



DALIA: a relational DAtabase of tree, shrub and LIAna taxa recorded in the Functional Urban Area of Campobasso (Italy)*

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Abstract

We developed the DALIA relational database (DAtabase of tree, shrub and LIAna taxa), which contains records of tree, shrub, and liana taxa recorded in the Functional Urban Area of Campobasso, a small city located in the inner-Mediterranean Region of Southern Italy. The DALIA database, developed through the PostgreSQL data management system, includes 170 species and subspecies (126 native and 44 alien) belonging to 46 taxonomic families (35 native species and 23 alien species). Each taxon, whether native or alien, was classified according to multiple ecological, functional, and biogeographic groups. Moreover, the diagnostic value for Habitats Directive 92/43/EEC, the IUCN red list conservation category, and, specifically for alien taxa, residence time and invasion status are reported. We described the dataset by bar and donut charts, density plots, and box plots. Results highlighted that native taxa are mainly Eurasian deciduous and Mediterranean evergreen with a prevalent zoochorous dispersal. By contrast, alien taxa are from Temperate Asia, North America, and Tropical Asia and count many anemochorous species with winged diaspores. Alien plant taxa show different characteristics in terms of ecological and disturbance indicator values, indicating a potential greater competitiveness in highly disturbed environments than native ones. The DALIA checklist of native and alien plant taxa collects important ecological information that is useful for monitoring plant diversity, implementing ecological restoration actions, and supporting sustainable urban greenery plans and actions.

Keywords

Dispersal mode, Ecological indicators, Urban biodiversity, Woody flora inventory

Introduction

The urban environment is a complex and dynamic system in which human settlements, agricultural, semi-natural,

and fragmented natural areas, each with distinct ecological values, are interconnected with one another (Young et al. 2006). Among these elements, woods in cities provide essential ecosystem services, including habitat provision,

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climate regulation, better air and water quality, flood mitigation, carbon sequestration, and benefits to human health and well-being (Andersson-Sköld et al. 2015; Zefferman et al. 2018).

Urban green spaces play a crucial role in enhancing the livability of our cities, as they not only improve the quality of life for residents but also provide essential recreational areas that promote mental, physical, and social well-being (Wang'ombe 2024). Nature also plays a vital role in urban areas by actively contributing to climate change mitigation efforts (Pandey and Ghosh 2023).

However, urbanization, the main process shaping urban landscapes, significantly alters plant diversity and ecosystem functioning inside cities and suburban areas, often favoring the introduction and spread of non-native species, some of which are invasive (Kowarik 2011; Montaldi et al. 2024). In this context, plant inventories, especially when coupled with ecological traits, which document the key characteristics of plant taxa, serve as valuable tools for botanical research while also playing a crucial role in aiding plant diversity and habitat conservation at the regional (Bagella et al. 2024; Viciani and Alberti 2024) and national scale (Abbate et al. 2014; Bellis et al. 2024; Lončarević et al. 2024).

In Italy, the National Biodiversity Future Center (NBFC), supported by the Ministry of University and Research through NextGenerationEU funds, is a central hub for coordinating research efforts on biodiversity. The NBFC promotes the collection, transfer, and storage of biodiversity data to support effective monitoring while also ensuring that knowledge and technologies are accessible to diverse actors working on the territory (NBFC 2025). As a component of NBFC and the “Urban Biodiversity” working group (Spoke 5), we surveyed the woody plant species occurring into the Functional Urban Area (FUA, i.e., city and its commuting zone; Eurostat 2017) of a Mediterranean city (Campobasso, Molise Region). The inventory aims to improve our understanding of urban biodiversity in Italian cities, offering valuable insights for nature conservation and sustainable built environments.

In detail, we built up and compiled a relational database called DALIA (DAtabase of tree, shrub and LIAna taxa of urban forests in Campobasso), which includes the tree, shrub, and liana taxa recorded in the FUA of Campobasso. For each species, DALIA includes 30 attributes covering key ecological, functional, and biogeographic categories features such as chorological group, growth form, plant height, leaf type, leaf phenology, blooming period (months), generative diaspore, dispersion mode, diagnostic value for Habitats Directive 92/43/EEC, IUCN red list conservation category, Grime's CSR ecological strategy, and, specifically for alien taxa, resident time and status. Ecological Indicator Values for Europe and the Disturbance Indicator Values were also assigned. DALIA offers a comprehensive checklist of both native and alien plant woody taxa, along with essential ecological and conservation data, providing a valuable support for monitoring plant diversity, guiding ecological restoration efforts, and supporting the development of sustainable urban greenery.

