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Numerical classification and ordination of the floodplain forests in the Euxine region of Turkey

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Abstract: In this study, the phytosociological structure of floodplain forests in the Euxine region of Turkey was examined from a large-scale perspective. For this goal, all of the published relevés were analyzed using the numerical classification and ordination techniques, which are widely used in phytosociological studies all over the world. In summary, a syntaxonomical scheme for floodplain forests with 11 communities (five associations and one alliance were newly identified) was suggested as follows: *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *allerietosum petiolatae* Kavgacı et al. subass. nov. hoc loco; *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *junglandetosum regiae* Kavgacı et al. 2011; *Leucojo aestivi – Fraxinetum angustifoliae* Glavač 1959 *alnetosum glutinosae* Glavač 1959; *Smilaco excelsae – Fraxinetum angustifoliae* Pavlov et Dimitrov 2002 *prunellotosum vulgaris* Pavlov et Dimitrov 2002; *Apocyno veneti – Fraxinetum angustifoliae* (Özen 2010) Kavgacı et al. ass. nov. hoc loco; *Euphorbio strictae – Fraxinetum angustifoliae* (Aydogdu 1988) Kavgacı et al. ass. nov. hoc loco (*Alno – Quercion*, *Populetalia alba*, *Salici purpureae – Populetea nigrae*); *Aro hygrophyli – Fraxinetum angustifoliae* (Kutbay et al. 1998) Kavgacı et al. ass. nova hoc loco; *Pterocaryo pterocarpae – Alnetum barbatae* Quézel et al. 1992; *Platanthero chloranthae – Fraxinetum oxycarpae* Korkmaz et al. 2012; *Sambuco ebuli – Alnetum barbatae* (Korkmaz et al. 2012) Kavgacı et al. ass. nov. hoc loco (*Periploco graecae – Fraxinion angustifoliae* Kavgacı et al. all. nova hoc loco, *Populetalia alba*, *Salici purpureae – Populetea nigrae*); and *Geranio robertiani – Carpinetum betuli* Kavgacı et al. 2011 (*Carpino betuli – Fagion orientalis, Rhododendro pontici – Fagetalia orientalis*, *Querco – Fagatea*).

Key words: Euxine, floodplain forest, phytosociology, Turkey, vegetation

1. Introduction

Floodplain forests, representing habitats where the water table is usually at or near the surface and the land is covered periodicigally or at least occasionally with shallow water (Pivec, 2002; Paal et al., 2007), show rich biological and ecological diversity (Schnitzler et al., 2005), and if they are protected, they build an important part of biological richness on a regional scale (Schuck et al., 1994). Their biologic sustainability is strictly connected with the natural flooding regime (Kopeć et al., 2014), easily affected by anthropogenic factors. Due to that, they stand on very sensitive ecological conditions. These characteristics of floodplain forests make them more important in terms of ecosystem conservation than wood production today (Jackson, 1990; Tockner and Stanford, 2002).

The floodplain forests along the great rivers, specifically alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* and riparian mixed forests of *Quercus robur*, *Ulmus laevis*, *U. minor*, *Fraxinus excelsior*, and *F. angustifolia*, are defined as important and protected under the Habitat Directive of the European Union (EU Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, Annex I). Those kinds of ecosystems are also recognized as threatened ecosystems under the Bern Convention.

The coverage of the floodplain forests generally decreased not only in Europe (Klimo and Hager, 2000) but also in the other parts of the world (Müller, 1998; Moffatt and McLachlan, 2004) due to many different reasons like construction of dams and hydroelectric power stations, agriculture, drainage channels, grazing, etc. Those processes caused a loss of rich and valuable ecosystems in many places. Similarly in Turkey, most of the floodplain forests have been under human pressures for decades (Acatay et al., 1962; Pamay, 1967), and many of them are degraded. In this context, studying the biological and ecological conditions of these forests is important not only to understand and conserve the actual conditions but also to restore and rehabilitate the lost fields.

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As a result of this awareness, many studies elaborating biological and ecological diversity of floodplain forests have been carried out (Wildi, 1989; Brullo and Spampinato, 1999; Pavlov and Dimitrov, 2002; Turner et al., 2004; Vukelić and Baričević, 2004; Drescher, 2007; Willner and Grabherr, 2007; Baričević et al., 2009; Wallnöfer, 2009). Similarly, in Turkey, some phytosociological studies were carried out in the floodplain forests to understand their biological and ecological richness (Quézel et al., 1980; Aydoğdu, 1988; Kutbay et al., 1998; Özen, 2010; Kavgacı et al., 2011; Korkmaz et al., 2012). These studies were completely carried out in the floodplain forests in the Euxine region of Turkey, but their number is significantly less than the studies carried out in zonal vegetation (Ketenoğlu et al., 2010).

This study was carried out in this context to clarify the floristic richness of floodplain forests in the Euxine region of Turkey with a dataset prepared by the phytosociological studies carried out in floodplain forests, to make a syntaxonomical classification of communities and understand the geographical reasons behind the syntaxonomical differentiation. Such knowledge is useful to understand the floristic and ecological conditions of floodplain forests in the Euxine region of Turkey as a large-scale assessment and an essential base for latter syntaxonomic and synecological studies. It is also of value as a contribution for a probable national habitat classification system.

2. Materials and methods

The floodplain forests covering large areas in Turkey generally appear in the northern part of the country. Some of those forests were subjected to phytosociological studies, whereas the rest of the floodplain forests situated in other parts have not been studied yet. The floodplain forests that were phytosociologically studied are located in the İğneada region, Bursa Province, Sakarya Province, and Samsun Province, all of which are in the Euxine region of Turkey (Figure 1). In those works, a total of 111 relevés were sampled, and all were published. These relevés and publications are as follows: Quézel et. al. (1980), 6 relevés; Aydoğdu (1988), 15 relevés; Kutbay et al. (1998), 10 relevés; Özen (2010), 11 relevés; Kavgacı et al. (2011), 48 relevés; Korkmaz et al. (2012), 21 relevés. All of those relevés were stored in the TURBOVEG data base management program (Hennekens and Schaminée, 2001).

The numerical classification of the relevés was carried out with the PC-ORD program (McCune and Meffords, 2006) with the beta-flexible algorithm with β: –0.25 and Jaccard distance as a resemblance measure for dendrogram construction. Additionally, the diagnostic species of the communities were identified by a fidelity measure in the JUICE program (Tichý, 2002). The threshold of the phi value was subjectively selected at 0.50 for a species to be considered as diagnostic (Chytrý et al., 2002). The species having more than 50% occurrence frequency for a given community were defined as constant species, while species attaining a cover higher than 50% in more than 30% of the relevés were accepted as dominant species.

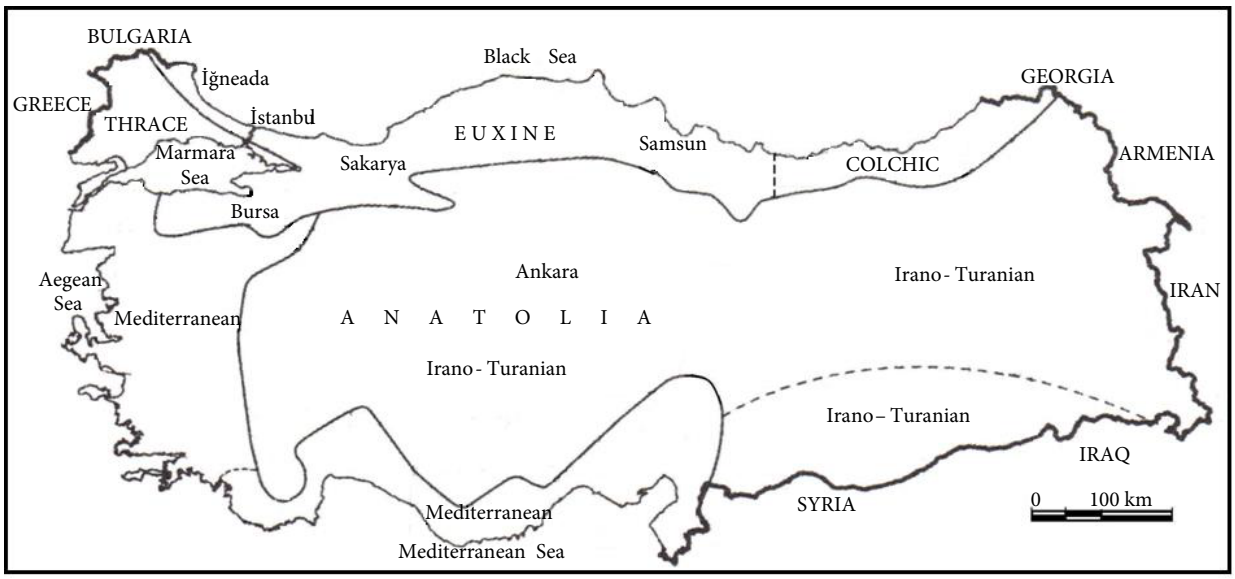

Figure 1. Map showing the phytogeographical regions of Turkey and indicating the provinces of floodplain forests in the Euxine region that were studied from the phytosociological point of view (İğneada and Sakarya, Bursa, and Samsun provinces).

