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# Leucojo-Fraxinetum parvifoliae Glavač 59 and Pruno-Fraxinetum Oberdorfer 53 of the Thessalian Pinios Delta (Greece)

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## Abstract

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The plant associations of the valleys of Leucojo-Fraxinetum parvifoliae (= angustifoliae) Glavač 59 and Pruno-Fraxinetum Oberdorfer 53 near the Delta of the Pinios River were investigated. Their floristic composition and their structure are described.

The plant associations of the hardwood as well as the softwood valleys have not been studied systematically in the Greek area until now despite their special structure, which is due to the location of the country in the Balkan peninsula and the influence of the mediterranean flora.

## Introduction

The plant associations Leucojo-Fraxinetum parvifoliae (= angustifoliae) Glavač 1959 and Pruno-Fraxinetum Oberdorfer 1953 have been studied near the Delta of the Pinios River in the Thessalian valley and a description of their floristic composition and structure is attempted. Inspite of the fact that the plant associations of the hardwood as well as the softwood valley forests have a special structure due to the location of the country in the Balkan peninsula and the influence of the mediterranean flora, they have not been systematically studied in the Greek area so far. The relatively few observations by Grisebach (1841), Mattfeld (1927, 1929), Stojanov (1929), Turril (1929), Horvat et al. (1974), Zoller et al. (1977), Strid (1980) and Raus (1980) refer mainly to sporadic registration and publication of data about Northern Greece, Macedonia and Thrace. Thus, it is evident that a systematic study of the valley plant associations might provide some hitherto unknown data for the Greek area. When compared to the existing data from the neighbouring Balkan countries and the other European countries, this might lead to interesting conclusions. At the same time it will contribute positively to the development and protection of the valley forests. The protection of these forests is of great importance.

