A preliminary survey of Collembola in forest nurseries of British Columbia

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ABSTRACT

A survey of 24 forest nurseries in British Columbia yielded 22 collembolan taxa, 10 of which are reported for the first time in this province. The species most frequently encountered was *Sminthurinus quadrimaculatus,* which was represented in 13 of the nurseries. Only one of the species collected, *Bourletiella hortensis* is a known pest of conifer seedlings, but it is not an obligate phytophage. The presence of sarophagous Collembola and predatory actinedid mites in the samples suggests that pest collembolan species are being controlled naturally by competition for food and by mite predators.
KEY WORDS: Forest nursery, Pest management, Acari, Collembola, *Bourletiella hortensis, Isotomurus palustris.*

RÉSUMÉ

Au cours de l'inspection de 24 pépinières forestiéres en Colombie-Britannique, on a relevé la présence de 22 taxons de collemboles, dont 10 étaient signalés pour la première fois dans cette province. L'espèce la plus fréquemment observée a été *Sminthurinus quadrimaculatus,* qui était présente dans 13 pépinières. Une seule des espèces recueillies, *Bourletiella hortensis,* est un ravageur connu des semis de conifères, mais elle n'est pas un phytophage obligatoire. La présence de collemboles saprophages et d'acariens actinédides prédateurs dans les échantillons donne à penser que deux facteurs naturels interviennet dans la limitation des populations de collemboles ravageurs: la compétition pour la nourriture et les acariens prédateurs.

INTRODUCTION

This report deals with Collembola collected from three bareroot and 21 container nurseries in British Columbia. Bareroot nurseries are traditional nurseries where seeds are planted outdoors in the soil. In container nurseries, seedlings are grown in individual containers in greenhouses, shelterhouses, or outdoor compounds where growing media and environmental conditions are more rigorously controlled. Collembola occur in all nurseries in British Columbia, but so far few have been identified to species (Sutherland *et al.* 1989).

Collembola, or "springtails," are minute arthropods, usually less than 1 cm long. The largest species known, *Tetrodontophora bielanensis* (Waga), measures up to 8 mm (Wallwork 1970). The Collembola have traditionally been classified in the Apterygota or primitive, wingless insects. However, the relationship of Collembola to the Insecta is uncertain and Scudder *et al.* (1979) considered them a separate Class in the Superphylum Arthropoda. Collembola are known from Devonian fossils and have a number of unique characteristics (Richards 1979). These include six abdominal segments that bear three peculiar appendicular derivatives: a collophore, tenaculum and furcula (springing organ). The furcula might be reduced or absent in some taxa. Collembola may also have a postantennal organ. Pronounced sexual dimorphism is rare. All species moult throughout their life.

The classification of the Collembola is controversial, but two orders (Arthropleona and Symphypleona) are generally recognized (Kevan 1980). Ordinal division is based primarily on shape of the abdomen. The Symphypleona are characterized by a globular abdomen that lacks distinct segments; Arthropleona have an elongate abdomen that is usually divided into six distinct segments. About 4450 species and subspecies have been described world-wide (Salmon 1964) and at least 520 are estimated to occur in Canada (Richards 1979). These estimates are very conservative because hundreds more species have been described since Salmon's 1964 compendium and in Canada the Collembola have not been extensively studied (Danks 1988).

Members of both orders feed on a wide range of organic materials and springtails occur wherever plants grow, including Antarctic and Arctic Islands. Collembola may be present in large numbers in forest soils and during mass emergence or swarming, estimates of over 1 million per m^2 have been reported (Christiansen 1964).

METHODS

In 1987-88, Collembola were hand-collected from styroblocks of container nurseries. Fine camel's-hair brushes were used to sweep specimens directly into vials (2.5 cm diameter) to which 75% ethanol was then added. Specimens were generally numerous on the sides and upper surfaces of styroblocks and this method proved more successful than aspiration. Collections in bare root nurseries were made form the soil surface in 1971-72 by the grease-film method (Marshall and Ilnytzky 1976). Collembola in bareroot nurseries, such as Koksilah and Green Timbers, are a source of inoculum for container nurseries that are built on the same site or when the former are converted to container nurseries.

Collembola were cleared by the Hille Ris Lambers method (Spencer 1959) and mounted in a modified Swann medium (Rusek 1974). A minimum of six individuals from each representative group were prepared for mounting; where less than six individuals were available, all specimens were mounted.

Species identifications were made from Christiansen and Bellinger (1980), but the family and generic classification mainly follow Salmon (1964) in order to better relate the results to the world fauna. In many cases, subgeneric designations in Christiansen and Bellinger (1980) corresponded to genera in Salmon; where there was disagreement an annotation is given for the name used herein.