The results of the classification were visualized by ordination techniques in the CANOCO 4.5 package (Ter Braak and Šmilauer, 2002). Detrended correspondence analysis (DCA), which is an indirect ordination method assuming a unimodal response of species to the environment, was run due to the high heterogeneity in the matrix of species (Lepš and Šmilauer, 2003).

We also calculated the spectra of geoelements according to Davis (1965–1985) and Davis et al. (1988), growth forms, and species richness. They were passively projected on the ordination plane in addition to the geographical variables (longitude and latitude). Correlations between DCA relevé scores and geographical variables, geoelements, growth forms, and species diversity parameters were calculated using the nonparametric Kendall coefficient in STATISTICA. Moreover, the comparison of geographical variables, phytogeographic regions, growth forms, and species diversity parameters for the described communities was visualized by a box-whisker diagram prepared in STATISTICA.

The nomenclature of plant species follows *Flora of Turkey* (Davis, 1965–1985; Davis et al., 1988) and a checklist of *Flora of Turkey* (Güner, 2012). New syntaxa were described in accordance with the International Code of Phytosociological Nomenclature (Weber et al., 2000)

3. Results

Classification analysis clearly showed the floristic differentiation of the floodplain forests in the Euxine region of Turkey (Figure 2), and it gave direction to the syntaxonomical revision of the floodplain forests. Similarly, ordination analysis indicated the differentiation of the floodplain forest communities (Figure 3), and it was very helpful to understand the geographical variation of floodplain forests in addition to observing the geoelements, growth forms, and species richness differences between forests. The geoelements, growth forms, species richness, and diversity differences between floodplain forests were also observed through box-whisker diagrams (Figures 4 and 5).

3.1. Classification

The classification of the relevés resulted in 11 clusters reflecting the different forest communities in the floodplain forests in the Euxine region of Turkey (Figure 2). These clusters show conformity with the communities studied in the previous papers. The synoptic table of these clusters with percentage frequency and modified fidelity index is provided in the Appendix.

Each of these clusters is represented by different diagnostic species and they are clearly separated from each other in terms of distributional patterns. According to that, the diagnostic, constant, and dominant species of these clusters with their distributions are as follows.

3.1.1. Cluster 1

Diagnostic species: *Ulmus laevis*; *Alliaria petiolata*, *Carex sylvatica*, *Viola alba*.

Constant species: *Acer campestre* subsp. *campestre*, *Corylus avellana* var. *avellana*, *Fraxinus angustifolia* subsp. *oxycarpa*; *Hedera helix*, *Sambucus nigra*; *Carex remota*, *Chaerophyllum temulum*, *Circaea lutetiana*, *Geum urbanum*, *Parietaria officinalis*, *Poa trivialis*, *Polygonum hydropiper*, *Rumex conglomeratus*, *Urtica dioica*, *Viola sieheana*.

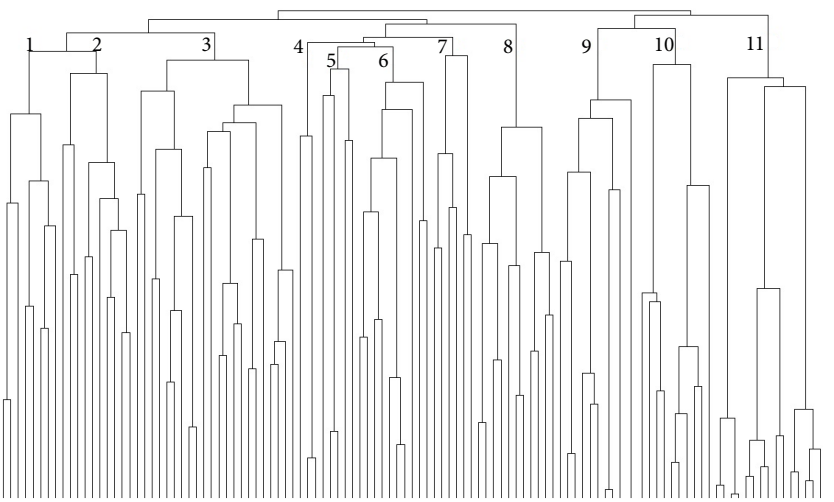

Figure 2. Hierarchical dendrogram of the relevés from floodplain forests in the Euxine region of Turkey. Numbers correspond to the clusters representing the different floodplain forest communities in the Euxine region.

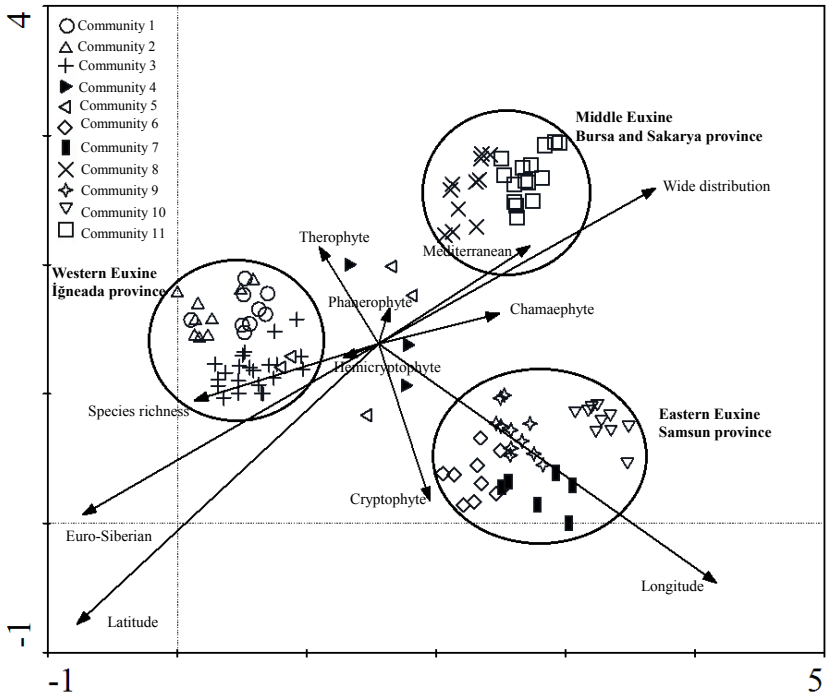

Figure 3. DCA ordination of the relevés from floodplain forests in the Euxine region of Turkey. Each symbol represents different floodplain forest communities (clusters in Figure 2). Geographical factors, phytogeographic region, growth form, and species richness parameters were passively projected on the ordination plane.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Saka floodplain forest in the İğneada region.

3.1.2. Cluster 2

Diagnostic species: *Acer heldreichii* subsp. *trautvetteri*, *Juglans regia*; *Rubus hirtus*, *Sambucus nigra*; *Chaerophyllum temulum*, *Parietaria officinalis*, *Phytolacca americana*.

Constant species: *Fraxinus angustifolia* subsp. *oxycarpa*, *Ulmus laevis*; *Hedera helix*, *Smilax excelsa*; *Brachypodium sylvaticum*, *Circaea lutetiana*, *Geum urbanum*, *Lamium maculatum*, *Lactuca muralis*, *Rumex conglomeratus*, *Urtica dioica*.

