ARTHROPODS COLLECTED FROM STEM RUST CANKERS OF HARD PINES IN WESTERN CANADA

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NORTHERN FOREST RESEARCH CENTRE
INFORMATION REPORT NOR-X-42
July 1972

CANADIAN FORESTRY SERVICE
DEPARTMENT OF THE ENVIRONMENT
5320 - 122 STREET
EDMONTON, ALBERTA, CANADA
T6H 3S5

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ABSTRACT

The arthropods collected from cankers of the pine stem rusts, Cronartium coleosporioides Arth., C. comandrae Pk., C. comptoniae Arth., and Endocronartium harknessii (J. P. Moore) Y. Hiratsuka, which occur on Pinus banksiana Lamb. and P. contorta Dougl. var. latifolia Engelm. in the Prairie Provinces and adjacent areas are listed. The list includes 218 species, represented by 192 insects, 21 mites, and 5 spiders. Some 178 species were collected from C. comandrae, 78 from E. harknessii, and lesser numbers from the other two pine stem rusts which were sampled less intensively. Many species were common to two or more rusts. The arthropod species which cause damage to the stem rust cankers or destroy the rust spores are briefly discussed.

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INTRODUCTION

In 1964 a study was initiated in the Alberta/Territories Region of the Canadian Forestry Service to identify the arthropods associated with cankers of the comandra blister rust, Cronartium comandrae Pk.,on lodgepole pine, Pinus contorta Dougl. var. latifolia Engelm., as some of these arthropods appeared to be responsible for destroying many rust aeciospores (Powell, 1971). During this study a few cankers of C. comandrae from jack pine, Pinus banksiana Lamb.(=P. divaricata (Ait.) Dumont , and cankers or galls of other pine stem rusts were also collected to check whether the species of arthropods reared were common to several species of pine stem rust.

A somewhat similar study was started in the Manitoba-Saskatchewan Region in 1965 to identify the arthropods associated with a large number of fungi. This study included canker samples on pine from two of the pine stem rusts - C. comandrae and the western gall rust, Endocronartium harknessii (J.P. Moore) Y. Hiratsuka.

This paper brings together the results of these studies and provides a list of the arthropods collected from cankers of the following pine stem rusts: Cronartium coleosporioides Arth. (stalactiform blister rust), C. comandrae, C. comptoniae Arth. (sweet fern blister rust) and Endocronartium harknessii, which occur on the hard pines, Pinus banksiana, and P. contorta in the areas of Western Canada served by the Northern Forest Research Centre. The list of species collected from C. comandrae

on P. contorta has already been published (Powell, 1971), but is included here with a few additions for completeness and for comparative purposes.

The pine stem rusts grow perennially in the living bark of pines where they produce their spermogonial and aecial states. Cankers of the rusts persist on branches and stems for many years before growth of the rust around the branch or stem eventually causes mortality. The cankers produced by the rusts of the genus Cronartium may vary from 1 cm to several meters long and consist of three distinct zones. The centre or oldest portion of the canker is composed of cracked, rough, dead bark tissues. Adjacent to this area is the aecial zone, often 5 cm or more wide, characterized by blister-like aecia that produce masses of dry, orange-yellow aeciospores from mid-May to August over an area occupied by the spermogonia of the previous year. Outside of this zone near the periphery of the canker is the spermogonial zone characterized, for a short period in mid- or late summer, by orange gelatinous droplets containing spermatia. Each of these zones is attractive as a habitat for different groups of arthropods. In the case of Endocronartium harknessii the cambium of the pine host is stimulated by the rust to produce globose-like galls rather than elongate cankers as in the case of the other three pine stem rusts. Sporulation occurs annually on the expanding gall surface until all of the cambium zone is killed. Such galls may become quite large and persist for over 200 years (Peterson, 1961). The habitat for arthropods on the cankers and galls is almost always partly destroyed by the gnawing of rodents which are attracted to the rust-infected succulent stem tissues. Similarly some of the arthropods extensively destroy parts of the cankers

or galls by mining into the stem tissues.

