Distribution and spread of bark beetles (Coleoptera: Scolytidae) around the Gulf of Finland: a comparative study with notes on rare species of Estonia, Finland and North-Western Russia

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A long-term faunistic study of bark beetles (Coleoptera: Scolytidae), conducted in Estonia, as well as in Karelia, Leningrad (St. Petersburg) and Murmansk provinces of Russia, enables a comparison of the species composition of bark beetles in the regions bordering Finland. Altogether the distribution patterns of 83 species of scolytids are examined. The northern borders of the distribution range for *Scolytus scolytus*, *S. multistriatus*, *S. laevis*, *Hylastes ater*, *H. opacus*, *Orthotomicus longicollis*, *Pityogenes trepanatus*, *Ips amitinus* and *Cryphalus abietis* in Northern Europe are redefined. The list of bark beetles for Estonia and North-Western Russia (Karelia, Leningrad and Murmansk provinces) with their occurrence in some biogeographical provinces of Fennoscandia (Ik, Kl, Kon, Ks, Kk, Lim) is given. Recent records of bark beetles, endangered or rare in Finland, and their current distribution in the neighbouring regions are discussed.

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1. Introduction

Natural barriers, such as seas (e.g. the Gulf of Finland between Estonia and Finland) represent barriers for the spread of insects. Although bark beetles (Coleoptera: Scolytidae) can be dispersed over quite a long distance by wind (Nilssen 1984, Byers 2000), the main way for their spreading seems to be step by step through their natural habitats. The route via Estonia and Leningrad (St. Petersburg) Province of Russia, i.e. the way bypassing Gulf of Finland, was considered the most probable route for the recent invasion of *Ips amitinus* Eichh. into Finland (Mandelshtam 1999). On the other hand, *Scolytus laevis* Chap., inhabiting elm trees (*Ulmus* spp.), was recorded in Estonia already in the 1930s (Kristian 1937, Leius 1939), i.e. it has been present in the vicinity of Finland for at least 70 years. *S. laevis* occurs even on the northern coastal region close to the Gulf of Finland (Voolma *et al.* 2000), but it is still absent in Finland (Heliövaara *et al.* 1998) despite of its host trees *Ulmus glabra* and *U. laevis* growing in central and Southern Finland (Hämet-Ahti *et al.* 1992, Mattila & Vakkari 1997). In the Leningrad Province of Russia, the range of *S. laevis* is limited to the southern parts of the province (Mandelshtam & Popovichev 2000). Thus, *S. laevis* cannot enter Finland via Isthmus Karelicus, and it has failed to spread over the Gulf of Finland for at least 70 years. A possible land route for the expansion of southern species northward to Finland runs through the north-western region of Russia, the Leningrad Province and Karelia.

The North-Eastern part of Europe, including Eastern Fennoscandia, Northern Baltics and North-Western Russia, is covered with boreal coniferous and mixed forests where the dominating conifer species are Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*), and the deciduous trees include birches (*Betula pendula, B. pubescens*) and aspen (*Populus tremula*), with a small proportion of other broad-leaved species, such as *Tilia cordata*, *Quercus robur*, and *Ulmus* spp. As host trees, these species are an indispensable prerequisite for the distribution of bark beetles. Because of the relatively short distances among Southern Finland, Estonia and North-Western Russia, there is no substantial difference in the species composition of woody plants in the regions. However, the forests in Finland, Russia and Estonia have been subjected to different human impact during the last century (Siitonen *et al.* 1995). Estonian and Russian forests are considered more "natural" i.e. less intensively managed than the Finnish forests. They can serve as refugia for insect species negatively affected by forest management, as demonstrated by comparative studies of some insects groups of Finnish and Russian Karelia (Siitonen & Martikainen 1994, Siitonen *et al.* 1995, 1996, Rutanen & Kashevarov 1997). Differences in forestry history and intensity of forest management between Finland and Russia have consequently a considerable impact on the bark beetle fauna (Martikainen *et al.* 1996).

The faunistics of bark beetles has been thoroughly investigated in Finland for a long time. Overviews of the Finnish bark beetles (Saalas 1917, 1923, 1931) have been of great importance not only for Finland but also for Karelia. Checklists of Scolytidae for separate provinces of Fin-

land were scrutinized by several authors (e.g. Nuorteva 1963, 1971). Later, the fauna of scolytids in the Nordic countries, including Finland, was reviewed and the distribution maps were compiled by Lekander *et al.* (1977). The quantitative biogeography of bark beetles in Northern Europe was analyzed by Heliövaara *et al.* (1991). Current knowledge on bark beetles of Finland was summarized by Heliövaara *et al.* (1998). However, in these works neither Karelia (currently included in the biogeographical region of Fennoscandia) nor the neighbouring Baltic countries were discussed.

