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RESEARCH ARTICLE

"Please list your favourite …": How to measure online plant knowledge as a component of plant awareness

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Societal Impact Statement

Plant awareness disparity is a widespread phenomenon in modern societies. It erroneously implies that plants are not necessary for humans. Understanding what plants people know and can describe is crucial for evaluating one of four central aspects of plant awareness disparity. This study proposes a new methodology for assessing the knowledge of plants online by analysing the vocabulary used to name and describe plants. Despite the high number of listed plants, both names and vocabulary used to describe plants were homogenised and limited. Educational effort is needed to enhance plant vocabulary so that plants can become the subject of conversation.

Summary

- This study addresses the methodological gap in plant awareness studies by examining adult knowledge of plants from eco-semiotic and quantitative linguistic perspectives. Understanding what plants people know and can describe and how they do this is crucial for bridging the gap in plant knowledge and addressing plant awareness disparity.
- The novel methodology involved analysing responses from an online questionnaire distributed to residents of Tartu, Estonia. The questionnaire covered various aspects of plant knowledge, including the ability to list, describe and explain the importance of different plant categories: wild trees and shrubs, wild herbs and cultivated trees and shrubs. Data analysis included word count, contextual analysis and mapping of plant-related vocabulary used by participants.
- The study found significant diversity in the plants named by 149 adult participants, with 74 wild tree taxa and 225 wild herb taxa mentioned. Cultivated trees and shrubs were also widely recognised (168 taxa). Most descriptions focused on plant parts such as leaves and flowers, demonstrating rather poor vocabulary. The analysis highlighted the influence of personal experiences, cultural practices and educational background on plant knowledge.
- The results indicate robust plant knowledge among the study's participants, likely influenced by Local Ecological Knowledge and comprehensive school

curricula on botany. However, the study also detected a homogenisation of plant knowledge, potentially due to educational and popularisation efforts. The methodology demonstrated the potential of using linguistic analysis to understand plant knowledge and awareness, offering insights into enhancing plant-related education.

KEYWORDS
Estonia, local ecological knowledge, online methodologies, plant awareness, plant-related vocabulary

1 | INTRODUCTION

People's knowledge of the plants in their surrounding environment is crucial for various reasons, spanning ecological, educational, cultural, health, economic and societal domains. Educationally, this knowledge is an entry point for broader scientific literacy and cultivates critical thinking skills, such as observational and analytical capabilities. Culturally and historically, awareness of local flora is a means of preserving cultural identity and understanding historical context. The term "plant blindness" broadly refers to the inability or unwillingness to notice or differentiate plants in our surroundings and to acknowledge their role in our lives and their importance to the ecosystem. Since the notion of plant blindness was first defined by Wandersee & Schussler, 1999, many studies have argued the reasons for such a phenomenon (Jose et al., 2019; Krosnick et al., 2018). Being concerned with the ableist nature of the term, Parsley (2020) proposed to call the phenomenon Plant Awareness Disparity (PAD) and developed a PAD Index (Parsley et al., 2022) that includes four quantifiable components: attention, attitude, knowledge and relative interest.

PAD was not a universal phenomenon in the past. Some human cultures have developed intimate relationships with plants from early childhood (Balding & Williams, 2016; Parsley, 2020). In 1930s Estonia, the average farm child was able to differentiate "only" 50–100 plants on their way from home to school, with some naming over a hundred (Vilberg, 1928). Indeed, Stagg and Dillon (2022) have demonstrated that plant awareness develops through interaction with significant plants. In a modern, plant (and nature-) distant world, many plant enthusiasts have learned to appreciate and interact with plants by growing up on farms, spending time in nature or being influenced by inspirational plant lovers (Jose et al., 2019). Also, Stagg et al. (2024) have concluded, relying on an intensive literature review, that educational interventions increase plant awareness.

Scientists have been debating various explanations for PAD, ranging from ecological adaptation, where plants were perceived as less dangerous to humans compared to animals (Wandersee & Schussler, 2001), to theories suggesting that the slow life cycle of plants allows humans to overlook them (New et al., 2007). Pany and Heidinger (2015), in their study on how the perceived usefulness of plants affects students' interest, found that although medicinal plants often sparked interest, such conclusions could not be generalised on the individual level. A recent study among schoolchildren in Spain revealed a statistically significant bias in favour of animals, who were recognised and identified more frequently than plants across all educational levels studied (Marcos-Walias et al., 2023). Notably, Pany et al. (2022) also found a positive correlation between the attribution of the characteristics of life and the knowledge about them. However, the "knowledge" component pertains to the general awareness of plant usefulness rather than specific plant identification, and all PAD components are about perceptions.

PAD represents the loss of essential knowledge acquired through generations of informal education (Blue et al., 2023), and this gap needs to be addressed by integrating plant knowledge into formal education. Brownlee et al. (20213), for example, advocate for the inclusion of an equal number of plants (compared with animals) in introductory biology textbooks. Earlier, Colon et al. (2020) proposed bringing botany more into focus and offering an immersive botanical experience for undergraduates, while Thomas et al. (2022) positioned plants as an essential element of sustainability education and practice, and Stroud et al. (2022) warned of the *extinction of botanical education* which would create an existential threat.

Given that PAD is age-dependent (Wulandari et al., 2023), we aim to adopt a methodologically novel approach by examining actual plant knowledge in the adult population from the eco-semiotic perspective to establish a baseline. We are focusing on adults likely exposed to both Local Ecological Knowledge (LEK) and school (formal) education that includes comprehensive plant studies as a part of the compulsory curriculum. While this methodological test aims to identify key elements to address plant awareness disparity, it acknowledges its limitations. However, it offers us the prospect of a quick and affordable method for assessing the linguistic dimensions (e.g. "language of living things", Brown, 1984) of plant awareness within a specific group of people.