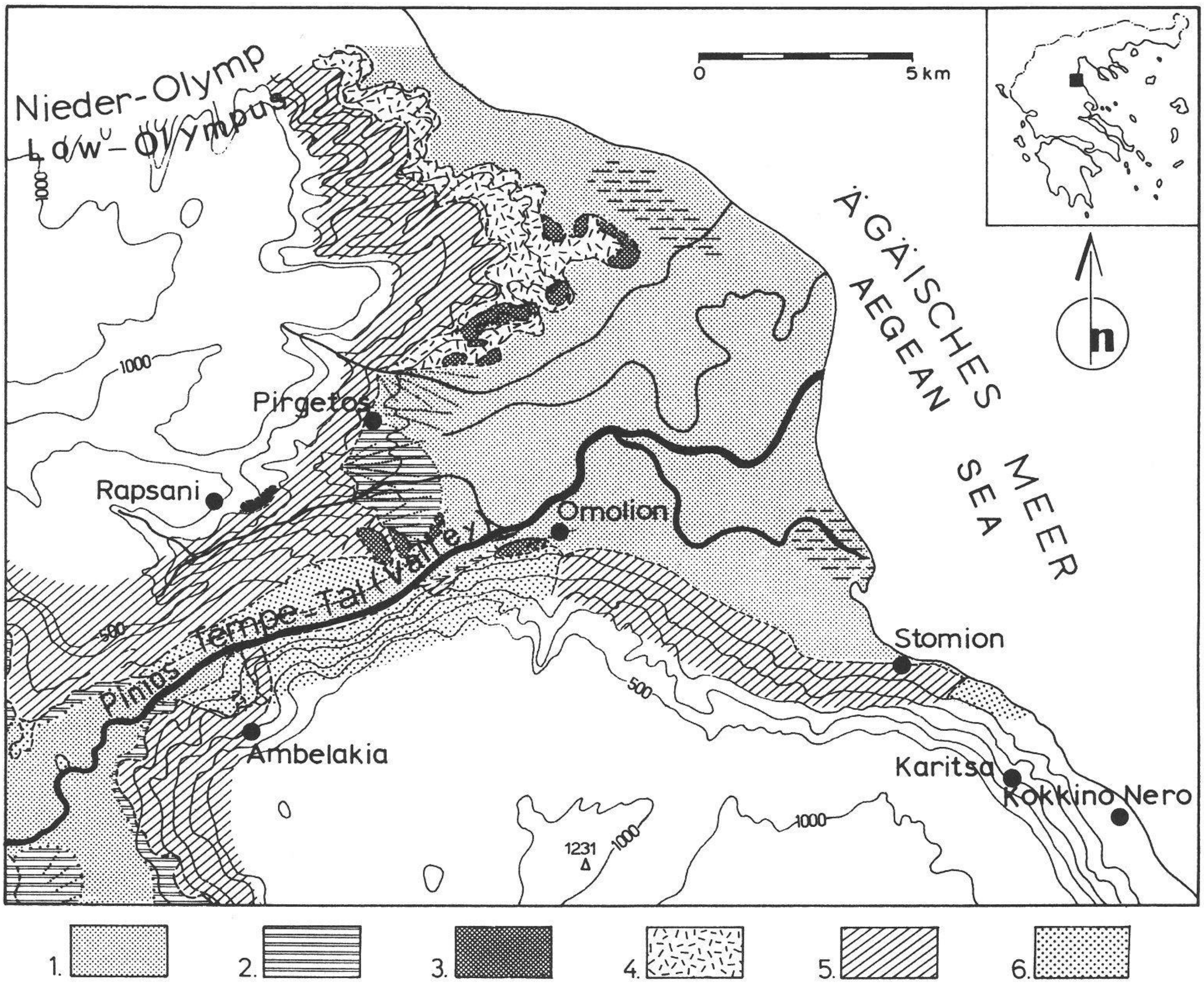


Fig. 1. Geomorphology of the Thessalian Pinios Delta. 1. Holocene deltaic deposits; sand and clays, 2. Upper Pleistocene alluvial fan deposits (conglomerates and sands), 3. Villafranchian talus cones, 4. Upper Tertiary lacustrine and continental deposits, 5. Gneisses and mica schists of Pelagonian zone, 6. Calcareous rocks.

## Geology-geomorphology

The Thessalian Pinios River crosses the Tempe valley which lies between Mount Olympos and Mount Ossa. After leaving the Tempe valley it crosses a small alluvial area, flows into the Aegean sea and forms a flat and long Delta at its estuary. After it exits from the Tempe valley the dynamics of the waterflow is low. It is, therefore, at this location that it deposits a fine sandy material, which forms many sediments rich in mud and clay.

From a geological point of view, the Pinios Delta and its broader area are part of the Pelagonian zone. According to Schneider (1968), the Pinios Delta is formed by holocenic deposits of sand and clay which are at least 3–4 meters thick. The fringes of the Delta as well as the slopes of Mount Ossa and Mount Olympos are formed by upper Pleistocene conglomerates, sand of alluvial fans, villafranchian talus cones of slopes and upper Tertiary lacustrine-continental deposits. A considerable part of the slopes and the calcareous rocks of the river sides of the Tempe valley is covered by the gneiss and mica schists of the Pelagonian zone (Fig. 1).

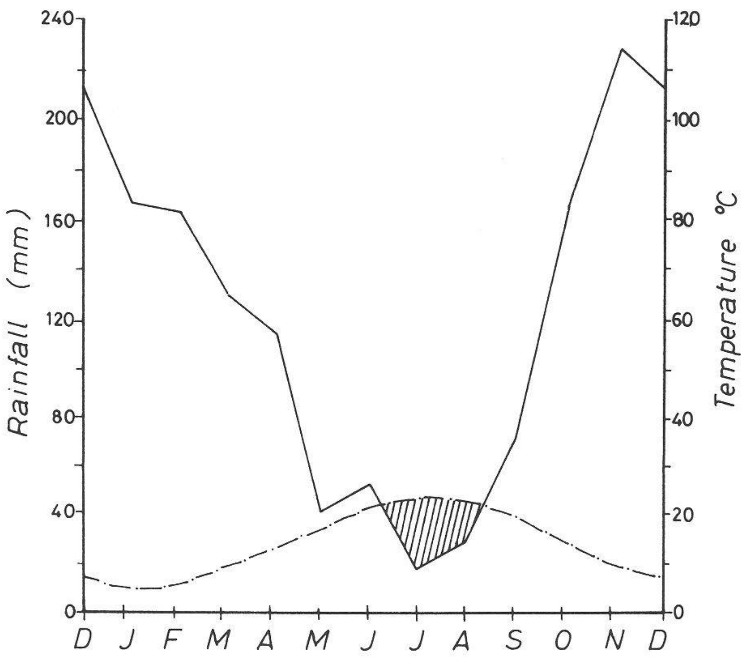


Fig. 2. Ombrothermic diagram from the meteorological station of Karitsa.

Table 1. Average temperature and rainfall values from the meteorological station of Karitsa.

| Months | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average temp. °C | 5.3 | 5.5 | 9.1 | 12.4 | 17.2 | 21.3 | 23.6 | 22.7 | 19.8 | 14.8 | 10.2 | 7.6 | 14.1 |
| Average rainfall mm | 166.2 | 163.0 | 129.4 | 115.1 | 40.2 | 52.2 | 17.9 | 28.9 | 72.2 | 167.5 | 228.5 | 221.6 | 1392.4 |

## Climate

The nearest meteorological station is at Karitsa, a village 380 m above sea level. Its direct distance from the research area is 12.5 km in a S.E. direction. The data, collected by the Forest Research Institute of Athens, covers a period of 10 years (1977–1986). The average temperature and rainfall for every month are given in table 1. At the bottom of this table the average annual values are given. At the same time the ombrothermic diagram from the meteorological station is given in Fig. 2.

The following can be deduced from the data of table 1 and the ombrothermic diagram:

1. The average temperature of the coldest month is 5.3 °C
2. A dry period from July to August appears during the six "summer" months.
3. The average rainfall of the most humid month (228.5 mm) is more than three times as high as that of the driest month (17.9 mm).
4. The average temperature of the four hottest months is above 10 °C, while the average temperature of the hottest month is 23.6 °C.