Methodology

Study area

The FUA of Campobasso (Italy) covers 1,028 km² and has approximately 100,000 inhabitants, with a population density of 97.3 inhabitants/km² (ISTAT 2025). Campobasso, located at an altitude of 701 m a.s.l., is characterized by a temperate sub-Mediterranean climate (Pesaresi et al. 2017) with an average annual temperature of 13.28°C and average annual precipitation of 806 mm (1991–2021) (Martinelli and Matzarakis 2017). Land use is characterized by 41% of agricultural land, 35% by natural and semi-natural habitats, and 24% by artificial areas (D'Angeli et al. 2024). According to the Map of Nature of the Molise Region (Ceralli et al. 2021; D'Angeli et al. 2024), the main forest types in the study area can be assigned to six different EUNIS habitat types (Chytrý et al. 2020): Southern Italic *Quercus cerris* forests (T19), Southern Italic *Quercus frainetto* forest (T19), Italo-Sicilian *Quercus pubescens* forest (T19), Southern Mediterranean riparian *Populus alba* forest (T14), Deciduous self-sown forest of non-native trees (T1J), and Coniferous forest (T3).

The FUA of Campobasso contains a significant number of Natura 2000 sites, with 17 Special Area of Conservation (SAC) entirely within its boundaries; among them, SAC IT7222101 “Bosco la Difesa”, SAC IT7222125 “Rocca Monforte” and SAC IT7222295 “Monte Vairano” are located in the core area of the city.

Data collection, structure, and accessibility

DALIA includes both published (Varricchione et al. 2024) and unpublished data on tree, shrub and liana taxa recorded in the FUA of Campobasso. The dataset is compiled based on vegetation surveys carried out in 2023 and 2024 as part of the NBFC project (Spoke 5–Urban Biodiversity), partially integrated with data from the urban greenery census of Campobasso Municipality (Città di Campobasso 2025).

The database contains 170 plant species and subspecies, and 30 attributes (descriptors in columns) (Suppl. material 1) concerning: a) scientific name (Portal to the Flora of Italy 2024; WFO 2024) and respective patronymic, and common name in Italian (Portal to the Flora of Italy 2024) and English (Stace 2019); b) taxonomic family (Bartolucci et al. 2024); c) residence time (EAS-IN 2024; Galasso et al. 2024) and status (Galasso et al. 2024) in Italy; d) chorology (Pignatti 1982 for natives; WFO 2024 for aliens); e) life form (Raunkiaer 1934; Pignatti et al. 2017–2019); f) growth form (Pignatti et al. 2017–2019); g) plant height (Díaz et al. 2022); h) plant growth habit (Díaz et al. 2022); i) leaf type (Chytrý et al. 2024); l) leaf phenology (Chytrý et al. 2024; WFO 2024) m) bloom months (Pignatti et al. 2017–2019); n) bloom length (Pignatti et al. 2017–2019); o) generative

diaspore (van der Pijl 1982; Hintze et al. 2013; Sádlo et al. 2014); p) dispersion mode (Vittoz and Engler 2007; Lososová et al. 2023; CABI 2024; Chytrý et al. 2024); q) diagnostic, constant, and dominant species for EU-NIS habitats (Chytrý et al. 2020); r) diagnostic species of Habitats Directive 92/43/EEC (Biondi et al. 2009); s) IUCN category and population trend for Europe (Rivers et al. 2019; IUCN 2024); t) Ecological Indicator Values of Europe (EIVE) (Dengler et al. 2023); u) Disturbance Indicator Values (DIV) (Midolo et al. 2023); v) Grime CSR strategy (Pierce et al. 2017). All categories are listed in the Suppl. material 1. Species were categorized as native (native and archaeophyte – allochthonous taxa introduced before 1492) and alien (taxa introduced after 1492, i.e., neophytes) (Galasso et al. 2018, 2024).

DALIA relational database was created using the PostgreSQL data management system (PostgreSQL Global Development Group 2024).