This work aims to test a novel methodology comprised of online free listing of known plants (a method routinely used in ethnobotany during field interviews, e.g. Zambrana et al., 2018) in specific etically (scientist) defined categories and subsequent eliciting of descriptions of the named plants and their importance for the person. For a specific case example, we aimed to highlight semantic and conceptual dependencies in the plant's naming and description based on the category of plants. As Estonia is *circa* 50% covered by forest, we expected trees to dominate the responses and anticipated profound knowledge of different aspects of plant-related vocabulary.

2 | DATA AND METHODS

2.1 | Background

This study is grounded in the assumption that Estonian adults have routinely studied plants as part of their school curricula. During certain periods, some age groups were required to compile herbariums in school and/or collect fresh fruits or dried medicinal plants for procurement, both during Soviet occupation and in the challenging economic times following Estonia's regained independence. The Estonian self-image is deeply interwoven with a biophilic nature, as reflected in local culture and practices. This national identity, often characterised by the image of Estonians as forest people by best-selling author Valdur Mikita, underscores the importance of plants in the Estonian ethos.

The study was conducted in Tartu, Estonia's second-largest city, with a population of approximately 95,000. It hosts the oldest university (established in 1632) in the region. The city is verdant, featuring numerous parks, a historic and well-established university botanical garden and several institutions dedicated to promoting nature, specifically plants.

Moreover, the Estonian language boasts a wealth of literature aimed at popularising plant knowledge. Popular science journals such as *Eesti Loodus* (Estonian Nature) and *Horisont* are issued bi-monthly and continue to attract a wide readership. The Estonian scientific community adheres to binominal plant nomenclature, a system established in the 1920s with new species names determined by a specially established plant name commission. In a tradition celebrating the country's rich biocultural diversity, Estonia annually selects and promotes the tree, orchid, moss, mushroom, animal, insect, bird, fish, etc., of the year through various media channels.

2.2 | Survey

An online survey targeting Tartu residents was developed in collaboration with the Herbarium of the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences (TAA) and conducted via Google Forms between September 2021 and January 2022. The survey was distributed through local social media groups. It was designed to cover many questions, with the objective of mapping city dwellers' attitudes towards parks and green areas. The obtained dataset (Kohv, 2022a) contributed to the second author's master's thesis (Kohv, 2022b). Prior to its wider distribution, the survey underwent a preliminary test within a control group of three individuals.

The participant pool consisted exclusively of Tartu residents, ensuring a diverse representation from various city districts to generate a comprehensive dataset for this study. A total of 149 respondents from diverse backgrounds and residential areas of Tartu participated anonymously in the survey. The majority of them reported spending at least two hours outside at least once a week; the mean age was around 50 years, and more than three-quarters of the respondents were women (Figure 1). Most participants reported a higher education level and living in one of Tartu's districts. It is essential to note that not all respondents answered every survey question, and only those interested in the subject answered the online questionnaire, which created potential bias.

2.3 | Data analysis

While the study was more extensive, for this methodological paper, we analysed the responses to the three questions. Respondents were supposed to (a) list up to ten plants significant to them within three pre-defined categories (or groups):

1. Wild trees (and shrubs)
2. Wild herbs (herbaceous plants)
3. Cultivated trees (and shrubs)

After free listing every group, they were asked to (b) explain why those are important to them and (c) provide descriptions of the listed plants. The last question aimed to assess people's ability to observe plants and to understand the primary attributes people notice.

Our analysis aimed to identify the characteristics observed and mentioned in plant descriptions. We extracted the responses into Microsoft Excel and utilised the n-gram generator (Reuneker, 2019) for the question-based analysis. To count the most frequently mentioned taxa, we manually reviewed the n-gram outcomes to account for all variations in local names, thereby assessing plant diversity. It is important to note that due to vague descriptions and the use of common names, identifying some taxa at the species level was challenging, leading to general identification at the genus level in some cases; for example, *Betula pendula* (*arukask*) and *Betula pubescens* (*sookask*), which a few people also identified more specifically on the species level. For correlating local names and Latin names, we relied on the long-term study of local plant names by the first and last authors and official Estonian plant terminology (including but not limited to the Index of Estonian Plant Names, https://taimenimed.ut.ee/). We used the Plants of the World Online database (https://powo.science.kew.org) to provide the accepted Latin name, which may differ from the one provided in the national flora.

Additionally, we identified variations in the descriptions related to colour, habitat, season plant part and other frequently mentioned keywords. Detrended Correspondence Analysis (DCA) was performed in Past 4.16c (Hammer et al., 2001) to analyse the adjectives applied to different plant groups. For other illustrations, Microsoft Excel and RAWGraphs 2.0 (Mauri et al., 2017) were used.

For a more detailed qualitative analysis, we selected two commonly mentioned wild plants (birch and dandelion) to explore the elements of their descriptions and their socio-cultural importance. The potential influence of LEK and school education was evaluated through the variations in local names and context of descriptions.