Dominant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Saka floodplain forest in the İğneada region.

3.1.3. Cluster 3

Diagnostic species: *Carpinus betulus*; *Carex sylvatica*, *Melica uniflora*, *Mercurialis perennis*, *Viola sieheana*.

Constant species: *Acer campestre* subsp. *campestre*, *Corylus avellana* var. *avellana*, *Fraxinus angustifolia* subsp. *oxycarpa*, *Quercus robur* subsp. *robur*, *Ulmus minor*; *Crataegus monogyna*, *Hedera helix*, *Smilax excelsa*; *Carex remota*, *Circaea lutetiana*, *Dactylis glomerata*, *Geum urbanum*, *Lamium maculatum*, *Lactuca muralis*, *Rumex conglomeratus*, *Ruscus aculeatus*, *Viola alba*.

Dominant species: *Carpinus betulus*, *Fraxinus angustifolia* subsp. *oxycarpa*; *Ruscus aculeatus*.

Distribution area: Mostly located in the Mert and Erikli floodplain forests in the İğneada region.

3.1.4. Cluster 4

Diagnostic species: *Ulmus laevis*; *Galium debile*, *Galium paschale*, *Iris pseudacorus*, *Lysimachia vulgaris*, *Polygonum lapathifolium*.

Constant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus angustifolia* subsp. *angustifolia*; *Rosa canina*, *Smilax excelsa*; *Carex remota*, *Leucojum aestivum*, *Rumex conglomeratus*.

Dominant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus angustifolia* subsp. *oxycarpa*; *Carex remota*, *Iris pseudacorus*, *Leucojum aestivum*, *Polygonum hydropiper*.

Distribution area: Very restricted distribution in the Saka floodplain forest in the İğneada region.

3.1.5. Cluster 5

Diagnostic species: *Carex divulsa*, *Lolium perenne*, *Lysimachia nummularia*, *Ranunculus constantinopolitanus*, *Trifolium hybridum*.

Constant species: *Fraxinus angustifolia* subsp. *oxycarpa*, *Ulmus minor*; *Crataegus monogyna*; *Brachypodium sylvaticum*, *Dactylis glomerata*, *Oenanthe silaifolia*, *Poa trivialis*, *Ranunculus repens*, *Rumex conglomeratus*, *Ruscus aculeatus*.

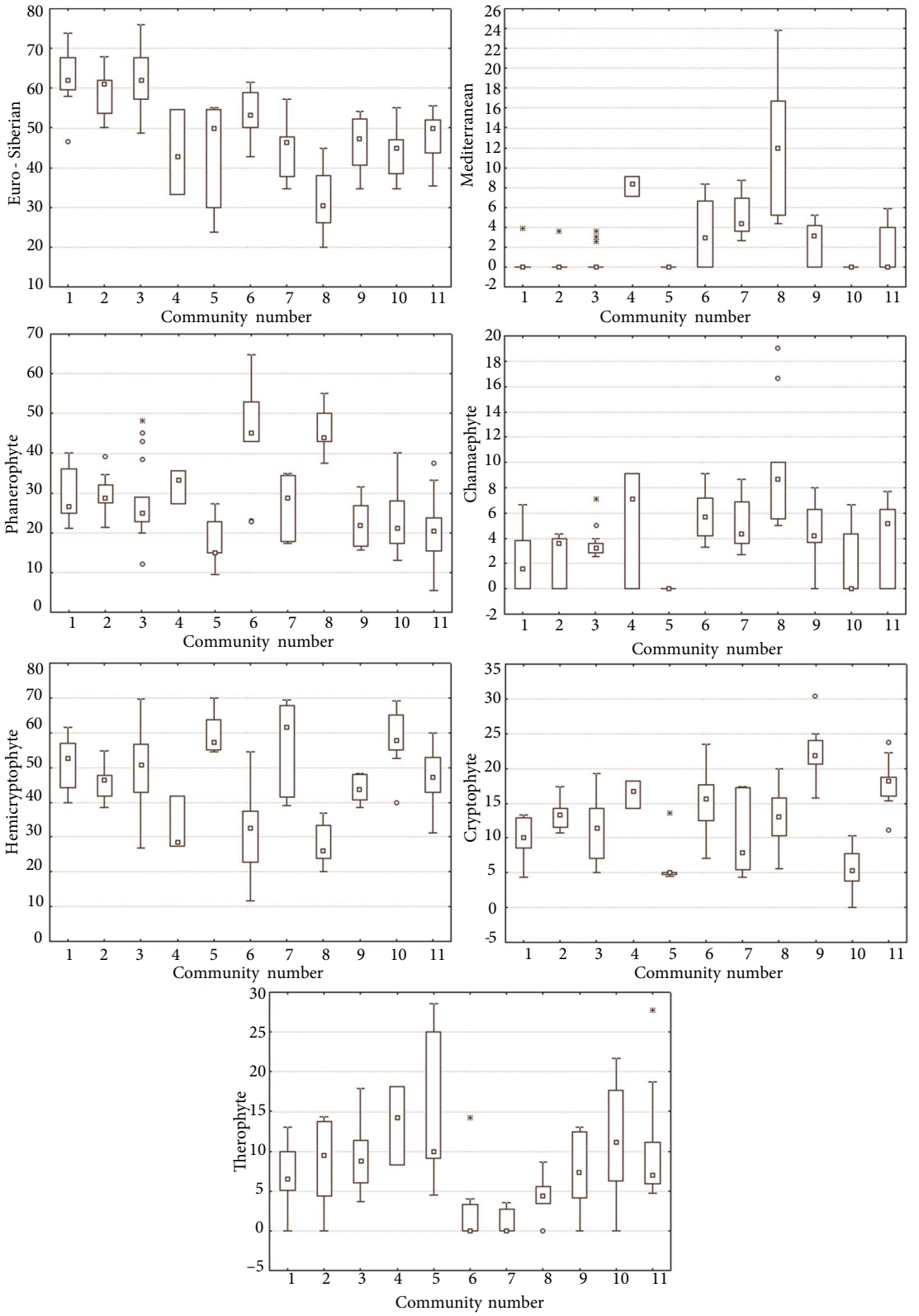

Figure 4. Diagrams of geoelements and growth forms for each community. Numbers correspond to the cluster (community) numbers in Figure 2. □ : Median, ▯ : 25%–75%, I : nonoutlier range, o: outliers, *: extremes.

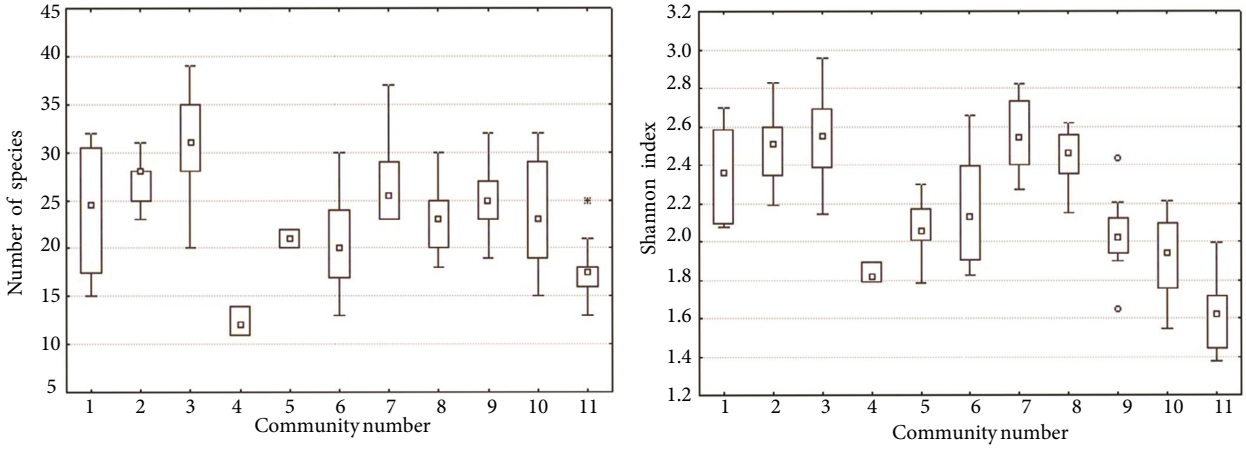

Figure 5. Diagrams of species richness (number of species) and species diversity (Shannon diversity index) for each floodplain forest community. Numbers correspond to the cluster (community) numbers in Figure 2. □ : Median, ▯ : 25%–75%, I : nonoutlier range, o: outliers, *: extremes.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*, *Ulmus minor*; *Ruscus aculeatus*.

