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Change in medical plant use in Estonian ethnomedicine: A historical comparison between 1888 and 1994

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ABSTRACT

Aim of the study: The aim of this paper is to compare the changes in the utilization of species from various hemeroby categories (indicating the degree of sensitivity of the plant to human impact) using historical data concerning the years 1888–1994.
Materials and methods: The authors digitised 8808 handwritten reports, reflecting local ethnopharmacological knowledge from 8 selected collections from the Estonian Folklore Archives of the Estonian Literary Museum. They were semi-quantitatively analyzed according to the sensitivity to human impact of 540 taxa that could possibly be related to the plant vernacular names given in the reports.
Results: Although in different periods of time the number of ethnopharmacologically used plants has changed, the proportion of plants utilized from each group has remained relatively same, consisting on average of: 23% anthropophytes, 42% apophytes, 32% hemeradiaphores and 3% hemerophobes. Comparison of the application of the most used plants revealed considerable changes of plant utilization, in which the varied use of the most popular anthropophytes increased and the applied scope of the most popular hemeradiaphores and hemerophobes decreased almost by twofold in one century. Case studies on seven taxa are presented, of them, use of *Allium sativum* L., *Aesculus hippocastanum* L. and *Mentha xpiperita* L. increased, whereas the use of *Hordeum* L., Orchidaceae, *Paris quadrifolia* L. and *Briza media* L. decreased greatly.
Conclusions: This research contributes to the better understanding of the cognitive and human ecological concepts underlying the use of medicinal plants in Estonia. Strong increase in the ethnomedical utilization of plants depending on human influence, and a decrease in the use of taxa that do not prefer human activities indicates that, despite some of the population still have access to natural resources and diverse knowledge of the medical use of plants, the majority relies on a very narrow selection and a rather restricted herbal landscape.

1. Introduction

Ethnobotanical research on medicinal plants has been carried out for more than a hundred years internationally, mainly within indigenous populations. It is widely agreed that plant medical use is a relevant component of local ecological knowledge and should be looked at as a complex phenomenon, covering historical, geographical, cultural, cross-cultural, economic, and social aspects (Vandebroek et al., 2004; Reyes-García et al., 2006; Lozada et al., 2006; Jarić et al., 2007; Eyssartier et al., 2008; Lira et al., 2009; Liu et al., 2009; Molares and Ladio, 2009; Thomas et al., 2009b). Moreover, it is important to understand the utilization of plants, as it is not always based on preference, or linked to purpose-specific characteristics of plants or durability and ease of handling etc., but can also depend on the accessibility of plants for the person in need. Stepp and Moerman (2001) demonstrated that, among the Highland Maya and Native Americans, weeds were substantially preferred for medical use. Pieroni et al. (2002) stressed the importance of weeds in the local diet among the Arbëreshëin from Southern Italy. Leonti et al. (2003) demonstrated that ecological factors (such as the importance of some taxa in managed house gardens) influence the ethnomedical importance of a taxon, using the example of medicinal flora of the Popoluca, Mexico. It has also been shown that Swedish peasants "cultivated" medicinal plants in quite an extensive manner on their roof-tops, along roadsides, by removing other taxa in the meadows (Svanberg, 2006). Several researchers have repeatedly demonstrated the positive correlation between the accessibility/availability and perceived usefulness of plant species (Thomas et al., 2009a). However, to the best of our knowledge, very few studies (Svanberg, 2006; Stepp and Moerman, 2001) reflect the correlation between the sensitivity to human impact and the use of those plants for medical pur-

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poses. The classification of synatropic plants, i.e. vegetation that is ecologically associated with humans, first proposed by Nageli and Thellung, (1905, referred through Vilberg, 1923: 416) and developed further by Linkola (1916, referred through Laasimer, 1965: 261) and Thellung (1919), is a standard classification used in Central European plant ecology. Estonia has a long history of research into the sensitivity of native and naturalized plants to human impact (Vilberg, 1923; Enari, 1944; Rebasoo, 1962). The majority of plants growing in Estonia have been attributed with the human impact sensitivity factor, which indicates the degree of sensitivity of the plant to human impact (Kukk, 1999), called the hemeroby categories in this paper. The use of hemeroby categories in ethnopharmacological research helps to reflect the relation between deepness of the everyday contact with the plant and its medical use.

There are only a few places in the world in which diachronic quantitative comparison stretching over a longer period of time is possible (Heinrich et al., 2006; Łuczaj, 2010a). Although various approaches, involving the use of diachronic data for ethnopharmacological purposes (leading to drug discovery), have been outlined by Heinrich et al. (2006), the quality of older, accidental data differs greatly from the quantitative result of modern fieldwork, making the use of earlier scanty data sets complicated (De Natale et al., 2009), and patterns of changes in plant use difficult to ascertain. Estonian folklore collections of local ecological knowledge are valuable data for conducting such a diachronic analysis.

The aim of this paper is to compare the changes in the utilization of species from various hemeroby categories using historical data concerning the years 1888–1994. The working hypothesis for this article is that Estonians who lived at the end of 20th century more frequently preferred to use plants depending on human influence, than those living at the end of 19th century.

This is one of the first steps in a lager project analysing Estonian folkloristic data on medicinal plant use and the application of the concept of herbal landscape in ethnopharmacological research. With it, the authors seek to establish a framework for future research and collaboration in order to acknowledge the possible ethnopharmacological richness of similar as yet unused data collections.

2. Background

The vegetation of Estonia is very diverse. Forests, mires and grasslands alternate with cultivated land; meadows and grasslands constitute up to one fifth, whereas almost half of the territory is covered with forests, including also peaty soils, which may be considered to cover almost one third of Estonia (Valk, 1988; Peterson, 1994; Paal, 1998). The indigenous flora of Estonia includes 1441 species (incl. hybridogenic species) of vascular plants. This number also includes taxa whose existence in the present Estonian flora is unclear (herbarium evidence provided, but no fresh findings). In totally 718 species and subspecies have migrated or escaped from cultivation (including naturalized) (Kukk, 1999). Since the second half of 20th century, intensive agriculture, caused by collectivization and urbanization, has resulted in the diminishing or even disappearance of local species (Kukk and Kull, 2006).

A century ago the rural population (consisting predominantly of Estonian speaking peasants) relied considerably on homemade medicines and in some parishes a whole human generation would grow up without any of them ever having seen a doctor (Sõukand and Raal, 2004). Even now, medicinal plants are still widely used. Many young and middle-aged people, who have not acquired their plant knowledge in the traditional way, still try to rebuild it using historical and modern herbals. Such a change in the origin of herbal knowledge has also influenced the nomenclature of the species used. The use of herbs is rather spontaneous in Estonia, due to the long tradition of herb use and the fact that plants can still be collected in nature and are widely sold in pharmacies (Sõukand and Kalle, unpublished fieldwork results).

3. Methods

3.1. Folk heritage collections

In 1888, the Estonian folklorist and linguist, Jakob Hurt (1839–1907), launched his famous appeal to the "active sons and daughters of Estonia" to collect local oral folk heritage. Among other requests (to collect songs, myths, beliefs etc.), he asked people to send popular descriptions on plant (medical) use, initiating a long lasting collecting tradition as well as laying the foundation for future research (more on the ethnopharmacological part of this appeal see in Sõukand and Raal, 2005). According to the homepage of the Estonian Folklore Archives of the Estonian Literary Museum in Tartu (www.folklore.ee/era/leidmine/index.html), at the beginning of 2008 the archive had in its possession 1,434,904 handwritten pages (last accessed 07.02.2010).