Based on these data we can define the climate of the area of the meteorological station as mediterranean continental with a dry – hot summer and a mild winter of the Csa type according to Korpen's classification.

Taking into consideration (a) the above classification of the climate in the area of the meterological station, (b) the geographical location and the vegetation of the area, and (c) Mavrommatis' (1980) systematic classification, we can conclude that the area belongs to a semi-humid bioclimatic floor with mild winter, and that its bioclimate has an intense mediterranean character.

**Vegetation**

The Pinios issues from the narrow pass of the Tempe valley and flows towards its delta forming banks and flat spaces which are covered with valley forest vegetation. This has the form of thin belts or, where the ecological factors and human influence allow, of detached stands.

Along the valley there are no big forest complexes like the "Longos" in Bulgaria which were the subject of a special study by Stojanov (1929). Being close to the eumediterranean zone of vegetation (Quercetalia ilicis), it has a geographical location that does not allow the development of valley forests of the "Longos" type (Zoller et al. 1977, Raus 1980).

The valley forest of the Pinios River today is very sparse and scattered. Among its remnants are cultivated areas and meadows, which are grazed by herds of small and big animals all year round.

The most important role in the shaping of the vegetation in this part of the Pinios River is played by the softwood *Salix alba, S. fragilis, Populus alba, P. nigra* and plantations of cultivated hybrids of the euroamerican poplar. The native species of *Salix* and *Populus* surround the bed of the river along its banks. They expand on flat positions of recent deposits and often climb along the torrents of the slopes of Olympos and Ossa.

Frequently, the shrub species *Salix amplexicaulis, S. cinerea* and *S. triandra* mix with species of *Juncus* and clusters of the species *Arundo donax, Phragmites australis* and *Scirpus maritimus*. Also, groups of valley forests are formed by the oriental planetree (*Platanus orientalis*). Among these there are numerous characteristic species of the Populetalia order, i.e.,: *Alnus glutinosa, Carex hirta, C. remota, Humulus lupulus, Mentha aquatica, Populus nigra, Rubus caesius, R. ulmifolius, Salix alba, S. amplexicaulis, Saponaria officinalis, Solanum dulcamara, Ulmus minor* etc. The existence of groups of valley forests of oriental planetrees indicates a transition to a mediterranean type of valley forests.

Moreover, *Fraxinus angustifolia* or *Alnus glutinosa* are predominant in places which are flooded for long periods of time. They form valley forests of hardwood, although, as pointed out, the valley forests of softwood are the most important in the shaping of the vegetation. They are to be seen in places where the dynamics of the waterflow is higher. From this point of view, the alluvic positions in relation to the soil conditions, the level of underground water and the duration of the floods show alternating ranges of hardwood and softwood forests which owe their existence to the active local factors (soil, water), and not to the general climatic conditions.

Finally, islets of reed-beds of *Phragmites australis* appear along the river bed and the streams which flow into it in flat and marshy areas. *Arundo donax* appears at some boundary positions of well-drained soils. At the delta and the marshy areas, which the sea water seems to invade at high tide, the reed-beds become particularly prominent.

The valley forests including those of Pinios must be seen as model remnants of azonic formations, which have been preserved deep into the mediterranean area. It is evident from their composition that they preserve many floristic elements of the northern forest of the Balkan peninsula. It can also be seen by the composition of the vegetation that, in contrast to the present time, it had once been almost without clearings of fields, shrubs and meadows.

## Research material and method

In order to study the plant sociological units of hardwood forest clusters of *Fraxinus angustifolia*, a study has been carried out at these sites. This study was conducted along the bed of the low course of the river and, more specifically, where it leaves the Tempe valley, and up to the Delta. A representative remnant of a high-standing and closed canopy of hardwood valley forests of *F. angustifolia* was marked out at the "Giolia" position of Omilion village. Appropriate sampling plots of 200–250 $m^2$ were selected at different positions, and 14 vegetation samplings were carried out following the Braun-Blanquet (1964) method. Positions with young individuals or with individuals of old age but in a very sparse condition were excluded as non-representative.

The vegetation samples were tabulated to determine the vegetation units of these forests. The vegetation units with the corresponding information for their structure and composition are given in table 2 (a plant sociological table for the classification of differential species). Moreover, the presence classes (I–IV), the life forms and the chorological area of the species which take part in the composition of the vegetation units are also given.

Finally, the nomenclature of the vegetation units was based on Horvat et al. (1974), and of the species on Flora Europaea (Tutin et al. 1964–1980).

## Structure and analysis of the plant associations

The tabulation of the vegetation samples disclosed two prominent plant associations: the Leucojo-Fraxinetum parvifoliae (=angustifoliae) Glavač 59, and the Pruno-Fraxinetum Oberdorfer 53.

