










Vegetation of open habitats in the Turku Archipelago (Finland): the GrassPlot dataset FI_A sampled during the 21st EDGG Field Workshop

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Abstract: The 21st Field Workshop of the Eurasian Dry Grassland Group (EDGG) was conducted from 28 June to 6 July 2025 in the Turku Archipelago, Finland, and was the first Field Workshop ever held in Northern Europe. The research expedition aimed to survey the diversity of semi-natural pastures and meadows, rocky dry grasslands, sandy grasslands, coastal habitats, wooded pastures, heathlands, and wetlands in the region, focusing on vascular plants, bryophytes, and lichens. In total, we sampled 170 nested-plot series from 1 cm² to 10 m², and for a subset of 38 plots extended sampling to a seventh grain size of 100 m² (full “EDGG Biodiversity Plots”). Mean species richness ranged from 2.9 species in 1 cm² to 51.6 species in 100 m², with bryophytes and lichens contributing increasingly higher fractions at larger grain sizes. Plots were preliminarily assigned to 14 vegetation classes, namely the *Cakiletea maritimae*, *Calluno-Ulicetea*, *Festuco-Brometea*, *Honckenyo-Elymetea*, *Juncetea maritimi*, *Koelerio-Corynephoretea*, *Molinio-Arrhenatheretea*, *Nardetea strictae*, *Oxycocco-Sphagnetetea*, *Phragmito-Magnocaricetea*, *Polygono-Poetea*, *Scheuchzerio-Caricetea*, *Sedo-Scleranthetea*, and *Trifolio-Geranietea*. The collected plots can serve as a baseline for long-term monitoring; the final dataset will be integrated into GrassPlot (ID: FI_A), EVA and sPlot.

Keywords: biodiversity; bryophyte; coastal vegetation; Finland; grassland; lichen; nested plot; semi-natural; syntaxonomy; Turku Archipelago; vascular plant; vegetation-plot database.

Nomenclature: Euro+Med (2025) for vascular plants, Hodgetts et al. (2020) for bryophytes, www.indexfungorum.org for lichens; Mucina et al. (2016) for syntaxa.

Abbreviations: EDGG = Eurasian Dry Grassland Group.

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Introduction

The Eurasian Dry Grassland Group (EDGG) has organized annual Field Workshops (research expeditions) since 2009 with the goal of comprehensively documenting and analysing plant diversity of grasslands and other open habitats throughout the Palaeartic biogeographic realm. A key focus of these expeditions is the collection of high-quality original data from underrepresented countries and vegetation types (Dengler et al. 2016a). Central to the Field Workshops is the objective to record biodiversity of various taxa and specifically vegetation using the standardized EDGG methodology. This standardised approach uses multi-scale (0.0001-100 m² nested plots) and multi-taxon, sampling to systematically collect biodiversity and composition data of vascular plants, bryophytes, and lichens, complemented by optional recording of invertebrates (Dengler et al. 2016b; Dengler et al. 2021). The Field Workshops take place in different regions one or two times a year. By 2025, EDGG has organized 20 of these events, resulting in numerous publications (Bergauer et al. 2022; Cancellieri et al. 2024; Khodosovtsev et al. 2024; Vynokurov et al. 2024b; Guarino et al. 2025; Klopsch et al. 2025).

The 21st Field Workshop in Finland was the second Field Workshop held in 2025 (Vynokurov et al. 2024a), and the first ever conducted in Northern Europe (Miskova et al. 2025). It aimed at collecting a representative dataset of all natural and semi-natural habitat types of the Turku Archipelago. The focus during the workshop was on three distinct regional zones defined by environmental conditions (Inner, Intermediate, and Outer Turku Archipelago), representing a high diversity of habitats, including coastal meadows, heathlands, rocky grasslands, forest edges, as well as wooded pastures and meadows. In addition to collecting grassland data from a region new to the EDGG, a main goal of the 21st Field Workshop was to contribute to the development of a long-term monitoring system for open habitats in the Turku Archipelago, in collaboration with the local organizers. This effort will create a valuable reference for tracking environmental changes and understanding habitat dynamics in that region over time.