METHODS AND MATERIALS

The method of collecting and rearing arthropods from C. comandrae on P. contorta has already been reported (Powell, 1971). For the other studies, field collections of the rust were brought to the laboratory from May to October and placed in containers for rearing. Each collection was examined daily for adult arthropods during their normal developmental period. In October these collections were stored in a cool (2° to 5°C) area for 3 months then placed at room temperature and examined at regular intervals for any further emergence. A single collection consisted of one canker to 50 such cankers or galls. The number of collections, the total number of cankers sampled, and the number of specimens of each arthropod species collected were tallied, although for the more common species, the totals were not always complete as only representative specimens were retained. The number of canker samples collected to determine the arthropod fauna varied considerably for each of the pine rust species (Table 1). The most intensive sampling was carried out on C. comandrae on P. contorta in southern Alberta, and on E. harknessii on P. banksiana and P. contorta throughout the region. Collections from C. coleosporioides and C. comptoniae were very limited both in numbers and regional distribtuion.

RESULTS AND DISCUSSION

A total of 218 species of arthropods in 84 families and 160 genera

were collected (Table 2). These are represented by 192 insects, 21 mites, and 5 spiders. There is probably some duplication in the total number of species listed, as some of the material identified only as to genus is probably identical to that identified to species. Some 178 species of arthropods were collected from Cronartium comandrae, 166 species of these being present on Pinus contorta, and 30 species on P. banksiana. Fifty-four species were collected from Endocronartium harknessii on P. banksiana and 36 species on P. contorta, giving 78 different species from E. harknessii. Thirty-nine of the 78 species collected from E. harknessii were also found on C. comandrae, and three others on C. coleosporioides. Of the 16 species found on C. coleosporioides all were found on other pine stem rusts, and only one of the five species reared from C. comptoniae was not obtained from the other pine stem rusts. The following species were common to two or more rusts and usually both pine hosts: the mite Tyrophagus putrescentiae, the psocid Liposcelis sp., aphids of the genus Cinara, the beetles Epuraea obliquus, Melanophthalma sp., Pissodes schwarzi, Magdalis sp., Cylindrocopturus deleoni, Pityophthorus spp., and Orthotomicus spp., microledipotera of the genera Dioryctria and Eucordylea, sciarid and cecidomyiid flies, and several braconid wasps (Agathis binominata, Apanteles sp., Brachistes spp., Bracon spp., Microchelonus sp.) which are parasites of the other common inhabitants of the pine stem galls and cankers. Included in the list (Table 2) are three collections made of E. harknessii galls on Pinus sylvestris L. in Manitoba. With the exception of Venturia nr. concola the arthropods from this pine host were also present on P. banksiana.

Although the number of collections from the rusts C. coleosporioides

and C. comptoniae were small, they probably have associated with them a group of insects similar to that of the more intensively collected C. comandrae and E. harknessii. The canker of C. coleosporioides is probably a less suitable habitat for arthropods than cankers of C. comandrae or C. comptoniae as the canker is long and narrow, also the spermogonial state which attracts many insects especially flies is less pronounced. A spermogonial state has rarely been reported for E. harknessii and this may be a reason why Dipterous species, other than the sciarids, are poorly represented in our collections (see Table 2). The gall of E. harknessii may provide a different type of habitat niche for some species which may explain why only about half the species collected on E. harknessii were represented in the collections from the other pine stem rusts, and why many species collected from the canker-forming pine stem rusts were not collected from E. harknessii. However, more intensive collection throughout the region may modify this finding. Only the collections of E. harknessii were fairly evenly distributed geographically (Table 1). Forty-one arthropod species were collected from E. harknessii galls in Manitoba, 29 in Saskatchewan, and 40 in Alberta and adjacent areas of the Yukon, Northwest Territories and Kootenay National Park in British Columbia.

