

DISTRIBUTION OF STONEFLIES (INSECTA: PLECOPTERA) IN ESTONIA

Henn TIMM

Institute of Zoology and Botany, Estonian Agricultural University, Võrtsjärv Limnological Station, 61101 Rannu, Tartumaa, Estonia; htimm@zbi.ee

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Abstract. Twenty-two species of stoneflies belonging to five families were found in more than 1200 samples (mainly from 1985–99). Six of them were recorded for the first time in Estonia. The majority of the species inhabited only running waters and preferred moderate or fast flow, and stony or gravelly bottom, water moss, or twigs as a substrate. The commonest species were *Nemoura cinerea* (the only species occurring also on western islands), *Isoperla grammatica*, *Taeniopteryx nebulosa*, *Leuctra digitata*, and *Nemurella pictetii*. Most of the Estonian species are common in neighbouring areas. *Diura nanseni* is of northern and *Perlodes microcephala* of southern distribution. As occurrence of stoneflies always indicates high or very high water quality, the knowledge on their presence or absence in different regions of the country is necessary in environmental monitoring.

Key words: Plecoptera, Estonia, fauna, distribution.

INTRODUCTION

Stoneflies are almost worldwide in distribution, occurring from the tropics to polar areas. The highest species diversity is found in temperate zones. There exist more than 1700 species of stoneflies (Brittain & Saltveit, 1996). Stonefly larvae live in running waters and in the littoral of oxygen-rich lakes. In Estonia, they are found in streams, rivers, and springs. North European Plecoptera are well studied by Brinck (1949) and Lillehammer (1988). Zhil'tsova (1966, 1977) described Russian species. Because stoneflies are very sensitive to different kinds of pollution, they are widely used as bioindicators (Rosenberg & Resh, 1993).

The body of both the imago and the larva is flattened dorso-ventrally, the antennae being long and filiform. Adult stoneflies cannot fly long distances, and their ability to cross natural barriers is thus limited. They drink water; some species eat algae before egg-laying. The life-span of adults lasts from some days

to weeks. Eggs require about 250 to 800 day degrees for development in water (Brittain & Saltveit, 1996).

The larvae differ from other bottom animals in two segmented hairlike abdominal cerci, which form always at least one-third of total head and body length. Active larval development often occurs in winter months with near-zero temperature. Most larvae inhabit stony or gravelly bottom; few occur on sand sediment. The larvae moult 12–33 times before metamorphosis. They feed on leaf detritus, moss, and algae, or on other insects (in Estonia, only Perlodidae and Chloroperlidae are predators).

The order Plecoptera has remained one of the most insufficiently studied insect groups in Estonia. Haberman (1934) presented four plecopteran taxa from the upper reach of the Ahja Stream (South Estonia): *Nemoura cinerea*, *Nephelopteryx* (= *Taeniopteryx*) sp., *Isoperla grammatica*, and *Isogenus nubecula*. Adults of *Nemoura cinerea* were found in western Estonia (Vilbaste, 1985). Haberman (1955) presumed the occurrence of ca 40 species of Plecoptera in Estonia; the number suggested by Maavara (1956), Voore (1961), and Remm (1966) is smaller, 30. Brief faunistic notes have been presented earlier by the author (Timm, 1994). Relationships between some plecopteran taxa and environmental parameters have also been discussed (Timm, 1997).

MATERIAL AND METHODS

Qualitative handnet samples (total 1187), combined with hand-picking, were collected by the author in 1985–99. In addition, 171 samples from 1958–99 were obtained from Tarmo Timm, Ado Seire (both from the Institute of Zoology and Botany), Margo Hurt (Võru County Government), and Kristiina Mardi (University of Tartu). The majority of the samples were collected from April to June (mostly in May), and from August to October. Plecopteran larvae were fixed in 70% alcohol. Magnification used for identification was $\times 4$ –40. Keys by Lillehammer (1988), Zhil'tsova (1977), and Hynes (1977) were used for identification. Fieldwork in 1999 (135 samples) was financed by the Estonian Science Foundation (grant No. 3692).