According to the relevant bibliography (Adamović 1909, Mattfeld 1927, 1929, Stojanov 1927, 1929, Wendelberger 1956–1957, 1973, Glavač 1959, 1962, 1969, 1975, Géhu 1961, Wraber 1961, Krausch 1965, Fukarek and Fabijani 1968, Ritter-Studnička and Grgić 1971, Horvat et al. 1974, Zoller et al. 1977, Raus 1980, Strid 1980), the developmental rhythms of these plant associations of the Pinios valley are equivalent to other fields of hardwood valley forests in northern Greece and the Balkan peninsula.

There is a clear distinction between these plant associations. It concerns the ecological conditions of their development stations, which are determined by local soil factors, level of the underground water table, and morphological formations of the Pinios valley soil.

Thus, the plant association Leucojo-Fraxinetum parvifoliae appears at sites which have a closer connection to the present river bed and provide more favourable conditions for the growth of hydrophilic plant species, and, therefore, show a greater relation in their physiognomy to the Alnetea forests.

Contrary to this, the Pruno-Fraxinetum plant association appears at slightly elevated stands of the bed fringes, where there is better drainage with appropriate soil conditions for the development of many broad-leaved plant species. It acts as a connecting link between the hydrophilic forests of Alnetea and the mixed deciduous forests of Querco-Fagetea (Oberdorfer 1953, 1957, Glavač 1959, 1975, Horvat et al. 1974).

This plant association (Pruno-Fraxinetum) of the Greek area shows a divergence in its structure and composition of characteristic species in relation to the corresponding plant associations of the valley forests of the central European (Oberdorfer 1953) and the Balkan area (Glavač 1969, 1975, Stojanov 1929, etc.). This is due to the geographical position of Greece, the influence of the mediterranean climate and the dominance of mediterranean floristic elements.

Such divergences are attributed to the absence of characteristic species of northern areas and are detected in other forest plant associations as well. They are characteristic of transitional plant associations. In this particular case we are dealing with azonic model formations which invaded the mediterranean area and were preserved at biotopes with conditions corresponding to those of the northern areas.

The characteristic species *Prunus padus* which does not exist in Greece but appears in the northern Balkan areas, and almost everywhere in the rest of Europe, must not be a determining element for a different name of the already defined plant association. This is so because the biochore as well as the floristic composition are essentially the same as those of the northern areas.

### *1. The plant association Leucojo-Fraxinetum parvifoliae Glavač 59*

According to Raus (1980) this plant association covers small and discontinued sites of the old beds and of depressions which are flooded even when they have lost their natural connection to the river, a fact that has also been verified by our observations on the site.

There is no vigorous waterflow at these stations. But, the waterflow is often either raised as underground, or the stations are flooded by sources which are active for long periods of time.

The floods are more frequent in spring and autumn when the level of the surface water rises in relation to the type and duration of the rain periods. The altitude and the morphological formation of the soil of the present river bed play an important role, too.

The surface water withdraws during the summer period but remains at low depth as underground flow. The average high level of floods can be determined with sufficient accuracy from the bark of the trunks at the lower limit of their coverage by lichens and mosses which are present in abundance. A valley forest of *Fraxinus angustifolius (=parvifolius)* resists and develops at these periodical ups and downs of the water level. The characteristic plant association Leucojo-Fraxinetum parvifoliae (=angustifoliae) Glavač 1959 develops after the withdrawal of the surface water and the massive appearance of the geophyte *Leucojum aestivum*, which blooms comparatively late.

At the sites where this plant association appears, the soil is usually sedimentary with a very fine, clayish texture of great fertility which favours the overwhelmingly good development of the Leucojo-Fraxinetum forests.

The composition of this plant association is given in the following plant sociological table (table 2).

Many other species which are also indicative of a hydrophilic character, apart from the dominating and characteristic species *Leucojum aestivum* and *Fraxinus angustifolius*, constitute this plant association, i.e.: *Alisma plantago-aquatica, Iris pseudacorus, Lythrum salicaria, Mentha aquatica, Oemanthe fistulosa, Phalaris arundinaceae, Ranunculus* *repens, Sparganium erectum, Typha latifolia* etc. According to Horvat et al. (1974), depending on the soil conditions and the level of the underground water, these species form many combinations. If some of them do not have the status of plant associations they at least are accorded that of plant subassociations. They also help to distinguish the plant association Leucojo-Fraxinetum parvifoliae from others of corresponding forests of the Fagetalia order, which show a xerothermic character.

A rich plant subassociation of reeds, the Phragmito-Caricetosum (Horvat et al. 1974) has developed at stations close to the above mentioned plant association. They occur on stagnant waters, at the fringes of streams with constant waterflow, and at marshy positions. The location of this plant subassociation at the wettest and highly marshy localities is due to the fact that the species *Phragmites australis* as well as the tall species of the genus *Carex (C. pendula, C. riparia* etc.) have, in contrast to many other species, an internal system of ventilation.

