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Research Article

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Riparian woodland flora in upland rivers of Western Greece

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Abstract

Although natural riparian woodlands are an important feature that affects the quality of aquatic conditions in streams and rivers, surveying riparian zone flora is rarely implemented in the Mediterranean countries. We developed a rapid assessment method for gathering standardized plot-based woody flora and vegetation data from riparian woodlands. In 2005 we surveyed 218 streamside vegetation plots at 109 sites in upland areas of four major rivers in mainland Greece (Alfios, Acheloos, Arachthos, and Aoos). Here we describe the survey method and provide selected results from its initial implementation. The simplicity and effectiveness of this survey procedure supports the use of rapid site-based biodiversity surveys for riparian zones alongside aquatic status assessments.

Keywords: Riparian zone; Riparian woodland; River ecological assessment.

Introduction

Since riparian vegetation directly affects the structure and functioning of in-stream conditions, it is important to consider riparian zones when assessing the environmental state of rivers (NAIMAN *et al.,* 2005). The importance of riparian features is recognized by the European Water Framework Directive (2000/60/EC) since the assessment of a river's status is partly based on hydromorphological quality criteria that include the evaluation of the structure and condition of riparian zones (IVITS *et al.,* 2008). Unfortunately, riparian zone assessments are often not included in evaluations of aquatic ecological status and attention is rarely paid to the streamside flora or vegetation. A reason for this neglect perhaps reflects a poor appreciation of the riparian area's interrelations with in-stream ecological conditions. Furthermore, streamside riparian zones show a remarkable heterogeneity and bio-complexity and this poses challenges to standardized survey work so they remain poorly researched, especially in the Mediterranean countries (AGUIAR *et al.,* 2000; HUPP & RINALDI, 2007; CHATZINIKOLAOU *et al.,* 2008).

Vegetation patterns play an important part in riparian zone delineation because hygrophilous plants often dominate and create distinctive ribbon-like riparian woodlands and wetlands. NAIMAN *et al.* (2005) define riparian zones as 'semi-terrestrial areas influenced by freshwaters, normally extending from the edges of water bodies to the edges of upland communities'. Furthermore, in relation to rivers: 'the riparian zone encompasses the stream channel between the low and high water marks towards the uplands where vegetation may be influenced by elevated water tables or flooding and by the ability of soils to hold water' (NAIMAN & DÉCAMPS, 1997). Natural riparian vegetation is indicative of river corridor ecological integrity and it has often been severely degraded by human activities. In cultural landscapes, such as in the Mediterranean, it is often difficult to discriminate between human or natural disturbances to the vegetation; only in the mountains do substantial semi-natural riparian habitats still exist (AGUIAR *et al.,* 2000).

Assessing the natural vegetation patterns and ecological integrity of thin linear networks of riparian zones usually requires on-site assessment. Although remote sensing can be useful for land-use and woodland delineations (IVITS *et al.,* 2008) many anthropogenic pressures and modifications are not effectively documented through remote sensing studies (e.g. surface water abstraction, invasive alien plants, overgrazing, dumping, rubbish etc). Site-based field protocols for riparian assessments have therefore been developed in many parts of the world (WINWARD, 2000; NRC, 2002; MUNNE *et al.,* 2003). Within this framework, a site-specific knowledge of the local flora of riparian zones is essential for an integrated assessment of a river's ecological condition and biodiversity.

We developed a survey method to rapidly collect streamside vegetation data for use simultaneously with in-stream aquatic ecological assessments (e.g. sampling of macro-invertebrates, fish, birds, aquatic flora and physico-chemical attributes). An important reason for using a rapid assessment method is to take the riparian zone into full consideration when applying aquatic bio-assessment protocols, thus treating the river as a holistic 'river corridor'. Our survey gives emphasis to riparian woodlands since they characterize natural riparian woody vegetation over most of Europe and are considered one of the most vulnerable riparian zone features. In this paper, we report on protocol method development and the riparian phanerophyte flora of four upland river systems in mainland Greece.