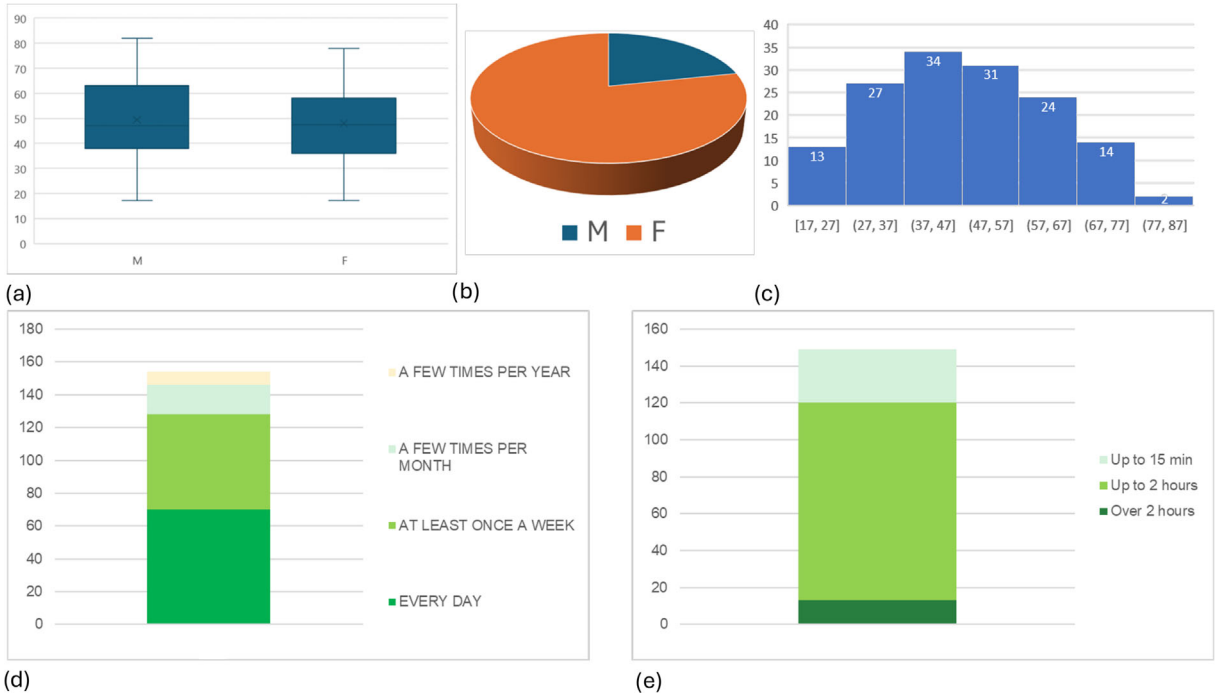

FIGURE 1 Demographic characteristics. (a) Distribution of ages between genders. (b) The proportion by gender, with women dominating as active respondents. (c) The age distribution of respondents. Self-evaluation of respondents about the frequency (d) and time (e) spent in green areas (including wild/rural areas). A large proportion of the respondents visited green areas frequently and stayed there for a relatively longer time.

3 | RESULTS

3.1 | Survey responses

The categorisation of plants into wild herbaceous plants was relatively univocal, especially for the most frequently mentioned herbs. However, there was overlap in the list of the most named wild and cultivated trees/bushes, with four taxa (*Malus*, *Syringa vulgaris*, *Crataegus* and *Sorbus*) appearing in both categories as being among the most often mentioned.

3.1.1 | Wild trees

In this survey, 145 participants listed **wild trees and shrubs**, naming a total of 74 taxa. Notably, 37% of the respondents listed ten or more taxa, and less than five taxa were named by 19% of the respondents, the most popular being Birch (*Betula*). Nineteen taxa were named by more than ten people (Table S1). Approximately half of the respondents (49%) justified their preference for using products from trees or shrubs (for medicine, food and aesthetics). For example, one of the most popular answers was picking lime blossoms and making tea from them. People also considered it important to collect sap from birch and maple trees. However, trees and shrubs were generally harvested outside urban environments, in rural areas or as far away as possible from denser settlements (more remote parks, more wooded edges of the city) or in personal gardens within the city. Additionally, 20% of all respondents reported not collecting anything from wild trees. Wild trees were also associated with several beliefs, traditions, personal memories and experiences. Thirty people also mentioned aesthetic reasons for the inclusion of some species on the list. Twenty-four people did not describe wild trees and bushes, while 39 gave a general description and 25 provided detailed descriptions of trees; three respondents described taxa through utilitarian aspects and six through emotional relationships.

3.1.2 | Wild herbs

For **wild herbs**, 143 participants named 225 taxa in total, with dandelion (*Taraxacum*) being the most frequently mentioned. While 27% of respondents listed ten or more species, 26% named fewer than five and 10% used general terms like "forest berries", "hay" or "grass" without specifying the species. Eighteen taxa were named by ten or more people (Table S1).

The named plants grow in different habitats, and many are not anthropophilic. Two respondents also named mushrooms, which indicates that some people still consider them plants. Most of the referred to uses of herbaceous wild plants are related to their medicinal use (17%), while 29 people responded that they do not collect or use any herbs, and 13 others did not answer the question. Forty-five respondents did not describe the herbs that they free listed, while 43 people described them generally, and 24 people described them in detail. Twenty-eight respondents declared they knew the plants but did not want to describe them (no time, too much work, does not make

sense), while three others declared that they could not describe the plants they listed. Five additional people described utilitarian aspects instead of the plant itself.

3.1.3 | Cultivated trees

Regarding **cultivated trees and shrubs**, 143 participants listed 168 taxa. However, more than ten people named only 11 cultivated plants, the most popular being the apple tree (*Malus*). At least ten taxa were named by 22% of respondents, and 31% named less than five taxa. Three people declared that they do not have cultivated plants around their homes, while 9% of the respondents did not name any taxa. One hundred and twenty-six people justified their free list, and 16 declared that they did not use ornamental and fruit trees and did not attach any importance to them. Ninety-two people justified their choice based on the expected use of the products for food. Garden produce was more highly valued by people who had their own gardens. Trees and shrubs planted by the respondents themselves were considered important: in an urban environment, people value the opportunity to grow their own food. Moreover, 50 respondents valued the aesthetic appearance of cultivated trees and bushes. Of the 87 people who responded to the question asking for a description of the utilised cultivated plants, 44 provided general and 24 detailed descriptions of them; 19 others claimed to know the plant but did not want to describe it, while 6 said they could not do so. Four people described utilitarian aspects instead.