From the eight most promising collections the authors digitized all reports (8808) that where found to reflect the use of medicinal plants (see Table 1). The digitized reports were categorized by original vernacular names and author-created disease keywords (corresponding to historical diseases; symptoms; injuries etc.) into the Historical Estonian Herbal Medical Database (HERBA) (Sõukand and Kalle, 2008). Through the years 1888–1994; altogether 13,081 cases of ethnopharacological use of plants and fungi were detected. As the folklore has been collected unevenly (see Fig. 1) and following the course of historical events in Estonia, the whole period was divided into 5 smaller periods:

1888–1920 – including the WW I and war of independence (1918–1920) – with almost no records, which explains the relatively longer time covered by this period.
1921–1940 – the period of the First Estonian Republic, characterized by the establishment of academic botanical education in Estonian and the wide spread use of popular herbals.
1941–1960 – WW II and the post-war period, characterized by the anguish and fear of the native population due to the Soviet terror, resulting in very scanty collecting of all folkloristic information.
1961–1980 and 1981–1994 – the two last periods characterize true Soviet time with restriction of information on plant use – just one official herbal was published during the whole of the Soviet era, although in 5 gradually improved editions (Kook and Vilbaste, 1962; Tammeorg et al., 1972, 1973, 1975, 1984) preceding the breakthrough of "western" herbals in 1991. The shorter time span of the last period marks the end of a certain era in Estonian folk medicine, since after 1994 a mass of translated, and, later, original, herbals were published.

3.2. Changes in taxa used according to their sensitivity to human impact

As voucher specimens do not accompany the used archival data and vernacular names can often be attributed to several species, the number of identified taxa has to be considered as the potential number. All together, 540 taxa with a known category of sensitivity to human impact were identified. The data on sensitivity to human impact given in Kukk (1999) was applied to the list of potential HERBA plants, using an unpublished database maintained by the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences. The plants were attributed hemeroby cate-

Table 1
List of Estonian folklore collections containing herbal lore and digitized for HERBA in this stage of research.

Abbreviation	Full name of the collection	Years of collection	No of pages of full collection	No of texts digitised for HERBA
H	Folklore collection of J. Hurt	1860–1906	114,696	906
EKS	Collection of Literary Union of Estonia	1872–1924	2962	149
E	Collection of M.J. Eisen	1880–1934	90,100	427
ERM	Folklore collection of Estonian National Museum	1915–1925	9398	168
E, StK	Folklore collection of M.J. Eisen's scholars	1921–1927	8334	49
ERA	Folklore collection of Estonian Folklore Archives	1927–1944	265,098	1880
ALS	Collection of Academic Veterinary Society	1928–1934	4094	94
RKM	Folklore collection of folklore department of Estonian Literary Museum	1945–1996	447,231	5135
		Sum	941,913	8808

gories keeping in mind the following principles (based on Kukk, 1999):

Anthropophytes cannot survive without humans; they need to live in an environment considerably changed by humans and if not cultivated, they at least need treading or intensive mowing (for example *Chamomilla suaveolens* (Pursh) Rydb. or *Plantago major* L.). These plants grow in places that are visited very often (including courtyards and pedestrian foot-paths), also home gardens. The group of anthropophytes also includes cultivated plants.

Apophytes include plants needing interaction with humans from time to time. These plants grow most often in pastures or hay meadows, beside cultivated fields and occasionally visited pathways (for example *Hypericum* sp., *Achillea milefolium* L., etc.). A good example of an aphopyte is also *Juniperus communis* L., dying out in forested areas when finally surrounded by high trees, while living happily on pastured meadows and giving a very unique look to the wooded pastoral meadows of Western Estonia.

The category of **hemeradiaphores** is more complicated in its relationship with humans. The plants of this category are indifferent to human influence and can grow either in the areas affected by humans or in relatively undisturbed areas. They can tolerate human influence to a certain extent and if they receive too much disturbance, they either become apophytes (become dependent on humans to a certain extent) or hemerophobes (disappear from the habitat). This category also includes many nowadays widely used wild berries like *Vaccinium vitis-idea* L., *Oxycoccus palustris* Pers., *Vaccinium myrtillus* L.; their utilization as hemeradiaphores is only possible as long as care is taken to make sustainable use of the resources.

Hemerophobes can live just few steps away from a human settlement, but prefer to grow without human disturbance. Hemerophobes do not have to be rare species, for example *Paris quadrifolia* L. and *Lycopodium annotium* L. are common in Estonia.

Over a longer time, the plant can go from one category to another – a hemeradiaphore can become a hemerophobe or an apophyte, an anthropophyte can become an apophyte, a hemeradiaphore can be introduced into cultivation and through that become an anthropophyte etc.

3.3. Changes in the number of use-reports

The nomenclature of species shows only the presence of the taxon in at least one person's herbal landscape, but in order to evaluate the changes in the medical importance of specific hemeroby groups the number of use-reports (UR, Tardìo and Pardo-De-Santayana, 2008) related to the most frequently used taxa from each group was analyzed. Among the groups, the number of well-known and specifically named plants varies greatly and the larger the number of taxa selected for this study, the greater will be the chance for a mistake in the identity of the plant. That is the main reason why, for every hemeroby group, only ten most frequently used taxa were selected. The texts relating to the selected taxa were revised for details and clarification. In the later analyses, the total number of use reports of ten most frequently used plants, among all groups, is taken as 100%. The proportion of uses in each period was calculated and graphs drawn, including calculation of the *R*-squared value using Excel and significance level (P) using 4 SAS.

If species were identified only on the genera or family level according to folk classification, but the members of the upper taxa were belonging to different hemeroby groups, the most likely category was chosen. For example, *Ribes nigrum* L., native to Estonia, is according to Kukk (1999) a hemeradiaphore, but the plant used in the 20th century was certainly cultivated, and thus the species was placed in the anthropophyte group. Native hemeradiaphore *Tilia cordata* Mill. is nowadays seldom used, instead a common garden tree, anthropophyte *Tilia platyphyllos* Scop., with bigger leaves and

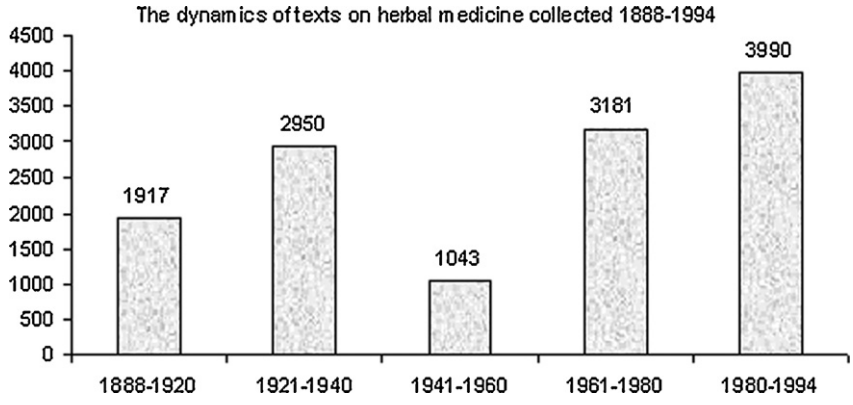

Fig. 1. Dynamics of text collection from 1888 to 1994. Number indicates the number of texts collected.