Method and Materials

Site selection and survey assessment

This explorative survey was undertaken on an expedition from 21 July to 21 September 2005 resulting in a total of 109 surveyed river sites. Because both riverbanks of each site were surveyed independently the total vegetation study consisted of 218 riparian woodland plots. Mainly upland riparian zones were surveyed (ranging from 238 m to 1325 m elevation), on perennial streams of the Hellenid mountain ranges, within four major river basins in the western half of Greece (Alfios, Acheloos, Arachthos, and Aoos) (Fig.1). Detailed maps of the surveyed sites are provided in ECONOMOU *et al.* (2007).

Representative river reaches were selected in order to conduct both in-stream and riparian surveys; sites of varying degrees of apparent anthropogenic degradation on the river's main stem and its tributaries were surveyed. The simultaneous application of several bio-assessment approaches imposed sampling design restrictions since most sites were situated near road access, although the sites were generally well-dispersed over the river basin. Sites only on perennial streams were selected, and efforts were made to select sites with a generally homogenous character at the river's reach scale. Finally only a very few anthropogenically degraded sites were surveyed; no river sections within urban areas or villages were surveyed. Most sites had a semi-natural or near-natural character and most riparian woodlands were assessed as being in good or medium condition (ZOGARIS, *et al.,* In Press).

Defining riparian zone features: riparian woodland zone and the wider riparian zone

Two different survey procedures were conducted simultaneously at each site:

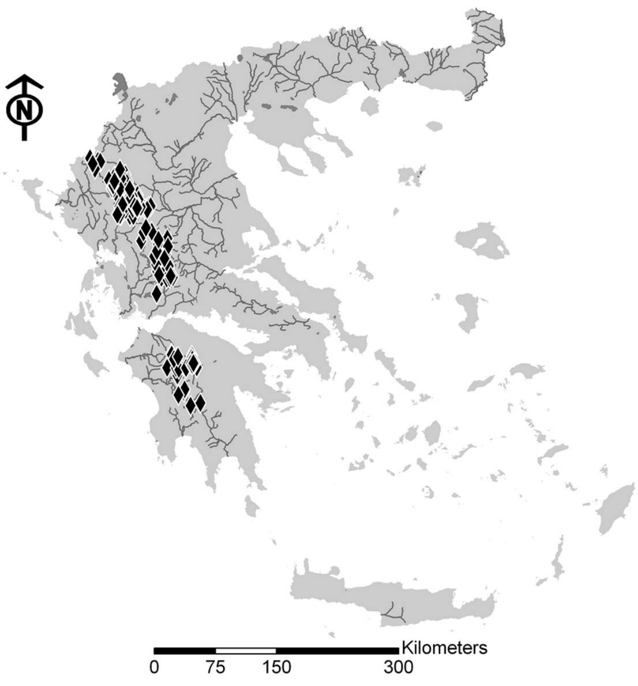

Fig. 1: Upland river site locations surveyed on the western slope of the Hellenid ranges of mainland Greece.

a) recording of the phanerophyte species cover from plots on each river bank and b) bio-assessment procedures including an assessment of anthropogenic pressures and degradation on the wider river corridor of each river site (ZOGARIS in press; ECONOMOU *et al.,* 2007).

For the riparian vegetation survey we focused our attention specifically on the streamside woodland area within the wider riparian corridor, denoted here as the 'riparian woodland' (Fig.2). This distinctive streamside strip of woodland vegetation is often easily recognizable since it forms the first rooted line of perennial woody vegetation immediately adjacent to the stream's active channel. The woody vegetation boundary on the active channel's upland end is labeled here the 'greenline' defining the first phanerophyte vegetation edge developing beside the riverbed. An analogous term was coined independently by WINWARD (2000). The riparian woodland's upland lateral limits are usually also defined by recognizable vegetational and topographic changes usually associated with a lack of high floodwater interaction, reduced soil wetness, and/or minimal groundwater influence. The upland limit of the riparian woodland is therefore often distinguished by a marked decline of hygrophilous or mesophytic vegetation, creating a so-called 'brownline' between the truly ter-