In this report, we describe the sampling of the 21st Field Workshop and the resulting GrassPlot dataset FI_A. At the same time, we provide some first insights into the floristic composition of the vegetation and diversity patterns.

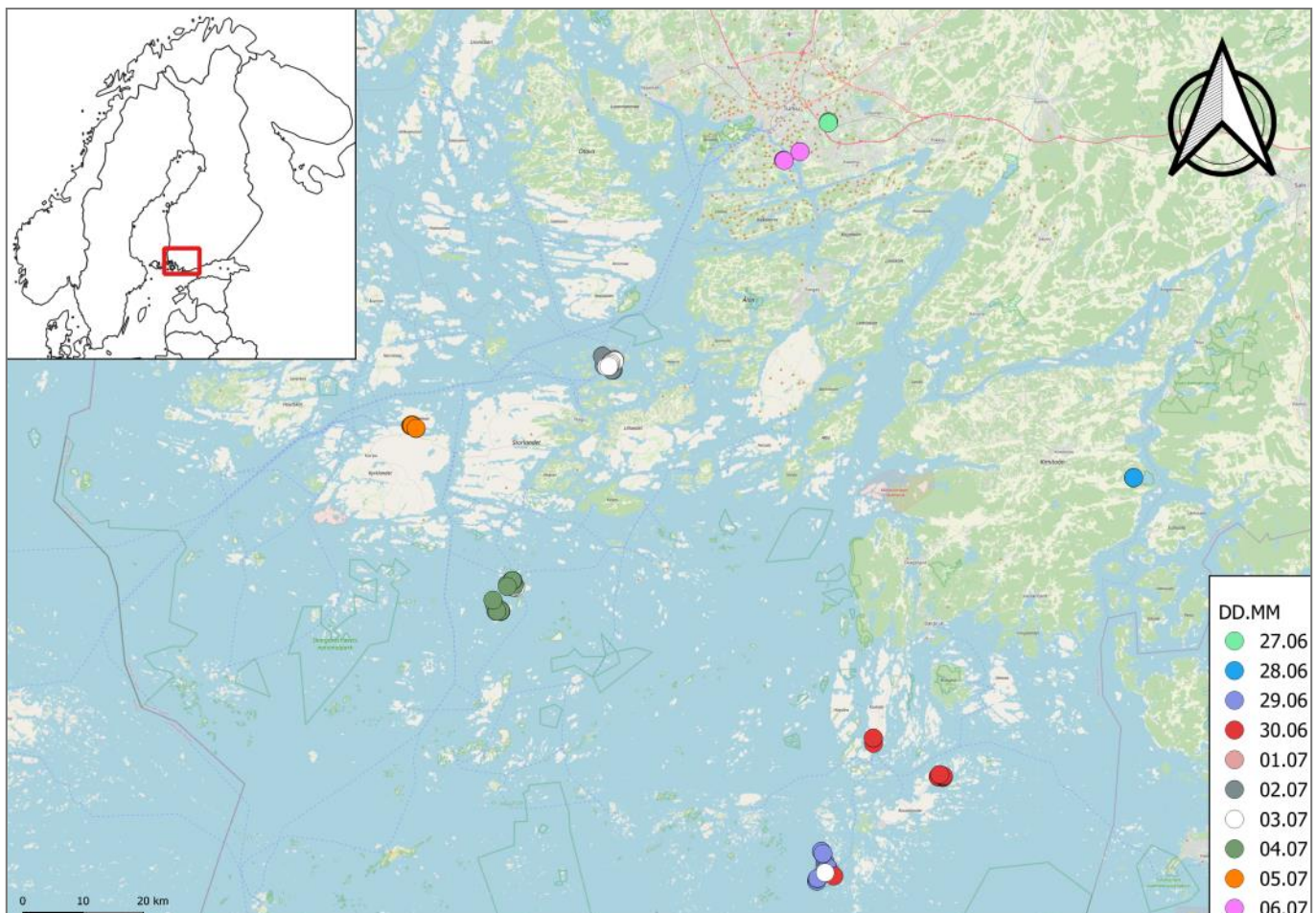


Figure 1. Map of the study region, sampling localities investigated during the 21st EDGG Field Workshop. Base map: ©2026 Google, country border, extracted from OpenStreetMap (openstreetmap.org).