The contribution of the plant species which are characterised as Lianes to the composition of the Leucojo-Fraxinetum parvifoliae plant association forests is poor. They are represented by the following climbing plants: *Hedera helix, Periploca graeca, Rosa sempervirens, Solanum dulcamara.*

Therefore, from the point of view of the degree of presence of Lianes and of their contribution, this plant association does not have the character and the physiognomy of the plant associations of the "Longos" valley forests of Bulgaria (Stojanov 1929), but is rich in woody Lianes which appear in wet soils. According to the reports of Mattfeld (1927, 1929), Turril (1929) Stojanov (1929), Soó (1957), and Zoller et al. (1977), valley forests of the "Longos" type were or are appearing in the northern Greek area, i.e. in the river beds of the Strymon, the Nestos (lower than Xanthi) and the Evros. According to the data provided by the above-mentioned authors, species which are present in the "Longos" forests are absent from the stations of the Leucojo-Fraxinetum plant association of the Pinios River.

A comparison of the corresponding plant sociological catalogues of the "Longos" forest of the northern part of Macedonia to those parts of the Balkan peninsula which are to the north, reveals that the floristic differences in the Lianes of the "Longos" type formation and in the corresponding forest compositions of the Pinios are not only due to the geographical positions and the phytogeographical composition of the forest formtion of the corresponding areas, but are also due to the different ecological conditions (climate and soil).

In contrast to the poorer soils of the study area the soil of the river deposits of these northern areas of the Balkan peninsula is wetter and marshy, rich in clay and humus (Stojanov 1929, Oberdorfer 1957, Glavač 1975). In addition, the climate is of a continental character while the valley of the low flow of the Pinios River is under the strong influence of the mediterranean climate.

Finally, despite these differences, it should be noted that in regard to the participation of many hydrophilic species in the composition of the Leucojo-Fraxinetum parvifoliae plant association, the latter is the best possible and shows its relatedness to the Alnetea forests.

### *2. The Pruno-Fraxinetum Oberdorfer 53 plant association*

Many valley forests were converted from Alnetea forests into Pruno-Fraxinetum forests to provide soils fertile for agriculture. This was achieved through bed change or