Data accessibility

DALIA database is financed by NBFC project and data ownership is retained by the contributors; by the end of the project, this database will flow into larger data repositories NBFC to ensure easy data access and interoperability. Till then, DALIA database can be downloaded freely at the following link [<https://zenodo.org/records/15395163>].

Data analysis

To characterize the dataset in terms of taxonomic composition, we computed the percentage of each family, distinguishing between native and alien species. Families representing less than 2% were grouped as ‘other’ (native or alien). Additionally, we analyzed the proportion of native and alien taxa across the following attributes: a) chorology, and b) dispersal mode and generative diaspore types. The Grime values were visualized in a triangle CSR strategy, built separately for natives and aliens. We also computed the density plots to visualize the distribution of EIVE’s values (Moisture-M, Temperature-T, and Nitrogen-N), and we adopted the 25th and 75th percentiles as thresholds to distinguish taxa with medium or high EIVE’s values (Saatkamp et al. 2023). The distribution of species across different Disturbance Indices Values (DIV) was analyzed using boxplot graphs.

Descriptive analyses were conducted using R Statistical Software (v4.3.0; R Core Team 2023), using the “ggplot2” package (Wickham 2016) for donut chart, bar chart, Grime triangle, and boxplot; “dplyr” (Wickham et al. 2023), “tidyr” (Wickham et al. 2024), and “GGally” (Schloerke et al. 2024) packages for density chart and stacked bar chart. Statistical differences in Disturbance Indices Values between native and alien plants were compared using Wilcoxon-Mann-Whitney tests (Wilcoxon 1945; Mann and Whitney 1947).

Results

DALIA database includes 170 woody species and subspecies, both native and alien plants, belonging to 46 taxonomic families, with 35 families for natives and 23 families for aliens (Figure 1). The most frequent taxonomic family for native species is *Rosaceae*, followed by *Salicaceae* and *Fabaceae* and the most common non-native family is *Pinaceae*, followed by *Fabaceae* and *Sapindaceae* (Figure 1).

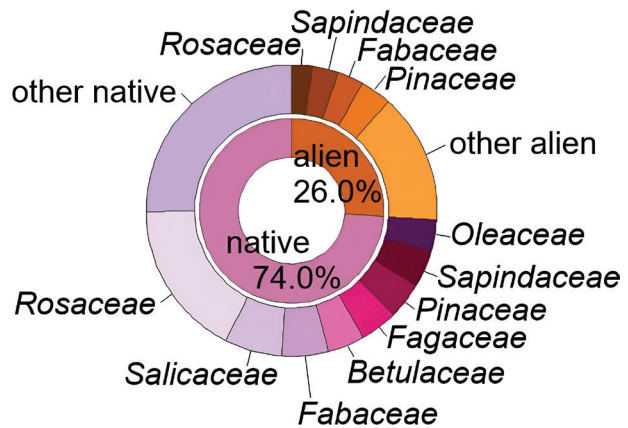


Figure 1. Taxonomic families’ percentage for native species and alien species. Families with a percentage < 2.0% were grouped in ‘other native species’ and ‘other alien species’.

Of these 170 taxa, 126 are native and 44 are aliens (25%); alien taxa include 31.8% invasive, 20.5% naturalized, and 34.1% casual.

This insight greatly differs from what has been recorded in large cities, where aliens in the urban floras make up 40% of the total number of taxa (Pyšek 1998; Ricotta et al. 2009; Lososová et al. 2012).

DALIA contains 91 tree taxa (53.5%), 64 shrubs (37.7%), and 15 lianas (8.8%), and includes 62 diagnostic species of EU forest habitats.

Regarding the European IUCN Red List, there are three Vulnerable species (VU) and one Near Threatened species (NT) at the European level. Finally, there is only one endemic taxon, *Acer cappadocicum* subsp. *lobelii*.

Focusing on the Natura 2000 network, 77 species are found within the N2K Sites (45.3%). Among these 70 are native (55.5%), and 7 (15.9%) are aliens, of which 3 are invasive (*Ailanthus altissima*, *Amorpha fruticosa*, *Robinia pseudoacacia*). Riparian forests are the most invaded habitat (Varricchione et al. 2024), and *Robinia pseudoacacia*, and *Amorpha fruticosa* are the most widespread invasive species.