During the recent decades, the bark beetle fauna of Estonia (Voolma *et al.* 1996, 1997a, 1998, 2000), Karelia (Yakovlev *et al.* 1986, 2000, Sharapa & Shcherbakov 2000), the Murmansk (Mozolevskaya *et al.* 1981, Sharapa 1985, Mozolevskaya & Sharapa 1996) and Leningrad provinces (Mandelshtam & Popovichev 2000) has been revised. Each of these papers added new species to the regional faunas, previously unknown from these territories. Besides, the documented expansion of the range of *Ips amitinus* Eichh. (Koponen 1975, 1980, Mandelshtam 1999), previously regarded as a southern species, has recently reached more northern regions. Therefore, a comparative faunistic analysis of Scolytidae in the countries adjacent to Finland may provide new clues on the finding of new species in Finland in the future. In addition, checklists of bark beetles of the former Finnish territories, Isthmus Karelicus (biogeographical province Ik and a part of province Kl), the Karelian biogeographical provinces Kon (Kivach Nature Reserve with nearby areas), Ks (National Park of Paanajärvi) and Kk (Keret Archipelago and Kandalaksha Nature Reserve), and the Murmansk region (Lappland Nature Reserve, Lim) have been taken into account.

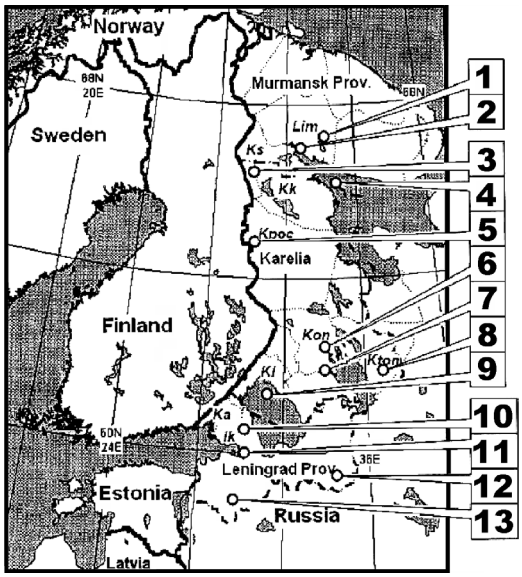

Fig. 1. The study region (Estonia and North-Western Russia) with the biogeographical provinces of eastern Fennoscandia (Ik, Ka, Kl, Kon, Kton, Kpoc, Ks, Kk, Lim). Main collection sites in Russia are indicated with numbers. **Murmansk Province:** 1 – Khibiny Mountains, environs of Monchegorsk (Lim); 2 – Isle Velikii, Kandalaksha Nature Reserve (Kk); **Karelia:** 3 – Paanajärvi National Park (Ks and Kk); 4 – Isle Srednii (Kk); 5 – Kalevala National Park (Kpoc); 6 – Kivach Nature Reserve (Kon); 7 – Petrozavodsk area (Kon); 8 – Pudozh (Kton); 9 – Valamo archipelago (Kl); **Leningrad (St. Petersburg) Prov.:** 10 – Lembolovo (Ik) and Vaskelovo; 11 – St. Petersburg; 12 – Cherentsovo, Tikhvin Distr.; 13 – Jashchera, Luga Distr.

2. Material and methods

The paper is based on long-term investigations conducted by the authors in different localities of North-Western Russia (Karelia, Leningrad and Murmansk provinces) and in the Republic of Estonia. Biogeographical provinces of Fennoscandia concerning the study, and main collection sites, in Russia are shown in Fig. 1. The complete set of collection sites cannot be mapped in detail due to the small resolution of the map. Some additional collecting sites are listed in the text; all sites can be found from sources listed in References [e.g. Mandelshtam & Popovichev (2000) for Leningrad Province etc.].

The fauna of the Leningrad (St. Petersburg) province was reconstructed using the analysis of bark beetles collected from 60 localities of the province between 1987 and 2001 (Mandelshtam & Popovichev 2000), with more than 20,000 specimens being collected. The fauna of the Fennoscandian biogeographical province Ik (Isthmus Karelicus) was compiled by combining data of several years, collected in the St. Petersburg area, Zelenogorsk (Terijoki), the River Sestra (Solnechnoye), Roschino (Raivola), Petja-

järvi, Sosnovo (Rautu), Orekhovo and Lembolovo, and in the vicinity of Vaskelovo, an area separated from Lembolovo (Ik) by a river.

The fauna of Southern Karelia (the Fennoscandian province Kl) was compiled on the basis of local faunal lists for Valamo, Loimola, Kuznechnoye and Vladimirskaya Buchta. The fauna of Valamo was studied during three visits to Valamo Island (August 1989, June 1990 and 1992) by the expedition of the St. Petersburg State University. The list of the bark beetles of the Kivach Nature Reserve (Kon) was completed during the expeditions of the Moscow State Forestry University (MSFU) in 1987 and in 1989 (Mosolevskaja *et al.* 1991). About 7,000 specimens of bark beetles in Kivach Nature Reserve were trapped. The fauna of the Paanajärvi National Park (Ks and Kk) was the subject of study in the course of joint expeditions of the Karelian Forest Institute and the MSFU in 1998–2000 (Yakovlev *et al.* 2000). Data on the bark beetles of Karelia in general were collected during over 15 years (Yakovlev *et al.* 1986). About 3,000 specimens of bark beetles were collected in Paanajärvi National Park and about 2,000 in other regions of Karelia.