**Table 2:** Plantsociological table

| Lifeforms | | 1 | 2 | 11 | 12 | 5 | 10 | 3 | 4 | 13 | 14 | 6 | 7 | 8 | 9 | Presence classes | Chorological area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of stand examined | 1 | 2 | 11 | 12 | 5 | 10 | 3 | 4 | 13 | 14 | 6 | 7 | 8 | 9 | | |
| | Altitude 10 m | | | | | | | | | | | | | | | | |
| | Height of trees (m) | 20 | 25 | 15 | 15 | 20 | 20 | 25 | 25 | 18 | 22 | 20 | 20 | 25 | 25 | | |
| | Cover of trees (%) | 70 | 65 | 60 | 70 | 85 | 60 | 75 | 70 | 65 | 50 | 75 | 80 | 85 | 75 | | |
| | " " shrubs (%) | 30 | 35 | 15 | 10 | 10 | 15 | 10 | 20 | 10 | 10 | 25 | 10 | 20 | 25 | | |
| | " " herbs (%) | 95 | 100 | 90 | 95 | 90 | 95 | 60 | 80 | 100 | 100 | 50 | 60 | 60 | 85 | | |
| | Size of stand ($m^2$) | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 150 | 200 | 250 | 200 | 200 | 200 | | |
| | Number of species | 38 | 36 | 29 | 23 | 34 | 21 | 19 | 14 | 17 | 17 | 14 | 14 | 19 | 14 | | |
| | **Ch. sp. Alliance, Order a. Class**[1] | | | | | | | | | | | | | | | | |
| P | Fraxinus angustifolia Vahl[2] ħ | 4.5 | 3.4 | 4.4 | 4.4 | 4.4 | 3.3 | 4.5 | 3.4 | 3.4 | 3.3 | 4.4 | 5.5 | 5.5 | 4.5 | V | subatl-smed |
| P | Fraxinus angustifolia Vahl[2] ħ | 1.2 | 1.2 | +.2 | 1.2 | 2.2 | +.2 | 1.2 | +.2 | 2.2 | +.2 | 2.2 | +.1 | +.2 | +.2 | V | subatl-smed |
| H | Runex sanguineus L. | 1.2 | 2.2 | +.2 | +.2 | +.2 | +.2 | 1.2 | +.2 | +.2 | +.2 | +.1 | +.1 | +.2 | +.2 | V | subatl-smed |
| P | Periploca graeca L. | +.2 | 1.2 | +.1 | . | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.1 | 2.2 | 1.1 | +.2 | V | omed-osmed |
| G | Leucojum aestivum L. ssp. aestivum | +.2 | +.2 | . | . | 1.2 | +.2 | 5.5 | 3.4 | +.2 | 2.3 | 3.2 | 4.4 | 4.4 | 2.3 | V | smed-med |
| H | Lythrum salicaria L. | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | . | +.2 | . | . | +.2 | +.2 | IV | eurassubozean, circ |
| H | Galium palustre L. | +.2 | +.2 | . | . | +.2 | +.2 | +.2 | +.2 | . | +.2 | +.2 | +.2 | +.2 | +.2 | IV | no-eurasubozean |
| W (H) | Carex riparia Curtis | 2.3 | 3.4 | . | . | +.2 | 4.4 | 1.2 | 1.2 | 5.5 | 2.3 | . | . | 1.2 | 1.2 | IV | euras (subozean) - med |
| Ch | Lysimachia nummularia L. | +.2 | 2.3 | +.2 | +.2 | 1.2 | +.2 | . | . | +.2 | +.2 | +.2 | . | . | . | IV | eurasubozean-smed |
| P | Ulmus minor Miller | 1.2 | +.2 | +.2 | 1.2 | . | +.1 | . | . | +.2 | . | . | . | +.1 | +.1 | III | smed (-gemässkont) |
| P | Rubus ulmifolius Schott | +.2 | +.2 | +.2 | 1.2 | +.2 | +.2 | . | . | +.2 | . | . | . | . | . | III | wmed-atl |
| H (G) | Aegopodium podagraria L. | +.2 | . | +.2 | . | . | 1.2 | 2.2 | . | . | . | . | . | +.2 | . | II | euras (Kont) |
| | **Ch. a. diff.sp.Ass. Leucojo-Fraxinetum parvifoliae (angustifoliae) Glavac 1959:** | | | | | | | | | | | | | | | | |
| W (H) | Iris pseudacorus L. | . | . | . | . | 1.2 | +.2 | 2.2 | +.2 | +.2 | 1.2 | 1.2 | +.2 | +.2 | 1.2 | IV | euras (subozean)-smed |
| H | Ranunculus repens L. | . | . | . | . | 1.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | . | IV | no-euras-smed |
| W | Alisma plantago-aquatica L. | . | . | . | . | +.2 | . | 3.4 | 2.2 | . | 1.2 | 1.2 | 1.2 | 3.2 | 1.2 | III | smed-gemässkont |
| W (H) | Phalaris arundinacea L. | . | . | . | . | 1.2 | . | 1.2 | +.2 | +.2 | 3.4 | . | +.2 | +.2 | 4.5 | III | no-euras, circ |
| H (W) | Mentha aquatica L. | . | . | . | +.2 | . | +.2 | +.2 | +.2 | . | +.2 | . | . | +.2 | . | III | euras-smed (-med) |
| P | Solanum dulcamara L. | . | . | . | . | +.2 | . | +.2 | . | . | 1.2 | +.2 | +.2 | +.2 | . | III | euras-smed |
| H, W | Oenanthe fistulosa L. | . | . | . | . | +.2 | +.2 | . | . | . | . | +.2 | +.2 | +.2 | +.2 | III | subatl-smed-med |
| H, W | Lycopus europaeus L. | . | . | . | . | +.2 | . | +.2 | . | . | . | . | . | +.1 | +.2 | II | euras-smed |
| P | Cornus sanguinea L. ssp. sanguinea | . | . | . | . | +.2 | +.2 | . | . | +.2 | +.2 | . | . | . | . | II | smed (-subatl) |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ch. a. diff. sp. Ass. Pruno-Fraxinetum Oberdorfer 1953:** | | | | | | | | | | | | | | | | |
| H | Brachypodiun sylvaticum (Huds.) P.B. | 2.2 | 1.2 | 4.4 | 3.4 | 1.3 | . | . | . | . | . | . | . | . | . | II | euras (subozean)-smed |
| H | Carex muricata group | +.2 | +.2 | 1.2 | . | +.2 | +.2 | . | . | . | . | . | . | . | . | II | med-smed |
| H | Poa palustris L. | +.2 | +.2 | . | +.2 | +.2 | . | . | . | . | . | . | . | . | . | II | no-euras (kont), circ |
| Th | Sonchus asper (L.) Hill ssp. asper | +.2 | . | +.1 | +.2 | +.1 | . | . | . | . | . | . | . | . | . | II | eurassubozean (-smed) |
| P | Prunus spinosa L. | +.2 | +.2 | 1.2 | 1.2 | . | . | . | . | . | . | . | . | . | . | II | eurassubozean (-smed) |