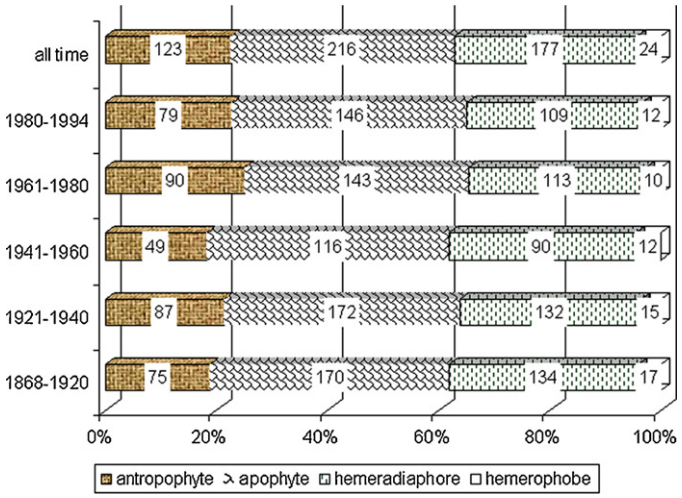

Fig. 2. Use of potential medicinal plants: sensitivity to human impact of taxa used in certain time periods. Number indicates represented taxa in each period.

blooms, is used since it gives more results for less effort. *Plantago* sp., often used fresh to heal smaller cuts and bleeding, represents several species growing in Estonia, but mostly *P. major* L. was used, since it grew on people's everyday paths.

3.4. Case studies

The decline of plant use could be caused among other reasons by: (1) nature protection, (2) acknowledgments of poisonous properties, (3) retreat of the disease, (4) changes from extensive to intensive agriculture. The increase of plant use could be mostly caused by: (1) introduction of species into cultivation, (2) introduction of species though literature, media and market (incl. pharmacies). To demonstrate the main trends of the changes, seven taxa were relatively randomly selected from the species that can be easily detected by the vernacular names that may be attributed to one particular taxon. Selected taxa reflect on the most observable provokers of the changes like education, literature and epidemiology.

In the situation where a commonly used plant was identified to a genus level, which comprises several very common species not distinguished by folk taxonomy, only the genus was identified and analysis conducted on a genus level. Reports on the use of those seven taxa were extracted from the database and where needed the vernacular names were related to binominals according to data presented in the text and using several secondary sources; only use-reports with the high credibility of plant identification (cf. Łuczaj, 2010b) were taken into the consideration. The percentage of representation of the selected plants in the use-reports from each period was calculated and graphs drawn, including calculation of the R-squared value using Excel and significance level (P) using 4 SAS.

4. Results and discussion

4.1. The sensitivity to human impact

Analysis of the division between hemeroby categories during 1888–1994 (Fig. 2) shows, that among the 540 taxa potentially used in Estonian folk medicine the most represented (40%) group were apophytes, 23% of the potentially used taxa were anthropophytes, 33% were hemeradiaphores, and only 4% were hemerophobes. Although through the different periods of time, if taken separately, the number of used plants is uneven (from 40% (anthropophytes

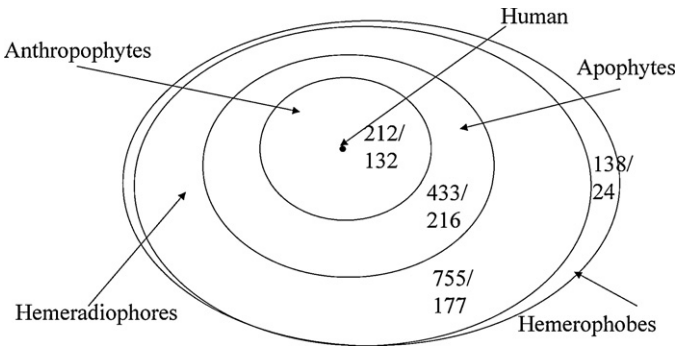

Fig. 3. Medical use of species attributed hemeroby categories. First number indicating the entire flora from the given category/second number shows medically used taxa.

in II WW and post-war period) to 79% (apophytes during the First Estonian Republic in 1921–1940) of all potential plants in the groups), the distribution of species within every given period according to sensitivity to human impact remains quite similar and the changes are statistically insignificant ($P_{\text{anthropophyte}} = 0.22$. $P_{\text{aphophyte}} = 0.37$, $P_{\text{hemeradiaphore}} = 0.11$, $P_{\text{hemerophobe}} = 0.32$).

Among the vascular plants of Estonia 58% of anthropophytes and 50% of apophytes, but only 23% hemoradiaphores and 17% of hemerophobes (Fig. 3) were potentially utilized for medical purposes.

Based on the results of the first stage of the analysis, we can agree with Thomas et al. (2009a) who find that people tend to choose for healing, those plants that grow in their nearby surroundings, and indicate that it applies not only to individual plant species but also to entire vegetation communities. Our results are also in agreement with the suggestion that plant knowledge and intensity of plant use diminish with the distance travelled from human settlements (Martin, 2004). The statement of Stepp and Moerman (2001) that widely used medicinal plants "need to be abundant and accessible" and the Pieroni et al. (2002) findings on the importance of weedy vegetables also support our results.

Access to the plants and their availability on request has been one of the most important factors among indigenous people when selecting between different treatment options (Thomas et al., 2008). Species depending on human activity are a part of the known landscape and are easy to locate if needed; gardens and sidewalks are always at hand and plants growing there are familiar in terms of recognition and use (cf. Voeks, 2004). The prevalence of the plants liking human influence also corresponds to the central place foraging theory, which demonstrates the adaptation of organisms to the distribution of resources (Stephens and Krebs, 1986). As a model to explain the mechanism of change in the use of medicinal plants over time the authors employ the notion of herbal landscape, a cognitive field associated with plants used to treat or prevent diseases, established within specific cultural and climatic zones, that is either personal or shared within a certain group of people (Sõukand and Kalle, 2010b) Presumably, the personal herbal landscape develops in the course of a person's everyday activities, as traditionally (in Estonia) plants were gathered from places visited during seasonal activities. (Sõukand and Kalle, 2010a, cf also Farina, 2006; Zimmerer, 2001). The hypothesis of dependence of plant usage on its relation to everyday activity is also supported by Pieroni et al. (2002).

4.2. Changes in use-reports

The fact that the proportion of potentially used taxa remained relatively unchanged indicates two possibilities: anthropohytes still share their names with hemeradiaphores, as no-one has col-

Table 2
Most frequently used plants in four hemeroby categories and the number of use-reports (UR).

Top 10 anthropophytes

1888–1920	UR	1921–1940	UR	1941–1960	UR	1961–1980	UR	1981–1994	UR
Plantago sp.	67	*Allium cepa* L.	133	*Allium cepa* L.	57	*Allium cepa* L.	133	*Chamomilla* sp.	275
Chelidonium majus L.	47	*Plantago* sp.	93	*Plantago* sp.	50	*Plantago* sp.	131	*Allium cepa* L.	247
Secale cereale L.	39	*Chamomilla* sp.	67	*Chamomilla* sp.	37	*Chamomilla* sp.	98	*Plantago* sp.	233
Allium cepa L.	26	*Chelidonium majus* L.	43	*Tilia* sp.	20	*Chelidonium majus* L.	64	*Chelidonium majus* L.	162
Chamomilla sp.	21	*Secale cereale* L.	39	*Chelidonium majus* L.	20	*Tilia* sp.	48	*Tilia* sp.	135
Solanum tuberosum L.	21	*Tilia* sp.	39	*Avena sativa* L.	18	*Allium sativum* L.	25	*Avena sativa* L.	99
Fumaria officinalis L.	20	*Linum usitatissimum* L.	30	*Linum usitatissimum* L.	9	*Solanum tuberosum* L.	24	*Allium sativum* L.	50
Linum usitatissimum L	19	*Solanum tuberosum* L.	29	*Secale cereale* L.	7	*Linum usitatissimum* L.	22	*Fumaria officinalis* L.	47
Pisum sativum L.	13	*Fumaria officinalis* L.	27	*Allium sativum* L.	6	*Avena sativa* L.	22	*Ribes nigrum* L.	32
Cannabis sativa L.	12	*Avena sativa* L.	20	*Capsella bursa-pastoris* (L.) Medik.	5	*Secale cereale* L.	17	*Solanum tuberosum* L.	31
Sum top 10 anthropophytes	285		520		229		584		1311