Study area

The 21st Field Workshop took place in the Turku Archipelago in the Archipelago Sea (Baltic Sea), off southwestern Finland (Fig. 1; von Numers, 2011). The Turku Archipelago covers a shallow non-tidal area and includes more than 22,000 islands, ranging in size from a few square meters to inhabited islands spanning tens of square kilometres (Granö et al. 1999). The Archipelago Sea Area is designated as a biosphere reserve and includes several Natura 2000 sites (Skärgårdshavets Biosfärområde – Saaristomeren biosfäärialue). Its southern part forms the Archipelago Sea National Park, which contains both traditionally managed cultural landscapes (semi-natural grasslands, wooded pastures) and strictly protected areas with low human impact (forests, seashores; Heinonen, 2016). This mosaic structure creates a wide range of environmental conditions and habitats across the islands.

The study area extended from 59.80° to 60.24° northern latitude and from 21.62° to 22.84° eastern longitude, with elevations ranging from 0 to 63 m a.s.l. The climate is maritime, thus relatively mild, although the early part of the growing season often exhibits continental characteristics, including low precipitation and higher insolation compared to the mainland. The average length of the growing season is about 180 days, with a mean annual precipitation of 500 mm and an average ice-cover duration of 70 days (Atlas of Finland 1993). The mean annual temperature is ca. 7 °C (Karger et al. 2017). The islands emerged from the sea after the last glaciation, around 12,000 years ago (Aikio 2020). Since prehistoric times, the culture and economy of the people in the Archipelago Sea depended on both terrestrial and marine resources (Leppäkoski et al. 1999). All large islands with nutrient-rich soils have been inhabited and used for agriculture since the Middle Ages. Beyond the medieval

settlements, expansion of farming and a population boom 100–200 years ago led to increased human activity, also on smaller islands in the outer archipelago, creating many of the traditional landscapes still visible today, while the traditional land use often has ceased (Leppäkoski et al. 1999).

Today, the grassland network of the Archipelago Sea is among the ecologically most significant ones in Finland (Raatikainen et al. 2017). The region supports a diverse mosaic of open habitats whose structure and composition are profoundly shaped by historical and contemporary anthropogenic disturbance regimes, particularly traditional agricultural practices such as grazing and mowing (Leppäkoski et al. 1999). Typical semi-natural communities include heaths, calcareous sub-thermophilous meadows, acidic herb-rich dry meadows, mesic meadows, and wooded meadows (Table 1, Fig. 2). Moreover, natural open habitats, such as rocky outcrops, brackish salt marshes, mires and coastal shorelines are also widespread, offering a mosaic of diverse site conditions.

Methods

To enable sampling of a sufficient number of plots for statistical comparisons among the various habitat types as well as a sufficient for vegetation classification, we modified the normal EDGG Field Workshop methodology (Dengler et al. 2016b, 2021). In addition to some traditional “EDGG Biodiversity Plots” (with seven grain sizes up to 100 m² and two nested subseries in opposite corners of the largest plot), we mainly sampled “Half Biodiversity Plots” with only six grain sizes (up to 10 m²) and no replication. In total, we collected 170 10 m² plots, of which 38 were complete “EDGG Biodiversity Plots”, i.e. still more than in most previous Field Workshops (Table 1).

Table 1. Overview of the sites studied during the 21st EDGG Field Workshop.

Location	“Half Biodiversity Plots”	“Biodiversity Plots”	10 m ² plots (total)
Berghamn	18	6	30
Boskär	5	5	15
Hailuoto	3	0	3
Hiittinen	8	2	12
Kasnäs	3	1	5
Kemio	2	0	2
Örö	18	4	26
Östra Långholm	3	1	5
Seili	26	14	54
Turku (mainland)	2	2	6
Vattkast	6	3	12
Total	94	38	170

Table 2. Overview of the vegetation classes studied during the 21st EDGG Field Workshop.