| G | Tamus communis L. | 1.2 | 1.2 | +.2 | 1.2 | . | . | . | . | . | . | . | . | . | . | II | med (-atl) |
| H | Arum italicum Miller[3] | +.2 | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | II | wsmed-med |
| H | Cruciata laevipes Opiz | +.2 | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | II | smed-eurassubozean |
| H | Ranunculus velutinus Ten. | 2.3 | 2.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | II | osmed-med |
| H | Geum urbanum L. | +.2 | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | II | eurassubozean-smed |
| P | Rosa sempervirens L. | 1.2 | . | +.2 | +.2 | . | . | . | . | +.2 | . | . | . | . | . | II | subatl-smed-med |
| H | Oenanthe pimpine lloides L. | +.2 | . | +.2 | +.2 | . | . | . | . | +.2 | . | . | . | . | . | II | wsmed-med |
| H | Dactylis glomerata L. | +.2 | . | 2.2 | 1.2 | . | . | . | . | . | . | . | . | . | . | II | eurassubozean-smed |
| H | Melissa officinalis L.[4] | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | II | osmed |
| H | Lathyrus pratensis L. | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | II | euras (subozean)-smed |
| P | Crataegus monogyna Jacq. | 1.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | II | smed (-subatl) |
| H(Ch) | Trifolium repens L. ssp. repens | +.2 | +.2 | . | . | +.2 | . | . | . | . | . | . | . | . | . | II | eurassubozean-smed |
| H | Ranunculus neapolitanus Ten. | 1.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | osmed-med |
| H | Taraxacum officinale group | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | no-euras (-subozean) |
| Th | Vicia grandifolia Scop. | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | osmed |
| G | Symphytum bulbosum C. Schimper | +.2 | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | osmed |
| | **Companion sp.** | | | | | | | | | | | | | | | | |
| H | Prunella vulgaris L. | +.2 | . | +.2 | +.2 | . | +.2 | . | . | +.2 | . | . | . | . | . | II | no-euras |
| H | Carduus pynochephalus L. | +.2 | +.2 | +.2 | . | +.2 | . | . | . | . | +.2 | . | . | . | . | II | med |
| H | Thalictrum aquilegifolium L. | . | +.2 | +.2 | . | . | +.2 | +.2 | . | . | . | . | . | . | . | II | gemässkont |
| H | Althaea officinalis L. | . | +.2 | . | . | +.2 | +.2 | . | . | . | . | . | . | . | . | II | omed-kont |
| H | Rorippa sylvestris (L.) Besser | . | +.2 | . | . | +.2 | . | . | . | . | . | . | . | +.2 | . | II | eurassubozean-smed |
| H | Plantago major L. ssp. major | . | . | +.2 | +.2 | +.2 | . | . | . | . | . | . | . | . | . | II | no-eurassubozean |
| H | Viola reichenbachiana Jord. ex Bor. | +.2 | . | +.2 | . | . | . | . | . | . | . | . | . | . | . | I | subatl-smed |
| W | Ranunculus trichophyllus[5] | . | . | . | . | . | . | +.2 | +.2 | . | . | . | . | . | . | I | smed-euras-subozean |
| H | Epilobium hirsutum L. | . | +.2 | . | . | . | . | +.2 | . | . | . | . | . | . | . | I | eurassubozean-smed |
| H | Bellis perennis L. | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | . | I | subatl-smed |
| G(H) | Ranunculus ficaria L. | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | . | I | eurassubozean-smed |
| G | Dactylorhiza maculata (L.) Soo' | . | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | no-eurassubozean |
| Th | Stellaria media (L.) Vill.[6] | . | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | no-euras-med |
| P | Salix alba L. ssp. alba | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | smed-eurassubozean |
| P | Platanus orientalis L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | omed |
| P | Smilax excelsa L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | obalk |
| H | Humulus lupulus L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | euras-smed, circ |
| Th | Polygonum hydropiper L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | euras-smed |
| H | Potentilla reptans L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | euras-smed |
| H | Cardamine pratensis L. | . | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | I | no-euras, circ |
| H | Veronica anagalloides Cuss. | . | . | . | . | . | . | . | . | . | . | +.2 | . | . | . | I | med-smed |
| Ch, P | Hedera helix L. | . | . | . | . | . | . | . | . | . | . | +.2 | . | . | . | I | subatl-smed |
| W | Sparganium erectum L.[7] | . | . | . | . | . | . | . | . | . | . | . | +.2 | . | . | I | euras-smed |
| Th | Torilis japonica (Houtt.) D. | . | . | . | +.2 | . | . | . | . | . | . | . | . | . | . | I | eurassubozean-smed |
| H | Myosotis sylvatica (Ehrh.) Hoffn. | . | +.2 | . | . | . | . | . | . | . | . | . | . | . | . | I | pralp-no |