Top 10 apophytes

1888–1920	UR	1921–1940	UR	1941–1960	UR	1961–1980	UR	1981–1994	UR
Achillea millefolium L.	77	*Achillea millefolium* L.	103	*Achillea millefolium* L.	56	*Achillea millefolium* L.	131	*Achillea millefolium* L.	257
Juniperus communis L.	59	*Potentilla anserina* L.	89	*Tussilago farfara* L.	33	*Valeriana officinalis* L.	82	*Valeriana officinalis* L.	152
Sorbus aucuparia L.	58	*Solanum dulcamara* L.	83	*Valeriana officinalis* L.	23	*Artemisia absinthium* L.	79	*Origanum vulgare* L.	134
Valeriana officinalis L.	48	*Juniperus communis* L.	78	*Artemisia absinthium* L.	22	*Artemisia vulgaris* L.	79	*Tussilago farfara* L.	106
Solanum dulcamara L.	41	*Urtica* sp.	77	*Artemisia vulgaris* L.	20	*Tussilago farfara* L.	74	*Hypericum* sp.	88
Tussilago farfara L.	41	*Tussilago farfara* L.	65	*Potentilla anserina* L.	17	*Origanum vulgare* L.	72	*Urtica* sp.	84
Briza media L.	39	*Valeriana officinalis* L.	64	*Juniperus communis* L.	17	*Urtica* sp.	57	*Potentilla argentea* L.	73
Artemisia absinthium L.	32	*Artemisia vulgaris* L.	56	*Briza media* L.	15	*Juniperus communis* L.	52	*Juniperus communis* L.	69
Urtica sp.	32	*Artemisia absinthium* L.	52	*Hypericum* sp.	14	*Hypericum* sp.	49	*Potentilla erecta* (L.) Raeusch	62
Artemisia vulgaris L.	29	*Potentilla erecta* (L.) Raeusch	44	*Potentilla erecta* (L.) Raeusch	12	*Potentilla argentea* L.	40	*Rubus idaeus* L.	56
Sum top 10 apophytes	456		711		229		715		1025

Top 10 hemeradiaphores

1888–1920	UR	1921–1940	UR	1941–1960	UR	1961–1980	UR	1981–1994	UR
Betula sp.	100	*Betula* sp.	80	*Pinus sylvestris* L.	25	*Betula* sp.	90	*Betula* sp.	79
Thymus serpyllum L.	62	*Thymus serpyllum* L.	52	*Betula* sp.	23	*Picea abies* (L.) H. Karst.	65	*Pinus sylvestris* L.	73
Picea abies (L.) H. Karst.	37	*Pinus sylvestris* L.	52	*Picea abies* (L.) H. Karst.	22	*Pinus sylvestris* L.	60	*Vaccinium myrtillus* L.	58
Alnus glutinosa (L.) Gaertn.	28	*Daphne mezereum* L.	51	*Polygonatum* sp.	18	Dryopteridaceae	52	*Picea abies* (L.) H. Karst.	56
Menyanthes trifoliata L.	27	*Equisetum pratense* Ehrh.	45	*Thymus serpyllum* L.	17	*Thymus serpyllum* L.	52	Dryopteridaceae	49
Padus avium Mill.	24	*Picea abies* (L.) H. Karst.	43	Dryopteridaceae	16	*Arctostaphylos uva-ursi* (L.) Spreng.	32	*Vaccinium vitis-idaea* L.	49
Daphne mezereum L.	23	*Alnus glutinosa* (L.) Gaertn.	37	*Arctostaphylos uva-ursi* (L.) Spreng.	12	*Padus avium* Mill.	28	*Arctostaphylos uva-ursi* (L.) Spreng.	39
Pinus sylvestris L.	22	*Padus avium* Mill.	36	*Alnus glutinosa* (L.) Gaertn.	7	*Daphne mezereum* L.	26	*Thymus serpyllum* L.	36
Convallaria majalis L.	18	*Frangula alnus* Mill.	29	*Menyanthes trifoliata* L.	7	*Anemone nemorosa* L.	24	*Padus avium* Mill.	29
Huperzia selago (L.) Bernh. ex Schrank et Mart.	15	*Menyanthes trifoliata* L.	28	*Padus avium* Mill.	6	*Vaccinium vitis-idaea* L.	22	*Anemone* sp.	25
SUM top 10 hemeradiaphores	354		453		153		429		493

All hemerophobes

1888–1920	UR	1921–1940	UR	1941–1960	UR	1961–1980	UR	1981–1994	UR
Lycopodium clavatum L.	15	*Paris quadrifolia* L.	28	*Lycopodium* sp.	4	*Lycopodium* sp.	8	*Lycopodium* sp.	14
Actaea spicata L.	9	*Lycopodium* sp.	23	*Cypripedium calceolus* L.	2	*Paris quadrifolia* L.	5	*Paris quadrifolia* L.	5
Hedera helix L.	9	*Actaea spicata* L.	14	*Paris quadrifolia* L.	1	*Actaea spicata* L.	2	*Actaea spicata* L.	2
Lathraea squamaria L.	8	*Hedera helix* L.	11	*Linnaea borealis* L.	1	*Cypripedium calceolus* L.	2	*Chimaphila umbellata* (L.) W.P.C.Barton	2
Paris quadrifolia L.	8	*Cypripedium calceolus* L.	8	*Actaea spicata* L.	1	*Hedera helix* L.	2	*Cypripedium calceolus* L.	2
Cypripedium calceolus L.	7	*Lathraea squamaria* L.	4					*Linnaea borealis* L.	2
Linnaea borealis L.	3	*Linnaea borealis* L.	4					*Hedera helix* L.	1
Mercurialis perennis L.	2	*Orthilia secunda* (L.) House	4					*Lathyrus vernus* (L.) Bernh.	1
Taxus baccata L.	1	*Ulmus laevis* Pall.	1						
SUM all hemerophobes	62		98		9		19		29

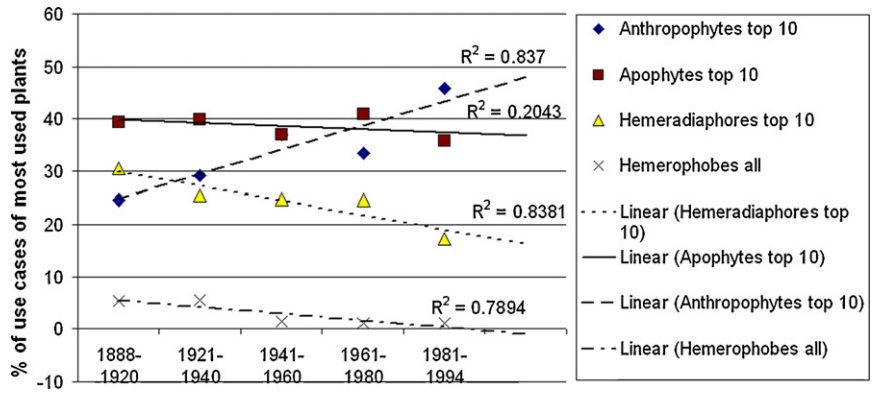

Fig. 4. Graphical representation of changes in the utilization of the most frequently used taxa according to human impact groups. The sum of all use cases reflecting the most frequently used plants is taken as 100%.

lected vernacular plant names since the 1960's and/or there are still at least some people knowing and using plants not needing/liking human impact, although the majority prefers cultivated plants and those living close to humans. To understand the changes that had occurred within the herbal landscape over time, we endeavoured to explore the taxa most represented in each of the four groups over the whole period (Table 2).