Vegetation class	10 m ² plots
<i>Cakiletea maritima</i>	1
<i>Calluno-Ulicetea</i>	8
<i>Festuco-Brometea</i>	13
<i>Honckenyo-Elymetea</i>	3
<i>Juncetea maritimi</i>	14
<i>Koelerio-Corynepharetea</i>	35
<i>Molinio-Arrhenatheretea</i>	39
<i>Nardetea strictae</i>	5
<i>Oxycocco-Sphagnetea</i>	1
<i>Phragmito-Magnocaricetea</i>	1
<i>Polygono-Poetea</i>	3
<i>Scheuchzerio-Caricetea</i>	4
<i>Sedo-Scleranthetea</i>	32
<i>Trifolio-Geranietea</i>	11
Total	170

The plots were sampled at 10 locations (nine islands and the mainland in Turku) selected to represent different geological conditions and the gradient from the mainland through the Inner and Intermediate to the Outer Turku Archipelago (Table 1). Within each island, we tried, within the available time, to capture the different open habitat types present (Fig. 2) and, if the same main habitat type occurred in multiple patches, to collect multiple plots separated spatially. According to our preliminary expert-based assignment, we sampled plots from 13 vegetation classes, with wet to mesic grasslands (*Molinio-Arrhenatheretea*), dry sandy grasslands (*Koelerio-Coryneporetea*), and rocky outcrop communities (*Sedo-Scleranthetea*) being most represented (Table 2).

In each subplot of any size, we recorded the presence of all vascular plants as well as terricolous bryophytes and lichens with the shoot-presence method (Dengler 2008), while at

10 m² their cover was additionally estimated in percent (Dengler & Dembicz 2023). Critical specimens were collected and identified in the laboratory also with the use of stereomicroscopes and compound microscopes. In each 10 m² plot, we also measured the standard set of structural and environmental variables of EDGG (Dengler et al. 2016b).

Moreover, from each 10 m² plot, a mixed soil sample of the upper 10 cm was taken in five random points inside each plot, air-dried and later analysed in the lab for standard soil parameters. This was done by sieving to the fine-soil fraction after additional air-drying and, the following parameters were measured in the lab: pH (in H₂O, electrometrically), electrical conductivity (µS/cm, electrometrically), organic C content (mass %, determined by combustion in a furnace at 550 °C for 90 minutes) and soil texture (by granulometry).



Figure 2. Different open habitat types sampled during the Field Workshop. A – Shoreline community with *Crambe maritima* on gravel, B and C – Meso-xeric grasslands, D – Heathland, E – Rocky grasslands, F – Wooded meadow. Photos: A–C – D. Vynokurov, D–F – J. Dengler.

Initial results and discussion

Floristic composition

According to preliminary results, 438 vascular plant, 108 bryophytes and 51 lichen taxa were recorded across all vegetation plots. After the completion of the identification of critical taxa, the numbers might slightly change. Currently, the digitisation of the field data is finished, and all entries are being checked for accuracy and completeness. While the identification has already been completed for critical lichens, that of collected bryophytes and critical vascular plant species (*Festuca spp.*) by specialists is ongoing. The most frequent vascular plants in the habitats of the region (based on the 170 10-m² plots) were *Agrostis capillaris* (recorded in 56% of the plots), *Galium verum* (49%), *Rumex acetosella* (38%), *Festuca rubra* (38%), *Stellaria graminea* (37%), *Trifolium repens* (36%), *Rumex acetosa* (33%), *Achillea millefolium* (32%), *Veronica chamaedrys* (32%), *Anthoxanthum odoratum* (27%), *Potentilla argentea* (27%), *Avenella flexuosa* (27%), *Poa angustifolia* (26%), *Helictotrichon pubescens* (25%), *Veronica officinalis* (25%), and *Plantago lanceolata* (25%). Among bryophytes, *Rhytidiadelphus squarrosus* (37%), *Brachythecium albicans* (31%), *Ceratodon purpureus* (28%) and *Pleurozium schreberi* (28%) were most commonly recorded. Finally, among lichens, *Cladonia furcata* (31%) reached the highest frequency.