The fauna of the Murmansk Province (the Fennoscandian biogeographical provinces Kk and Lim) was studied during expeditions of the MSFU in 1972–1994 (Mozolevskaja & Sharapa 1996). More than 50,000 specimens were collected in the Murmansk Province during these field studies. Because *Hylastes* spp. were overrepresented in window traps in Karelia, the total figures do not reflect the exact species prevalence and the efforts to compile the bark beetle fauna. More importantly, a specialized search for bark beetles was performed in all regions.

The list and distribution maps of the bark beetles of Estonia were completed on the basis of more than 16,000 collection specimens and by collecting insects from nearly all squares of 10x10 km of the country (Voolma *et al.* 2000, Fig. 2).

The collections of the authors` institutions, and those of the Zoological Institute of Russian Academy of Sciences, St. Petersburg (ZISP) and the Moscow Zoological Museum (MZM) were examined for obtaining additional information about species distribution in the region. Old references on the occurrence of bark beetles in the region were re-evaluated. The nomenclature of bark beetles used in this paper follows Silfverberg (1992), with some additions by Pfeffer (1994) and Bright & Skidmore (2002).

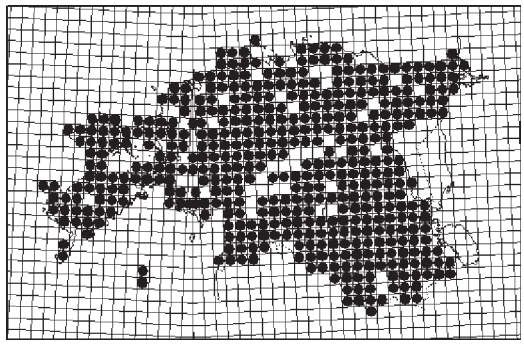

Fig. 2. Locality records of Scolytidae according to the UTM squares of 10 × 10 km in Estonia.

3. Results

Data on the distribution of bark beetles in Estonia (Voolma *et al.* 2000), in the Leningrad Province of Russia (Mandelshtam & Popovichev 2000), in Southern Karelia (Yakovlev *et al.* 1986, Mosolevskaja *et al.* 1991), in Northern Karelia (Mozolevskaja & Sharapa 1996, Yakovlev, 1996, Yakovlev *et al.* 2000), and in the Murmansk Province (Mozolevskaja & Sharapa 1996) were re-checked and supplemented with new records by the authors. Altogether 83 species of bark beetles were recorded from Estonia, Finland and North-Western Russia including Karelia, the Murmansk and Leningrad provinces. Table 1 presents a list of bark beetles known from Finland, Estonia and North-Western Russia with their occurrence according to biogeographical provinces of Eastern Fennoscandia.

The following 30 species occurred in all studied regions: *Hylurgops glabratus*, *H. palliatus*, *Hylastes brunneus*, *H. cunicularius*, *Xylechinus pilosus*, *Tomicus minor*, *T. piniperda*, *Dendroctonus micans*, *Phloeotribus spinulosus*, *Polygraphus poligraphus*, *P. subopacus*, *P. punctifrons*, *Scolytus ratzeburgi*, *Pityogenes bidentatus*, *P. chalcographus*, *P. quadridens*, *Orthotomicus laricis*, *O. proximus*, *Ips acuminatus*, *I. sexdentatus*, *I. typographus*, *Dryocoetes*

Table 1. Bark beetles (Coleoptera, Scolytidae) known from Finland, Estonia and North-Western Russia [Leningrad (St. Petersburg) Province, Karelia and Murmansk Province], with their occurrence in some biogeographical provinces of Fennoscandia. Abbreviations: Fin = Finland, Est = Estonia, St. Ptb – Leningrad (St. Petersburg) province, Ik, Kl, Kon, Ks, Kk, Lim – biogeographical provinces of Fennoscandia in Russian Karelia, and Mur = Murmansk province of Russia. (+) = records that were not verified with labelled collection specimens and thus not checked by the authors; (1) = unique records; /+/ = records near province borders, and i = introduced with imported timber.