RESULTS AND DISCUSSION

Twenty-two Collembolan taxa were identified from the 24 nurseries (Table 1). Seventeen of these were identified to species; the other five could be identified only to genus because of poor specimen condition or inability to fit the description of North American species.

Ten of the identified species (** in Table 1) were recorded in British Columbia for the first time. The list contains many common species, but did not include members of the Onychiuridae nor five species reported by Beirne (1972) to cause damage in agricultural crops. *Sminthurinus quadrimaculatus* was the most frequently encountered species, occurring in 13 of the nurseries surveyed. The next most frequently encountered species, *Willowsia buski*, is a household pest (Scott 1954). These species, however, are not known to attack living plants.

Two recognized plant pests, *Bourletiella hortensis* and *Isotomurus palustris*, were also encountered. *B. hortensis* is regarded as cosmopolitan (Salmon 1964). In Canada, it has been reported from Nova Scotia, Quebec, Ontario, Manitoba and British Columbia (Christiansen and Bellinger 1980). It appears to be an indiscriminate feeder (Marshall 1978) and causes damage to many agricultural crops (Edwards and Heath 1964; Beirne 1972). It also feeds on seedlings of larch, pine, and Engelmann, Sitka and white spruce and western hemlock in bareroot nurseries (Bevan 1965; Marshall and Ilnytzky 1976). No damage has yet been reported in container nurseries (Sutherland *et al.* 1989).

Table 1
Collembola and Acari from British Columbia forest nurseries.

COLLEMBOLA	
BRACHYSTOMELLIDAE	
Brachystomella parvula (Schäffer) **	GC *
Brachystomella stachi Mills **	GC
ENTOMOBRYIDAE	
Entomobrya sp.	CN, CR, NU, TH
Lepidocyrtus sp.	NO
Lepidocyrtus sp.? *bipunctatus* Packard ** (a)	MB
Orchesella zebra Guthrie **	GC
Willowsia buski (Lubbock)	HN, HY, IF, MB, NO, RC, SU, SY, TH
Willowsia sp.	CR, HY
HYPOGASTRURIDAE	
Hypogastrura matura (Folsom) **	RR, TE
Hypogastrura trybomi (Schött) **	HY
ISOTOMIDAE	
Isotoma viridis Bourlet	GC
Parisotoma notabilis (Schäffer) (b)	GC
Isotoma sp.	RC
Isotomurus palustris (Müller)	GB, KN
Proistoma immersa (Folsom) **	GC
NEANURIDAE	
Morulodes serratus (Folsom) (c)	CN
Pseudachorutes sp.	NU
SMINTHURIDAE	
Bourletiella hortensis (Fitch)	EG, GB, HY, KN, NO, RC, SU, WN
Bourletiella sp.	IF, KN, WN
Eusminthurus sminthurinus (Mills) ** (d)	HY
Sminthurinus quadrimaculatus (Ryder) **	CN, CR, CF, EG, HE, HN, HY, IF, NO, RC, SK, SY, WN
Sphaeridia pumilis (Krausbauer) ** (e)	KN
ACARI	
BDELLIDAE	
Bdellodes sp. nr. *bisetosa* Atyeo	AG, HY, RC
ERYTHRAEIDAE	
? *Erythrites* sp.	WN
EUPODIDAE	
Eupodes voxencollinus Thor	EG, MB, NU, SU, VN
PENTHALODIDAE	
Penthalodes turneri Baker	KN

* Abbreviations, location and sampling dates of the 24 nurseries follow, with (BRR) standing for Bareroot and (CON) for Container nursery: 1. AG, Arbutus Grove, Sidney (CON) 88.06.08; 2. CN, Campbell River, Campbell River (CON) 87.11.01 and 88.08.26; 3. CR, Chilliwack River, Chilliwack (CON) 88.06.03; 4. CF, Crown Forest, Armstrong (CON) 88.06.15; 5. EG, Elmore Greenhouses, Nanoose (CON) 88.06.06; 6. GB, Green Timbers, Surrey (BRR) 71.05.19; 7. GC, Green Timbers, Surrey (CON) 87.11.24; 8. HE, Hammer Enterprises, Maple Ridge (CON) 88.04.27; 9. HN, Harrop, Nelson (CON) 88.06.18; 10. HY, Hybrid, Pitt Meadows (CON) 88.04.27 and 88.05.03; 11. IF, Industrial Forest Service, Prince George (CON) 88.06.21; 12. KN, Koksilah Canada, Duncan (BRR) 72.08.21; 13. MB, MacMillan Bloedel, Nanaimo (CON) 88.06.09 and 88.08.25; 14. NO, Northwood, Prince George (CON) 88.06.21; 15. NU, Nuu-chah-nulth, Port Alberni (CON) 88.06.09; 16. RR, Red Rock, Prince George (CON) 87.09.12; 17. RC, Reid Collins, Aldergrove (CON) 88.05.30; 18. SK, Skimikin, Tappen (CON) 88.10.04; 19. SU, Summit, Telkwa (CON) 88.06.23; 20. SY, Sylvan Vale, Black Creek (CON) 88.06.09; 21. TE, Telkwa, Telkwa (BRR) 71.10.12; 22. TH, Thornhill, Terrace (CON) 88.06.23; 23. VN, Vernon, Vernon (CON) 88.06.15; 24. WN, Woodmere, Smithers (CON) 88.06.23.