Distribution area: Mert and Erikli floodplain forests in the İğneada region.

3.1.6. Cluster 6

Diagnostic species: *Carpinus orientalis*, *Quercus hartwissiana*, *Ulmus glabra*; *Arum hygrophylum* subsp. *euxinum*, *Clinopodium vulgare* subsp. *vulgare*, *Helleborus orientalis*, *Pulicaria dysenterica*.

Constant species: *Acer campestre* subsp. *campestre*, *Fraxinus angustifolia* subsp. *oxycarpa*, *Fraxinus excelsior*; *Hedera helix*, *Smilax excelsa*; *Leucojum aestivum*, *Primula acaulis* subsp. *rubra*, *Ruscus aculeatus*.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Galeriç, Çakırlar, and Hacıosman Forests in Samsun Province.

3.1.7. Cluster 7

Diagnostic species: *Fraxinus excelsior*, *Periploca graeca*, *Pterocarya pterocarpa*, *Tilia rubra* subsp. *caucasica*; *Crataegus pentagyna*, *Vitis vinifera*; *Agrostis stolonifera*, *Poa pratensis*, *Stachys sylvatica*.

Constant species: *Alnus glutinosa* subsp. *glutinosa*; *Smilax excelsa*; *Circaea lutetiana*, *Galium palustre*, *Glechoma hederacea*, *Lapsana communis*, *Oenanthe silaifolia*, *Potentilla reptans*, *Sambucus ebulus*, *Solanum dulcamara*.

Dominant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus excelsior*.

Distribution area: Yeşilırmak delta in Samsun Province.

3.1.8. Cluster 8

Diagnostic species: *Populus alba*; *Paliurus spina-christi*, *Rosa canina*, *Rubus sanctus*, *Styrax officinalis*, *Vitis sylvestris*; *Arundo donax*, *Asparagus aphyllus* subsp. *orientalis*, *Lavandula stoechas*, *Osyris alba*, *Plantago lanceolata*, *Plantago major*, *Samolus valerandi*, *Scirpoides holoschoenus*, *Sparganium erectum* subsp. *neglectum*, *Apocynum venetum* subsp. *sarmatiense*.

Constant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus angustifolia* subsp. *oxycarpa*, *Quercus robur* subsp. *robur*, *Ulmus minor*; *Crataegus monogyna*, *Hedera helix*, *Smilax excelsa*; *Polygonum hydropiper*, *Rumex conglomeratus*, *Ruscus aculeatus*.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Bursa Province.

3.1.9. Cluster 9

Diagnostic species: *Crataegus rhipidophylla*, *Frangula dodonei* subsp. *dodonei*, *Rubus canescens*; *Arum maculatum*, *Carex divulsa*, *Geranium purpureum*, *Lysimachia verticillaris*, *Oenanthe pimpinelloides*, *Phyla nodiflora*, *Platanthera chlorantha*, *Primula acaulis* subsp. *rubra*, *Trachystemon orientalis*.

Constant species: *Fraxinus angustifolia* subsp. *oxycarpa*, *Periploca graeca*; *Hedera helix*; *Arum italicum*, *Euphorbia stricta*, *Galium palustre*, *Geum urbanum*, *Juncus effusus*, *Leucojum aestivum*, *Lysimachia nummularia*, *Poa trivialis*, *Polygonum persicaria*, *Urtica dioica*.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Gölardı floodplain forest in Samsun Province (Terme).

3.1.10. Cluster 10

Diagnostic species: *Alnus glutinosa* subsp. *barbata*, *Ficus carica* subsp. *carica*; *Rubus canescens*; *Apium graveolens*, *Asperula involucrata*, *Calystegia silvatica*, *Carex riparia*,

Cirsium arvense, *Equisetum arvense*, *Polygonum persicaria*, *Rumex tuberosus* subsp. *tuberosus*, *Sambucus ebulus*.

Constant species: *Hedera helix*; *Circaea lutetiana*, *Geum urbanum*, *Urtica dioica*.

Dominant species: *Alnus glutinosa* subsp. *barbata*.

Distribution area: Gölardı floodplain forest in Samsun Province (Terme).

3.1.11. Cluster 11

Diagnostic species: *Salix caprea*; *Rubus idaeus*, *Smilax aspera*; *Alisma plantago-aquatica*, *Capsella bursa-pastoris*, *Carex pendula*, *Euphorbia altissima*, *Galium rotundifolium*, *Oenanthe aquatica*, *Oenanthe fistulosa*, *Plantago major*, *Poa bulbosa*, *Ranunculus marginatus*, *Trifolium repens* var. *repens*, *Trifolium resupinatum* var. *resupinatum*.

Constant species: *Alnus glutinosa* subsp. *glutinosa*, *Fraxinus angustifolia* subsp. *oxycarpa*, *Ulmus minor*; *Galium palustre*, *Lysimachia vulgaris*, *Potentilla reptans*, *Prunella vulgaris*, *Rumex conglomeratus*, *Urtica dioica*.

Dominant species: *Fraxinus angustifolia* subsp. *oxycarpa*.

Distribution area: Süleymaniye floodplain forests in Sakarya Province.

3.2. Ordination

The ordination shows clear gradients along both axes (Figure 3). The floodplain forest communities (clusters in Figure 2) from İğneada floodplain forests situated at the national border with Bulgaria are placed at the left side of axis 1, while the communities from Bursa, Sakarya, and Samsun provinces are at the right side. Similarly, the communities from Sakarya and Bursa provinces are placed at the top of axis 2, whereas the communities in the İğneada region are placed at the middle and the communities of Samsun Province are at the bottom of the gradient.

Geographical factors (latitude and longitude) also have clear gradients along the ordination axis and significant correlations with floodplain forest communities (Figure 3; Table). Because of the latitudinal variation of the Euxine region, the floodplain forests in Bursa and Sakarya provinces are situated more to the south in comparison with the forests in İğneada and in Samsun Province. Similarly, along the longitude, the forests in the İğneada region represent the Western Euxine floodplain forests, while the forests in Sakarya and Bursa provinces represent the Middle Euxine floodplain forests and the forests in Samsun Province represent the Eastern Euxine distributions.

The dominance of Euro-Siberian floristic elements in the floodplain forest communities in the İğneada region is very clear, and it is significantly correlated with axis 1 (Figures 3 and 4). The proportion of Mediterranean floristic elements shows an increase especially at the floodplain forest in Bursa Province (Figures 3 and 4).

From the growth forms, the gradients of chamaephytes and cryptophytes are very apparent (Figure 3). In addition to these, phanerophytes show a significant correlation with community gradients (Table). Similarly, the gradient of species richness is very clear on the ordination plane (Figure 3). It has a significant correlation with community gradients (Table). Community 3 represents the species-richest floodplain forest, whereas Community 4 is the species-poorest floodplain forest in the Euxine region (Figure 5).

4. Discussion

4.1. Floodplain forest communities

Cluster 1 was classified as *Fraxino angustifoliae – Ulmetum laevis typichum* in the original work (Kavgacı et al., 2011). However, according to the classification analysis, it was represented by diagnostic species, and due to that it was revised as *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *allerietosum petiolatae* Kavgacı et al. subass. nov. hoc loco (Typus: Kavgacı et al., 2011, Table 1, relevé 8 – holotypus hoc loco). It represents a multicohort stand structure with a height of more than 30 m. Kavgacı et al. (2011) reported that, during the summer, they had the typical appearance of floodplain forests, containing numerous nitrophilous high-stalk plants (*Urtica dioica)* forming dense, impassable stands with their rhizomes and other plants (*Chaerophyllum temulum*, *Parietaria officinalis*), indicating that nutrients were brought regularly into the stands.