Species	Fin	Est	St. Ptb	Russian Karelia					Mur
				Ik	Kl	Kon	Ks	Kk	Lim
Hylurgops glabratus (Zett.)	+	+	+	+	+	+	+	+	+
H. palliatus (Gyll.)	+	+	+	+	+	+	+	+	+
Hylastes brunneus Er.	+	+	+	+	+	+	+	+	+
H. cunicularius Er.	+	+	+	+	+	+	+	+	+
H. angustatus (Hbst.)	–	(+)	–	–	–	–	–	–	–
H. attenuatus Er.	–	(1)	–	–	–	–	–	–	–
H. opacus Er.	+	+	+	+	–	+	–	+	+
H. plumbeus Blandf.	–	–	+	+	–	–	–	–	–
Hylesinus crenatus (F.)	+	+	+	–	–	–	–	–	–
H. fraxini (Panz.)	+	+	+	–	–	–	–	–	–
H. varius (F.)	(1)	+	–	–	–	–	–	–	–
Xylechinus pilosus (Ratz.)	+	+	+	+	+	+	+	+	+
Hylurgus ligniperda (F.)	–	+	+	–	–	–	–	–	(1)
Tomicus minor (Htg.)	+	+	+	+	+	+	+	+	+
T. piniperda (L.)	+	+	+	+	+	+	+	+	+
Dendroctonus micans (Kug.)	+	+	+	+	+	+	+	+	+
Phloeotribus spinulosus (Rey)	+	+	+	+	+	+	+	+	+
Polygraphus subopacus (Thoms.)	+	+	+	+	+	+	+	+	+
P. poligraphus (L.)	+	+	+	+	+	+	+	+	+
P. punctifrons Thoms.	+	+	+	+	+	+	+	+	+
Carphoborus cholodkovskyi Spess.	+	+	+	–	–	+	–	+	+
C. rossicus Sem.	+	–	+	–	–	+	–	+	+
C. minimus (F.)	(1)	–	(1)	–	–	–	–	–	–
C. teplouchovi Spess.	–	–	–	–	–	–	–	+	+
Scolytus multistriatus (Marsh.)	–	+	+	–	–	–	–	–	–
S. scolytus (F.)	–	+	+	–	–	–	–	–	–
S. triarmatus (Egg.)	–	+	–	–	–	–	–	–	–
S. ratzeburgi Jans.	+	+	+	+	+	+	+	+	+
S. laevis Chap.	–	+	+	–	–	–	–	–	–
S. mali (Bechst.)	+	+	+	–	–	–	–	–	–
S. intricatus (Ratz.)	+	+	+	+	–	–	–	–	–
S. carpini (Ratz.)	–	(+)	–	–	–	–	–	–	–
S. morawitzi Sem.	–	–	–	–	–	–	–	–	+
S. rugulosus (Ratz.)	+	+	+	–	+	–	–	–	–
Pityogenes chalcographus (L.)	+	+	+	+	+	+	+	+	+
P. irkutensis Egg.	+	–	+	–	–	+	/+/	+	+
P. saalasi Egg.	+	–	(+)	–	–	–	+	+	+
P. trepanatus (Nördl.)	+	+	+	+	–	–	–	–	–
P. quadridens (Htg.)	+	+	+	+	+	+	+	+	+
P. bidentatus (Hbst.)	+	+	+	+	+	+	+	+	+
Orthotomicus longicollis (Gyll.)	+	+	+	–	–	+	–	–	–
O. starki Spess.	–	–	+	–	–	–	–	+	+
O. proximus (Eichh.)	+	+	+	+	+	+	+	+	+
O. suturalis (Gyll.)	+	+	+	+	–	+	+	+	+
O. laricis (F.)	+	+	+	+	+	+	+	+	+
Ips acuminatus (Gyll.)	+	+	+	+	+	+	+	+	+
I. sexdentatus (Börn.)	+	+	+	+	+	+	+	+	+

I. duplicatus (Sahlb.)	+	+	+	+	+	+	–	+	+
I. typographus (L.)	+	+	+	+	+	+	+	+	+
I. amitinus (Eichh.)	+	+	+	+	+	+	+	+	–
I. cembrae (Heer)	–	–	+	–	–	–	–	–	+
I. subelongatus Motsch.	i	i	–	–	–	–	–	–	–
Lymantor coryli (Perris)	+	+	+	–	–	–	–	–	+
Dryocoetes baikalicus Reitt.	–	–	–	–	–	–	–	–	+
D. alni (Georg)	+	+	+	+	+	+	/+/	+	+
D. autographus (Ratz.)	+	+	+	+	+	+	+	+	+
D. hectographus Reitt.	+	+	+	+	+	+	+	+	+
Crypturgus subcribrosus Egg.	+	+							
C. cinereus (Hbst.)	+	+	+	+	+	+	+	+	+
C. pusillus (Gyll.)	+	+	+	+	+	+	+	+	+
C. hispidulus Thoms.	+	+	+	+	+	+	+	+	+
Trypodendron domesticum (L.)	+	+	+	/+/	+	–	–	–	–
Tr. laeve Egg.	+	+	+	+	+	+	+	+	–
Tr. lineatum (Oliv.)	+	+	+	+	+	+	+	+	+
Tr. signatum (F.)	+	+	+	+	+	+	+	+	+
Xyleborus dispar (F.)	+	+	+	/+/	+	–	–	–	+
X. cryptographus (Ratz.)	+	+	+	/+/	+	+	–	–	+
X. monographus (F.)	–	(+)	(+)	–	–	–	–	–	–
Trypophloeus alni (Lind.)	+	+	+	+	–	–	–	–	+
T. bispinulus Egg.	+	+	+	–	+	–	/+/	+	–
T. asperatus (Gyll.)	+	+	+	–	+	–	–	+	+
T. discedens Palm	+	+	–	–	–	–	–	–	–
Ernoporicus caucasicus (Lind.)	(1)	–	–	–	–	–	–	–	–
Ernoporus tiliae (Panz.)	+	+	+	–	–	–	–	–	–
Cryphalus abietis (Ratz.)	+	+	+	+	–	–	–	–	–
C. saltuarius Weise	+	+	+	+	+	+	+	+	+
Pityophthorus micrographus (L.)	+	+	+	+	+	+	+	+	+
P. lichtensteinii (Ratz.)	+	+	+	+	+	+	/+/	+	+
P. morosovi Spess.	–	+	+	–	–	–	–	+	+
P. glabratus Eichh.	+	(+)	(1)	–	–	(+)	–	–	–
P. traegardhi Spess.	+	+	+	–	–	+	+	–	+
P. lapponicus Stark	–	–	–	–	–	–	–	–	(+)
Gnathotrichus materiarius (Fitch)	i	–	–	–	–	–	–	–	–

hectographus, *D. autographus*, *Crypturgus cinereus*, *C. hispidulus*, *C. pusillus*, *Trypodendron lineatum*, *T. signatum*, *Cryphalus saltuarius*, and *Pityophthorus micrographus*.