The present list of arthropods (Table 2) increases the number of species reported from C. comandrae on Pinus contorta by six (Powell 1971). Other reports (see Powell 1971) list a few species associated with pine stem rusts, mostly from Cronartium ribicola J.C. Fisch. or C. fusiforme Hedgc. & Hunt ex. Cumm. Byler et al. (1972) reported that numerous insects were present on galls of E. harknessii (=Peridermium harknessii J.P. Moore) on Pinus muricata D. Don and P. radiata D. Don in California, although only

Dioryctria spp., Pityophythorus sp. and Ips radiata were named. They found 34% of the galls damaged by Pityophythorus sp. and 18% by Dioryctria spp., on one plot. Wong (1972) found larvae of Dioryctria banksiella present in 45% of the galls of E. harknessii collected in Manitoba and Saskatchewan, and described the form of its damage to the gall. He also listed the hymenopterous parasites recovered in rearings of D. banksiella. In the present study most of the canker damage was caused by larvae of Dioryctria spp. with less canker damage caused by Laspeyresia, Grapholitha, and Eucordylea larvae. The weevils of the genera Pissodes, Cylindrocopturus, and Magdalis, and most of the scolytids also cause considerable damage to the cankers but probably only as secondary species that attack trees already weakened by the rust. The three species considered by Powell (1971) to be mycetobionts - Epuraea obliquus, Paracacoxenus guttatus and Mycodiplosis spp., all reduce the production of spores but do little damage to the underlying infected bark tissue. Many of the other species only cause slight damage to the cankers and are probably only scavengers and can be classified as mycetophages.

ACKNOWLEDGEMENTS

We are indebted to specialists of the Entomology Research Institute, Canada Department of Agriculture, Ottawa, Ontario, for the identification of most of the arthropod material. Other specialists who contributed to the identification of various faunal groups are: L. M. Gardiner, and B. A. Sugden, Canadian Forestry Service, Department of the

Environment, respectively at Sault Ste. Marie, Ont., and Vernon, B.C.; C. W. O'Brien, Department of Entomology, University of California, Berkeley; R. J. Gagné, U.S. Department of Agriculture, National Museum, Washington, D.C.; C.V.G. Morgan, Canada Department of Agriculture, Summerland, B.C.; C. T. Parsons, Manchester Depot, Vermont; W. E. Ricker, Fisheries Research Board, Biological Station, Nanaimo, B.C.; A. L. Turnbull, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C.; and T. A. Woolley, Department of Zoology, Colorado State University, Fort Collins. We also wish to acknowledge the assistance of personnel of the Forest Insect and Disease Survey, and L. S. Skaley, Northern Forest Research Centre, Edmonton, in the collecting, rearing, mounting, and preparing of the specimens.

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Table 1. NUMBER OF ARTHROPOD COLLECTIONS BY RUST HOST, PINE HOST, AND GEOGRAPHICAL DISTRIBUTION

	Number of Collections						
	Alta.	Sask.	Man.	NWT.	Yukon	B.C. (Kootenay NP)	Total
Cronartium coleosporioides							
on *Pinus banksiana*	2						2
on *P. contorta*	8						8
Cronartium comandrae							
on *Pinus banksiana*	2	19	15	5			41
on *P. contorta*	166*	3			2		171
Cronartium comptoniae							
on *Pinus banksiana*				2			2
Endocronartium harknessii							
on *Pinus banksiana*	10	49	77	1			137
on *P. contorta*	33	3			1	7	44
on *P. sylvestris*			3				3

* Includes cage collections as well as rearing collections.

Table 2. ARTHROPODS COLLECTED OR REARED FROM CANKERS OF *CRONARTIUM COLEOSPORIOIDES*, *C. COMANDRAE*, *C. COMPTONIAE*, AND *ENDOCRONARTIUM HARKNESSII* ON *PINUS BANKSIANA* (A), AND *P. CONTORTA* (B) IN WESTERN CANADA.