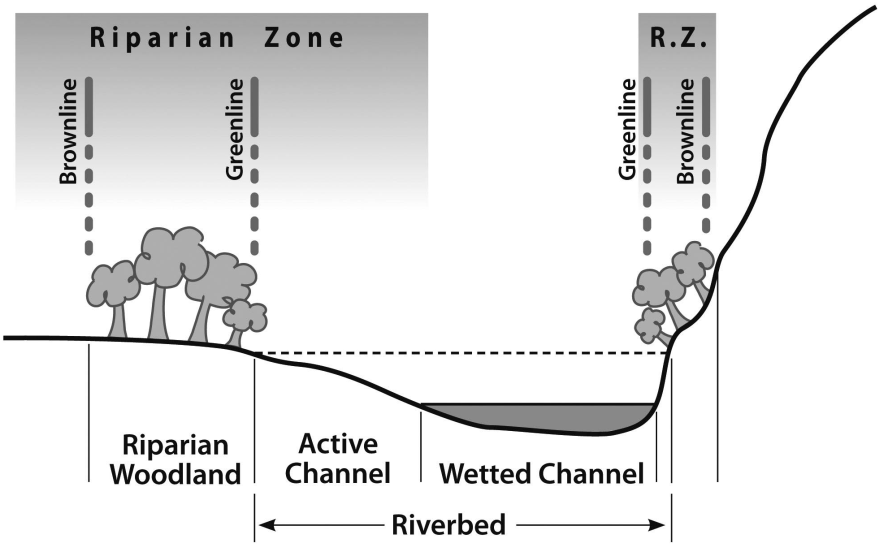

Fig. 2: Schematic cross-section of a generic Mediterranean river corridor depicting the riparian zone and the riparian woodland (shown by tree symbols). The riparian woodland does not include the riverbed's non-vegetated active channel (defined by the dotted horizontal line denoting the annual high-water mark). Within the active channel vegetation is usually restricted to non-woody species able to survive extended periods of inundation and fluvial flood stress. The riparian woodland usually begins at the first rooted-line of trees on the upland end of the active channel ('greenline') and ends where there is a marked decline of hygrophilous vegetation ('brownline'). Along steep banks the riparian zone and riparian woodland is extremely narrow.

restrial and the riparian zone's semi-terrestrial vegetation. This distinctive boundary between true upland terrestrial vegetation and the riparian vegetation is usually prominent, especially in semi-arid climatic areas and on agricultural land (NAIMAN *et al.,* 2005).

The assessed riparian plot length was standardized at 100 m since this length has proven adequate in characterizing floristic richness and is widely used in river assessments in Mediterranean Europe (FERREIRA & MOREIRA, 1999; MUNNÉ *et al.,* 2003). At each site, both banks immediately opposite to each other were delineated as riparian woodland survey plots as shown in Fig. 3. The width of the assessed vegetation plots necessarily varied since they are related to each locality's extent of riparian woodland. Here, the assessor determined the width of the plot, which always began at the end of the riverbed's active channel ('greenline') and ended near the lateral extent of the hygrophilous riparian woodland ('brownline'), i.e. the assessed width ranged from 2 to 50 meters (Fig. 3). If woodland was absent or very sparse the plot may have been as narrow as 2 m in width (i.e. in this case the plot was also aligned with the upper edge of the active channel). Within the 100m long rectangular woodland plots the percentage cover of all woody plants was estimated from within the plot. The assessor visually estimated percentage cover of the areal cover projection of each species by thoroughly walking the entire plot, sometimes criss-crossing twice or more times through the woodland to locate all woody phanerophyte species. This was the most time-consuming part of the survey, often requiring 20 to 30 minutes. Nearly all woody taxa were identified on-site, usually to species level. Operational 'morphospecies' names were used if plants were