3.2 | Most named and described plants

While the number of most listed taxa was quite even among wild groups, it was almost two times less for the cultivated species. The diversity of represented plant families was higher in wild herbs, followed by wild trees and bushes, while cultivated trees and bushes were predominantly from the Rosaceae family (Figure 2). Overall, 26% of the taxa mentioned in free lists were described; however, the percentage varied by group, with 28.2% for trees, 22.6% for wild herbs and 19.5% for cultivated trees. Wild *Prunus padus* was described by more than half of the respondents who mentioned it, while the least described species (5.8%) was cultivated *Prunus insitita* (Table 1, Figure 2). Additionally, the dynamics of the correlation between free-listing and description differed by group (Figure 3): there was a linear correlation between the number of mentions in a free-listing and the number of mentions in descriptions, following slightly different best-fit trajectories. The most popular wild trees were proportionally more mentioned and described on the basis of the sum of mentions, yet for

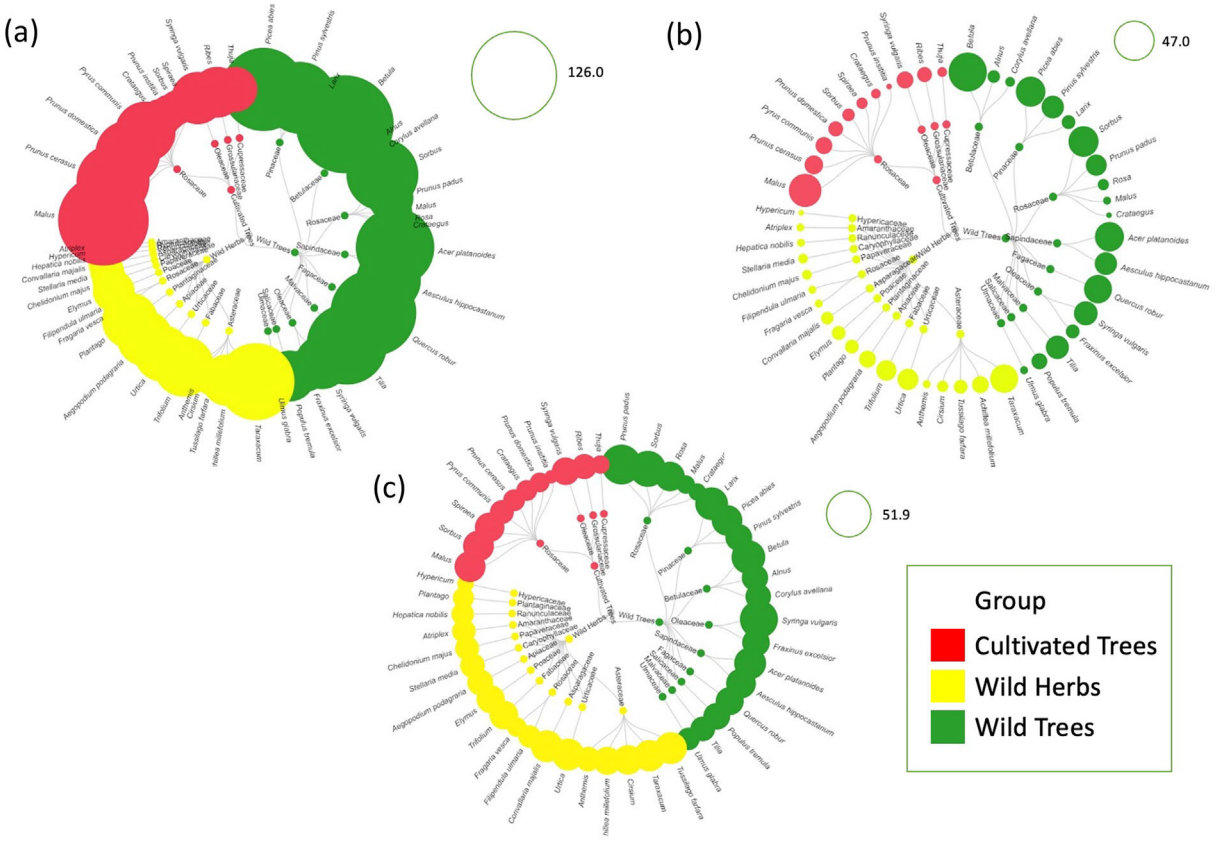

FIGURE 2 Circular dendrograms illustrating the relationships between groups and families, number of mentions in the free-listing section (a), in the description section (b) and the percentage of respondents who described the named taxa (c). While there is a clear dominance of wild trees, the proportion of people describing the taxa is diverse only in exceptional cases and remains around 20–30% of the respondents.

TABLE 1 The five most popular taxa in the three plant categories. The diversity and number of mentions (if more than one) of their local names. NF – number of times it was named first in the list by a respondent (if it was more than once). NM – number of mentions, ND – number of description instances. Percentage (%) of people providing at least some type of description.