Biodiversity

Species richness values for the various taxonomic groups (complete vegetation, vascular plants, bryophytes, and lichens) are presented in Table 3. Mean total species richness exhibited a strong positive relationship with sampling area, increasing from a mean of 2.9 species in the smallest grain size (1 cm²) to 51.6 species in the largest grain size (100 m²).

However, a comparative analysis with previous EDGG Field Workshops revealed generally lower mean richness values in the current study, particularly pronounced at the larger sampling scales. The lower mean richness values observed in this study compared to previous EDGG Field Workshops should be interpreted considering habitat composition and sampling scope. By including a broader range of habitat types—particularly those that are inherently species-poor such as wet grasslands, coastal habitats, and heathlands - the workshop captured a larger environmental gradient than previous workshops, which have focused on more homogeneous and high-diversity dry grasslands or subalpine to alpine habitats. For example, at the grain size of 10 m², mean species richness was 30.7 for the complete vegetation (20.7 for vascular plants). These values are much lower than those reported from the Field Workshops in Armenia (50.7 and 46.8; Vynokurov et al. 2024a), Austria: (41.5 and 34.1; Magnes et al. 2020), Siberia: (48.5 and 43.9; Polyakova et al. 2016), Bulgaria: (38.5 and 34.1; Dembicz et al. 2021), and Romania (60.5 and 57.2; Turtureanu et al. 2014). However, they are higher than the values reported from the Field Workshop in Southern Ukraine: 28.1 and 24.3; Moysiyenko et al. 2022). The relatively low vascular and total species richness can be attributed to the fact that we did not only collect dry grasslands as in most of the previous Field Workshops, but also habitats known to be poor in vascular plants, such as *Cakiletea maritimae*, *Calluno-Ulicetea* and *Honckenyo-Elymetea*. If we compare just within the same class, the mean vascular plant species richness of the stands in the Turku Archipelago is close to the Palaeartic average according to the GrassPlot Diversity Explorer (v.2.10; [GrasslandDiversityExplorer](#); see Biurrun et al. 2021), e.g. *Festuco-Brometea* (ca. 34 species in the Turku Archipelago vs. 34.6 species as Palaeartic mean) and *Molinio-Arrhenatheretea* (ca. 29 species vs. 30.3 species).

Table 3. Descriptive statistics of the scale-dependent richness patterns across all sampled plots from the 21st EDGG Field Workshop in the Turku Archipelago.

Area (m ²)	n	All species			Vascular plants			Bryophytes			Lichens		
		mean	min	max	mean	min	max	mean	min	max	mean	min	max
0.0001	170	2.9	0	7	1.9	0	7	0.9	0	4	0.2	0	5
0.001	170	4.6	0	13	2.9	0	10	1.3	0	7	0.4	0	5
0.01	170	7.8	0	20	5.1	0	18	2.0	0	12	0.7	0	8
0.1	170	12.7	1	30	8.4	0	27	2.9	0	13	1.4	0	10
1	170	19.8	1	41	13.2	0	38	4.4	0	13	2.2	0	13
10	170	30.8	3	67	20.8	0	52	6.3	0	18	3.7	0	18
100	38	51.6	9	92	35.3	8	72	10.8	1	28	5.5	0	24

Mean bryophyte and lichen richness also increased with area, rising from 0.8 and 0.2 species in 1 cm² size to 10.7 and 5.4 species in 100 m², respectively (Table 3). In comparison with the aforementioned previous EDGG Field Workshops, the present one generally recorded a higher mean richness of bryophytes and lichens, particularly for bryophytes at larger grain sizes. For lichens, the present workshop showed the highest mean richness among all compared EDGG Field Workshops at the smaller grain sizes; for example, at 0.1 m² it reached 1.4 species (Armenia: 0.3, Austria: 0.8, Switzerland (inneralpine dry grasslands): 0.5, Siberia: 0.6, Bulgaria: 0.4, Romania: 0.2, South Ukraine: 1.0). At larger grain sizes, however, some previous Field Workshops reported higher lichen richness than recorded here.