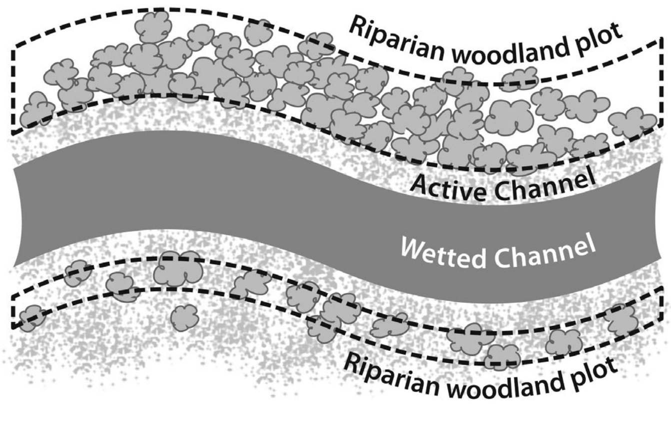

Fig. 3: Schematic plan-view of riparian woodland plots delineated in this study (dotted lines). Each plot's longitudinal length is standardized at 100 m but the width varies with the extent of the riparian woodland (shown in dark grey patches). The assessor determines the width of the plots, which always begin at the end of the active channel ('greenline') and usually end near the lateral extent of the riparian woodland ('brownline'). Otherwise, the plot may be as narrow as 2 m in width if woodland features are absent or very sparse (e.g. bottom riparian plot).

not identified to species-level in the field (e.g. *Clematis, craetegus, Rosa (small-leaved)*). During this survey trial identifications were made primarily by the first author in the field and only a small number of voucher specimens were collected; therefore several unidentified taxa had to remain at genus level.

Results and Discussion

Vegetation and flora

In upland areas riparian woodlands frequently form very narrow woodland strips. Only in exceptional cases did riparian woodlands have widths of over 100 m (n=4) and only 18 riverbanks had riparian woods that were wider than 30 m. The widest riparian woods where located in the Aoos (e.g. Bourazani, Konitsa Plateau) and the upper Acheloos (e.g. Kakorema confluence, Kamnaitikos tributary). 111 plant taxa were recorded in total (including unidentified operational taxonomic units). Maximum richness of phanerophytes per plot was 31, and the mean phanerophyte species richness was 11.6 (SD=5.9). Table 1 presents the phanerophyte species richness per basin with richness per plot and pertinent environmental attributes of each basin. Table 2 shows the frequency of occurrence of 105 identified tree and shrub taxa per river basin. Mean values of percentage coverage in the surveyed plots for each species per basin are shown. The thirty most abundant taxa are ranked by their percentage cover in all basins {i.e. the five most abundant species in terms of relative cover in all basins are *Platanus orientalis* (39,17%), *Salix elaeagnos* (12,21%), *Alnus glutinosa* (7,43%), *Rubus* (7,04%), and *Clematis* spp. (4,83%)}.

Table 1
Environmental parameters and recorded phanerophyte species richness per basin.

River	ACHELOOS				ALFIOS				AOOS				ARACTHOS			
	(n = 112)				(n = 34)				(n = 24)				(n = 48)			
	Mean	Min.	Max	Std. Dev.	Mean	Min	Max	Std. Dev.	Mean	Min	Max	Std. Dev.	Mean	Min.	Max	Std. Dev.
Elevation (m)	745	277	1197	258.2	449	270	735	120	786	338	1325	413	606	238	1036	202.42
Gradient (%)	2.14	0.39	7.5	1.70	0.95	0.2	2	0.57	1.22	0.36	3.08	0.80	2.62	0.11	10	2.87
Watershed (km^2)	189	7.7	1390	275	333	21	834	295	326	6	1166	351	97	13.7	322	84.69
Planerophyte Species per plot	10,7	1	22	5,1	8,3	1	21	3,8	15,2	3	31	7,7	13,8	4	25	5,9
Total Species	90				45				67				63			

Table 2
Mean values of species' percentage coverage in the surveyed plots per basin and for all basins. 105 taxa are shown; the thirty most abundant taxa in terms of mean percentage cover within all four river systems are in bold.