Comparison of the UR of the most frequently used plants in all four groups show that anthropophytes and apophytes are used in more than 70% of the selected cases. Fig. 4 shows the changes of utilization of the most frequently used taxa.

Only the utilization of the most frequently used apophytes has almost not changed during the century, but the changes in use of all other groups are statistically significant ($P_{\text{anthropophyte top 10}} < 0.05$. $P_{\text{aphophyte top 10}} = 0.5$, $P_{\text{hemeradiaphore top 10}} < 0.05$, $P_{\text{hemerophobe top 10}} < 0.05$). The use of the most popular anthropophytes increased from 26.6% in the first period to 45.8% in the last period and the use of hemeradiaphores and hemerophobes decreased accordingly from 30.6% in the first period to 17.3% in the last period for hemeradiaphores and from 5.4% to 1% for hemerophobes. This corresponds with the rapid abandonment of wild green vegetables in Poland during the 20th century (Łuczaj, 2010a) indicating that the population of Eastern Europe has moved farther away from nature. The results indicate, that although there still are people in Estonia who have broad knowledge of plant use, the number of people with a narrow herbal landscape has increased considerably.

There are many reasons for that, including those that can be measured and followed and those that are hard to assess. One relatively easily followed factor can be the influence of formal botanical education at the school level and the intensive use of herbals, which in Estonia became especially popular after 1920. Leonti et al. (2010) suggest that herbals and nowadays also other media may have great influence on herbal use, having demonstrated that about 20% of the sample data from contemporary Campania (Italy) was with high probability influenced by the herbal of Matthioli, published in 1598. Although the general literacy level among Estonians in 1890 was the highest in all of the Russian Empire, being almost 90% at the end of the 19th century (Vahtre, 2004), formal botanical education in schools and at university was given in Russian, and was hardly understood by peasants (Paatsi, 2003). Although by the end of the 19th century a considerable amount of literature regarding plant use had been published in the Estonian language (including almanacs and popular medical books), they all had very modest influence on the ethnomedical knowledge of Estonians, as local vernacular plant names seldom corresponded to the plant names used in literature. In 1918, all plants received "official" Estonian names, sometimes derived from vernacular names. From this point commenced a time when the older generation (still using vernacular names) and the younger generation (relying on formal education) had difficulty understanding each other without an additional effort from both sides. On the other hand, the unification of the knowledge of the new generation and the "official" names of the plants gave people a better chance to understand and adopt knowledge passed on through literature. Also, information on nature protection and poisonous and/or useful plants spread via the written word and became widely accessible (Kalle and Sõukand, 2011).

Advances in medicine and hygiene, reaching the lay population of peasants after the 1920's, provoked epidemiological changes (reduction of stomach diseases and skin complaints caused by malnutrition, poor hygienic conditions etc.). Also, better availability of medical care and new improved medicines created the situation where self-collecting of medicinal plants was no longer necessary to the same extent as in earlier times, when conventional medical care was poorly available in rural areas.

Urbanization began already in the 1930's, but after the Soviet occupation, WW II and collectivization the surviving younger population strived to migrate into the towns, further deepening the gap between different generations and the chain of traditional knowledge was broken for many families. The last two generations, raised in the town setting, visiting their grandparents only on summer vacation, may constitute majority of the respondents with a narrow herbal landscape. We should add here that extensive, small farm agriculture was, forcibly, abandoned after WW II in favor of Soviet intensive collective farming, where all belonged to all, which means that a traditional way of life, taking care of one's own surroundings, was accessible to only very few people. The result was unfavorable for many plant habitats, especially for hemeradiaphores, and access to them decreased.

The small proportion of the hemerophobe group, and the fact that it almost disappeared from the medical use during the last century, could be explained by changes in the life settings of Estonians as they were less and less often exposed to the habitats of hemerophobes, especially since the second half of the 20th century. For whatever reason, the less a person interacted with nature in the course of his/her everyday life, the smaller was the chance for developing a rich herbal landscape, characteristic of 19th century peasants. A considerable part of post WW II generations of Estonians grew up knowing only the official medicinal plants they collected for pharmacies as schoolchildren, or ones they cultivated in their gardens for tea, resulting in the narrowing of their herbal landscape, covering predominantly only the area of anthropopytes.

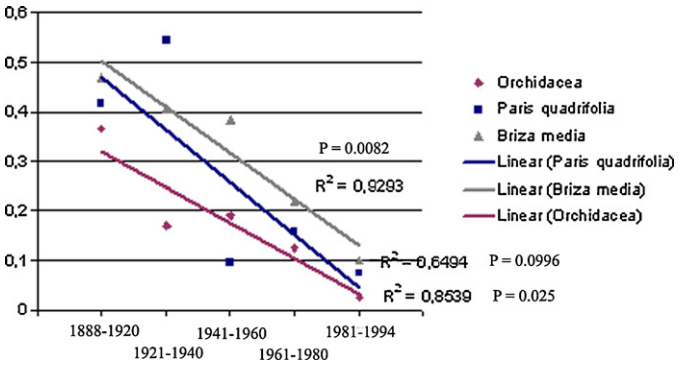

Fig. 5. Plants exhibiting decline in use during one century: Orchidaceae, *Paris quadrifolia* L. and *Briza media* L.

4.3. Case studies

Trying to follow more or less traceable changes that may cause the withdrawal of some species from folk medical use and thus from the herbal landscape, we analyse the use of seven taxa. Four of them are from the anthropophytes group, simply because they are closely bound to people and are representatives of the group mostly bearing names that could be attributed to only one specific taxon. The other three represent the remaining groups. Four of the selected taxa almost disappeared from medical use during one century, while the other three became more popular only recently. As the collecting of folklore in different time periods was uneven, the percentage of use was calculated according to the UR in every selected period (Fig. 1) and the probability factor P calculated, showing that the changes that occurred with *Allium sativum* L., Orchidaceae, *Briza media* L. and *Mentha xpiperita* L. are statistically significant ($P < 0.05$), whereas only the results for *Aesculus hippocastanum* L. do not respond even to a lower statistical significance ($P < 0.1$) due to the shorter time-span (no records in the first period). The graphical representations of the changes in use are given in Figs. 5–7.

4.3.1. Decline in use

4.3.1.1. Orchidaceae – orchid family. Plants of this family, such as the early purple orchid, *Orchis mascula* (L.) L., military orchid *Orchis militaris* L., early marsh orchid *Dactylorhiza incarnata* (L.) Soó and heath spotted orchid *Dactylorhiza maculata* (L.) Soó, were often undistinguishable on a name level, and all orchids with blue-red blooms were named with similar titles such as *jumala/kuradi käsi/käpp/sõrm* [god's/devil's hand/paw/finger] etc. (Vilbaste, 1993), refering to the plant's root. The representatives of the family were used to cure several diseases such as epilepsy, paralysis, skin problems etc. The following text demonstrates the typical image of the orchids within the rural population at the end of the 19th century:

> Another medicine for epilepsy grows on the meadow; people call them god and devil's paw. This plant has two roots beneath, one white, the other black; these are like two paws. Pick up those roots, dry them, pulverise and take in. H II 55, 269/70 (4b) < Tarvastu parish (1896).

Although, one taxon of this family, lady's slipper *Cypripedium calceolus* L., due to its extraordinary appearance, was distinguished from the other species and its resemblance to a shoe (hence the vernacular names related to shoes – *king*, *-pätt*, *-kott*, *-pastlad* (Vilbaste, 1993)). This linked the plant with the mythological creature named *külmking* [literally "coldshoe"], which was associated with a disease of *külmking* (one of the few mythological diseases which had remained known in Estonian folk medicine at the end of the 19th century). Plant was also used against cold (*külm*).