The analysis of the data stored in the DALIA database reveals a high plant diversity concerning tree, shrub, and liana taxa for the FUA of Campobasso when compared with other similar studies ((Roma-Marzio et al. 2016), with a high percentage of native species (Quaranta et al. 2025).

As concerns chorology, native taxa are mainly Eurasiatic, and subordinately Euromediterranean and Steno-Mediterranean, whereas aliens mainly come from Temperate Asia, North America, and Tropical Asia (Figure 2).

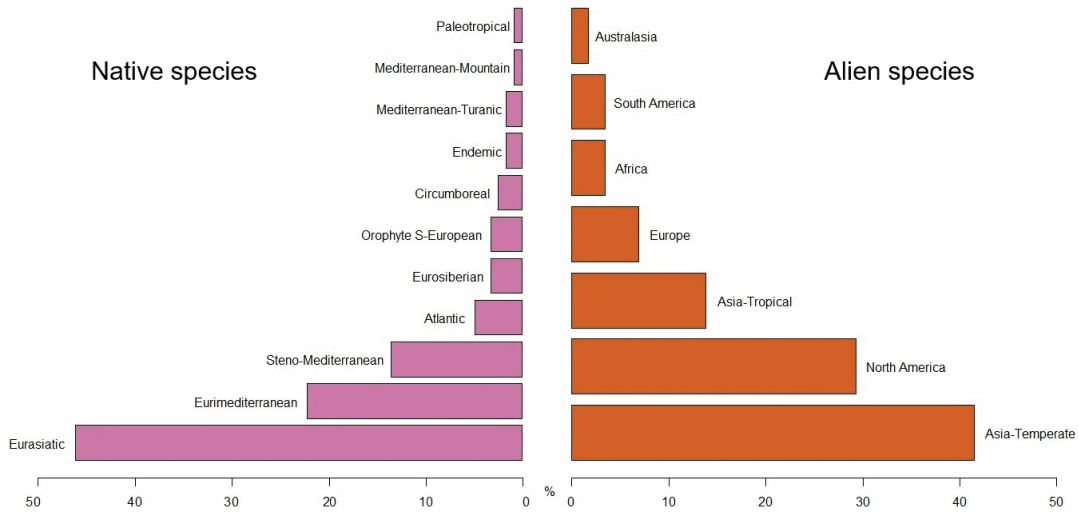


Figure 2. Percentages of each chorological group for native species and categories of native distribution of alien species.

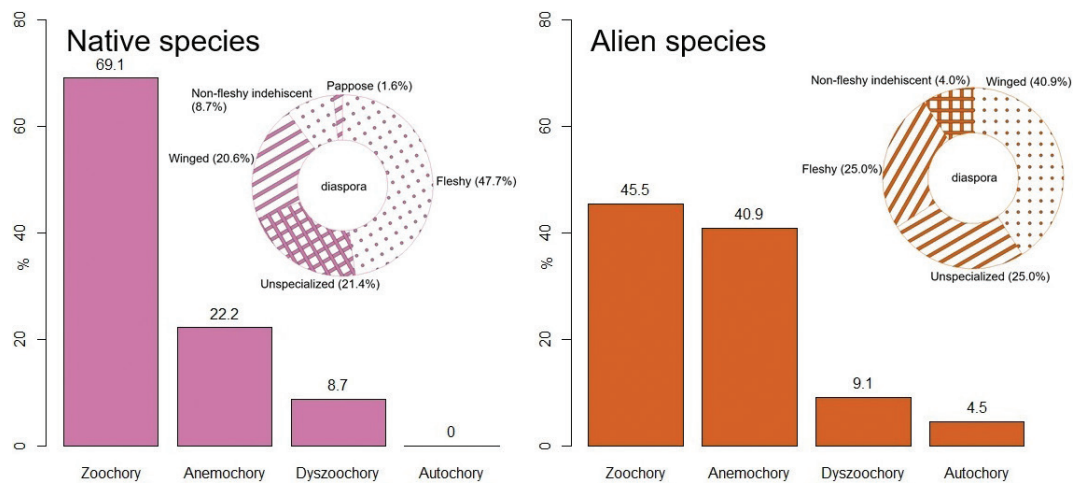


Figure 3. The bar charts show the dispersion mode of natives and aliens; in the donut charts, the percentages of the generative diaspore types for natives and aliens.