** Newly recorded in British Columbia.

(a) Listed in subgenus *Seira* by Christiansen and Bellinger (1980).

(b) Listed in the genus *Isotoma* by Christiansen and Bellinger (1980).

(c) Salmon (1964) listed this in the genus *Lathriopyga,* but more recent authors place it in *Morulodes* (Massoud 1967; Christiansen and Bellinger 1980; Fjellberg 1985).

(d), (e) Listed in the genera *Sminthurinus* and *Sminthurides,* respectively, by Christiansen and Bellinger (1980).

Isotomurus palustris is common in Europe and is probably cosmopolitan (Salmon 1964). In Canada, it has been recorded from the Arctic, Ontario and British Columbia (Salmon 1964). This species also appears to be an indiscriminate feeder and has attacked sugar beets, sugar cane and tobacco (Scott 1954; Paclt 1956).

Only a few numbers of species were collected in most nurseries, with the highest number of six species being present at Hybrid nurseries. No Collembola were collected at Arbutus Grove and Vernon nurseries. Failure to obtain specimens at these two nurseries is undoubtedly due to collection methods rather than a complete absence of Collembola. Except for Campbell River, Hybrid and MacMillan Bloedel nurseries, which were sampled twice, all other nurseries were sampled only once (Table 1). This limited sampling and omission of soil in styroblocks and other habitats on nursery floors were inadequate to give a representation of the entire collembolan fauna.

Both container and bareroot nurseries provide conditions that are conducive to the establishment and maintenance of numerous species of Collembola. Such conditions include high relative humidity, temperatures well within ranges tolerated by Collembola, and plentiful food in the form of pollen and decomposing organic matter. Therefore, the 22 species collected probably represents less than half of the total number of species present, considering the known distribution of North American Collembola (Christiansen and Bellinger 1980).

Although pest species are of special concern in nurseries, free-living Collembola could be beneficial in two important ways. Firstly, Collembola may aid in the reduction of inoculum of fungal diseases. Many species of Collembola consume fungi as a major component of their diet (Takeda and Ichimura 1983). *Onychiurus encarpatus* Denis and *Proisotoma minuta* (Tullberg), which occur throughout North America and are voracious feeders on some fungi, are being investigated as potential control agents for *Rhizoctonia solani* Kühn, a pathogen of cotton seedlings (Curl *et al.* 1988; Lartey *et al.* 1989) and other crops. Secondly, predators such as *I. viridis* might be helping to control phytophagous Collembola.

While no special attempt was made to sample mites (Acari), four actinedid species (*Bdellodes* sp. nr. *bisetosa* Atyeo, *?Erythrites* sp., *Eupodes voxencollinus* Thor and *Penthalodes turneri* Baker) were found among the Collembola (Table 1). Only *E. voxencollinus* was represented in many nurseries. *E. voxencollinus* and *P. turneri* are not known to feed on Collembola, although they are in families considered general predators (Krantz 1978). However, species in *Bdellodes* and *Erythrites* are potential natural control agents for Collembola (Hoy *et al.* 1983).

It is only under exceptional conditions of high populations and lack of alternative food supply are Collembolan pest species expected to sufficiently damage germinating seedlings to make chemical or other control necessary (Edwards 1962, Christiansen 1964). Since damage has not yet been reported in container nurseries, collembolan pests are apparently kept from reaching high numbers by competition with free-living collembolan species and by the presence of predators. Mites are considered to be the major predator controlling collembolan populations (Wallwork 1970). The sampling technique used in this study cannot give information on collembolan populations and their fluctuations relative to such predators. Therefore, further studies are required in order to determine the effect of collembolan species on germinating conifer seedlings and to determine when control measures would be warranted in British Columbian nurseries.

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