The special features of this family resulted in their being attributed with mythological qualities, promising help from a divine or devilish power associated with plants. Being relatively widely reported in early folklore (almost 0.36%), their mentioning gradually decreases almost 15 times to 0.025% of all reports, although the absolute UR changes less (from 7 to 1).

The reason for such a decrease lay probably in the magical nature of the properties of the plant, but most importantly, the entire family was announced endangered and all species were taken under protection by law since 1936 (being among the first taxa taken under protection in Estonia) and their harvesting for all uses was prohibited. Although the main reason for their protection lay in the beauty of the blooms, not in the massive medical use, the results affected folk medicine as well. It is noteworthy that some members of this family are hemeradiaphores, while others are apophytes, requiring human disturbance like pasturing and mowing.

4.3.1.2. P. quadrifolia L. – herb paris. At the end of the 19th century and the beginning of the 20th century the herb paris was widely used to heal fatal health problems and skin diseases. Its use in Estonian folk medicine was first documented already in 1823 by the local pastor and estophile Johann Wilhelm Ludwig von Luce (1756–1842) (Luce, 1823). Its poisonous properties were first acknowledged in Estonian already at the end of the 19th century (Spuhl-Rotalia, 1897), but the decrease in medical use occurred only after WW II. The reason may be that, while Estonians still lived the tradition (*sensu* Ingold and Kurttila, 2000), they knew exactly how to use the plant, so the poisonous properties were used wisely. Later, when intensive urbanization and botanical education broke the chain of local ecological knowledge (Sõukand and Kalle, 2010a), only a few people remained who remembered the use and even less actually used the plant.

4.3.1.3. B. media L. – quaking grass. Once being the most frequently used plant for treating malaria, quaking grass retreated from modern use with the disappearance of the disease. In 1827–1832 about 1400 persons died in Estonia as a result of malaria (Rootsmäe, 1987). Later on, in the 20th century, when the swamps were drained and malaria disappeared, the plant was, here and there, used against other "shaking" diseases such as colds and even epilepsy. Quaking grass trembled, as did the person with malaria or a cold. This was one of the most explicit applications of the Doctrine of Signatures in herbal folk medicine, generally very modestly applied in the Estonian context (Sõukand, 2007). Still, there are several other "trembling" plants growing in Estonia, but never used for healing malaria. It seems that the use of this plant against the "modern cold" was not effective and so the plant was almost abandoned already in 1960s. Thus the trembling properties of the plant could be serving as a memory aid (for more on the doctrine of signature as a possible memory aid see Bennett, 2007) to keep the tradition alive as long as it was needed.

4.3.1.4. Hordeum L. – barley. As a plant with a long history of cultivation, barley, owes its decline in use mostly to herbicides and the decrease in everyday contact with the plant and also the fact that more effective cures for diseases treated with it were invented. Some early folklore reports indicate the use of the barleycorn (*odra iva*) against the sty in the eye (*odraiva*), but mostly barley was used to heal skin problems and often the use was accompanied with a magical procedure.

4.3.2. Increase in use

4.3.2.1. A. sativum L. – garlic. The Estonian name for garlic, *küshlohg* (modern *küüslauk*) was first documented by the Baltic German pas-

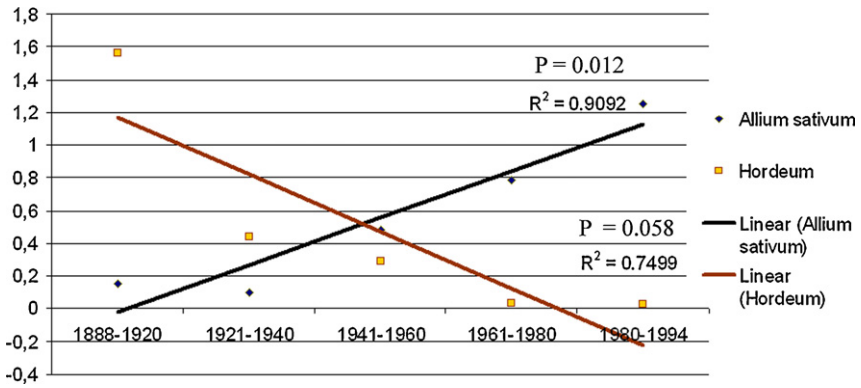

Fig. 6. Decline in use of *Hordeum* L. and increase in use of *Allium sativum* L.

tor Heinrich Stahl (1600–1657) in the vocabulary supplement to his novel book on Estonian grammar (Stahl, 1637). Although garlic was cultivated in manors and towns already at the very beginning of the 19th century (Zigra, 1808), there are very few records in HERBA on its medical use until the second half of the 20th century. Although its medical use was already promoted in Estonian at the beginning of 20th century (Michaelis, 1911), the rise of garlic use began after 1962, when the popular herbal (Kook and Vilbaste, 1962) described the healing properties of the plant. By that time, garlic was already present in culinary use and cultivated widely, so the advice given in the book could be adopted quite easily.

4.3.2.2. A. hippocastanum L. – horse-chestnut. Although the horse-chestnut was a popular tree in manor parks since the 18th century, it was first mentioned in folk medicine only in 1932, after promotion in popular medicinal plant books. It was mostly used for rheumatic problems: a tincture made of blooms or conkers, externally applied. Also, the conkers were carried in pockets against rheumatics and other diseases (cf. Clark, 1896), substituting the similarly used potato.

4.3.2.3. M. xpiperita L. – peppermint. Two native medically used *Mentha* species grow in Estonia: wild mint *M. arvensis* L. and water mint *M. aquatica* L. Cultivated peppermint, having a better taste and being easily grown, is now preferred in use, although some people sometimes also call the wild species *piparmünt* [peppermint]. Peppermint had already been cultivated in Estonia for a long time, but in monastery (Amelung, 1896), manor, and pharmacy gardens (Seuberlich, 1912) only. Peasants (predominately Estonians) did not cultivate it. At the end of the 19th century peppermint was hardly used at all for medical purposes, but later its use was encouraged by several herbals.

The delay in the spreading of the use of "classical" medicinal plants (especially the lack of the use of garlic and mint in earlier periods) is proof that, despite a wider understanding that the whole of Europe was influenced by ancient herbals and plant use, Estonians kept their early tradition of plant use relatively bound to the locally growing plants, including those cultivated on farm fields. Although garlic, onion, parsley, mustard etc. as well as mint were cultivated in Estonia already in the Middle Ages (Mänd, 2004), they were the prerogative of the upper class. Estonian society in the Middle Ages was strictly polarized and two separate worlds existed: the one shared by the German upper class and urban culture, which was opposed to the other composed of the rural, Estonian speaking, population (Valk, 2001). The first welcomed alien plants, popular in Europe, by growing them in manor gardens and fields, while the second, owning no land and no formal right to its use for own purposes, relied mostly on wild-growing species. This polarization lasted up to the establishment of the independent Estonian Republic in 1918.

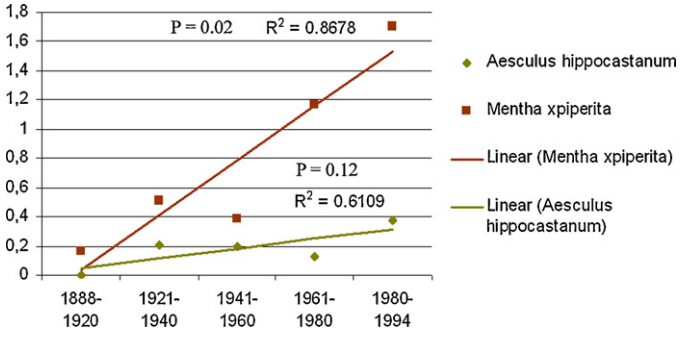

Fig. 7. Plants exhibiting increase in use during one century: *Aesculus hipocastanum* L. and *Mentha xpiperita* L.

