Chapter 9
Plant Parasitic Nematodes in Alaska

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9.1 Introduction

Compared with every other U.S. state and by any standard, Alaska has a small agricultural base. Cash receipts in 2016 for this largest of states were $33.9 million, less than half that of Rhode Island, the smallest state (USDA ERS 2018) (Table 9.1). Alaska imports more than 95% of its food needs (Alaska Cooperative Extension Service 2011), which is a matter of concern for the state government. Since the 1970s, the state has encouraged and supported large agricultural projects that produce specific products such as feed grains (Lewis and Pearson 1998). In 2008, the Alaska governor issued Administrative Order No. 265 establishing the Alaska Food Resource Working Group (Parnell 2013). The broad goal of this working group was to promote increased use of locally grown and harvested foods within the state and its agencies, institutions and schools. One specific area addressed was to "...provide recommendations to protect, preserve and develop the state's agricultural land for the benefit of all Alaskans." In 2009, the Alaska Department of Natural Resources, Division of Agriculture developed a long-term plan for agriculture with the mission of promoting and encouraging development of a stable and profitable agricultural industry in Alaska (ADNR-DA 2009). Included in this report are recommendations related to plant diseases, including the use of plants as a natural way to solve conservation issues and reestablish ecosystem function; collection, selection and release of high-latitude germplasm; plant solutions to battle invasive species; and production of disease-free seed of potatoes.

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Table 9.1 Important crops grown in Alaska

	2017		2012	
Crop	Hectares	Value ($)	Hectares	Rank in US
Hay	8498	9 million	9775	47
Potatoes	182	2.7 million	274	36
Barley	2225	1.3 million	1799	43
Oats	688	241,000	365	39
All vegetables	NA	NA	429	50

Source: https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=ALASKA

Alaska's agricultural history illustrates the tenacity of growers and researchers in making agricultural production viable (AAFES 1998), with a particularly sustained effort to develop crops adapted to the climate.

9.2 Plant Parasitic Nematodes

Nematodes do not appear to be a factor in crop production. Based on the only significant survey of plant parasitic nematodes in mainland Alaska (Bernard and Carling 1986), the state has a diverse array of species (Table 9.2). Although 520 samples were collected in this survey, these plus Aleutian samples and a few earlier species descriptions are a small effort for a very large area. Thus, our knowledge of Alaskan plant parasitic nematodes remains extraordinarily sparse, resting on no more than a dozen publications (see Andrassy 2000, 2003c for lists of described species). Holovachov (2014) listed the known true Arctic nematodes, including a number of free-living Alaskan nematodes (Dorylaimida, Mononchida, etc.) described by Andrassy (2003a, b, c). Most of these papers are pure taxonomy, but Bernard and Carling (1986) provided the results of a mainland survey aimed at plant parasitic taxa, including earlier Aleutian records and a few other species. In this paper they listed 24 genera and 54 species-level taxa, many of them unidentified and representing undescribed species. In addition to the records reported above, additions to the Alaskan plant parasitic fauna include a series of papers on plant parasitic nematodes of the Aleutian Islands and the mainland (Bernard 1981, 1982, 1984, 1992), three species of *Longidorus* (needle nematodes) (Robbins and Brown 1996), four species of *Nagelus* (Powers et al. 1983) with individual species of *Pararotylenchus* (Baldwin and Bell 1981) and *Pratylenchoides* (Baldwin et al. 1983).

The 1986 survey aimed at getting an overall picture of the Alaskan plant parasitic nematofauna partially to form a baseline of what indigenous nematodes could be present as agriculture expanded. In the survey, only two agricultural sites were sampled: old agricultural sites at the Pt. McKenzie Research area, now covered with mixed vegetation, had a ring nematode, *Criconemoides annulatus*; and a potato field at the Kaslin Agricultural Station on Kodiak Island contained *Helicotylenchus* and

Table 9.2 Plant parasitic nematodes reported from Alaska

Species[a]	Localities	Hosts or associated plants	References
Atalodera crassicrustatus	Adak, Amchitka Islands	*Leymus mollis*	Bernard (1981)
Criconema longulum	Adak, Amchitka Islands, Columbia Glacier region	*Leymus mollis*	Bernard (1982) and Bernard et al. (1995)
Criconema psephinum	Adak Island	*Anemone narcissifolia, Carex macrochaeta, Geranium erianthum, Leymus mollis, Lupinus nootkaensis, Plantago macrocarpa*	Bernard (1982)
Criconemoides annulatus[b]	Widespread	Numerous plant associations	Bernard and Carling (1986)
Helicotylenchus spitsbergensis	Adak, Amchitka Islands	*Toefieldia coccinea*	Bernard (1984)
Hemicycliophora amchitkaensis	Amchitka Island	*Leymus mollis*	Bernard (1982)
Heterodera trifolii	Noorvik	Potato garden	Bernard (1984)
Longidorus alaskaensis	Hess Creek at Dalton Highway	*Alnus* sp., *Rosa acicularis*, *Salix* sp.	Robbins and Brown (1996)
L. bernardi	Hess Creek at Dalton Highway	*Alnus* sp., *Rosa acicularis*, *Salix* sp.	Robbins and Brown (1996)
L. paralaskaensis	Chena and Chatanika Rivers near Fairbanks	*Alnus* sp., *Rosa acicularis*	Robbins and Brown (1996)
Meloidodera eurytyla	Adak Island	*Honckenya peploides, Leymus mollis*	Bernard (1981)
Meloidogyne subarctica	Adak Island	*Leymus mollis*	Bernard (1981)
Merlinius adakensis	Adak Island, southern mainland	*Leymus mollis*	Bernard (1984)
M. joctus	Wrangell	Grasses and herbaceous groundcover	Thorne (1949)
Mesocriconema xenoplax	Adak, Amchitka Islands	*Leymus mollis*	Bernard (1982)
Nagelus borealis	Atigun Pass	Alpine tundra	Powers et al. (1983)
N. leptus	Steese Highway	*Alnus* sp.	Powers et al. 1983
N. obscurus	Fairbanks	*Picea glauca*	Powers et al. (1983)
Ogma seymouri	Adak Island	*Arnica unalaschcensis*	Bernard (1982)
Pararotylenchus megastylus	Summit Lake	*Populus tremuloides*	Baldwin and Bell (1981)
Paratylenchus amundseni	Adak Island	*Leymus mollis*	Bernard (1982)
Pratylenchoides magnicauda	Alaska	*Populus tremuloides*	Baldwin et al. (1983)