River	ACHELOOS (n = 112)	ALFIOS (n = 34)	AOOS (n = 24)	ARACHTHOS (n = 48)	All Basins (n = 218)
Abies x borisii-regis	3,95		0,06	0,30	**2,10**
Acer campestre	0,62		0,30		0,35
Acer hyrcanum			0,04		
Acer monspessulanum	0,06	0,97	0,25	0,09	0,23
Acer obtusatum	0,87		0,58	0,44	**0,61**
Acer pseudoplatanus	0,41			0,29	0,28
Aesculus hippocastanum	0,51			0,04	0,27
Ailanthus altissima		0,06			0,01
Alnus glutinosa	2,58	0,06	10,71	22,31	**7,43**
Amelanchier spec.			0,33		0,04
Arbutus unedo	0,02				0,01
Arundo donax		0,09		0,02	0,02
Asparagus spec.	0,02				0,01
Buxus sempervirens			2,55		0,28
Carpinus betulus	0,07				0,04
Carpinus orientalis	2,21		1,60	4,51	**2,30**
Celtis tournefortii	0,01				0,01
Cerasus avium	0,02			0,06	0,02
Cerasus spec.	0,01	0,09	0,21	0,05	0,05
Cercis siliquastrum	0,40	0,06	0,50	0,51	0,38
Cistus spec.	0,01			0,15	0,04
***Clematis* spp.**	3,57	9,62	5,50	4,04	**4,83**
Cornus mas	0,95		0,67	0,94	**0,77**
Cornus sanguinea	0,03	2,50	1,79	0,88	**0,79**
Cornus spp.	0,35			0,57	0,30
Corylus avellana	0,14	0,06	0,92	0,52	0,30
Corylus colurna	0,04				0,02
Corylus spp.	0,14		1,04	0,04	0,20
Cotinus coggygria	0,38		1,00	0,72	**0,46**
***Crataegus* spp.**	0,95	0,50	0,59	0,19	**0,67**
Cupressus sempervirens		0,24			0,04
Daphne laureola	0,09		0,01		0,05
Erica arborea	0,03				0,01
Erica spec.			0,04		
Euonymus latifolius	0,11				0,06
Euonymus spp.	0,02		0,17		0,03

(continued)

Table 2 (continued)

River	ACHELOOS (n = 112)	ALFIOS (n = 34)	AOOS (n = 24)	ARACHTHOS (n = 48)	All Basins (n = 218)
Fagus sylvatica	0,68		2,38	1,92	**1,03**
Ficus carica	0,12	2,06	0,38	0,15	**0,45**
Frangula alnus	0,01		0,08		0,01
Fraxinus ornus	1,47	1,44	2,54	3,08	**1,94**
Hedera helix	1,07	5,79	4,58	2,90	**2,60**
Hippocrepis emerus subsp.emeroides	1,11	0,41	0,92	1,52	**1,07**
Humulus lupus	0,06	0,85	1,29	0,23	0,36
Juglans regia	0,20	1,21	0,38	0,35	0,41
Juniperus foetidissima	0,01				
Juniperus oxycedrus	1,63		1,04	1,02	**1,17**
Laburnum anagyroides	0,43				0,22
Laurus nobilis		2,00			0,31
Ligustrum vulgare			0,88		0,10
Malus sylvestris	0,13				0,07
Nerium oleander		0,12			0,02
Olea europea	0,01				
Ostrya carpinifolia	4,41	0,32	3,04	1,90	**3,07**
Paliurus spina-christi	0,02		0,13	0,21	0,07
Periploca graeca			0,58		0,06
Phillyrea latifolia	0,54	1,79	0,62	0,56	**0,75**
Phlomis fruticosa	0,03	0,71			0,12
Pinus nigra	0,54		18,17	2,06	**2,73**
Pistacia terebinthus	0,04		0,08		0,03
Platanus orientalis	40,23	59,71	18,67	32,38	**39,17**
Populus nigra			5,29		**0,58**
Populus tremula				0,02	
Populus hybrid	0,02	0,88		0,25	0,20
Prunus coccomilia	0,36				0,18
Prunus spec.	0,56	0,03	0,04	0,06	0,31
Prunus spinosa	0,02		0,08		0,02
Pyracanthus coccinea	0,38		1,71	0,67	**0,53**
Pyrus amygdaliformis	0,01	0,09	0,08		0,03
Pyrus communis	0,01		0,08	0,02	0,02
Pyrus spec.			0,08		0,01
Quercus cerris	0,16		0,33		0,12
Quercus coccifera	1,00	3,62	0,38	0,98	**1,33**
Quercus frainetto	0,85		0,38	0,46	**0,58**
Quercus ilex	0,21	1,03			0,27