5. Conclusion

This research contributes to a better understanding of the historical changes in the folk medical use of plants and to the better understanding of the cognitive and human ecological concepts underlying the use of medicinal plants. In Estonia, within the studied time scale (1888–1994), there has been a strong tradition of use of medicinal plants habituating close to human settlement. Although the proportion of reported potential taxa among co-habitants and human-avoiding species has through the century remained almost the same, the analysis of the number of user-reports shows a strong increase in the utilization of the plants depending on human activity, whereas the use of taxa that do not favor human activity diminishes. This indicates that, despite some of the population still have access to natural resources and diverse knowledge of plants, the majority relies on a very narrow selection of plants and has a very restricted herbal landscape. This was caused in the first place by changes in socio-economic relations, and later by people's limited contact with nature and the loss of traditions by the majority. These processes were associated with urbanization, the spread of formal botanical education that does not give an account of the ethnobotanical heritage, good availability of academic medical care, lessening of the need for self-medication and the wide availability of literature promoting the use of plants belonging mostly to anthropophyte and apophyte groups. The more limited the contact with nature and the smaller the need for collecting medicinal plants, the smaller is the chance that people actually acquire knowledge about plants and later use it. This all leads to greater dependence on plants needing human influence for survival, reflecting the preference to rely on familiar and dependable plants.

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References

Amelung, F., 1896. Der Herbarius-Codex des Revaler Stadt-Archivus und ein Blic auf die ehstländischen Klostergärten im Mittelalter. *Beiträge zur kunde Ehst*-Liv- und Kurlands 5, 69–78.

Bennett, B.C., 2007. Doctrine of signatures: an explanation of medicinal plant discovery or dissemination of knowledge? Economic Botany 61, 246–255.

Clark, R., 1896. Horse chesnuts as a preventive of rheumatism. Notes and Queries 9, 507–508.

De Natale, A., Pezzatti, G.B., Pollio, A., 2009. Extending the temporal context of ethnobotanical databases: the case study of the Campania region (Southern Italy). Journal of Ethnobiology and Ethnomedicine 5, 7.

Enari, L., 1944. Kultuuri mõju Eesti floorale. Doktoritöö. [Cultural influence on Estonian flora. Doctoral dissertation.] Käsikiri, säilit. Tartu Ülikooli Raamatukogus. [Manuscript, kept in the Tartu University Library.] TÜ matemaatika-loodusteaduskond. Tartu.

Eyssartier, C., Ladio, A.H., Lozada, M., 2008. Cultural transmission of traditional knowledge in two populations of North-western Patagonia. Journal of Ethnobiology and Ethnomedicine 4, 25.

Heinrich, M., Kufer, J., Leonti, M., Pardo-de-Santayana, M., 2006. Ethnobotany and ethnopharmacology—interdisciplinary links with the historical sciences. Journal of Ethnopharmacology 107, 157–160.

Farina, A., 2006. Principles and Methods in Landscape Ecology. Toward a Science of Landscape. Springer.

Ingold, T., Kurttila, T., 2000. Perceiving the Environment in Finnish Lapland. Body and Society 6, 183–196.

Jarić, S., Popović, Z., Mačukanović-Jocić, M., Djurdjević, L., Mijatović, M., Karadžić, B., Mitrović, M., Pavlović, P., 2007. An ethnobotanical study on the usage of wild medicinal herbs from Kopaonik Mountain (Central Serbia). Journal of Ethnopharmacology 111, 160–175.

Kalle, R., Sõukand, R., 2011. Omanimetus või õige nimetus? Eestlaste ravimtaime tundmiste alustest (Endemic name or correct name? On the foundations of Estonians' knowledge of medicinal plants). Akadeemia 23, 62–81.

Kook, O., Vilbaste, G., 1962. Eesti NSV ravimtaimed. (Estonian medicinal plants). Eesti Riiklik Kirjastus, Tallinn.

Kukk, T., 1999. Eesti taimestik. (Vascular plant flora of Estonia). Teaduste Akadeemia Kirjastus, Tallinn.

Kukk, T., Kull, T., 2006. Globaalne ja lokaalne Eesti taimestik. In: Rohumets, I. (Ed.), Lehed ja tähed: looduse ja teaduse aastaraamat (Leaves and Stars: Yearbook of Nature and Science). Tallinn, Loodusajakiri, pp. 10–17.

Laasimer, L., 1965. Eesti NSV taimkate. (Vegetation of the Estonian S.S.R.). Eesti NSV Teaduste Akadeemia Zooloogia ja Botaanika Instituut, Valgus, Tallinn.

Leonti, M., Cabras, S., Weckerle, C.S., Solinas, M.N., Casu, L., 2010. The causal dependence of present plant knowledge on herbals – contemporary medicinal plant use in Campania (Italy) compared to Matthioli (1568). Journal of Ethnopharmacology 130, 379–391.

Leonti, M., Ramirez, F.R., Sticher, O., Heinrich, M., 2003. Medicinal flora of the Popoluca, México: a botanical systematical perspective. Economic Botany 57, 218–230.

Linkola, K. 1916. Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee. I–II. Acta Soc. pro Fauna et Flora Fenn., 45, 1–2. Helsinki.

Lira, R., Casas, A., Rosas-López, R., Paredes-Flores, M., Pérez-Negrón, E., Rangel-Landa, S., Solís, L., Torres, I., Dávila, P., 2009. Traditional knowledge and useful plant richness in the Tehuacán–Cuicatlán Valley, Mexico. Economic Botany 63, 271–287.

Liu, Y., Dao, Z., Yang, C., Liu, Y., Long, C., 2009. Medicinal plants used by Tibetans in Shangri-la, Yunnan, China. Journal of Ethnobiology and Ethnomedicine 5, 15.

Lozada, M., Ladio, A., Weigandt, M., 2006. Cultural transmission of ethnobotanical knowledge in a rural community of northwestern Patagonia, Argentina. Economic Botany 60, 374–385.

Luce, J.W.L.v., 1823. Topographische Nachrichten von der Insel Oesel, in medicinischer und ökonomischer Hinsicht. Häcker, Riga.

Łuczaj, Ł., 2010a. Changes in the utilization of wild green vegetables in Poland since the 19th century: A comparison of four ethnobotanical surveys. Journal of Ethnopharmacology 128, 395–404.

Łuczaj, L., 2010b. Plant identification credibility in ethnobotany: a closer look at Polish ethnographic studies. Journal of Ethnobiology and Ethnomedicine 6, 36.

Martin, G.J., 2004. Ethnobotany: A Methods Manual (Earthscan People Plants International Conservation Series). Earthscan Publications Ltd.

Michaelis, A.A., 1911. Imejõud taimedes (Miracle Power of Plants). Kunsti ja teaduse kirjastus, Tallinn.

Molares, S., Ladio, A., 2009. Ethnobotanical review of the Mapuche medicinal flora: use patterns on a regional scale. Journal of Ethnopharmacology 122, 251–260.

Mänd, A., 2004. Pidustused keskaegse Liivimaa linnades 1350–1550. [Fests in the towns of Liivimaa in the Middle Ages]. Eesti Keele Sihtasustus, Tallinn.

Nageli, O., Thellung, A., 1905. Die Flora des Kantons Zürich. I Tell: Die Ruderal- und Adventiivflora des Kantons Zyrich. Vierteljahrschrift d. Naturf. Gesellsch, Zürich.