Category	Latin name	Family	Local names	NF	NM	ND	%
Wild Trees	*Betula* spp.	Betulaceae	kask (107), kased (8), arukask (7), sookask, kaseke	35	126	47	37.30
	Quercus robur L.	Fagaceae	tamm (92), tammed (5)	28	97	25	25.77
	Picea abies (L.) H. Karst.	Pinaceae	kuusk (87), kuused (4)	10	91	28	30.77
	Tilia spp.	Malvaceae	pärn (78), pärnad (7)	20	85	17	20.00
	Acer platanoides L.	Sapindaceae	vaher (74), vahtrad (6), vahter	12	81	27	33.33
Wild Herbs	*Taraxacum* sect. Taraxacum F.H.Wigg.	Asteraceae	võilill (73), võililled (5)	35	78	25	32.05
	Trifolium spp.	Fabaceae	ristik (28), ristikhein (15), ristikkud (3), aasristik, kassiristik	7	48	13	27.08
	Urtica spp.	Urticaceae	nõges (22), kõrvenõges (18), raudnõges, nõgesed		42	14	33.33
	Aegopodium podagraria L.	Apiaceae	naat (40), naadid	7	41	9	21.95
	Plantago spp.	Plantaginaceae	teeleht (39), teelehed (2)	7	41	6	14.63
Cultivated Trees	*Malus* spp.	Rosaceae	õunapuu (69), õunapuud (21), õun (10), paradiisiõun (2), iluõunapuu (2), iluõunapuud (2), sügisõunapuu, õunad	58	108	34	31.48
	Prunus cerasus L. /*P. avium* (L.) L.	Rosaceae	kirss (24), kirsipuu (14), murel (13), kirsipuud (7), kirsid (8), maguskirss (2), murelid (2), hapukirss	5	70	11	15.71
	Prunus domestica L.	Rosaceae	ploomipuu (23), ploom (20), ploomid (6), ploomipuud(6), munaploom		55	7	12.73
	Pyrus communis L.	Rosaceae	pirnipuu (25), pirn (15), pirnipuud (6), pirnid (2)		48	9	18.75
	Syringa vulgaris L.	Oleaceae	sirel (28), sirelid (7), topeltsirel	10	36	9	25.00

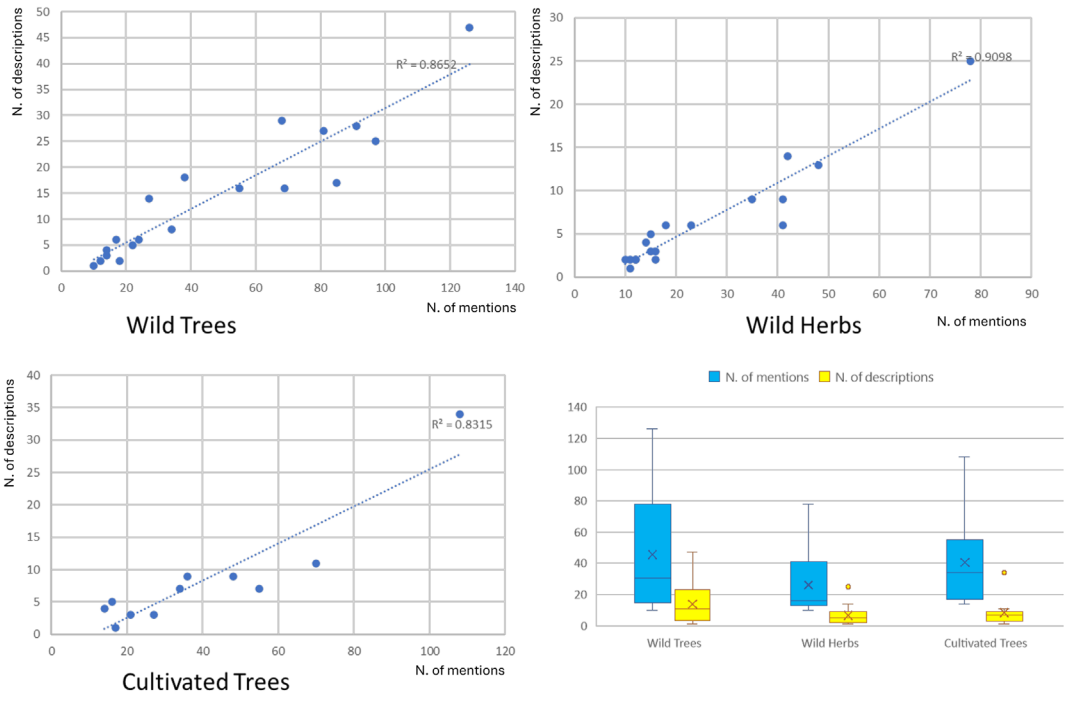

FIGURE 3 The proportional relationship between the most popular named and described plants in all three categories. The wild trees (a), wild herbs (b) and cultivated trees (c) all give linear correlation, while the R^2 of the wild herb trendline is slightly larger, signalling a stronger linear correlation. Yet, the comparison summary of mentions of the most popular species in the free list and description clearly shows that trees, especially wild trees, are more named and described (d).

each of the three categories, there was a marker species (*Betula*, *Taraxacum* and *Malus*) that was named and described the most.

3.3 | Plant parts most popular in descriptions

Plant parts deserve special attention, as they are the most frequently used descriptors. Leaves were the most mentioned plant parts (132 mentions), followed by flowers (114 mentions). The prevalence and proportion of the plant parts mentioned varied across tree groups (Figure 4). Wild trees were represented by the nine most mentioned plant parts, with leaves overwhelmingly predominant. Wild herbs featured five plant parts, with flowers predominating, followed by descriptions of leaves and stems. Cultivated trees and bushes were associated with fewer mentions but the highest number of plant parts (10), among which flowers, leaves and fruits were relatively equally mentioned. In the Estonian language, there is a qualitative distinction between fruits (*viljad* – typically larger, like apples or plums) and berries (*marjad* – generally smaller, like blackberries or blueberries). The former term was mainly used to describe cultivated plants, while the latter was used for wild trees, although the differences are relatively minor.

3.4 | Other vocabulary used for describing plants in different groups

Almost all of the most-mentioned adjectives were applied across all three groups, with the exception of "small" and "wide", which were not used for cultivated trees. However, certain adjectives were more often attributed to specific groups, like "good", "very" and "high" to wild trees, "flowering" and "smelling" to cultivated trees and "small" to wild herbs (Figure 5a). The colour analysis revealed a diverse palette of mentioned colours, with "blue" being unique to wild herbs. "Green" (representing leaves) was most frequently mentioned for wild trees, "yellow" for wild herbs (often in reference to yellow flowers) and "red" for cultivated trees (describing various shades of red) (Figure 5b). The use of conjunctions and propositions in plant descriptions was relatively evenly distributed among the groups (Figure 5c). The descriptions were associated with all seasons, but "fall" (autumn) was predominant in all three groups (Figure 5d).