Order Family Species	*C. coleosporioides* (A)	*C. coleosporioides* (B)	*C. comandrae* (A)	*C. comandrae* (B)	*C. comptoniae* (A)	*E. harknessii* (A)	*E. harknessii* (B)
ARACHNIDA							
ARANEIDA							
Theridiidae							
Theridion sp.				1		2	
Clubionidae							
Clubiona sp.				4			
Micryphantidae							
Ceraticelus prob. *alticeps* Fox.				1			
Linyphiidae							
Pityohyphantes phrygianus (Koch)				1			
Agelenidae							
Cryphoeca sp.							1
ACARINA-MESOSTIGMATA							
Ascidae							
Proctolaelaps sp. nov.?				1			
Laelapidae							
Androlaelaps casalis (Berlese)				68+			3
ACARINA-PROSTIGMATA							
Eupodidae							
Unidentified sp. immature				6			
Bdellidae							
Bdellodes longirostris (Hermann)				3			
Thoribdella sp.nr. *simplex* Atyeo				3			

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Tydeidae							
Unidentified sp.				2			
Anystidae							
Anystis sp.				2			
Erythraeidae							
Abrolophus sp.				1			
Balaustium sp.				2			
Bochartia kuyperi Oudemans				1			
Trombidiidae							
Unidentified sp. immature				1			
Eriophyidae							
Unidentified sp. immature		1					2
ACARINA-ASTIGMATA							
Saproglyphidae							
Saproglyphus sp.						2	
Acaridae							
Tyrophagus putrescentiae (Schrank)			11+	3		53+*	
Histiogaster arborsignum Woodring				30+			
Histiogaster sp.				1			
ACARINA-CRYPTOSTIGMATA							
Camisiidae							
Camisia biurus Koch.				2			2
Oribatulidae							
Scheloribates sp.				1			
Ceratozetidae							
Dentizetes rudentiger Hammer				10+			
Diapterobates principalis (Berlese)				260+			
Trichoribates sp.nr.*lamellata* (Ewing)				5			
COLLEMBOLA							
Unidentified sp.		30				30	
Poduridae							
Hypogastrura armata (Nicolet)				6			

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Hypogastrura sp.nr.matura (Folsom)				8			
Hypogastrura socialis (Uzel)				10			
Hypogastrura sp. immature				4			
Entomobryidae							
Entomobrya nivalis (L.)				3			
Entomobrya comparata Folsom				1			
Entomobrya sp. immature				1			
Tomocerus flavescens Tullberg				27			
PLECOPTERA							
Capniidae							
Eucapnopsis brevicauda Claassen				1			
Leuctridae							
Perlomyia utahensis Needham & Claassen				1			
PSOCOPTERA							
Liposcelidae							
Liposcelis sp.	15+	15+		64+		15	
Psocidae							
Loensia sp.				2			
Psocus sp.				1			
Psocus ? sp. immature				21+			2
Pseudocaeciliidae							
Peripsocus sp.				1			
THYSANOPTERA							
Thripidae							
Frankliniella sp.				1			
Taeniothrips sp.				1			
Phlaeothripidae							
Tubilifera immature				1			
Gnophothrips fuscus (Morgan)		4+		12+			
Haplothrips sp.nr.subtilissimus Hal.				1			

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
HEMIPTERA							
Anthocoridae							
Tetraphleps uniformis Parshley				3			
Miridae							
Deraeocoris spp.				2			
Platylygus luridus (Reuter)				2			
Lygus sp.							1
Nabidae							
Unidentified sp.				1			
Aradidae							
Aradus cinnamoneus Panzer				1			
Pentatomidae							
Chlorochroa ligata Say				2			
HOMOPTERA							
Psyllidae							
Psylla striata Patch				1			
Achilidae							
Epiptera sp.nr.*pallida* Say				1			
Aphididae							
Essigella sp.				1			
Cinara banksiana Pepper & Tissot						5	
Cinara brevispinosa (Gillette & Palmer)				15			
Cinara medispinosa (Gillette & Palmer)				120+			10
Cinara murrayanae (Gillette & Palmer)				47+			
Cinara sp.nr.*murrayanae* (Gillette & Palmer)				10+			
Cinara sp.						3	3
NEUROPTERA							
Hemerobiidae							
Hemerobius sp.?				3			
Sympherobius angustus Banks.?							1
Coniopterygidae							
Unidentified sp.				2			