Cluster 2 is another subassociation of *Fraxino – Ulmetum laevis* (Kavgacı et al., 2011), and it is known as *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *junglandetosum regiae* Kavgacı et al. 2011. It shows similar

Table. Kendal correlation coefficients (weighted correlation) between first two DCA axes and geographical variables and species diversity, geoelement, and growth form properties. ***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$.

Axis	Latitude	Longitude	Species richness	Species diversity	Euro-Siberian	Mediter-ranean	Phaner-ophyte	Chamae-phyte	Hemicry-ptophyte	Crypto-phyte	Thero-phyte
1	–0.45***	0.71***	–0.24***	–0.42***	–0.40***	0.12	–0.16*	0.12	0.07	0.08	–0.06
2	–0.07	–0.21***	0.00	–0.01	–0.14*	–0.07	0.05	–0.14*	0.09	–0.36***	0.19**

physiognomic and ecological characteristics with *Fraxino angustifoliae – Ulmetum laevis allerietosum petiolatae.*

Cluster 3 represents the association *Geranio robertiani – Carpinetum betuli* Kavgacı et al. 2011. This community is mostly distributed in the less humid and nutrition-poor sites in comparison with the other communities in the İğneada region (Kavgacı et al., 2011). It is formed by multicohort stand structures reaching a height of more than 30 m. Differently from the other communities in the İğneada region, this community represents a zonal forest characteristic, because its floristic composition is mainly formed by a flora of broadleaved forests. This association is characterized by the highest species richness in comparison with the other communities in the Euxine region (Figure 5).

Cluster 4 was identified as *Leucojo aestivi – Fraxinetum angustifoliae* Glavač 1959 *alnetosum glutinosae* Glavač 1959 (Kavgaci et al., 2011). It is distributed at the most humid parts of the floodplain forests in a region that is in depressions and flooded or even submerged throughout the year. It generally displays a single cohort coppice stand structure. This association represents the species-poorest floodplain forest community in the Euxine region of Turkey.

Cluster 5 was defined as *Smilaco excelsae – Fraxinetum angustifoliae* Pavlov et Dimitrov 2002 *prunellotosum vulgaris* Pavlov et Dimitrov 2002 (Kavgacı et al., 2011). Similarly to the other communities in the İğneada region, this community also shows a multicohort stand structure reaching a height of more than 30 m. This forest is distributed in humid habitats that are distant from the river and therefore poorer in means of nutrients, differently from the previous communities in the region. Kavgacı et al. (2011) reported that these habitats were still humid, but lay along small brooks and therefore were soaked with trickling water, which was partially also stagnant.

Cluster 6 was identified by Kutbay et al. (1998) as the same community as the communities described by Quézel et al. (1980) in Samsun Province and Aydoğdu (1988) in Sakarya Province. Kutbay et al. (1998) called the community *Pterocaryo pterocarpae – Fraxinetum angustifoliae*, whereas Quézel et al. (1992) nominated the community as *Pterocaryo fraxinifoliae – Alnetum barbatae*. On the other hand, our classification analysis showed that this forest was different from the communities studied by Quézel et al. (1980) and Aydoğdu (1988). Due to that, it was revised from the syntaxonomical point of view and called *Aro hygrophyli – Fraxinetum angustifoliae* (Kutbay et al. 1998) Kavgacı et al. ass. nov. hoc loco (Typus: Kutbay et al., 1998, Table 1, relevé 9 – holotypus hoc loco).

Cluster 7 represents the *Alnus glutinosa* subsp. *glutinosa*-dominated forests with the dense appearance of *Alnus glutinosa* subsp. *barbata* along the Yeşilırmak delta in Samsun Province and it is known as *Pterocaryo fraxinifoliae – Alnetum barbatae* Quézel et al. 1992. It was first studied by Quézel et al. (1980) and nominated by Quézel et al. (1992) as *Pterocaryo pterocarpae – Alnetum barbatae*. Later on, it was named by Korkmaz et al. (2012) as *Pterocaryo fraxinifoliae – Alnetum barbatae.*

Cluster 8 represents the *Fraxinus angustifolia* subsp. *oxycarpa*-dominated forests in Bursa Province (Yeniköy) (Özen, 2010). Özen (2010) said that this forest was the same as the *Fraxinus angustifolia*-dominated forests in Samsun Province studied by Kutbay et al (1998). Kutbay et al. (1998) called the community *Pterocaryo pterocarpae – Fraxinetum angustifoliae*, indicating that the floristic composition of the community is highly similar (49.46%) to that reported by Quézel et al. (1992). Although Özen (2010) called the community *Alno glutinosae – Fraxinetum angustifoliae,* he did not make any syntaxonomic identification about the community. However, the name *Alno - Fraxinetum oxycarpae* was already used by Kárpáti in 1962 (Brullo and Spampinato, 1999). On the other hand, our classification analysis revealed that the *Fraxinus angustifolia*-dominated forest of Özen (2010) was floristically differentiated by Kutbay et al. (1998). Due to that, this community was classified as a new association (*Apocyno veneti – Fraxinetum angustifoliae* (Özen 2010) Kavgacı et al. ass. nov. hoc loco (Typus: Özen 2010, Table 4, relevé 2 – holotypus hoc loco).

Cluster 9 appears in the Gölardı floodplain forest in Samsun Province (Terme) (Korkmaz et al., 2012) and was described as *Platanthero chloranthae – Fraxinetum oxycarpae* Korkmaz et al. 2012. It is located in the less humid parts of the floodplain forests in the area in comparison with the other community dominated by *Alnus glutinosa* subsp. *barbata*. Due to previous anthropogenic pressures, this forest was intensively degraded (Korkmaz et al., 2012). It has a multicohort stand structure reaching a height of about 20 m.

Cluster 10 represents the *Alnus glutinosa* subsp. *barbata*-dominated forests in the Gölardı floodplain forest in Samsun Province (Terme) (Korkmaz et al., 2012). Korkmaz et al. (2012) accepted that this community was the same as the *Alnus glutinosa* subsp. *barbata*-dominated community described by Quézel et al. (1992) and called *Pterocaryo fraxinifoliae – Alnetum barbatae* (Quézel, Barbero et Akman 1980) nom. mutatum. However, the classification analysis showed that this community was floristically different than the community described by Quézel et al. (1992). Due to that, it was classified as a new association with the name of *Sambuco ebuli – Alnetum barbatae* Kavgacı et al. ass. nova hoc loco (Typus: Korkmaz et al., 2012, Table 8, relevé 44 – holotypus hoc loco). On the other hand, it is seen that the diagnostic tree species, *Pterocarya pterocarpa*, of Quézel et al. (1992)

does not appear in this community, which clearly shows the difference. Korkmaz et al. (2012) reported that this community, which was degraded, represented more humid parts than *Platanthero chloranthae – Fraxinetum oxycarpae* distributed in the same forest and it was formed by multicohort stands with a height of about 20 m.

Cluster 11 represents the *Fraxinus angustifolia*-dominated forests along the Sakarya River (Aydoğdu, 1988). The forest in the region was intensively degraded, and the flooding regime was destroyed by the artificial drainage channels (Çiçek, 2004), which affected the ecology, flora, and structure of the forests. The high appearances of some grassland and open-habitat species like *Capsella bursa-pastoris*, *Plantago major*, *Poa bulbosa*, and *Trifolium repens* var. *repens* is the result of this process. In the original work, this community was classified as the *Fraxinus angustifoliae – Euphorbia stricta* association without indicating any holotype. Due to that, it was reclassified as *Euphorbio strictae – Fraxinetum angustifoliae* (Aydoğdu 1988) Kavgacı et al. ass. nov. hoc loco (Typus: Aydoğdu 1988, Table 1, relevé 28 – holotypus hoc loco).

4.2. Syntaxonomic classification

Geographical differentiation was widely acknowledged for zonal forest communities (Ioannis et al., 2007; Kavgacı et al. 2012). Our results showed that such a differentiation was also valid for the azonal floodplain forest communities in the Euxine region of Turkey. According to the floristic similarity, these forests were grouped as Western (İğneada region), Middle (Sakarya and Bursa provinces), and Eastern (Samsun Province) Euxine floodplain forests.