The term "tree" (*puu*) was primarily associated with wild trees, while "bush" (*põõsas*) was mentioned equally across all three categories. Two people also used "tree" (referring to a tree-like structure or growth under the tree) to describe herbaceous plants, for which "plant" (*taim*) was the predominant reference.

Among the most mentioned plant taxa, the diversity of local names is relatively low due to variations in singular and plural forms and the naming of species within genera, or cultivated varieties in the case of cultivated plants, with one common word. Historical plant names are very rarely present, mainly referring to wild herbs and specific varieties. Although binominal Estonian folk plant names are generally not used, the adjective "*harilik*" (common) frequently appears among the local names for wild trees (27 times) and wild herbs (24 times), but less so for cultivated trees (8 times), indicating a strong influence from literature and/or school education.

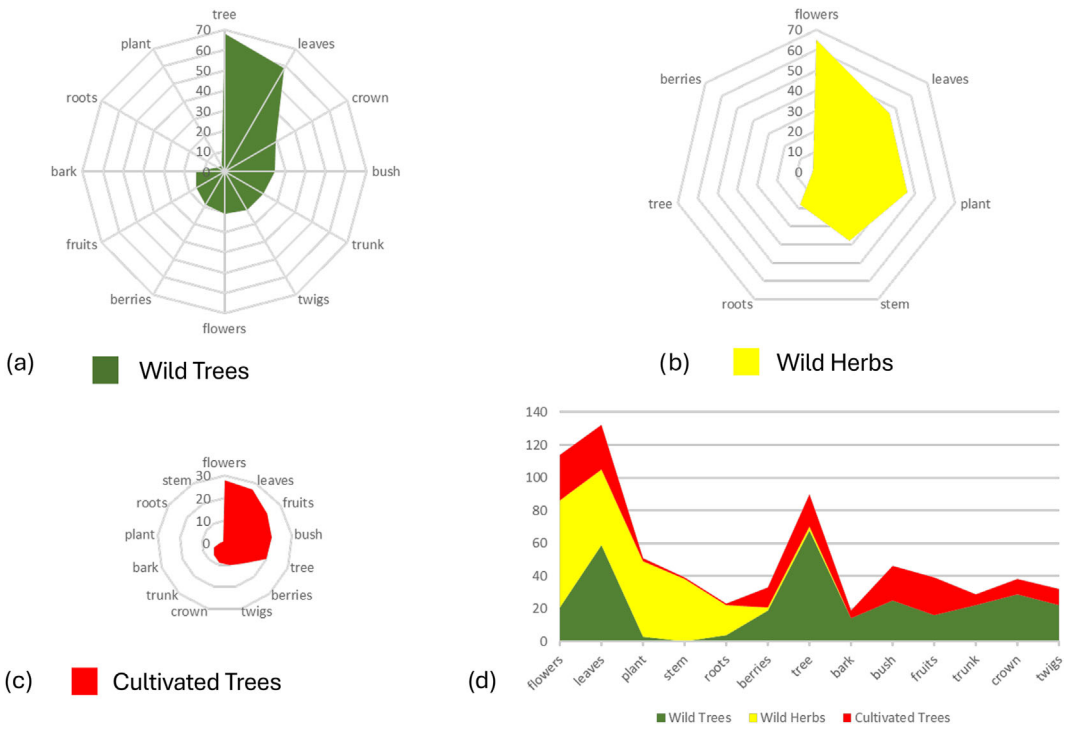

FIGURE 4 Representation of plant parts in the descriptions. The most diverse and numerous mentions of plant parts were for the wild tree category.

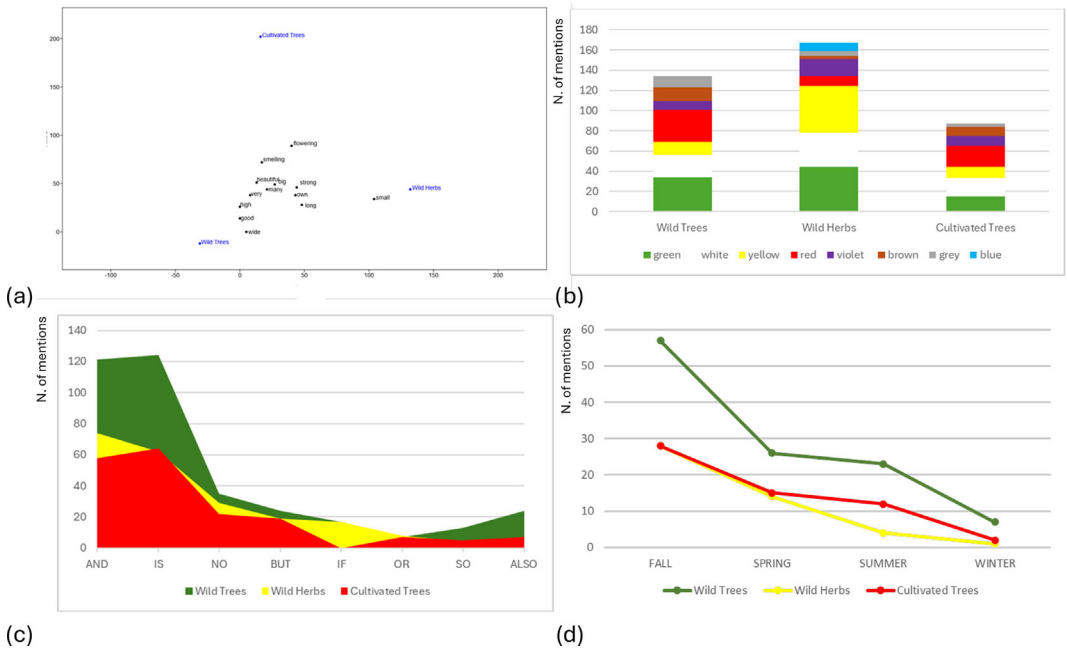

FIGURE 5 Analysis of the most popular sentence components, including adjectives (a), colours (b), connectors (c) and seasons (d). The vocabulary that is used to describe the categories varies, following their specific characteristics.