Table 2 (continued)

Order / Family / Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
COLEOPTERA							
Carabidae							
Calathus ingratus Dej.				1			
Staphylinidae							
Atheta sp.				60+			
gen.nr.Atheta				15			
Aleocharinae sp.						1	
Stenus sp.						1	
Staphylinid sp.						1	
Cantharidae							
Cantharis sp. immature				1			
Silis difficilis Lec.				1			
Melyridae							
Orchesia sp.						1	
Cleridae							
Phlogistosternus dislocatus Say.						1	
Nitidulidae							
Epuraea obliquus Hatch	36		16	244+	3	117	31
Epuraea sp.			15			38	
Mycetophagiidae							
Litargus sp.						2	
Lathridiidae							
Corticaria sp.		1		15+			3
Enicmus sp.				1			
Melanophthalma sp.				7		25	14
Microgramme filum (Aube)				25+			
Coccinellidae							
Unidentified sp. immature				1			
Tenebrionidae							
Tribolium confusum J. du Val.				4			
Tribolium sp.				4			
Corticeus sp.prob.praetermissus (Fall)				4			
Melandryidae							
Attalus sp.						1	
Canifa sp.						3	
Anobiidae							
Ernobius sp.				33+		6	
Cisidae							
Cisid sp.						5	
Scarabaeidae							

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Aphodius fimetarius (L.)				1			
Cerambycidae							
Acmaeops proteus (Kby.)				5			
Callidiini sp. immature				1			
Pogonocherus mixtus Hald.						3	
Curculionidae							
Scythropus sp.				1			
Pissodes schwarzi Hopk.				35+			3
Pissodes strobi Peck				1		1	
Magdalis sp.				12+		3	1
Cylindrocopturus deleoni Buchanan		10		79+		1	25
Scolytidae							
Dendroctonus murrayanae Hopk.				2			
Dendroctonus ponderosae Hopk.				1			
Dendroctonus sp.				1			
Pityophthorus murrayanae Blkm.				5			
Pityophthorus tuberculatus Eich.		20				7	
Pityophthorus sp.						8	
Pityogenes knechteli Sw.		3		20+			1
Pityogenes sp.							1
Ips pini (Say)				2	2		2
Orthotomicus caelatus (Eich.)						1	1
Orthotomicus latidens (Lec.)			2	1	2		20
LEPIDOPTERA							
Geometridae							
Eupithecia albicapitata Pack				5			10
Pyralidae							
Dioryctria abietivorella (Grote)				15+		13*	9
Dioryctria banksiella Mutuura, Munroe & Ross	9		27+	2		122+*	5
Dioryctria sp.,prob.contortella Mutuura,Munroe & Ross - immature				5			4
Dioryctria reniculella (Grote)						1*	
Dioryctria sp.		4	7	6	13	46*	21
Olethreutidae							
Epinotia nisella Clerck.						1	
Epinotia sp.		1		1			
Laspeyresia sp.		1		28+			1

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Laspeyresia sp.gp.2.immature (but not cupresana Kft.)				1			
Grapholitha sp.prob. caeruleana Wlshm.				21+			
Grapholitha sp.				2			
Petrova sp.prob. albicapitana Busck.							1
Tortricidae							
Choristoneura pinus pinus Free.						3	
Gelechiidae							
Pulicalvaria sp.			37	1			19
Eucordylea (Recurvaria) florae Free.			4	20		37+	26
Eucordylea (Recurvaria) starki Free.			2	8			3
Eucordylea (Recurvaria) sp.			2	21+		1	
Chionodes obscurusella Cham.						2	
Gelechid sp.						1	
Blastobasidae							
Holococera immaculella McD.			5			4	
Unidentified sp. immature				1			
Ethmiidae							
Pyramidobela coloradella Wlshm.				3			
DIPTERA							
Tipulidae							
Tipula (Pterelachisus) serta Loew.				1			
Mycetophilidae							
Cordyla sp.				1			
Sciaridae							
Lycoriella sp,			1			73	
Bradysia sp.nr.varians Johannsen				63			
Bradysia sp. 1				183+			
Bradysia sp. 2				1			
Bradysia sp. 3				10+			
Bradysia spp. (at least 4 spp.)	1		77	300+			
Plastosciara sp.nov.				1			
Sciarid sp.						370+	