Since the floodplain forests in the İğneada region are mainly dominated by Euro-Siberian flora, these communities were classified under *Alno – Quercion roburis* (Kavgacı et al., 2011), which is the typical alliance of the Balkan and Central European floodplain forests (Brullo and Spampinato, 1999), except the *Geranio robertiani – Fraxinetum angustifolia* including more zonal broadleaved vegetation characteristics than azonal vegetation (Kavgacı et al., 2011). This community was classified under the zonal vegetation *Castaneo – Carpinion* (Kavgacı et al., 2011). However, the zonal deciduous forests dominated by *Carpinus betulus* and *Fagus orientalis* in the Euro-Siberian phytogeographical region were classified as *Carpino – Fagion* in a latter study (Kavgacı et al., 2012). Thus, *Geranio robertiani – Fraxinetum angustifolia* should also be classified under this alliance.

There is no alliance identification for the floodplain communities in the Middle Euxine (Bursa and Sakarya provinces) and Eastern Euxine (Samsun Province). The clear geographical variation between floodplain forests as Western, Middle, and Eastern Euxine indicates a probable separation at alliance level.

The gradient of the Mediterranean phytogeographical region with the floodplain forest in the Middle Euxine is very apparent, especially for *Apocyno veneti – Fraxinetum angustifoliae*, which is also characterized by a high proportion of phanerophytes and chamaephytes. The Mediterranean climate easily penetrates the Black Sea Region along the Marmara Sea and related basins and may affect the flora of the Middle Euxine. The high appearance rates of plants from the Mediterranean region in the flora of *Apocyno veneti – Fraxinetum angustifoliae*, like *Asparagus aphyllus* subsp. *orientalis*, *Lavandula stoechas* subsp. *stoechas*, *Osyris alba*, and *Apocynum venetum* subsp. *sarmatiense*, indicate the strict connection of this community with Mediterranean floodplain forests. Thus, a new alliance identification for these communities may be done. However, the diagnostic species analysis for these communities was not satisfactory. This can be related to the insufficient number of relevés from the region, and there is no phytosociological study from the floodplain forests in the Mediterranean Turkey. On the other hand, these forests are intensively degraded, and the high appearances of some grassland and opening species in the flora of these forests like *Plantago major*, *Plantago lanceolata*, *Poa bulbosa*, and *Trifolium repens* var. *repens* indicates the degradation that may also result in insufficient results. Thus, it seems suitable for these communities (Middle Euxine) to include them in *Alno – Quercion* because of the geographical closeness to the İğneada region until another syntaxonomic assessment of floodplain forests enriched with relevés from Mediterranean Turkey.

The distribution of the communities in Samsun Province (Eastern Euxine) is clearly differentiated from the other communities from the geographical point of view. Similarly, in terms of growth form spectrum, the communities in this region show differences (Figure 4). For example, *Aro hygrophyli – Fraxinetum angustifoliae* in this region is characterized by the highest proportion of phanerophytes and lesser proportion of therophytes with *Pterocaryo pterocarpae – Alnetum barbatae. Platanthero chloranthae – Fraxinetum oxycarpae* in this region is the richest community in terms of the cryptophytes. On the other hand, these forests are clearly differentiated from the other communities with the high appearances of *Rubus canescens*, *Periploca graeca*, *Polyganum persicaria*, *Primula acaulis* subsp. *rubra*, *Carex divulsa*, and *Fraxinus excelsior*. The appearance of some Hyrcano-Euxine, Caucasian, and Transcaucasian species in those communities like *Pterocarya pterocarpa* and *Alnus glutinosa* subsp. *barbata* also reflects their eastern structure. Because of that, it seems suitable to define this community under a new alliance representing the floodplain forests in the Eastern Euxine dominated by *Fraxinus angustifolia*, *Fraxinus excelsior*, and *Alnus glutinosa* subsp. *barbata* with the

name *Periploco graecae – Fraxinion angustifoliae* all. nov. hoc loco. The *Alnus glutinosa* subsp. *barbata* forests in the Colchic Region were classified as *Alnion barbatae* under *Rhododendron – Fagetalia*, which is the characteristic order of the Euro-Siberian zonal deciduous forests (Quézel et al., 1980; Quézel and Barbero, 1992; Akman, 1995; Korkmaz et al., 2008). However, *Alnion barbatae* forests are more riverine and ravine forests rather than being floodplain forests, but 14 diagnostic species were identified for *Alnion barbatae* (Akman, 1995) and only two of them, *Circaea lutetiana* and *Frangula dodonei* subsp. *dodonei*, are sparsely distributed in the Eastern Euxine floodplain forests.

Description of this new alliance is as follows:

Name: *Periploco graecae – Fraxinion angustifoliae* all. nova hoc loco.

Nomenclatural type – holoptypus: *Platanthero chloranthae – Fraxinetum oxycarpae* Korkmaz et al. 2012 holotypus hoc loco. The association was validly published by Korkmaz et al. (2012).

Diagnostic species: *Rubus canescens*, *Periploca graeca*, *Polygonum persicaria*, *Primula acaulis* subsp. *rubra*, *Carex divulsa*, and *Fraxinus excelsior*.

Ecological conditions: Hygrophilous floodplain forests dominated by *Fraxinus angustifolia*, *Alnus glutinosa* subsp. *glutinosa*, *Alnus glutinosa* subsp. *barbata*, and *Fraxinus excelsior* in the Eastern Euxine region of Turkey.

According to these assessments, the syntaxonomical scheme of floodplain forest communities in the Euxine region of Turkey can be suggested as follows:

Class: *Salici purpureae – Populetea nigrae* Rivas-Martinez, Fernandez Gonzalez, Loidi, Lousa et Penas 2001

Order: *Populetalia alba* Br.-Bl. ex Tchou 1948

Alliance: *Alno – Quercion* Horvat 1950

Subassociation: *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *allerietosum petiolatae* Kavgacı et al. subass. nov. hoc loco

Subassociation: *Fraxino angustifoliae – Ulmetum laevis* Slavić 1952 *junglandetosum regiae* Kavgacı et al. 2011

Subassociation: *Leucojo aestivi – Fraxinetum angustifoliae* Glavač 1959 *alnetosum glutinosae* Glavač 1959

Subassociation*: Smilaco excelsae – Fraxinetum angustifoliae* Pavlov et Dimitrov 2002 *prunellotosum vulgaris* Pavlov et Dimitrov 2002

Association*: Apocyno veneti – Fraxinetum angustifoliae* (Özen 2010) Kavgacı et al. ass. nov. hoc loco

Association: *Euphorbio strictae – Fraxinetum angustifoliae* (Aydogdu 1988) Kavgacı et al. ass. nov. hoc loco

Alliance: *Periploco graecae – Fraxinion angustifoliae* Kavgacı et al. all. nova hoc loco

Association: *Aro hygrophyli – Fraxinetum angustifoliae* (Kutbay et al. 1998) Kavgacı et al. ass. nova hoc loco

Association: *Pterocaryo pterocarpae – Alnetum barbatae* Quézel et al. 1992

Association: *Platanthero chloranthae – Fraxinetum oxycarpae* Korkmaz et al. 2012

Association: *Sambuco ebuli – Alnetum barbatae* (Korkmaz et al. 2012) Kavgacı et al. ass. nov. hoc loco

Class: *Querco – Fagetea* Br.-Bl. et Vlieger in Vlieger 1937

Order: *Rhododendro pontici – Fagetalia orientalis* Quézel, Barbéro et Akman 1980

Alliance: *Carpino betuli – Fagion orientalis* Kavgacı et al. 2012

Association: *Geranio robertiani – Carpinetum betuli* Kavgacı et al. 2011

Floodplain forests are biologically rich and also ecologically sensitive ecosystems (Tockner and Stanford, 2002) and they can easily be affected by external pressures that change their ecological, biological, and structural characteristics. Floodplain forests in Turkey have been negatively affected by human-induced activities (Çiçek, 2004; Efe and Alptekin, 1989), as is the case for the whole world (Müller, 1998). Because of that, understanding their ecological and biological richness is important not only for their sustainable management but also to restore and rehabilitate lost or degraded fields.