(continued)

Table 2 (continued)

River	**ACHELOOS (n = 112)**	**ALFIOS (n = 34)**	**AOOS (n = 24)**	**ARACHTHOS (n = 48)**	**All Basins (n = 218)**
Quercus petraea	0,04				0,02
Quercus pubescens	0,03	0,09			0,03
Quercus spec.	0,04		0,42	0,08	0,09
Rhamnus spec.	0,01				
Robinia pseudoacacia	0,04	0,29	0,08	0,77	0,24
Rosa (small-leaved) *spec.*	0,01		0,46		0,06
Rosa spec.	0,93	0,09	0,88	0,81	**0,77**
Rubus idaeus			3,13	0,90	**0,54**
Rubus spp.	4,37	14,71	11,00	5,88	**7,04**
Ruscus aculeatus	0,02	0,24	0,21		0,07
Salix amplexicaulis	0,59	2,50	3,63	1,10	**1,33**
Salix alba	2,68	9,35	5,25	3,46	**4,17**
Salix elaeagnos	16,00	4,62	6,38	11,67	**12,21**
Salix cf. *fragilis*	0,04				0,02
Salix purpurea	0,94	2,71	0,67	1,08	**1,21**
Salix triandra	0,06	0,88		0,02	0,17
Salix hybrid (unidentified)				0,04	0,01
Sambucus nigra	0,59		0,08		0,31
Smilax aspera		1,00		0,02	0,16
Sorbus aria	0,02		1,08		0,13
Sorbus spec.				0,06	0,01
Sorbus torminalis	0,13			0,02	0,07
Spartium junceum	0,29	0,32		0,65	0,34
Tamarix parviflora	0,02	1,71	0,50	0,13	0,36
Tamus communis			0,21	0,08	0,04
Tilia cf. *rubra*	0,01				
Tilia tomentosa	0,08				0,04
Ulmus minor	0,01		2,29	0,27	0,32
Ulmus procera	0,02			0,02	0,01
Ulmus spec.	0,03			0,29	0,08
Vitis vinifera	0,13	0,32	1,38	0,19	0,31

Upland riparian woodlands in Western Greece are distinctive and differ markedly from Western Mediterranean and Central European assemblages. Species-richness per plot and per basin is generally higher than other surveys in western Mediterranean riparian zones (FERREIRA & MOREIRA, 1999; SALINAS *et al.,* 2000; AGUIAR, 2004; HUPP & RINALDI, 2007). The prevalence of *Platanus orientalis* is the most distinctive feature of Greek riparian zones, since this species' European range is largely restricted to the margins of southeast Europe (STRID & TAN, 1997). This long-lived keystone species creates characteristic corridor-like linear groves. Our survey suggests that the longitudinal distribution of *Platanus orientalis* is limited by an elevation/climatic gradient (Figs 4 & 5). Above 800 m. elevation in the Pindos mountains, riparian *Platanus* trees are usually sparse and in exposed sites they are often stunted, with signs of presumably climate-stressed branches with many dead limbs. The species is most dominant in the middle section of the river courses (300-800 m.) and it was found to be especially dominant between 500 and 600 m (Fig. 4). In many midcourse reaches the species forms nearly pure groves of large centuries-old trees. At lower elevations the species coexists with many other terrestrial and hygrophilous plants and at higher elevations many terrestrial forest species co-dominate in mixed stands (Fig. 7). Interestingly, at higher elevations in the Pindos *Platanus* seems to be 'replaced' by *Salix elaeagnos* (Fig. 6).