RESULTS

Altogether, 22 species of Plecoptera were found (Table 1). Only 16 species had been recorded earlier (Timm, 1994). After identification of new samples and revision of old material in 1999, six species new for Estonia (*Amphinemura borealis*, *Leuctra fusca*, *L. nigra*, *Brachyptera risi*, *Diura nanseni*, and *Isoptena serricornis*) were found. One individual of *Leuctra* sp. had been misidentified as *Capnia bifrons* (Newman) in 1988. According to Zhil'tsova (1966), *C. bifrons*

occurs both northeast (Leningrad Region) and south (Lithuania) of Estonia; thus its presence in Estonia is possible but has not been confirmed. In Timm (1994), part of *A. borealis* was erroneously determined as *A. standfussi*; some specimens of *L. fusca* were confused with *L. digitata*. Two species (*I. nubecula* and *I. serricornis*) are so far represented by single records only. Zhil'tsova (1966) considered *I. nubecula* a common species in the Neva River and had also one record from the northeastern part of Estonia. The only specimen of *I. serricornis* was caught by M. Hurt in 1998 (the Peeli Stream in Võru County).

Table 1. List of Estonian stonefly species. ERDB – the Estonian Red Data Book (Timm, 1998)

Taxon	Number of records	ERDB (1998) category	Potential candidates for ERDB	Recorded also by Timm (1994)
Order: Plecoptera	850			
Family: Nemouridae	514			
<i>Amphinemura borealis</i> (Morton)	17			
<i>A. standfussi</i> (Ris)	13			+
<i>Nemoura avicularis</i> Morton	3	5		+
<i>N. cinerea</i> (Retzius)	379			+
<i>N. dubitans</i> Morton	11			+
<i>N. flexuosa</i> Aubert	3	5		+
<i>Nemurella pictetii</i> Klapálek	30			+
Family: Taeniopterygidae	57			
<i>Brachyptera risi</i> (Morton)	4		3	
<i>Taeniopteryx nebulosa</i> (Linnaeus)	51			+
Family: Leuctridae	94			
<i>Leuctra digitata</i> Kempny	45			+
<i>L. fusca</i> (Linnaeus)	6		4	
<i>L. hippopus</i> Kempny	17			+
<i>L. nigra</i> (Olivier)	4		4	
Family: Perlodidae	179			
<i>Diura bicaudata</i> (Linnaeus)	2		3	+
<i>D. nanseni</i> (Kempny)	4	3		
<i>Isogenus nubecula</i> Newman	1	3		
<i>Isoperla difformis</i> Klapálek	7	3		+
<i>I. grammatica</i> (Poda)	109			+
<i>Perlodes dispar</i> (Rambur)	9	3		+
<i>P. microcephala</i> (Pictet)	13	3		+
Family: Siphonoperlidae	6			
<i>Isoptena serricornis</i> (Pictet)	1		2	
<i>Siphonoperla burmeisteri</i> (Pictet)	3	3		+

Nine species (among them erroneously identified *C. bifrons*) were entered into the Estonian Red Data Book (Timm, 1998) (Table 1). In addition, five species (*Leuctra fusca*, *L. nigra*, *Brachyptera risi*, *D. bicaudata*, and *I. serricornis*) serve as candidates to be included in the Book as rare or endangered species, or as species with a limited known distribution.

The finding sites of the species recorded by the author are shown in Figs. 1–3.

In order to find more species of stoneflies in Estonia, sampling in late winter as well as identification of adults can be recommended.

Nemoura cinerea

N. cinerea formed the majority of specimens in the most abundant family Nemouridae (Table 1, Fig. 1). It was common and widespread even in running waters of the western islands (where no other plecopterans were found). Full-grown larvae occurred in spring, while young individuals were recorded in autumn. In Denmark, newborn larvae of *N. cinerea* appeared already in July to August (Bengtsson, 1984). In Estonia, *N. cinerea* was also very abundant in small streams starting from bogs, where it was accompanied by the isopod *Asellus aquaticus*. It inhabited even temporary ditches, but was never found in any bog-pools, and it avoided also very slow-flowing streams. In riffles with stony bottom and *Fontinalis* moss, *N. cinerea* was often replaced by other plecopterans (except on the western islands). In a few cases, the larvae were found even in floodplains (Emajõgi and Pärnu rivers), and once in a small Lake Arbi in Elva. The only plecopteran species known from Lithuanian lakes is *N. variegata* (= *cinerea*) (Kazlauskas, 1962).