The dispersion mode varies between native and alien plant taxa (Figure 3), with zoochory prevailing in both categories, but a higher incidence of anemochory among alien plants. The generative diaspore also differs between native and alien plant taxa, with fleshy diaspores prevailing among natives, and winged diaspores among aliens (Figure 3).

Grime's Triangle CSR strategy for native and alien plants showed a prevalent distribution along the C-S axis (competitor-stress tolerant) with a greater abundance of stress tolerator plants, especially among native ones (Figure 4). The main competitor plants are invasive aliens, such as *Ailanthus altissima*, *Paulownia tomentosa*, *Trachycarpus fortunei*, positioned at the top vertex of the triangle (C) (black circle at the top, Figure 4). Diagnostic species for EUNIS habitats and Habitats Directive (e.g. *Acer pseudoplatanus*, *Ostrya carpinifolia*, *Populus* spp., *Quercus* spp., *Salix* spp.) showed an intermediate stress tolerant/competitor (S-C) strategy (black circle at the bottom, Figure 4).

The analysis of EIVEs (Moisture, Temperature, and Nitrogen) showed consistent differences between native and alien plant taxa (Figure 5).

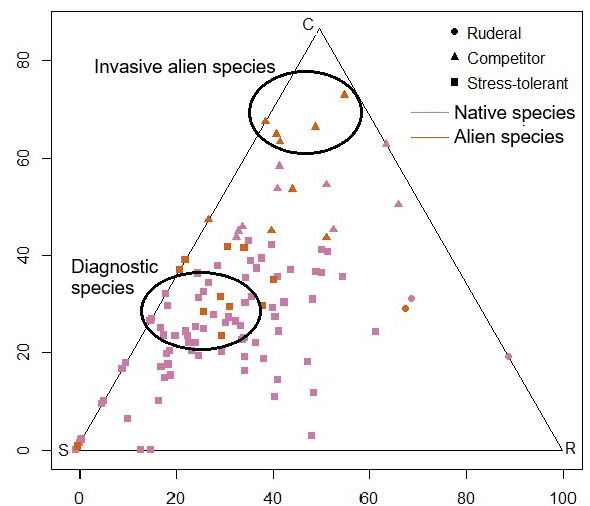


Figure 4. Grime's Triangle for natives and aliens, subdivided in ruderal, competitor and stress-tolerant species. The black circles indicate where the invasive alien species (i.e., *Ailanthus altissima*, *Paulownia tomentosa*, *Trachycarpus fortunei*) and some diagnostic species for EUNIS habitats and Habitats Directive (i.e., *Populus* spp., *Quercus* spp., *Salix* spp.) occur.