1. A: **Alno-Quercion roboris** Horvat 1938, O: **Fagetalia sylvaticae** Pawlowski 1928 a.,C: **Querco-Fagetea** Br.-Bl. et Vlieger 1937, 2. ssp. oxycarpa (Bieb. ex Willd.) Franco et Rocha Afonso, 3. ssp. italicum, 4. ssp. officinalis, 5. Chaix in Vill. ssp. trichophyllus, 6. ssp. media, 7. ssp. neglectum (Beeby) Schinz et Thell. in Schinz et R. Keller.

drainage. The transformation created more favourable conditions for the immigration of many species of the Querco-Fagetea class.

In spite of the fact that they have been widely destroyed, they still appear in the Pinios valley at the borders of marshy sites which are created through inundation, at least during the winter and the rainy periods. They also appear, even higher, all along the banks of streams and at the slopes of the adjacent cultivations and forests which they surround like a cloak.

From a floristic and ecological point of view, the remnants of the Pruno-Fraxinetum forests of the Pinios Valley occupy intermediate sites between the wet soil forests of Alnetea and the more xerothermic forests of Querco-Fagetea. The latter cover the slopes of the surrounding mountains, together with the Macchia.

The hydrophilic and transitional character of the Pruno-Fraxinetum forests is also revealed by vegetation sample 5 of the previous plant sociological table. This sampling took place at the border of a marshy position in the study area. It encompasses helobial species of Leucojo-Fraxinetum parvifoliae, i.e. *Iris pseudacorus, Ranunculus repens, Alisma plantago-aquatica* etc., but also species of the more xerothermic adjacent forest of Querco-Fagetea, i.e. *Brachypodium sylvaticum, Carex muricata* group and *Sonchus asper*. The latter species, as already stressed, are also part of the Pruno-Fraxinetum plant association.

Moreover, the presence in the Pruno-fraxinetum plant association of species of valley forests like *Salix alba, Platanus orientalis, Smilax excelsa, Humulus lupulus, Polygonum hydropiper, Potentilla reptans* and *Cardamine pratensis*, indicate its hydrophilic character and also justify its classification in the hardwood valley forests.

In the area of the low flow of the Pinios River, the Pruno-Fraxinetum forests have been cut but their remnants have been preserved to the present day in the form of groups, patches or belts.

The Lianes, as compared to those of the Leucojo-Fraxinetum plant association, are much more sparse, and limited to *Periploca graeca, Tamus communis* and *Rosa sempervirens*.

Table 2 shows that the Pruno-Fraxinetum plant association has many floristic elements characteristic of the adjacent forests of Querco-Fagetea, i.e. *Brachypodium sylvaticum, Carex muricata* group, *Crataegus monogyna, Dactylis glomerata, Geum urbanum, Melissa officinalis, Sonchus asper* etc. These have undoubtedly intruded from the adjacent plant associations of the Querco-Fagetea class of the slopes of Ossa and Olympos Mountains which surround the study area.

With the floristic composition displayed by the plant association Pruno-Fraxinetum as a result of the lower level of the underground water, its formations can be easily included into the plant associations of the Prunetalia order which are classified by Tüxen (1952) into the Querco-Fagetea order, and which he characterizes as cloak plant associations (Mandelgesellschaften) of deciduous forests.

However, the presence of *Fraxinus angustifolia*, the broader biochore of the Pinios valley and the conditions of the station, justify their characterisation as relics of former stands of Pruno-Fraxinetum forests.

In these, the presence of the characteristic species *Fraxinus angustifolia* plays a less important role, in relation to the Leucojo-Fraxinetum parvifoliae forests, because of the reduction of its competitive ability which is due to the drop of the level of the underground water.

At wet Pruno-Fraxinetum sites, one encounters areas fully covered by *Arundo donax* and *Equisetum maximum*, whereas *Phragmites australis* is extremely limited.

At slightly higher sites, and especially at the driest sloping borders of the valley, the Prono-Fraxinetum plant association is replaced by one similar to the Sibljak (Schibljak) mixed shrubland where the woody species have a dominant position: *Quercus coccifera, Paliurus spina-christi, Pyrus amygdaliformis, Rosa canina, Lonicera etrusca, Clematis vitalba,* and from the plant association Pruno-Fraxinetum: *Prunus spinosa* and *Crataegus monogyna.*

With this change of the vegetation towards the stations slightly higher than those of Pruno-Fraxinetum, an unusual contrast is created between the discontinued and residual valley forest of the Pinios river and the dense forests of the mountain slopes surrounding it and especially that of Ossa, where the most important role is played by the Macchia, the oak species and higher up by the chestnut and beech trees (Raus 1979, 1980).

Besides, *Platanus orientalis* rises to a considerable altitude along the torrents, whereas the hydrophilic *Alnus glutinosa* and species of the genera *Populus* and *Salix* are limited to the borders of the slopes and along the streams carrying water all year round.

## Zusammenfassung

In der vorliegenden Arbeit werden die Pflanzenassoziationen Leucojo-Fraxinetum parvifoliae (= angustifoliae) Glavač 59 und Pruno-Fraxinetum Oberdorfer 53 im Pinios-delta (Griechenland) untersucht und ihre floristische Zusammensetzung und Struktur beschrieben.

Die Auengesellschaften sowohl des Hartholzes als auch des Weichholzes sind im griechischen Raum bis heute noch nicht systematisch betrachtet worden, trotz ihrer besonderen Struktur, die eine Folge ihrer Lage auf der Balkanhalbinsel und des Einflusses der mediterranen Flora ist.

In dieser Beziehung bildet die systematische Betrachtung der obengenannten Pflanzenassoziationen einen Beitrag zur Kenntnis der Hartholzauen in den Flußtälern Griechenlands.

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