Other Nemouridae

N. dubitans inhabited only permanent streams and was much less abundant than *N. cinerea* (Fig. 1). Young larvae of these two species were very difficult to distinguish. Like in the case of *N. cinerea*, full-grown larvae were found in springtime. *N. avicularis* and *N. flexuosa* preferred small streams. Their larvae were found in late autumn or early spring, much more seldom than those of the former species. Their “rarity” may be due to their early metamorphosis in late winter (before the usual sampling period).

Full-grown larvae of *Nemurella pictetii* often occurred in various running waters and springs of South and East Estonia, mainly in springtime (Fig. 1). The distribution of *Amphinemura* was quite similar, but many larvae were found in summer as well.

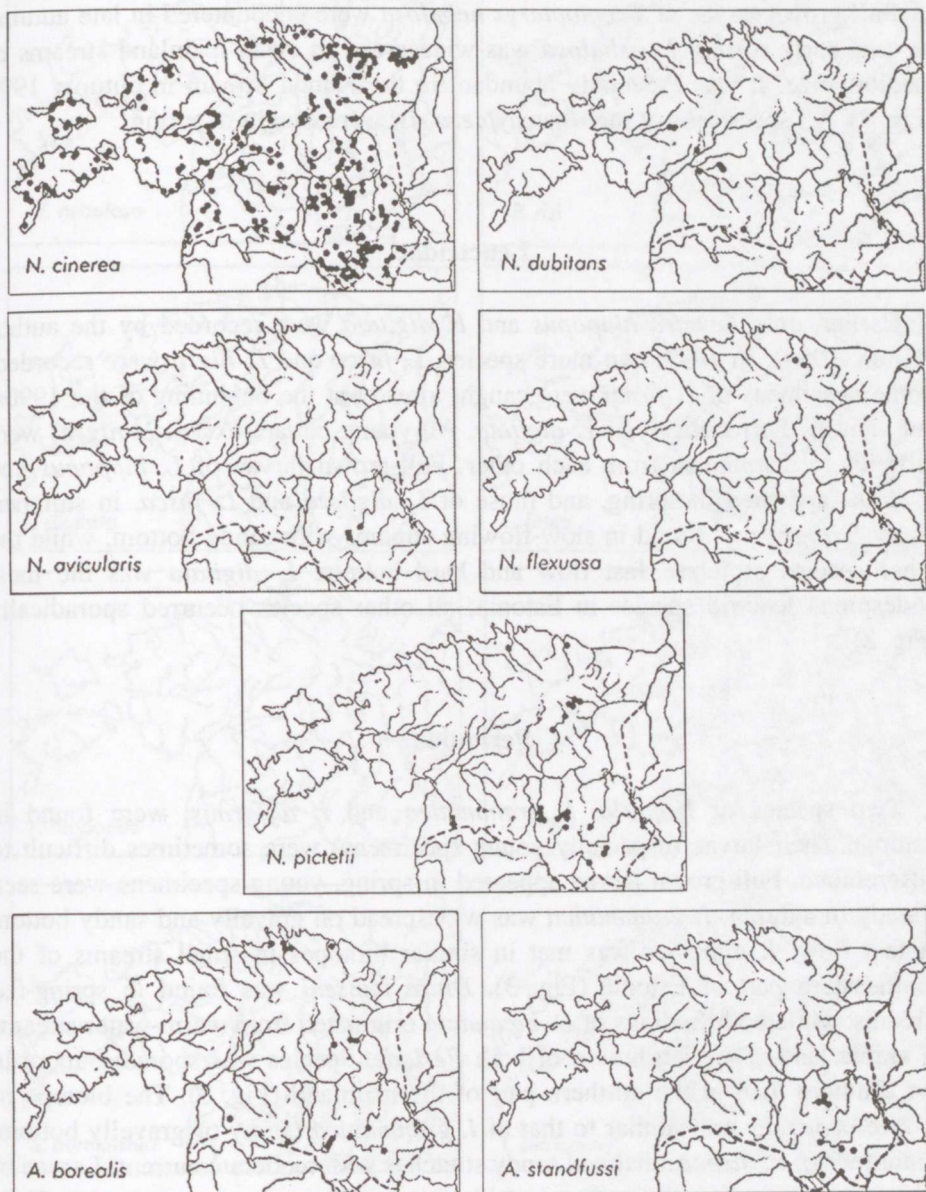


Fig. 1. Records of Estonian Nemouridae.