Ernoporicus caucasicus was recorded only in Southern Finland, and *Hylastes attenuatus* and *Scolytus triarmatus* were found only in Estonia. All these three species were reported once from each country. *Hylastes obscurus* was reported only from the Leningrad Province including Isthmus Karelicus (Ik). *Carphoborus teplouchovi* was reported only from the Kandalaksha Nature Reserve (Kk) and from the Chibiny Mountains, Kola Peninsula in the Murmansk province (Lim) (Mozolevskaya & Sharapa 1996). *Scolytus morawitzi*, *Dryocoetes baikalicus* and *Pityophthorus lapponicus* were found only in the Chibiny Mountains.

Hylesinus varius was found only in Southern Finland and Estonia, whereas *Scolytus mali* was recorded in Southern Finland, Estonia and in the Leningrad Province. The following five species were recorded only from Estonia and from the Leningrad Province (excluding Ik and Kl): *Hylurgus ligniperda*, *Scolytus scolytus*, *S. laevis*, *S. multistriatus*.

The records of *X. monographus* and *Hylastes angustatus* from Estonia, and the records of *X. monographus* and *Hylurgus ligniperda* from the Leningrad Province, were derived from references only and could not be checked by verifying with the available collection specimens.

Hylastes ater, *Hylesinus oleiperda* and *Xyleborinus saxesenii,* which all have been reported in some earlier references, do probably not have viable, permanent populations in the region.

4. Discussion

Several papers published since Saalas (1917, 1923, 1931) have added some new information to the Finnish and its separate provinces' scolytid fauna (e.g. Nuorteva 1955, 1963, 1971, Koponen 1975, 1980, Muona & Viramo 1986, Muona 1990, 1994, Sippola *et al.* 1995, Viramo 1996, Rutanen & Kashevarov 1997, Martikainen *et al.* 1999, Martikainen 2000, 2001). At the same time, the previous lists of the bark beetles of Estonia (Zolk 1932, Rubel 1964) were revised and supplemented by Voolma *et al.* (1996, 1997b, 1998, 2000). The list of bark beetles of the Leningrad Province (Gornostaev 1917) was significantly extended by Mandelshtam & Popovichev (2000). Papers on Southern Karelia, published since Titova (1959), have given much new information on the fauna of this region (Yakovlev *et al.* 1986, Mozolevskaja *et al.* 1991). Although the North Karelian fauna of Scolytidae has so far been poorly studied, it has recently caught the attention of researchers (Yakovlev *et al.* 2000). By now, the bark beetles of this region are relatively well known. The insect fauna of the Murmansk province, first investigated by V. N. Stark (Nestertschuk 1930, Stark 1930), was reviewed by Mozolevskaya & Sharapa (1996). All the mentioned papers have added new species to the regional faunas, and a comparative analysis of the present distribution of scolytids is required.

An example of a useful comparative approach in the case of neighbouring countries is the monitoring of continuously expanded range of *Ips amitinus*. First recorded by Mikutowicz (1905) in Estonia, and studied further in detail in Finland (Nuorteva 1955, Koponen 1975, 1980), it was later detected in North-Western Russia (Mandelshtam 1999). The revision of the authors' collections has allowed to report new findings of the species in the easternmost parts of the Leningrad Province (Mandelshtam & Popovichev 2000), in the Kivach Nature Reserve (*Kon*), in Northern Karelia (Paanajärvi National Park, Ks and Kk, Päozero areas, and Sredny Island and adjacent mainland territories, Kk, Loukhi region of Karelia). *I. amitinus* was also reported by Muona and Viramo (1986) in the province Ks in Finland. However, in the collections of T. V. Sharapa, a specimen originated on pine from the Murmansk province, Kk (Kandalaksha Nature Reserve, 27 July 1989). The last finding gave a new evidence of the ongoing expansion of the range of *I. amitinus*. Now the species occurs even beyond the Polar Circle. In 2000, E. Yakovlev reported a new finding of *I. amitinus* from the Pudozh region (Kton), indicating that the distribution range of *I. amitinus* has expanded not only northward, but also eastward. Interestingly enough, the enlargement of the range of *I. amitinus* does not occur in the south-eastern directions and the species is still absent in the Moscow province (Nikitsky *et al.* 1996, 1998, Petrov & Nikitskii 2001).