Mean species richness of vascular plants in 10 m² varied strongly and significantly among the vegetation classes (ANOVA: $p < 0.001$; Fig. 3). It ranged from 3.0 in our sole plot of the *Cakiletea maritima* to 41.2 ± 5.9 SD in the *Nardetea strictae* (Fig. 3). The highest vascular plant species richness was recorded in a *Festuco-Brometea* stand on Berghamn, with 52 species in 10 m², while the lowest was observed in two rocky grassland plots on Boskär and Seili, where no vascular plant species were recorded in 10 m² but numerous bryophytes and lichens.

Soil data

The mean soil depth of only 18 cm demonstrates that the islands are essentially rocky, with only limited soil development above the almost superficial bedrock (Table 4). The soil data reveal a predominantly acidic environment, with a mean pH of 4.36, ranging from extremely acidic (2.53) to near-neutral (6.90) (Table 4). The cover of particle sizes on

the soil surface varied greatly among plots, with some completely covered by fine soil, but others (almost) completely by either gravel or rock (Table 4). The variation in electrical conductivity, reaching up to 1022 $\mu\text{S}/\text{cm}$ (Table 4), highlights the significant influence of the Baltic Sea's brackish water on coastal vegetation communities.

Conclusions and outlook

Already the preliminary results of the 21st Field Workshop in the Turku Archipelago make an important contribution to the documentation and understanding of biodiversity across the levels of vascular plants, bryophytes and lichens in this region. High-quality ecological data were collected across a diverse mosaic of open habitats, including coastal meadows, heathlands, rocky grasslands, and wooded pastures. After the completion of the species identification, data cleaning and validation, this dataset can and will serve for multiple purposes. First, these precisely georeferenced plots can serve as a starting point for a long-term monitoring system for open habitats in the Archipelago, which is already planned by local collaborators. Second, we plan to use the 10 m² plots for a regional typological-syntaxonomic study to document and classify the vegetation types of the Turku Archipelago and place them in the European syntaxonomic classification system (Mucina et al. 2016) as well as in the EUNIS habitat typology, which is based on syntaxonomic units (Chytrý et al. 2020). Owing to the lack of phytosociological tradition, both systems are hitherto poorly developed in Fennoscandia. Third, beyond syntaxonomy, the high-quality data on three taxonomic groups, combined with comprehensive soil parameters, enable a wide range of further scientific investigations.

Table 4. Summary of data recorded in the field and the results of the soil data analysis across all sampled plots from the 21st EDGG Field Workshop in the Archipelago Sea. Soil depth, cover of stones and rocks, gravel and fine soil are based on field observations. Organic matter, pH and electrical conductivity are based on the analysis of the fine soil of the uppermost 10 cm in the lab.

Variable	Min	Max	Mean	SD
Mean soil depth (cm)	0	>60	18	18
Cover of stones and rocks (%)	0	100	11	20
Cover of gravel (%)	0	90	4	15
Cover of fine soil (%)	0	100	84	25
Organic matter (%)	0.4	32.9	8.2	7.8
pH (H ₂ O)	2.53	6.90	4.36	0.77
EC ($\mu\text{S}/\text{cm}$)	25	1022	255	203

The detailed and extensive records of lichens and bryophytes, in particular, provide opportunities to investigate ecological patterns such as species-area relationships, diversity-environment relationships, or community assembly processes, in taxa for which data are typically limited. Finally, once completed, the vegetation data will be integrated into the GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019) as dataset FI_A and subsequently to the European Vegetation Archive (EVA; Chytrý et al. 2016) and the global vegetation plot database “sPlot” (Bruehlheide et al. 2019). This will ensure broad accessibility and usability for regional, European, and global vegetation research and contribute to fill the problematic data gap of EVA and sPlot in Fennoscandia.

Author contributions

All co-authors helped with the field sampling and/or species identification. N.S. drafted the report and the map, J.D. coordinated shaping it into a scientific article, while all authors checked, improved and approved the manuscript.