(continued)

Table 9.2 (continued)

Species[a]	Localities	Hosts or associated plants	References
P. megalobatus	Adak, Amchitka Islands	*Leymus mollis*	Bernard (1984)
P. variabilis	Adak Island	*Leymus mollis*	Bernard (1984)
Pratylenchus pratensisobrinus	Adak Island	*Arnica unalaschcensis, Platanthera convallariaefolia, Viola langsdorffii*	Bernard (1984)
P. ventroprojectus	Adak Island	*Anemone narcissifolia, Plantago macrocarpa*	Bernard (1984)
Subanguina radicicola	Adak Island	*Elymus arenarius*	Bernard (1979)
Trichodorus aequalis	Elliott Hwy. at Tolavana River	*Picea glauca*	Bernard (1992)
T. californicus	Numerous sites from Prudhoe Bay to Taylor Highway area	*Alnus* sp., *Betula glandulosa*, *Cornus canadensis*, *Epilobium angustifolium*, *Populus balsamifera*, *Salix* spp., *Vaccinium* sp.	Bernard (1992)
T. carlingi	Central Alaska; Unalakleet River	*Betula payrifera, Populus tremuloides, Salix* sp.	Bernard (1992)
T. paucisetosus	Numerous sites in Fairbanks vicinity	*Picea glauca, Rosa acicularis*	Bernard (1992)

This list does not include taxa recognized any further than genus, including species of Criconematidae (*Criconema*, *Mesocriconema*), Telotylenchidae (*Geocenamus*, *Merlinius*, *Nagelus*, *Tylenchorhynchus*), *Dolichodera*, *Hoplolaimus*, *Paratylenchus*, *Pratylenchoides* and *Xiphinema*. A listing of these taxa can be found in Bernard and Carling (1986)

[a]Some generic names have been changed from the original reports to reflect current classification

[b]Called *Criconemella hemisphericaudata* in Bernard and Carling (1986)

Paratylenchus spp. (spiral and pin nematodes, respectively). Among samples made available in 1983, *Trichodorus californicus* was collected from a potato field at Copper Center (Bernard 1992) and a cyst nematode similar to *Heterodera trifolii* was collected from a potato garden at Noorvik. These few records shed little or no light on the vulnerability of Alaskan increased agriculture to plant parasitic nematodes.

Climate change is a phenomenon already affecting Alaska (ADEC 2018). Temperature increase is estimated to be twice that of the global average. Predicted changes in Alaska due to climate change and related to agriculture include hotter and drier summers with increasing evaporation exceeding increased precipitation, increases in wildfires and insect pest outbreaks, and accelerated thawing of permafrost (USGCRP 2009). The effects of this climate shift on indigenous plant parasitic nematodes cannot be predicted, as there has been no research done on their environmental preferences or tolerances. However, a warming climate makes the introduction of known pathogenic species more likely. For instance, potatoes account for most of the consumer food produced in Alaska (Table 9.1). Nematodes such as *Meloidogyne chitwoodi* (Columbia root knot nematode), *Globodera pallida* (pale potato cyst nematode), *M. hapla* (northern root knot nematode) and *Ditylenchus*

destructor (potato rot nematode) are serious pests of potato. They certainly could become established in a warming Alaska given their environmental preferences elsewhere (Brodie et al. 1993). *Heterodera avenae*, the oat cyst nematode, is an important pest of barley, oats and wheat in many parts of the world and occurs in Canada and several northern U.S. states (Rivoal and Cook 1993). With warming conditions it probably could establish itself in Alaska if given the opportunity.

Nematodes are abundant and diverse in Alaskan soils, with up to 8.9 million/m^2 in taiga forest soils (Freckman et al. 1977; Van Gundy et al. 1978). Nematodes quickly colonize soils newly exposed (<75 years) by glacial retreat (Bernard et al. 1995), with *Paratylenchus* spp. (pin nematodes) and *Criconema* spp. (ring nematodes) the first plant parasites to appear. More expansive studies (Nielsen et al. 2014; Wu et al. 2009) have shown that nematode assemblages in Alaska are diverse and complex. Modifications of these assemblages under the influence of climate change, which may be occurring more rapidly in Alaska than elsewhere, are difficult to predict (Gough et al. 2012). More research should be devoted to the dynamics of the soil biota to better understand Alaska's nematode future.

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