For *I. amitinus,* the most likely route of the contemporary colonization of Finland was established through Estonia and the Leningrad Province, bypassing the Gulf of Finland (Mandelshtam 1999). However, Lekander *et al*. (1977) suggested a different contemporary route of colonization in Finland for *Cryphalus abietis* Ratz.. Lekander *et al.* (1977) have referred that *C. abietis,* recorded only in the South-Western Finland, was introduced to Finland after an artificial regeneration of spruce stands in Denmark via Sweden, the Åland Archipelago and the Gulf of Bothnia. The distribution data on the occurrence of *C. abietis* throughout Estonia, and in the marine parts of the Leningrad province, that was not taken into account by Lekander *et al.* (1977), might support the existence of another route. Indeed, both *C. abietis* and *C. saltuarius* Weise can be found in the southern part of the former territory of Finland (Mesterjärvi, Ik), and even in Viipuri (Vyborg, Ka). *C. abietis* is quite common already in the Southern Isthmus Karelicus (Morskaya railway station, near St. Petersburg). Nevertheless, in the area of Virolahti (Ka), only *C. saltuarius* has been encountered (Nuorteva 1963), but the presence of *C. abietis* in Viipuri (park "Mon Repos") suggests that both *C. abietis* and *C. saltuarius* occur in the province Ka. Thus, it appears that the "southern" species *C. abietis*, restricted to the warmest coastal regions of Ik, Ka and Southern Finland, could enter Finland simply from the neighbouring territories of Russia, and therefore the proposed route through the Gulf of Bothnia seems unnecessarily complicated. We suggest that the route of *C. abietis* to Finland was probably the same as that of the Norway spruce (Moe 1970) and spruce-inhabiting *I. amitinus*,

i.e. bypassing the Gulf of Finland. However, *C. abietis* appeared in Finland much earlier, probably during one of the warm periods of post-glaciation era. The current range of *C. abietis* in the region is probably restricted to South-Western Finland, whole Estonia, the Southern Isthmus Karelicus and the south-western parts of the Leningrad Province. No documented evidence was found on the breeding of *C. abietis* in the Murmansk Province or Northern Karelia (Mozolevskaya & Sharapa 1996, Muona & Viramo 1986, Yakovlev 1996, Yakovlev *et al.* 2000), and only *C. saltuarius* from the Murmansk Province was found in the collections of Stark and V. A. Lipatkin, and from Northern Karelia (Ks and Kk) in the authors` collections.

The revision of Estonian (Voolma *et al.* 1996, 1997a) and Russian insect collections (Mandelshtam & Popovichev 2000, Yakovlev *et al.* 2000) has allowed to exclude *Hylastes ater* Pk. from the regional faunal lists for Estonia, the Leningrad province and Karelia. Seemingly, permanent populations in Finland do not occur either (Heliövaara *et al.* 1998). In Northern Europe, *H. brunneus* Er. (= *H. aterrimus* Egg.) completely substitutes for *H. ater*. The northern border of the distribution of *H. ater* in the Baltic countries and Russia is not clear. No documented evidence, based on collection specimens, is available on the breeding of *H. ater* in the Murmansk Province. However, numerous specimens of *H. brunneus* from the Kola Peninsula and Northern Karelia are preserved in the collections of V. N. Stark (ZISP), T. V. Sharapa, V. A. Lipatkin and A. N. Shcherbakov (MSFU), as well as M. J. Mandelshtam. The northernmost border of the distribution of *H. ater* in the Baltic countries crosses Latvia (Telnov *et al.* 1997) and the Moscow Province in Russia (Nikitsky *et al.* 1996, Petrov & Nikitskii 2001). Thanks to the courtesy of N. B. Nikitsky (MZM), we could study the extensive collections from the Moscow Province, collected using window traps. Unfortunately, we did not find *H. ater*; only one specimen of this species was found in the B. Sokanovsky`s collection (MZM) from the Moscow Province.

In contrast to *H. ater* and *Hylastes angustatus* Herbst, which should both be removed from the previous lists of bark beetles for North-Western Russia (Yakovlev *et al.* 1986, Mozolevskaya & Sharapa 1996, Mandelshtam & Popovichev 2000), *Hylastes opacus* Er. really breeds much further north in Karelia than reported by Lekander *et al.* (1977). *H. opacus*, previously reported from south of the 65th parallel (Lekander *et al.* 1977), was found in the provinces Kk and Lim, north of the Polar Circle.

Several other examples of "southern" bark beetles breeding in Karelia were verified. *Orthotomicus longicollis* Gyll., recorded from St. Petersburg (Stark 1952, Mandelshtam & Popovichev 2000) has successfully bred in pine stands of the Kivach Nature Reserve, Kon, for many years (Mozolevskaja *et al.* 1991). *O. longicollis* was first found in Karelia by researchers from MSFU (Mozolevskaja *et al.* 1991) and was later reported from Karelia (Siitonen *et al.* 1996).

Of special interest is the finding of *Lymantor coryli* Perr. on *Sorbus aucuparia* on the Kola Peninsula (Nestertschuk 1930, Mozolevskaya & Sharapa 1996). This rare species has not yet been found in Karelia, but it breeds in *Prunus padus* in the Leningrad Province (Mandelshtam & Popovichev 2000) and in *Frangula alnus* in Estonia (Voolma *et al.* 1997b, Süda 2001).