In the present study, totally 11 forest communities were described from the floodplain forests in Turkey to date and all of them are in the Euxine region. However, Turkey is a rich country in terms of floodplain forests, which may include large ecological, environmental, and biological differences. Thus, the number of phytosociological studies focusing on floodplain forests should be increased. Otherwise, the number of such studies constantly remains less than the works carried out in zonal vegetation (Ketenoğlu et al., 2010) and their biological and ecological richness may not be explored due to the ongoing anthropogenic pressures in those habitats.

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Appendix: Synoptic table with percentage frequency (first column) and modified fidelity index (phi coefficient) (second column) – 1) *Fraxino angustifoliae – Ulmetum laevis allerietosum petiolatae*, 2) *Fraxino angustifoliae – Ulmetum laevis junglandetosum regiae*, 3) *Geranio robertiani – Carpinetum betuli*, 4) *Leucojo aestivi – Fraxinetum angustifoliae alnetosum glutinosae*, 5) *Smilaco excelsae – Fraxinetum angustifoliae prunellotosum vulgaris*, 6) *Aro hygrophyli - Fraxinetum angustifoliae*, 7) *Pterocaryo pterocarpae – Alnetum barbatae*, 8) *Apocyno veneti – Fraxinetum angustifoliae*, 9) *Platanthero chloranthae – Fraxinetum oxycarpae*, 10) *Sambuco ebuli – Alnetum barbatae*, 11) *Euphorbio strictae – Fraxinetum angustifoliae*. The darkened numbers show the diagnostic species for the communities. The plants are ranked in accordance with their fidelity values.

Plant names	1	2	3	4	5	6	7	8	9	10	11
Juglans regia		80 89									
Phytolacca americana		80 83								10 2	
Acer heldreichii subsp. *trautvetteri*	13 5	80 82									
Sambucus nigra	63 41	100 74	9								
Chaerophyllum temulum	63 43	90 67	9								
Parietaria officinalis	75 46	100 67	27 7								
Lamium sp.		30 53									
Mercurialis perennis	13		86 70		40 26						
Melica uniflora			45 66								
Galium debile			5	67 77							
Iris pseudacorus		10	5	100 62		50 23	33 10	18	9		
Lysimachia vulgaris	13			100 58			50 21				87 48
Polygonum lapathifolium			50 41	67 58							
Galium paschale				33 56							
Ranunculus constantinopolitanus			23 10		80 66	30 17					
Lysimachia nummularia	25 4		36 13		100 62				64 34		
Lolium perenne					40 61						
Trifolium hybridum			9 7		40 54						
Arum hygrophilum subsp. *euxinum*						90 94					
Helleborus orientalis						70 82					
Quercus hartwissiana						60 54			27 19	20 11	
Pulicaria dysenterica						30 53					
Clinopodium vulgare subsp. *vulgare*						30 53					
Ulmus glabra						30 53					
Agrostis stolonifera					20 5	40 23	100 77				
Poa pratensis							50 69				
Stachys sylvatica							67 69			20 14	
Pterocarya pterocarpa						40 32	67 61				
Tilia rubra subsp. caucasica							33 56				
Polygonum sp.							33 56				
Carex sp.							33 56				
Asperula sp.							33 56				
Crataegus pentagyna							33 56				
Vitis vinifera							33 56				
Rubus species							33 56				
Symphytum sp.							33 56				
Arum sp.							33 56				
Apocynum venetum subsp. sarmatiense								91 95			
Paliurus spina-christi								82 90			
Sparganium erectum subsp. *neglectum*								73 84			
Vitis sylvestris	13 4							82 83			
Arundo donax								55 72			
Asparagus aphyllus subsp. *orientalis*								55 72			

Styrax officinalis								55 [72]			
Samolus valerandi								55 [72]			
Rubus sanctus						10		91 [66]	27 [11]	40 [22]	
Scirpoides holoschoenus subsp. *holoschoenus*								36 [59]			
Osyris alba								36 [59]			
Plantago lanceolata								36 [59]			
Lavandula stoechas subsp. *stoechas*								27 [50]			
Platanthera chlorantha									91 [95]		
Arum maculatum									73 [84]		
Oenanthe pimpinelloides									91 [80]		33 [22]
Crataegus rhipidophylla var. *rhipidophylla*									64 [63]	30 [24]	
Phyla nodiflora									36 [59]		
Frangula dodonei subsp. *dodonei*									55 [56]	30 [27]	
Trachystemon orientalis	13	40 [25]	23 [9]						73 [55]		
Geranium purpureum									36 [51]	10 [9]	
Lysimachia verticiliaris									27 [50]		
Alnus glutinosa subsp. *barbata*							33 [21]			100 [85]	
Calystegia silvatica										50 [69]	
Apium graveolens										40 [61]	
Equisetum arvense		10 [8]								40 [54]	
Carex riparia subsp. *riparia*									27 [25]	50 [53]	
Ficus carica subsp. *carica*									27 [25]	50 [53]	
Rumex tuberosus subsp. *tuberosus*										30 [53]	
Asperula involucrata										30 [53]	
Cirsium arvense										30 [53]	
Euphorbia altissima var. *altissima*											100 [100]
Poa bulbosa											60 [76]
Trifolium repens var. *repens*											60 [76]
Oenanthe aquatica											53 [71]
Capsella bursa-pastoris											53 [71]
Smilax aspera											40 [61]
Galium rotundifolium											40 [61]
Ranunculus marginatus											40 [61]
Trifolium resupinatum var.*resupinatum*					20 [17]						53 [59]
Alisma plantago-aquatica subsp. *plantago-aquatica*							33 [19]	36 [22]			73 [57]
Oenanthe fistulosa											33 [56]
Salix caprea											33 [56]
Carex pendula						40 [22]	50 [31]				73 [52]
Plantago major			5					100 [69]			87 [58]
ALNO- QUERCION											
Ulmus laevis	100 [53]	90 [46]		100 [53]							
Alliaria petiolata	50 [52]	20 [16]	9 [2]								
Carex divulsa		40 [26]	18 [5]		80 [64]						
Quercus robur subsp. *robur*	13	10	59 [34]		20 [2]			64 [38]			33 [13]
Cruciata laevipes			18 [41]								
Festuca gigantea			23 [46]								
Galium aparine		30 [21]	50 [41]				33 [24]				
Carex remota subsp. *remota*	100 [46]	40 [6]	82 [34]	100 [46]					27		

Circaea lutetiana	88	30	90	32	68	18							70	48	100	38			45	3	60	12								
PERIPLOCO- FRAXINION																														
Fraxinus excelsior subsp. *excelsior*													40	15	100	62			55	27	30	8								
Periploca graeca var. *graeca*																			91	81	30	19								
Carex divulsa					23	8							60	42					73	53										
Primula acaulis subsp. *rubra*					5														100	68	90	60								
Rubus canescens var. *canescens*																			55	41	80	65								
Polygonum persicaria																														
POPULATELIA ALBAE* and *SALICI- POPULETEA																														
Populus alba			10														91	72					47	31						
Fraxinus angustifolia subsp. *oxycarpa*	100	15	90	7	82	1	100	15	100	15	100	15					100	15	100	15	20		100	15						
Alnus glutinosa subsp. *glutinosa*	50	8	40	1			100	40			40	1	67	19	64	17							60	14						
Ulmus minor					68	23			80	31			33		73	26	45	8					73	26						
Potentilla reptans					5								67	34	27	4	45	17	30	6			73	39						
Urtica dioica subsp. *dioica*	100	37	100	37	45	2					10						55	8	60	12			93	33						
Cornus sanguinea subsp. *sanguinea*	25	7			5						40	19	50	28	27	9							40	19						
Oenanthe silaifolia	13				18				80	40	40	11	83	42									47	15						
Rumex conglomeratus	100	19	90	12	86	10	100	19	100	19	50		50		55		27		50				93	15						
Salix alba	13	23	10	18																										
Humulus lupulus			20	29									17	24																
Melissa officinalis	13	16	20	29	5	2																								
Rubus caesius	38	29	40	31			33	24																						
Lycopus europaeus			20	8	5				20	8			50	37							40	27								
Glechoma hederacea			10		45	18			20				83	46			36	11	50	21										
CARPINO - FAGION																														
Carpinus betulus	13	2			86	77																	20	9.4						
Rubus idaeus																							33	56						
Tilia tomentosa			10	10	32	46																								
Cornus mas					45	33			40	27	30	18	17	5																
RHODODENDRO - FAGETELIA																														
Sambucus ebulus			10										67	40	18						80	50	27	6.8						
Salvia forskahlei																					10	30								
Ruscus hypoglossum	13	18							20	32																				
Smilax excelsa	50		70	6	100	26	67	4			90	19	100	26	100	26	45		40											
Fagus orientalis					9	29																								
QUERCO - FAGETEA																														
Acer campestre subsp. *campestre*	75	32	10		95	47			20		70	29			18								27							
Carex sylvatica subsp. *sylvatica*	88	53	10		86	52			40	15																				
Viola alba subsp. *alba*	75	50	40	20	64	41																								
Rubus hirtus	25	11	70	53	50	34																								
Viola sieheana	75	39	10		91	51			20				50	20			9													