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Cecidomyiidae							
Anarete sp.				1			
Lestremiinae sp.immature				10+			
Mycodiplosis sp.immature	12	50		910+			
Cecidomyia sp.nov.					5		
Cecidomyiidi sp.	1			1		11	2
Dolichopodidae							
Medetera sp.				1			
Phoridae							
Phora spp.				4			
Megaselia (Aphiochaeta) spp.				4			
Chamaemyiidae							
Leucopis orbitalis group				1			
Piophilidae							
Piophila xanthopoda Melander & Spuler				1			
Lonchaeidae							
Lonchaea sp.nr.corticis Taylor				2			
Drosophilidae							
Paracacoxenus guttatus Hardy & Wheeler				95+			
Chymomyza sp.?				1			
Chloropidae							
Oscinellinae sp.				1			
Tachinidae							
Xanthophyto sp.nov.						1	1
HYMENOPTERA							
Braconidae							
Aphidius sp.				1			
Macrocentrus marginator Nees				5			
Brachistes strigitergum Cush				1			
Brachistes sp.nov.				5		4	
Brachistes sp.				7			
Calyptus sp.				1	3		
Diospilus sp.							1
Triaspis sp.				8			
Agathis binominata M. & W.			10			13*	
Agathis sp.			1				
Apanteles sp.			2	5			8

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Ascogaster sp.				5			
Chelonus (Microchelonus) eximius McComb			5				1
Chelonus sp.1				1			
Chelonus sp.2				6			
Microchelonus sp.			3	2		7	2
Bracon lutus Prov.						3	
Bracon pini Muesebeck				4			
Bracon sp.			1	18		7	
Doryctes californicus Marsh				16			
Braconid sp.				3			
Ichneumonidae							
Exeristes comstockii (Cr.)						3	
Scambus sp.				2			
Dolichomitus terebrans nublipennis (Vier.)				1			
Phrudus sp.				1			
Mastrus sp.				1			
Stiboscopus sp.nov.						4	
Gelis sp.				1			
Phygadeuon sp.				1			
Phaeogenes sp.			1				
Coelichneumon brunneri Rohw.			8	4			
Glypta sp.				7			
Lissonota sp.				1			
Pimplopterus sp.							1
Trathala sp.			3			6	
Temelucha sp.			1				
Venturia nr.concola (Rohwer)						1*	
Chalcidoidea							
Unidentified sp.				1			
Encyrtidae							
Copidosoma sp.			1				
Unidentified sp.				1			
Pteromalidae							
? Asaphes sp. ? nov.gen. or sp.				1			
Pachyneuron sp.			1				
Rhopalicus pulchripennis (Crawford)				1			
Tritneptis sp.				1			
Cricellius ? sp.				1			
Eurytomidae							
Eurytoma sp.				4			

Table 2 (continued)

Order Family Species	C. col. - A	C. col. - B	C. com. - A	C. com. - B	C. comp. - A	E. hark. - A	E. hark. - B
Chalcididae							
Trigonura sp.						1	
Brachymeria (Brachymeria) sp.				1			
Brachymeria sp.						1	
Chalcid sp.			2				
Ceraphronidae							
Ceraphron sp.				1			
Diapriidae							
Polypeza brunnea (Ashmead)				1			
Formicidae							
Camponotus herculeanus (L.)				7+			
Lasius crypticus Wilson				3+			
Lasius sitkaensis Pergande				1			
Formicinae sp.				3			
Vespidae							
Ancistrocerus albophaleratus (Sauss.)						1	

+ Species far more common than the number of specimens collected would indicate.

* Includes a few specimens collected from this rust on Pinus sylvestris L.

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