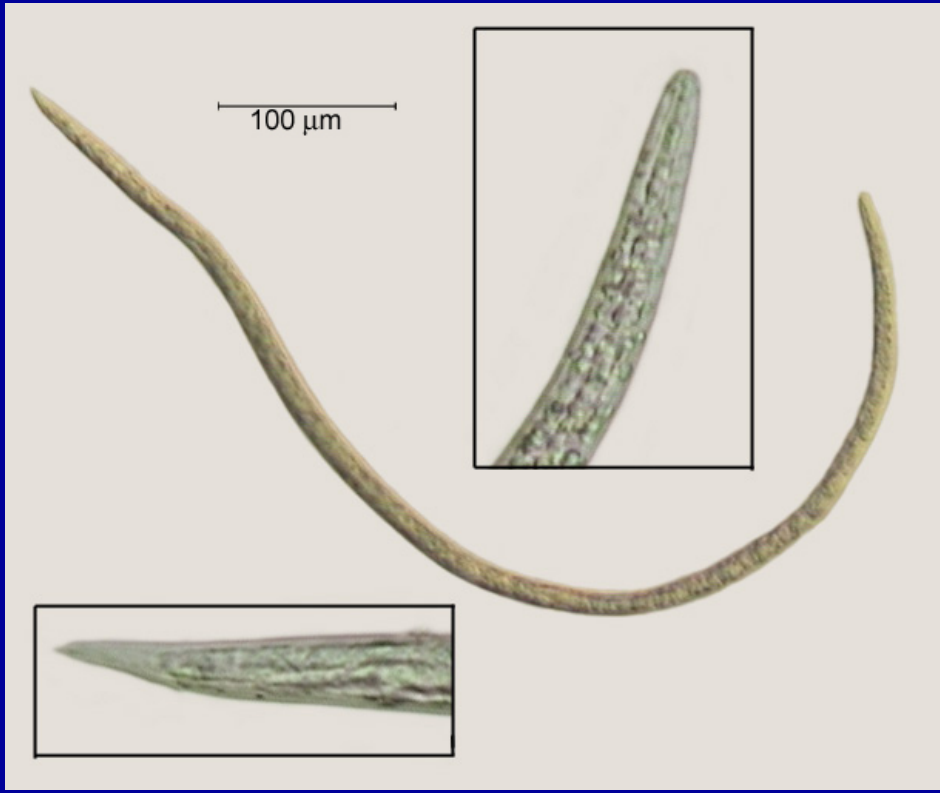
Life cycle


SUMMER
Seed and hay harvest may be toxic
Galls break down on soil surface releasing nematodes and bacteria
Anguina nematode with R. toxicus attached
Healthy ryegrass plant
Ingestion of the toxin by grazing animals typically results in their death
SPRING
FALL
Bacteria attach to nematodes and are carried into the developing plants
Animals graze on infected grasses, ingesting toxins
Bacterial gall
Nematode gall
Healthy seed heads
Bacteria take over some galls and produce slime and toxins
Nematodes invade grasses and produce galls before seedheads emerge
WINTER

Nematode Anguina spp serve as a vector for R. toxicus infection



Microphotograph of *Anguina* sp. nematode juvenile (J2) [photo courtesy of Dr. T.O. Powers]

Nematode *Anguina funesta* juveniles with *R. toxicus* (seen as dark dots on the surface of nematodes) adhered to the cuticle [photo from Stynes and Bird, Phytopathology, 1982, **72**:336-46]

Ingestion of the toxin by grazing animals results in their death

Dead sheep after eating infected annual ryegrass (*Lolium rigidum) in South Australia*

[photo: J.W. Finnie, Inst. of Medical and Veterinary Science (IMVS), South Australia]

Affected plants

Symptoms of gumming disease (*R. rathayi*) in Maryland and Oregon [photos: N.W. Schaad (left) and M. L. Putnam (right)].

Affected seeds

Healthy *Lolium rigidum* seed (left), *Anguina funesta* gall (center), and *Rathayibacter toxicus* colonized nematode gall (right) [photo: I. Riley]

Challenges

- Vector (nematode) not specific
- Host plant: primarily pasture grasses
- Gumming, slime in plant seed heads
- Toxins affecting all grazing animals produced: multiple
- Can be undetected for years
- Survival of vector, bacterium long term (years)

Veterinary challenges

- Neurological symptoms can mimic other diseases
- Animals do not develop immunity
- Treatments limited
- Toxins transmitted in contaminated hay/grass
- Primarily in Australia: also Japan, S. Africa

U.S. Situation

- Susceptible grasses
- Potential nematode vectors
- Related pathogens, e.g. *R. rathayi* in Oregon and Maryland
- Trade, transport, weather dissemination

Management practices

- Crop rotation
- Rotation among grazed pastures
- Harvesting hay before toxin production
- Inspection (surveys)
- Use of certified seed free of *R. toxicus*

Recovery

- Quarantine for hay products/forage grass seeds
- Reliable I.D. tests for *R. toxicus* and vectors
- Surveys/monitoring of grasses
- Education: plant & animal personnel

Needs

- Rapid, accurate diagnostic tools for *R. toxicus* and nematode vectors
- Toxins: role in ecology; genetic basis
- Nematode control
- Plants: breeding for resistance to toxin; pasture management for U.S.
- Animals: protection mechanisms, incl. vaccine(s)