Xyleborus dispar F., known to breed in Fennoscandia mainly in the areas with high summer temperature (mean temperature in July +16° C or more) (Lekander *et al.* 1977), was reported far north from the Kola Peninsula (Stark 1930, 1952, Mozolevskaya & Sharapa 1996).

Pityogenes trepanatus Noerdl., whose distribution in Finland is restricted to the south-western regions (Lekander *et al.* 1977) and has only occasionally been found in Northern Finland (Lekander *et al.* 1977) and Sweden (Lundberg 1995), was recently discovered in the Leningrad Province (Lebyazhye, southern coast of the Gulf of Finland) and in Petjajärvi (Ik) (Mandelshtam & Popovichev 2000). Interestingly, one of the findings of *P. trepanatus* in the Leningrad Province (Lebyazhye) and almost all records in Estonia (Voolma *et al.* 2000) are restricted to the coast.

None of the *Scolytus* species breeding on Ulmaceae were found in Finland or Karelia, despite *Ulmus* trees occurring in Finland and in the Kon province of Karelia (e.g. in Kizhi). The northernmost records of *S. scolytus* F. in Europe have been St. Petersburg city parks, the railway station of Sablino (south of St. Petersburg; Tosno

district, Leningrad Province), and the Island of Abruka in Estonia (Voolma *et al.* 1998, Voolma, Süda 1999). It should be mentioned that in Sweden *S. scolytus* has been completely replaced by the related species *S. triarmatus* (Egg.), which was reported from Sweden even farther north, compared with *S. scolytus* in Estonia (Lundberg 1995). Recently, *S. triarmatus* has been collected from an elm tree in Southern Estonia (leg./det. I. Süda). The northernmost European finding of *S. multistriatus* Marsh. has been recorded from a park in St. Petersburg (Mandelshtam & Popovichev 2000). *S. laevis* Chap. was also found in Northern Estonia (Voolma *et al.* 2000) and in the central parts of the Leningrad Province (Zhikharevo, River Lava canyon, southern shore of Lake Ladoga) (Mandelshtam & Popovichev 2000). However, *S. laevis* has been found much farther north in Sweden and Norway (Lekander *et al.* 1977). Until now, findings of *Scolytus* species, at least those of *S. laevis*, can be expected from Finland in areas where *Ulmus glabra* and *U. laevis* still grow.

Of special interest are the findings of the "northern" species of Scolytidae. *Ips sexdentatus* Börner was earlier common throughout Sweden and Finland, but there have been only a few findings in Southern Finland in the 1970s, probably attributed to an accidental introduction (Löyttyniemi 1975, Lekander *et al.* 1977). In recent decades, *I. sexdentatus* has also become rare in Sweden and is now included in the national Red List (Gärdenfors 2000). However, several recent findings of *I. sexdentatus* on the former Finnish territory (Leningrad Province) were reported during the last two decades from the vicinity of Lake Vysokinskoe (Ka) and Zelenogorsk (Terijoki, Ik). Although the species can be found throughout the province, it is not frequent there. In mature pine stands of Zelenogorsk, suitable for the breeding of *I. sexdentatus*, the species was recorded only once during the 16 years of monitoring. In Estonia, *I. sexdentatus* occurs throughout the country but is not numerous, and the records have become more scarce during recent years. *I. sexdentatus* occurs uniformly but infrequently in Karelia. However, *I. sexdentatus* cannot be considered a truly "northern" species, because it is distributed also in central and Southern Europe (Konca 1995, Rener & Maja 2001). Also, mass outbreaks of *I. sexdentatus* have occurred in Turkey (Schönherr *et al.* 1983) and it has infested pine trees even in Thailand (Browne 1972).

I. acuminatus was relatively common in St. Petersburg and in adjacent areas in the beginning of 1900's (Gornostaev 1917), but occurs now only sporadically there. The decline of *I. sexdentatus* and *I. acuminatus* Gyll. populations in the region cannot be solely explained by logging the big old-growth pines, but it may also be due to other reasons. The disappearance of *I. sexdentatus* from Southern Finland is discussed in relation to temperature and competition with *Tomicus piniperda* (L.) (Löyttyniemi 1975). The latter aspect has also been highlighted by Mandelshtam and Selikhovkin (2003) concerning *I. sexdentatus* in the Leningrad and Pskov regions of Russia.

Pityogenes saalasi Egg., described from the Kuusamo district (Ks), is still rather common in this region (Paanajärvi) and in the Monchegorsk district (Murmansk Province, Lim), but it has not been encountered in the Leningrad Province after Stark (1952). *Pityophthorus traegardhi* Spess., another "northern" species, was collected by the authors not only in the Murmansk Province, but also in the Kivach Nature Reserve (Kon) in Karelia and in the Leningrad Province, south of St. Petersburg.

Trypophloeus alni Lind., a rare species in Finland, has been found in the southern parts of province Ik (River Sestra) (Mandelshtam & Popovichev 1999) and on the Kola Peninsula, Murmansk Province (Stark 1930). *Trypophloeus bispinulus* Egg. was recently reported for the first time in Karelia (Kk, Paanajärvi, Päozero environs, Loukhi region, 8 August 1998; collected by A. N. Shcherbakov) (Yakovlev *et al.* 2000).