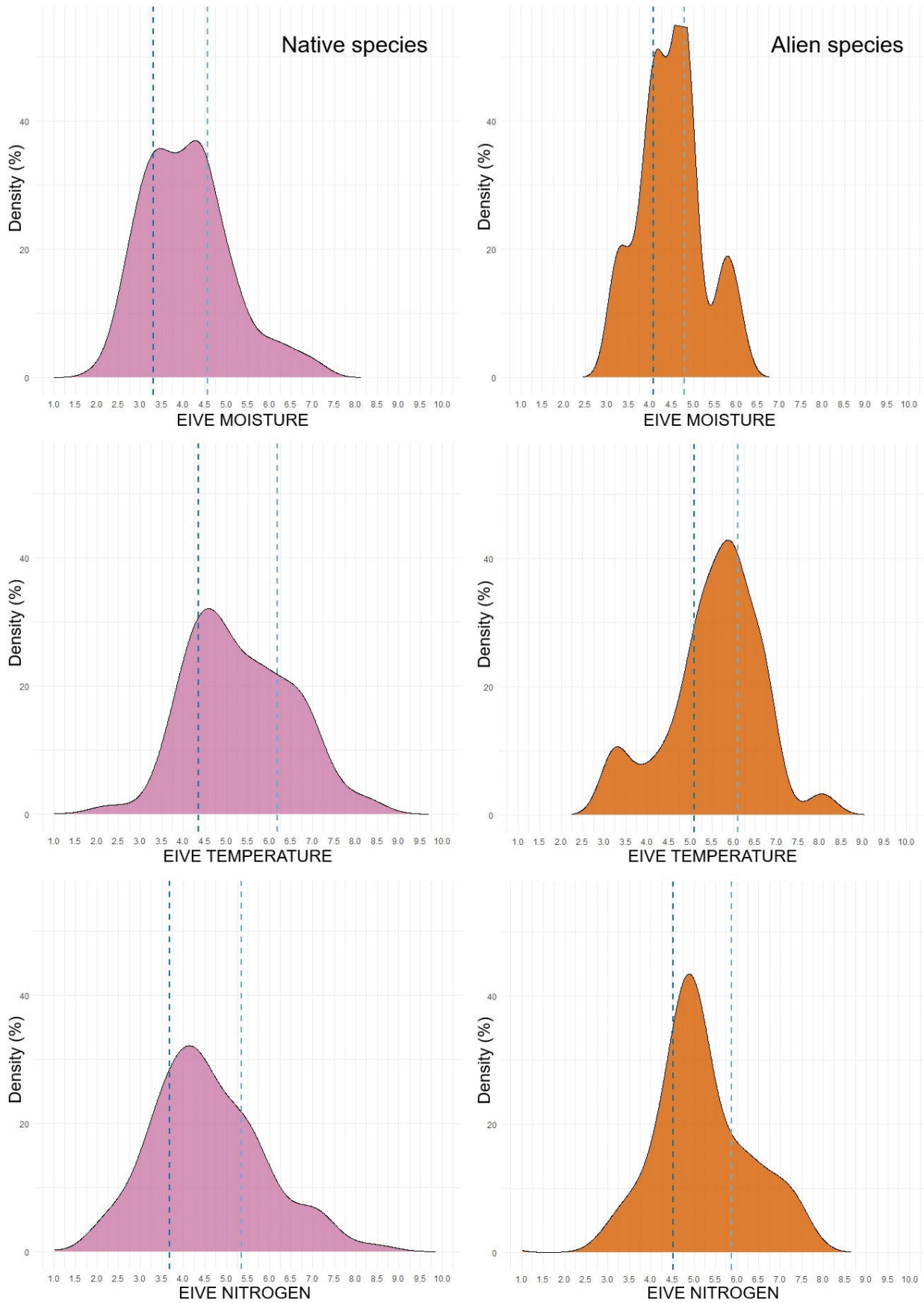


Figure 5. Density plots of EIVE's (Moisture, Temperature, Nitrogen) for natives and aliens with sectors based on percentile thresholds. The graph showed moisture, temperature, and nitrogen values' density as a percentage, with the 25th percentile (blue dashed line) and 75th percentile (light blue dashed line) demarcating the lower, middle, and upper ranges for each EIVE.

The range of EIVEs M, T, and N values is largest for native than alien taxa, but a higher proportion of alien woody species show medium-high EIVEs values.

The analysis of Disturbance Indices (Suppl. material 2) showed mean values significantly higher for the alien plants, especially for the ‘Soil Disturbance’ index.

Alien plant taxa show different characteristics in terms of ecological and disturbance indicator values, showing a potential greater competitiveness in highly disturbed environments compared to native species, as was observed in other studies (Kowarik 2011; Jauni et al. 2015).

Conclusion and future perspectives

DALIA significantly enhances our understanding of the distribution, ecology, and conservation of the 170 recorded woody taxa. The analysis of the data stored in the DALIA database reveals a high native plant diversity concerning tree, shrub, and liana taxa for the FUA of Campobasso.

DALIA is expected to act as a useful pilot tool for guiding the selection of plant species for Nature-based Solutions (NBS) and environmental restoration actions in cities of Italian and Mediterranean inner territories. It also provides valuable ecological information that can be utilized in urban greenery projects, emphasizing the added value of the avoidance of invasive and competitive alien plants while favoring native species found within the EU forest habitats of the nearby Natura 2000 areas.

This inventory of woody flora can also be used for educational purposes, aiming to enhance students’ and citizens’ understanding of the natural heritage of their city and surrounding areas.

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Supplementary material 1

Description and references for attributes included in DALIA database

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Supplementary material 2

Distribution of Disturbance Indices values between native species and alien species

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