Taeniopterygidae

Full-grown larvae of *Taeniopteryx nebulosa* were encountered in late autumn or very early spring. *T. nebulosa* was widespread in clean mainland streams of medium size. It was especially abundant in the Kunda Stream in autumn 1998 (Fig. 2). All specimens of rare *Brachyptera risi* were caught in spring.

Leuctridae

Earlier, only *Leuctra hippopus* and *L. digitata* were recorded by the author (Timm, 1994). In 1999, two more species, *L. fusca* and *L. nigra* were recorded. Some specimens of *L. fusca* were caught already at the beginning of the 1990s, but identified erroneously as *L. digitata*. All young larvae (except *L. nigra*) were difficult to distinguish from each other. Full-grown larvae of *L. hippopus* and *L. nigra* appeared in spring, and those of *L. digitata* and *L. fusca*, in summer. Hairy *L. nigra* was found in slow-flowing streams with sandy bottom, while the other species preferred fast flow and hard bottom. *L. digitata* was the most widespread leuctrid species in Estonia; all other species occurred sporadically (Fig. 2).

Perlodidae

Two species of *Isoperla*, *I. grammatica* and *I. difformis*, were found in Estonia. Their larvae (especially young specimens) were sometimes difficult to differentiate. Full-grown larvae appeared in spring, young specimens were seen already in autumn. *I. grammatica* was widespread on gravelly and sandy bottom in fast flow; *I. difformis* was met in similar biotopes in small streams of the southeastern part of Estonia (Fig. 3). *Diura nanseni* was found in spring-fed streams, while both findings of *D. bicaudata* originated from warm-water streams in arable land. The distribution of both *Perlodes* species was sporadic, more in the southern than in the northern part of the mainland (Fig. 3). The biotope of *P. microcephala* was similar to that of *I. grammatica* (stony or gravelly bottom, water moss); *P. dispar* inhabited sandy stretches with moderate current. Larvae of this species were found crawling outside water on logs or stream margins. Full-grown larvae appeared in springtime. The only reliable record of *Isogenus nubecula* from the lower reaches of the Pärnu River in Estonia dates from 1999 (Fig. 3).

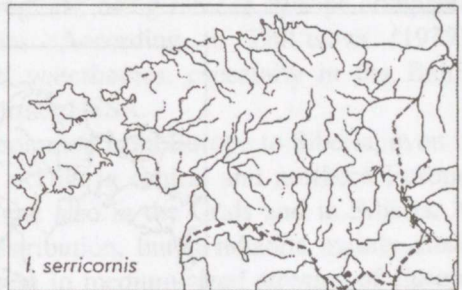
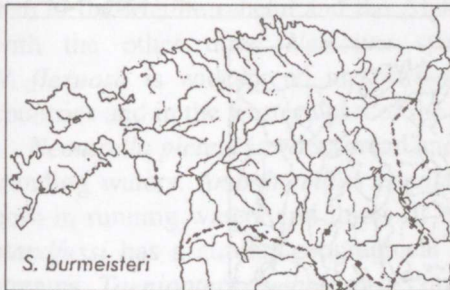
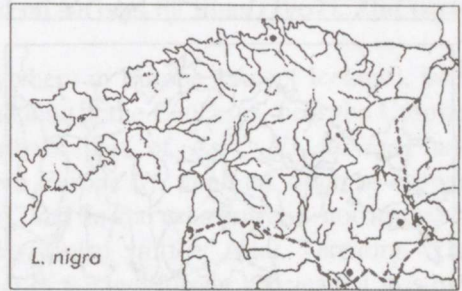
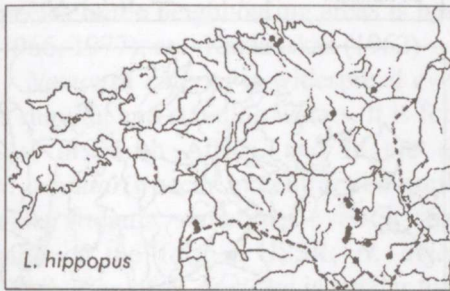
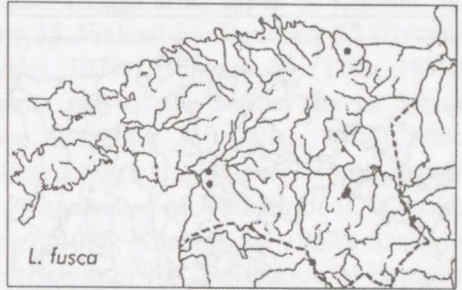
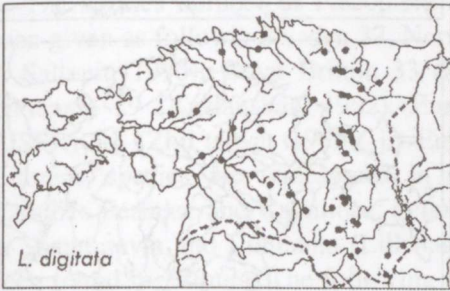
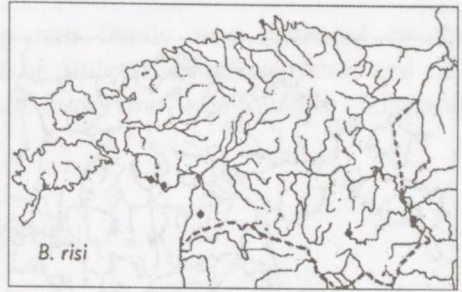
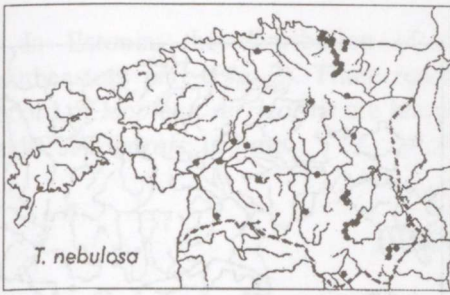