Carpinus orientalis subsp. *orientalis*															70	69	17	9	9	0										
Rosa canina	13		10		14		67	30											100	55	45	15			27	1.2				
Poa nemoralis					18	14	33	32																	27	24				
Dioscorea communis	13	4	10	1	18	10									30	24									27	20				
Quercus cerris					5	20																								
Vincetoxicum hirundinaria					5	20																								
Platanthera bifolia					5	20																								
Digitalis ferruginea subsp. *ferruginea*																			9	29										
*Cota tinctoria*var. *tinctoria*																			9	29										
Quercus petraea subsp. *iberica*			10	30																										
Fritillaria pontica					14	35																								
*Symphytum tuberosum*subsp. *nodosum*	13	28			5	8																								
Mespilus germanica	13	24			9	16																								
Sorbus torminalis	13	21			14	23																								
Sanicula europaea	25	28	10	7	23	25																								
Hedera helix	63	3	90	20	95	24			20		100	27	33				73	9	55		70	7	47							
Prunus x domestica	13	4	40	35	14	6													9	1	20	13								
Ajuga reptans	13	2			41	31			20	10	10		33	23																
Euonymus europeaus	13	1	10		27	16					40	29	33	22																
Ligustrum vulgare					23	5			20	3	40	20	17	0	36	17	45	25												
Corylus avellana var. *avellana*	75	49	50	28	64	39																								
Lactuca muralis	25	5	80	49	64	36			40	17																				
Brachypodium sylvaticum	50	18	80	40	50	18			60	25									36	8										
Crataegus monogyna	50	7	20		73	22	33		80	27	50	7			100	40	18													
Ruscus aculeatus	38		50	2	95	30			80	21	80	21	33		100	33	36		10											
OTHERS																														
Geum urbanum	75	24	90	33	82	28			20				17		9		64	16	70	20										
Prunella vulgaris	50	13	20		41	7			40	6	30		33	2	36	4			20		67	25								
Galium palustre											40	7	100	48			55	17	50	14	87	39								
Dactylis glomerata			50	18	73	35			80	40			33	6	9						33	5.8								
Poa trivialis	75	30	40	6	45	10	33	2	80	34							55	16	10											
Lamium maculatum	38	13	80	46	73	40			40	15																				
Euphorbia stricta			20		41	17			40	16							73	42	20		27	5.2								
Leucojum aestivum subsp. *aestivum*							67	30			70	33					82	42	30	4	27	1.2								
Polygonum hydropiper	63	34	20				33	11	40	16					64	35														
Lapsana communis subsp. *intermedia*													67	48			36	21	10		40	24								
Aegopodium podagraria	38	28	50	41	27	17																								
Arum italicum					27	20			20	12							55	49												
Solanum dulcamara											40	25	67	50					40	25										
Veronica montana	25	22	20	16	32	31																								
Juncus effusus					9				20	12							55	49	20	12										
Rubia tinctorum																	9	1	40	37	40	37								
Arctium minus	25	21	10	3	18	13											18	13	10	3										
Geranium robertianum			20	21	36	45																								
Ranunculus repens					5				60	48	30	18	33	21																
Poa annua									40	38											47	46								
Laurus nobilis											30	25	33	29	27	22														
Moehringia trinervia			20	18	14	9			20	18			17	13																

Calystegia sepium subsp. *sepium*													50	50	36	7						
Platanus orientalis															27	33					27	32
Orobanche caryophyllacea	13	17			23	35																
Myosotis laxa subsp. *caespitosa*			10	10	5	1															27	38
Clematis vitalba			20	19							30	32	17	14								
Pulmonaria obscura			20	29	18	25																
Galega officinalis					5						20	23					27	34				
Cirsium vulgare					5				20	20	10	6					18	17	10	6		
Polystichum setiferum	13	12	10	8													27	35				
Veronica serpyllifolia					18	25			20	29												
Bellis perennis									20	22	20	22									13	13
Veronica anagallis-aquatica											30	33	33	37								
Apium nodiflorum													33	39			27	30				
Lythrum salicaria																	27	36	20	25		
Aethusa cynapium	25	33	20	25																		
Petasites hybridus	13	16	20	29	5	2																
Eupatorium cannabinum			20	22									33	42								
Listera ovata					18	41																
Ranunculus brutius																					27	50
Viola odorata																					27	50
Mentha aquatica			20	29									17	24								
Deschampsia caespitosa					9	13			20	34												
Geranium lucidum					9	13			20	34												
Fragaria vesca					14	35																
Euphorbia palustris																	9	13	20	34		
Oxalis acetosella																					20	43
Physalis alkekengi	13	23																	10	18		
Physocaulis nodosus			10	24	5	9																
Scrophularia scopolii					9	29																
Dryopteris filix-max					9	29																
Ornithogalum sphaerocarpum					9	29																
Populus tremula subsp. *tremula*					9	29																
Milium effusum					9	29																
Cephalanthera damasonium					9	29																
Morus alba											20	43										
Taraxacum macrolepium											20	43										
Lagurus ovatus															18	41						
Crataegus microphylla subsp. *microphylla*															18	41						
Scolymus hispanicus subsp. *hispanicus*															18	41						
Euphorbia platyphyllos subsp. *platyphyllos*															18	41						
Trifolium fragiferum var. fragiferum																	18	41				
Stachys palustris																	18	41				
Asplenium scolopendrium																	18	41				
Rumex crispus																	18	41				
Polygonum salicifolium																			20	43		
Tanacetum parthenium	13	34																				
Scutellaria galericulata			10	30																		
Stellaria media			10	30																		
Anchusa officinalis			10	30																		
Chaerophyllum byzantium					5	20																
Chelidonium majus					5	20																

Senecio aquaticus			5 [20]								
Allium siculum subsp. *dioscoridis*			5 [20]								
Allium paniculatum subsp. *paniculatum*			5 [20]								
Cynosurus cristatus					20 [43]						
Bromus hordeaceus					20 [43]						
Hordeum geniculatum					20 [43]						
Polygonum aviculare					20 [43]						
Trifolium micranthum					20 [43]						
Trifolium repens var. *macrorrhizum*					20 [43]						
Alisma lanceolatum					20 [43]						
Myosotis alpestris subsp. *alpestris*					20 [43]						
Juncus bufonius					20 [43]						
Anthemis cotula					20 [43]						
Avena fatua var. *fatua*						10 [30]					
Verbena officinalis var. *officinalis*						10 [30]					
Erodium acaule						10 [30]					
Conyza canadensis						10 [30]					
Poa infirma						10 [30]					
Ranunculus bulbosus subsp. *bulbosus*							17 [39]				
Primula veris subsp. *macrocalyx*							17 [39]				
Vincetoxicum speciosum								9 [29]			
Medicago marina								9 [29]			
Tamarix smyrnensis								9 [29]			
Phillyrea latifolia								9 [29]			
Medicago lupulina									9 [29]		
Sonchus asper subsp. *glaucescens*									9 [29]		
Dorycnium graecum									9 [29]		
Ranunculus ophioglossifolius									9 [29]		
Potentilla recta									9 [29]		
Xanthium spinosum										10 [30]	
Chenopodium murale										10 [30]	