Several other widespread hygrophilous trees and shrubs often co-dominate riparian formations, creating distinctive but very heterogeneous assemblages. The most prevalent hygrophilous species are: *Salix elaeagnos, Alnus glutinosa, Salix alba* and *Salix amplexicaulis.* The percentage cover densities per plot of some of these species seem to be affected by elevation. *Salix elaeagnos,* although scarce in the Alfios, is common in the upper reaches of the other three major river basins where it creates dense stands, particularly at actively disturbed braided channels and at higher elevations (Fig. 6). *Salix alba* prefers sites with flatter terrain, usually associated with lower elevations (Fig. 8). *Alnus glutinosa* shows a slight tendency towards higher elevations, although

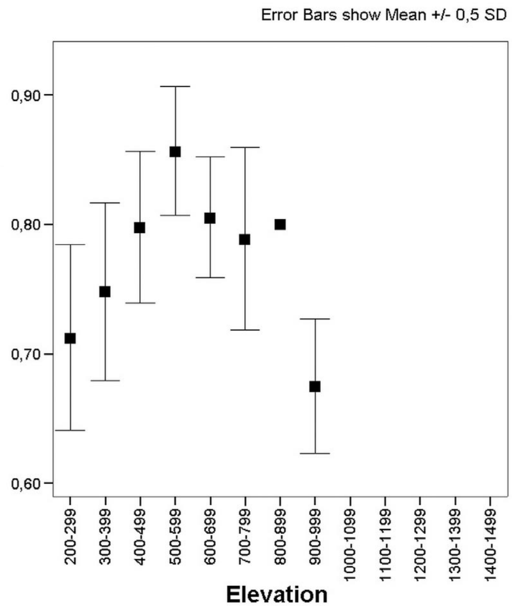

Fig. 4: Average percentage cover per plot where *Platanus orientalis* dominates (>50%) (n=74). The species is most dominant in the middle section of the river courses.

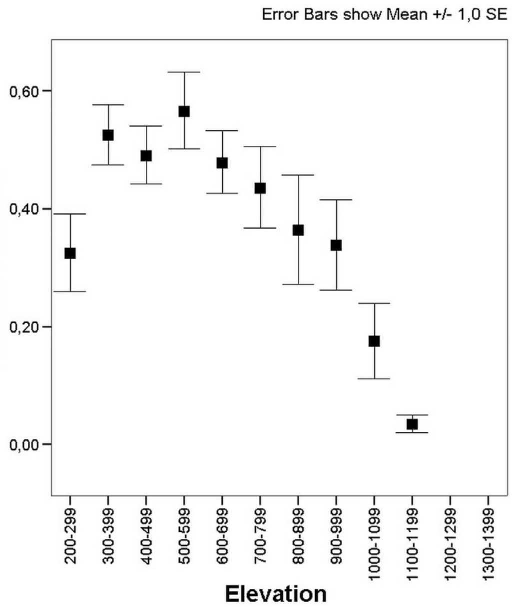

Fig. 5: *Platanus orientalis* relative percentage cover per elevation class (n = 218).