Fig. 2. Records of Estonian Taeniopterygidae, Leuctridae, and Siphonoperlidae.



Fig. 3. Records of Estonian Perlodidae.

Siphonoperlidae

In Estonia, the distribution of this rare family was restricted to the southeastern part (Fig. 2). Three records of *Siphonoperla burmeisteri* and one record of *Isoptena serricornis* are known. *S. burmeisteri* was found in springtime and *I. serricornis*, in June.

DISCUSSION

The species number of Plecoptera in the neighbouring areas of Estonia has been given as follows: Sweden 37, Norway 35, Finland 36, Denmark 25 (Brittain & Saltveit, 1996); Great Britain 33 (Hynes, 1977); Hungary 59 (Tóth, 1990), Lithuania 29 (Kazlauskas, 1962), European part of the former Soviet Union (USSR) 81 (Zhil'tsova, 1966); in Europe altogether 340 (Illies, 1967). Most Estonian species are widespread in other countries. However, some groups (families Perlidae and Capniidae; genus *Protonemura* of Nemouridae), common in Scandinavia and Lithuania (Lillehammer, 1988; Kazlauskas, 1962), have not been found in Estonia. The following description of the distribution of Estonian species in the neighbouring areas is based on surveys by Illies (1967), Zhil'tsova (1966, 1977), and Kazlauskas (1962).

Nemoura cinerea is widespread everywhere in Europe (except Iceland), both in running and standing waters. It is found also in the Caucasus, near the Caspian Sea, in North Africa, and in the northern part of Asia. *N. dubitans* and *N. avicularis* occur in central and northern Europe (*N. dubitans* often in brown-water streams, sometimes even in lakes), and in the western and northwestern parts of the former USSR; *N. avicularis* also in the Altai Territory. The distribution of *N. flexuosa* is similar to that of the two former species but it is met also in the Mediterranean and the Alps regions, being rarer in Europe compared with the other three *Nemoura* species. According to Zhil'tsova (1977), *N. flexuosa* is widespread in spring-fed waterbodies, especially in the Baltic countries and in the western part of the former USSR.

Nemurella pictetii is widespread and common from Europe to Siberia, even in standing waters. *Amphinemura borealis* occurs in central and northern Europe, both in running waters and mires. It is met also in the Urals and in Siberia. *A. standfussi* has a similar geographical distribution, but it inhabits mainly small streams. *Taeniopteryx nebulosa* is common in medium-sized streams of Europe and northern Eurasia. *Brachyptera risi* inhabits small streams in Europe.