Pityophthorus lapponicus Stark,1952 was considered having a disjunctive distribution range. The species was reported from the Chibiny Mountains in North-Western Russia, and from the Primorsk Territory, Far-Eastern Russia (Stark 1952). Stark (1930) was the first to mention a new *Pityopthorus* species from Chibiny, Lapland, and presented it later with a description of a new species, *P. lapponicus* (Stark 1952). Kurenzov (1941) has described *P. lapponicus* from the Far East, referring to the Stark's manuscript of "The Fauna of the USSR". Because we have failed to

find Stark's syntypes, supposedly preserved in ZISP, we had no possibility to confirm the identity of the specimens from Lapland and Primorsk. These may well represent different species, as all specimens from MSFU, determined as *P. lapponicus*, actually belong to *P. traegardhi*, and there have been no other recent findings of the species on the Kola Peninsula.

The distribution of *Trypodendron laeve* Egg. (= *Tr. piceum* Strand, *nec Tr. proximum* Niij.) in the northern regions was unclear for a long time, owing to the fact that it was confused with *Tr. lineatum* Ol. Recent reports by Muona (1990, 1994) support the suggested occurrence of the species including Northern Finland (Ks), Southern Finland and Russia (Kl, Ik, Kon), supplemented by the new findings from the Keret Archipelago (Kk), Leningrad Province (Ik and the territories around the Isthmus Karelicus) and Estonia (Voolma 1996, Voolma *et al.* 2000). Thus, *Tr. laeve* may be distributed throughout the whole studied region. The cotypes of *Tr. laeve* from the Natural History Museum, Vienna, Austria, have been studied and found to be distinct from *Tr. proximum* Niij. (Mandelshtam & Popovichev 2000). The types of *Tr. laeve* originate from Japan, suggesting a Transpalaearctic distribution. The male genitalia, useful for determination of *Trypodendron* species, have been found identical in the type specimens from Japan and in specimens from Northern Karelia.

Among the species rare in Finland (Kotiranta *et al.* 1998), several were found in Estonia and North-Western Russia. *Xyleborus cryptographus* Ratz. is common in Estonia and in the Leningrad Province where it is even abundant in some places, e.g. Kuznechnoye, Kl. *X. cryptographus* has repeatedly been reported from the Murmansk province (Stark 1930, 1952, Mozolevskaya & Sharapa 1996). Due to the wide distribution and frequent occurrence, this species cannot be referred to as requiring protection in Russia. *Carphoborus minimus* F. is considered critically endangered (and, in fact, extinct in Finland) and it has not been found in the St. Petersburg areas either (Mandelshtam & Popovichev 2000). However, one old specimen from St. Petersburg is preserved in B. Sokanovsky`s collection (MZM).

Crypturgus subcribrosus Eggers has been treated as a variety and a synonymy of *C. cinereus* (Herbst) in Russia (Mandelshtam & Popovichev 2000) and also in Central Europe (Postner 1974, Pfeffer 1994). However, according to Stark (1952), Lekander *et al.* (1977), Silfverberg (1992) and Lundberg (1995), they belong to a clearly distinguishable, separate species (Õunap 1996, Heliövaara *et al.* 1998).

Ips cembrae (Heer) and *I. subelongatus* Motschulsky infest various species of *Larix* in Europe and Asia. These putative species are distinguished by their host tree and geographic distribution, as it is not possible to distinguish them on the basis of morphological differences (Stauffer *et al.* 2001). According to many authors (e.g. Postner 1974, Pfeffer 1994), *I. subelongatus* is treated as a synonym of *I. cembrae*. However, recent DNA studies suggest that the *I. cembrae*-complex contains at least two taxa: *I. cembrae* infesting larch in Europe, and *I. subelongatus* infesting larch in Asia (Stauffer *et al.* 2001). In the region of the present study, the larch bark beetles (*Ips cembrae* or *I. subelongatus*) were not found in *Larix*, but they were instead recorded from spruce in St. Petersburg (Mandelshtam & Popovichev 2000) and from pine in the Murmansk Province (Nestertschuk 1930, Stark 1930, Mozolevskaya & Sharapa 1996). *I. subelongatus* has been imported to Finland on roundwood from Siberia (Siitonen 1990, 2000). The species has also been found in timber imported to Estonia from Russia. Because of the lack of molecular genetic data, it is unclear whether it was the western *I. cembrae* or the eastern *I. subelongatus* that was recorded in St. Petersburg and in Kola Peninsula.

Besides qualitative changes in the species lists for the northern and southern parts of the region, there are also differences in the relative abundance of many species in different provinces. For example, *Hylurgops glabratus* Zett. has significantly substituted for *I. typographus* L. in Northern Karelia (Paanajärvi). *H. glabratus* has become a much more common species already in the northern and especially in the eastern parts of the Leningrad Province compared with its southern parts.

However, with the present study our aim was to compare only the species lists of different regions. The comparison allowed us to redefine the contemporary distribution range of nine European bark beetle species: *Scolytus scolytus*, *S.*

multistriatus, *S. laevis*, *Hylastes ater*, *H. opacus*, *Orthotomicus longicollis*, *Pityogenes trepanatus*, *Ips amitinus* and *Cryphalus abietis.*

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