The descriptions of birch trees (*Betula*) covered a broad range of aspects, from general attributes like height and age, to specific details about leaves and trunks, with different respondents focusing on various details (Table 2). Moreover, the socio-cultural importance of the birch was emphasised through different personal and collective experiences. Dandelion (*Taraxacum*), the most popular herbaceous plant, was primarily described by its flowers, seeds and juice, which stains clothing. These descriptions reflect the detailed attention paid to specific plants without confusing them with similar species, a common issue with less-mentioned taxa. Notably, much of the vocabulary used, such as "*hiirekõrvad*" (mouse ears), is not found in key reference books, indicating even greater diversity in descriptions and terms used for less-mentioned taxa.

4 | DISCUSSION

4.1 | Plant knowledge as a component of awareness

The long list of plants that many people named indicates a well-established plant knowledge within this sample community and also confirms, for the specific example, that the level of the awareness is linked to the relevance of the plant, as suggested by Stagg et al. (2024). Additionally, the diversity of the named plants, especially in the wild herbs category, suggests a robust distribution of knowledge (Sõukand, 2024). The wide variety of taxa named in the cultivated category signals direct experience with cultivating yard trees, which may have had its roots in childhood experience with home gardens of summer cottages (Lohr & Pearson-Mims, 2005 also highlighted the importance of early interaction with plants) or familiarity with the nomenclature of taxa used in urban greenery. The relatively large number of people who answered the questionnaire and their distribution across various age groups demonstrate the interest of Tartu residents in plants. The first and the last authors observed a similar tendency ten years earlier when researching wild food plants used in childhood (Sõukand & Kalle, 2016). The personal importance of the described plants correlates well with interest in the direct interaction with plants, as highlighted by Krosnick et al. (2018).

4.2 | Linguistic PAD

The quantitative linguistic analysis of the plant-related vocabulary is crucial for several reasons and can be interpreted on multiple levels. The widespread use and circulation of numerous local plant names among the population serve as an effective tool against PAD, as naming something implies being aware of it. However, the sharp decrease in the diversity of names compared to the historical data (Sõukand & Kalle, 2008) points to homogenisation in uses, particularly medicinal (see also Sõukand et al., 2022, 2024), likely due to the influence of the centralised school education and other means of popularisation, regardless of its general importance for opposing PAD (Jose et al., 2019).

Describing plants requires familiarity with them and often a focus on details. From a semiotic perspective, identifying the specific features noticed and transferred in communication acts (either orally or in writing) in personal conversations or through popularisation sources is vital (Sõukand & Kalle, 2010). Analysing the open-response text used to describe a plant's features and explain the plant's importance from a personal viewpoint can guide the bridging of scholarly and

TABLE 2 Selected examples of comparative descriptions of birch and dandelion from the obtained responses. The descriptions of birch are richer and more numerous, and these trees are clearly more noticed and appreciated.

Characteristics	*Betula*	*Taraxacum officinale*
Height, general description	• the birches are about 35 years old, tall, different shapes • about 80–100 years old • the overall shape is elongated • 20 m high • deciduous • elongated crown • 6–7 m high	• high, low • smooth, green
Description of the leaves	• beautiful golden leaves in autumn and lovely fresh green leaves, "mouse ears" in spring • golden in autumn • leaves slightly triangular in shape with jagged edges, they will decompose within a year • leaves turn yellow in autumn • birch leaves are golden yellow • leaves green in summer, golden yellow in autumn • small, pale green leaves in spring • colourful in autumn • small leaves • heart-shaped leaves	• juicy • herbaceous rosette, leaves with saw-toothed edges, elongated • elongated, with serrated edges • shallow green leaves
Detailed description	• with white and black trunks, • tall deciduous tree with smooth white to greyish rough trunk • white trunk with black lines, • white bark with dark spots on the bark • trunk black and white variegated • white with black spots • pale trunk • white bark (partly with black spots)	• stem is hollow from the inside, without leaves; has sap • the sap is bitter and milky, stains clothing • has a large golden yellow flower at the stem end • flowers have many delicate golden/sunny yellow petals; the petals are close together • after flowering, fluffy white spheres
Flowering	• catkins in spring, pollinated by wind • blooms in early spring	• blooms in spring, in May • blooms until the fall (autumn)
Other descriptive elements	• with hanging branches, young, flexible • large, mobile • with pliable branches • slender, tall • tender hanging branches • fine • erect branches	• is pollinated by insects • seeds are equipped with a "parachute", i.e. they are spread by the wind • spreads well by seeds flying in the wind • produces white mists
Habitat	• mature birch forest (as in Ihaste) is also rare in the Estonian context • across the road in the park and behind the house in the "prairies"	
Socio-cultural importance	• very common tree in Estonia and good fuel for heating • the birch trees on my street are old and thick • the birch trees on my street are middle-aged, tall and produce good sap • the most eye-catching are mouse-ear leaves or powdery catkins • the big birches with their tender branches are particularly beautiful • deciduous, ornamental for its autumn yellow leaves • produces a lot of litter in the form of seeds and leaves • the birch trees seem to rustle • birches and syringa grow under the window • birches provide whisks for sauna, as well as colour • birch was my grandmother's surname • I associate birch with summer • birch sap is for drinking and leaves can be used for tea • birch comforts	• perennial plant • grows almost everywhere, including in pavement cracks • weed • grows out of asphalt fragments