All four *Leuctra* species are widespread in European running waters, *L. fusca* also in standing waters. Three of them (except *L. nigra*) are common also eastwards of Estonia.

Isoptera grammatica is widespread in European and North Asian running waters, while the distribution of *I. difformis* extends from central Europe to

northern Russia. *I. grammatica* inhabits medium-sized lowland streams, and *I. difformis*, small fast-flowing streams. *Diura bicaudata* lives in springs and standing waters from central Europe to Scandinavia as well as in the northwestern part of the former USSR. *D. nanseni* occurs in Scandinavia and northern Russia (European part).

Perlodes microcephala is met in whole Europe (except Scandinavia) and the Caucasus, always in running waters. *P. dispar* inhabits medium-sized streams in Europe and in the western part of the former USSR. *Isogenus nubecula* occurs from Central Europe to Scandinavia and in western Russia but also in Siberia, in medium-sized or large streams.

Siphonoperla burmeisteri occurs in small running waters from Central Europe to Scandinavia. The distribution of *Isoptena serricornis* is similar, but the species is rarer and inhabits somewhat larger streams. *I. serricornis* is met also in northern Russia and the Baltic countries, always as single individuals.

According to the system of the British Monitoring Working Party, presence of Nemouridae larvae indicates high water quality and presence of any other Plecoptera family, very high water quality (Armitage et al., 1983). Occurrence of *Brachyptera*, *Leuctra*, or any genus of Perlodidae or Siphonoperlidae marks the highest quality class in the quality system for Danish running waters, while *Amphinemura* and *Taeniopteryx* indicate the second highest quality level (Kirkegaard et al., 1998).

CONCLUSIONS

Altogether, 22 species of Plecoptera larvae from five families were found in the running waters of Estonia. The most widespread species were *Nemoura cinerea* (379 records; the only species present also on the western islands), *Isoperla grammatica* (109), *Taeniopteryx nebulosa* (51), *Leuctra digitata* (45), and *Nemurella pictetii* (30). Stonefly larvae occurred mostly in moderate or fast flow on stony or gravelly bottom, water moss or logs; a few species preferred sandy substrate. Full-grown larvae were met primarily in April–May (most of Nemouridae, Perlodidae, Siphonoperlidae), more seldom in spring and summer (some Leuctridae, *Amphinemura*) or late autumn (*Taeniopteryx*). The majority of the Estonian species are common in neighbouring areas. Some groups, occurring in other regions (Perlidae, Capniidae, *Protonemura*), have not yet been found in Estonia. *Diura nanseni* inhabits mainly the areas northwards of Estonia; *Perlodes microcephala* is of southern distribution. According to the author's opinion, 13 of the 22 established species should be entered in the Estonian Red Data Book. Most of them inhabit small clean streams. To complete the list of the Estonian species, taking of new bottom samples in winter as well as identification of adults can be recommended.

As most of the Estonian Plecoptera (as the whole order) serve as indicators of the highest water quality, the knowledge of their presence or absence throughout the country appears indispensable in procedures of estimation of biological water quality.

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KEVIKULISTE (*Insecta: Plecoptera*) LEVIK EESTIS

Henn TIMM

Peamiselt aastail 1985–1999 kogutud materjal (üle 1200 proovi) sisaldas 22 kevikuliste liiki 5 sugukonnast; 6 neist leiti Eestis esmakordselt. Eesti kevikuliste vastsed esinevad peaaegu eranditult vooluveses, enamasti mõõdukas kuni kiires voolus, kivisel või kruusasel põhjal, samblas või okstel. Kõige tavalisemad olid *Nemoura cinerea* (ainsa liigina esineb ka läänesaartel), *Isoperla grammatica*, *Taeniopteryx nebulosa*, *Leuctra digitata* ja *Nemurella pictetii*. Enamik Eesti liikidest on sagedased ka naabermaades. Põhjapoolse levikuga liik Eestis on *Diura nanseni*, lõunapoolne aga *Perlodes microcephala*. Et kevikulised kuuluvad veekogude hea või väga hea bioloogilise kvaliteedi oluliste indikaatorite hulka, on veekogude hindamisel tähtis teada, kas nad mingis piirkonnas looduslikult esinevad või mitte.