Paal, J., 1998. Rare and threatened plant communities of Estonia. Biodiversity and Conservation 7, 1027–1049.

Paatsi, V., 2003. Eesti talurahva loodusteadusliku maailmapildi kujunemine rahvakooli kaudu (1803–1918). [Formation of the natural science outlook of Estonian peasants through country schools (1803–1918).] Tallinna Pedagoogikaülikooli sotsiaalteaduste dissertatsioonid 5. TPÜ Kirjastus, Tallinn.

Peterson, K., 1994. Nature Conservation in Estonia, Juma, Tallinn.

Pieroni, A., Nebel, S., Quave, C., Münz, H., Heinrich, M., 2002. Ethnopharmacology of *liakra*: traditional weedy vegetables of the Arbereshe of the vulture area in southern Italy. Journal of Ethnopharmacology 81, 165–185.

Rebasoo, H.-E., 1962. Hiiumaa floora nimestik. [List of Hiiumaa flora.] Floristilised märkmed [Floristic notes]. 1, 204–252.

Reyes-García, V., Huanca, T., Vadez, V., Leonard, W., Wilkie, D., 2006. Cultural, practical, and economic value of wild plants: a quantitative study in the Bolivian Amazon. Economic Botany 60, 62–74.

Rootsmäe, L., 1987. Nakkushaigused surma põhjustena Eestis 1711–1850 (Infectious Diseases as Inducers of Death in Estonia in 1711–1850). ENSV Teaduste Akadeemia, Tallinn.

Seuberlich, E. (Ed.), 1912. Liv- und Estlands älteste Apotheken: Beiträge zu deren Geschichte. Gesammelt und bearbeitet von Erich Seuberlich, Riga.

Sõukand, R., 2007. Mis teeb taimest ravimtaime? (What makes the medicinal plant?). Acta semiotica Estica, 160–174.

Sõukand, R., Raal, A., 2004. Ravimtaimed Eesti rahvameditsiinis: ajalooline taust, etnofarmakoloogiliste andmete kogumine ja analüüs (Medicinal plants in Estonian folk medicine: historical background, collection and analysis of ethnopharmacological data). Akadeemia 8, 1734–1762.

Sõukand, R., Raal, A., 2005. Data on medicinal plants in Estonian folk medicine: collection, formation and overview of previous research. Folklore 30, 173–200.

Sõukand, R., Kalle, R., 2008. Historistlik Eesti Rahvameditsiini Botaaniline Andmebaas (HERBA) [Historical Database on Estonian Herbal Folk Medicine] http://herba.folklore.ee.

Sõukand, R., Kalle, R., 2010a. Plant as object within herbal landscape: different kinds of perception. Biosemiotics 3, 299–313, doi:10.1007/s12304-010-9078-9.

Sõukand, R., Kalle, R., 2010b. Herbal landscape: the perception of landscape as a source of medicinal plants. Trames 14, 207–226, doi:10.3176/tr.2010.3.01.

Spuhl-Rotalia, J., 1897. Kodumaa marjad, täielik õpetus. [Homeland berries, complete tutorial.] Peeti trükikoda, Viljandi.

Stahl, H., 1637. Anführung zu der Esthnischen sprach, auff Wolgemeinten Rath, und Bittliches Ersuchen. Chr. Reusner, Revall.

Stephens, D.W., Krebs, J.R., 1986. Foraging Theory. Princeton University Press, Princeton.

Stepp, J.R., Moerman, D.E., 2001. The importance of weeds in ethnopharmacology. Journal of Ethnopharmacology 75, 19–23.

Svanberg, I., 2006. Odlarmöda och trädgårdsnöje. In: Christensson, J. (Ed.), Signums svenska kulturhistoria, vol. 6. Frihetstiden, Signum, Lund, pp. 185–218.

Tammeorg, J., Kook, O., Vilbaste, G., 1972. Eesti NSV ravimtaimed (Estonian medicinal plants), second ed. Valgus, Tallinn.

Tammeorg, J., Kook, O., Vilbaste, G., 1973. Eesti NSV ravimtaimed (Estonian medicinal plants), third ed. Valgus, Tallinn.

Tammeorg, J., Kook, O., Vilbaste, G., 1975. Eesti NSV ravimtaimed (Estonian medicinal plants), fourth ed. Valgus, Tallinn.

Tammeorg, J., Kook, O., Vilbaste, G., 1984. Eesti NSV ravimtaimed (Estonian medicinal plants), fifth ed. Valgus, Tallinn.

Tardìo, J., Pardo-De-Santayana, M., 2008. Cultural importance indices: a comparative analysis based on the useful wild plants of southern Cantabria (Northern Spain). Economic Botany 62, 24–39.

Thellung, A., 1919. Zur Terminologie der Adventiv- und Ruderalfloristik. Allgemeine Botanische für Systematik Floristik, Pflanzengeographie (Karlsruhe) 24/25 36–42.

Thomas, E., Vandebroek, I., Goetghebeur, P., Sanca, S., Arrazola, S., Van Damme, P., 2008. The relationship between plant use and plant diversity in the Bolivian Andes, with special reference to medicinal plant use. Human Ecology 36, 861–879.

Thomas, E., Vandebroek, I., Van Damme, P., Goetghebeur, P., Douterlungne, D., Sanca, S., Arrazola, S., 2009a. The relation between accessibility, diversity and indigenous valuation of vegetation in the Bolivian Andes. Journal of Arid Environments 73, 854–861.

Thomas, E., Vandebroek, I., Sanca, S., Van Damme, P., 2009b. Cultural significance of medicinal plant families and species among Quechua farmers in Apillapampa, Bolivia. Journal of Ethnopharmacology 122, 60–67.

Vahtre, L., 2004. Äärmuslikkus ja äärmusetus eesti ajaloos. In: Rohumets, I. (Ed.), Lehed ja tähed: Looduse ja teaduse aastaraamat (Leaves and stars. Yearbook of nature and science). MTÜ Loodusajakiri, Tallinn, pp. 99–105.

Valk, H., 2001. Rural Cemeteries of Southren Estonia 1225–1880 AD. CCC papers, 3. Visby, Tartu.

Valk, U., 1988. Eesti sood (Estonian Peatlands). Valgus, Tallinn.

Vandebroek, I., Van Damme, P., Van Puyvelde, L., Arrazola, S., De Kimpe, N., 2004. A comparison of traditional healers' medicinal plant knowledge in the Bolivian Andes and Amazon. Social Science and Medicine 59, 837–849.
Vilbaste, G., 1993. Eesti taimenimetused. In: Ahven, E., Ahven, H., Parmasto, E., Ross, E. (Eds.), Emakeele Seltsi Toimetised nr 20. ETA Emakeele Selts, Tallinn.
Vilberg, G., 1923. Inimese kaudne mõju taimede levimisel (Indirect influence of human to the distribution of plants). Loodus [Nature] 7, 415–422.
Voeks, R.A., 2004. Disturbance pharmacopoeias: medicine and myth from the humid tropics. Annals of the Association of American Geographers 94, 868–888.
Zigra, J.H., 1808. Oekonomisches praktisches Handbuch über Gemüse-, Hopfen-Bau und Kultur der Ananas: nebst einem kurzen deutlichen Unterricht der Pfirsich-, Kirschen-, Pflaumen-, Wein- und Mistbeet-Treiberei, wie auch einer allgemeinen Übersicht der monatlichen Geschäfte in allen Theilen der Garten-Kunst/bearbeitet für's russische Reich von Joh. Herm. Zigra. J.C.D. Müller, Riga.
Zimmerer, K.S., 2001. Report on geography and the new ethnobiology. Geographical Review 91, 725–734.