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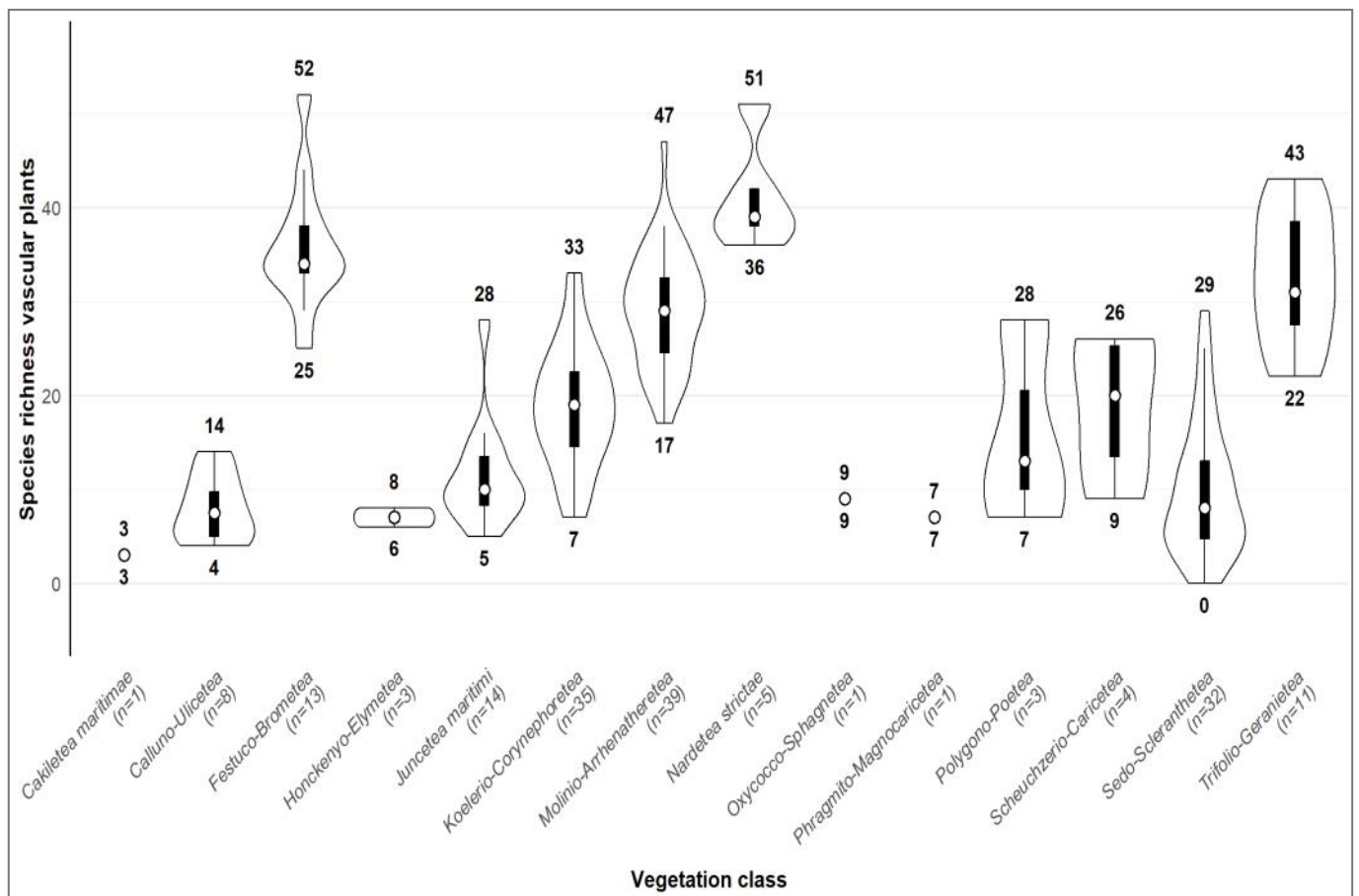


Figure 3. Vascular plant species richness in the 170 10-m² plots compared across the vegetation classes (preliminary assignment) in the Turku Archipelago. Violin plots complemented by boxplots in the centre indicate the distribution of species richness in each class. Values above and below the violin plot represent the maximum and minimum species richness, respectively. The mean species richness differed highly significantly among vegetation classes (ANOVA, $p < 0.001$).

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