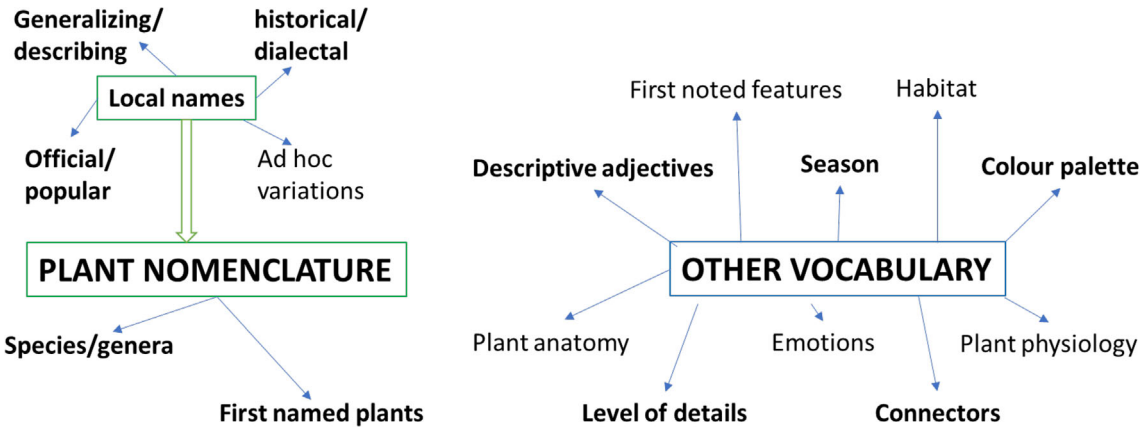

FIGURE 6 Categorisation of plant-related vocabulary. The aspects covered to a certain extent in the current study are highlighted. The list is not exhaustive and can be updated.

popular plant-related vocabulary. Figure 6 outlines the aspects to consider in the analysis of plant-related vocabulary.

The other vocabulary (beyond the plant nomenclature) used in the description of the plants stayed on a general level and was rather standard (following the best practice of scientific terminology e.g. Garnier et al., 2017, regardless of the existence of the specific folk ontology (sensu Ellen, 2016), even for a more detailed description. The reason might be the absence of specific prompts for deeper anatomical inquiry in the online questionnaire, which could have been remediated in a face-to-face interview. However, the relatively low percentage of the other descriptions provided (like that of the colour palette (Figure 5b) and anatomical features (Figure 4), may also signal the perceived confidence in the name provided and the expectation that the name alone is enough to identify the plant.

4.3 | Limitations and suggested improvements for future studies

As with all methodological tests, this one has its **limitations,** which we outline below, along with proposed **methodological improvements for future studies**:

- Free listing is a powerful tool even for online interviews, although not fully reliable (see also Zambrana et al., 2018). The questionnaire was designed so that the free list was done as an open text, which made the subsequent descriptions and explanations sporadic and data processing time-consuming. We recommend prompting the entry of plant names individually and asking supporting questions for all entered plants, potentially integrating AI for species-specific inquiries.
- The structure of the questionnaire may have influenced the frequency of descriptions. Since wild trees were named first, they showed the largest numbers in almost all categories, as respondents might have exerted too much effort into the initial answers and then felt fatigued when they reached the subsequent questions. Therefore, we propose allowing respondents to choose which category to answer first, indicating their interest in a specific category (and subsequently in the description of plants).
- Careful consideration should be given to defining the categories of plants inquired about. The specific division was based on long-term ethnobotanical fieldwork in Estonia, and even then, the way people categorise plants is not always univocal, as some plants can be both wild and cultivated. Thus, we recommend conducting pilot qualitative studies on local botanical knowledge before administering an online questionnaire or/and asking respondents to suggest the categories, then prompting free listings based on those suggestions.
- We analysed in detail only the most well-represented vocabulary (named by at least ten people). The depth of the analysis and the importance of the findings could be enhanced by considering individual differences (e.g. Pany & Heidinger, 2015).
- The questionnaire was completed by respondents who clearly had at least a basic interest in the subject and, therefore, is not completely representative. This limitation is difficult to address unless participation in the survey is made mandatory to randomly selected individuals or, for example, as a compulsory school assignment, in which case the results would likely differ both qualitatively and quantitatively.

However, these limitations do not diminish the value of the obtained analysis and contribute to a better understanding of the methodological challenges in studying plant awareness. Nevertheless, this methodology cannot replace classical PAD evaluation methods, although it can serve as a good aid for quick mapping of the situation in specific cultural and linguistic settings. The proposed improvements could facilitate methodological advances in data acquisition and analysis.

AUTHOR CONTRIBUTIONS

Raivo Kalle and Andres Kohv conceived and designed the study. Andres Kohv collected data. Raivo Kalle and Toomas Kukk supervised

the data acquisition. Renata Sõukand, Andres Kohv and Raivo Kalle conducted the data analysis; Renata Sõukand wrote the first draft of the article. Renata Sõukand, Andres Kohv, Julia Prakofjewa, Toomas Kukk and Raivo Kalle revised and edited the paper; all authors reviewed and approved the final version.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The dataset used for analysis is stored in the Folklore Archives of Estonian Literary Museum, ERA, DK 957.

ETHICS STATEMENT

The ethical guidance of the International Society of Ethnobiology (ISE, 2006) was rigorously followed. Data collection was conducted anonymously, ensuring the protection of participants' privacy and confidentiality. No sensitive personal information was collected, and the study posed no foreseeable risks to participants. Consequently, formal ethical approval was not required for this research, as per institutional and legal standards applicable to this type of study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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