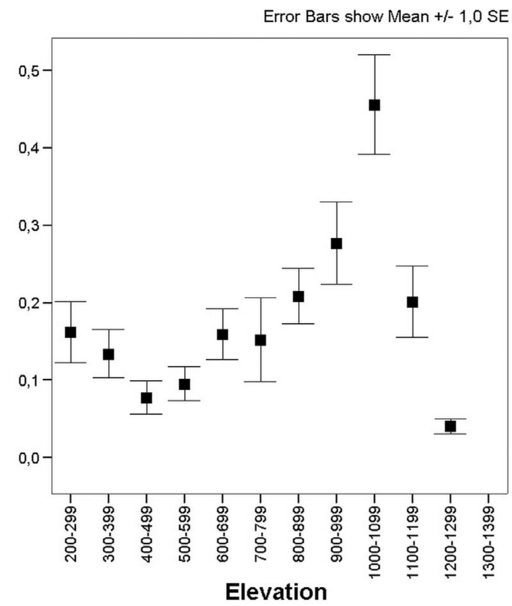

Fig. 6: *Salix elaeagnos* relative percentage cover per elevation class (n = 218).

stands are only locally dense and seem to require particular permanently moist conditions (Fig. 9). Apart from the typical hygrophilous species, many non-hygrophilous scrub, forest and cliff-dwelling woody species comprise important elements of the upland riparian flora, often including certain characteristic mesophytic forest trees and shrubs that seem to flourish in riparian zones (e.g. *Ostrya carpinifolia, Fraxinus ornus, Cornus* spp.). Vines are especially abundant, particularly *Hedera helix* and *Clematis* spp.. Brambles *(Rubus* spp.*)* belonging to at least three species, are common and widespread; and dense bramble thickets are particularly prevalent in riparian zones where tree cover has been disturbed by anthropogenic activities.

Species distributions and their relative abundance along the river's longitudinal axis may be influenced by a multitude of local environmental factors and anthropogenic pressures, including anthropogenic vegetational degeneration or species' over-exploitation in the historic past (DECAMPS *et al.,* 1988). Localized woodland regeneration was obvious in many upland sites where village-based agriculture has recently been abandoned. The southern, more populated riparian corridors (e.g. Alfios) may have been more heavily impacted by anthropogenic pressures in the recent past (RACKHAM, 2002). It is uncertain what role historic anthropogenic disturbance may play in the recorded geographical or river longitudinal distributional patterns. For example, many typically temperate montane forest species are absent from the uplands of the Alfios river basin in the Peloponnese (Table 1 and 2). The Aoos and upper Acheloos, the northernmost and least impacted river basins, harbour the largest number of forest species (Table 1). Of course some species absences are obviously due to natural causes, perhaps climatic, habitat parameters or biogeographic reasons. For example, perennial streamside riparian sites in the Alfios are at slightly lower elevations (mean elevation: 449m) than the more northerly river basins (mean elevations: 606 m – 786 m) (Table 1). Elevation seems to be an important driver in Greek riparian zone vegetation patterns. Interestingly, several distinctive riparian species commonly encountered in the lowlands (lower than the surveyed areas) are surprisingly absent or extremely scarce even in the lower parts of the mid-courses of the studied rivers (e.g. *Fraxinus angustifolia, Populus alba, Vitex agnus-castus, Nerium oleander, Tamarix* spp.,). These species along with other hygrophilous and wetland species create heterogeneous assemblages confined primarily to the lower course of the rivers in Western Greece (Fig. 7).

Only four alien trees were recorded. *Robinia pseudoacacia* was the most widespread alien tree (recorded at 14 site plots) but in no cases did this species dominate riverbanks in the surveyed plots. All other non-natives had a marginal presence: Populus hybrid (11 site plots), *Cupressus sempervirens* (2 site plots), *Ailanthus altissima* (1 site plot). The *Populus* hybrid that may be referred to as *Populus x canescens* was in nearly all cases planted by locals on agricultural edges. It should be noted that we did observe an invasive spread of *Robinia pseudoacacia* along the Arachthos river in many river reaches that were not sampled. Its distribution seems to be related to erosion-control afforestation projects (begun in the late 1960s) and we confirm its colonization of wilderness ravines since many

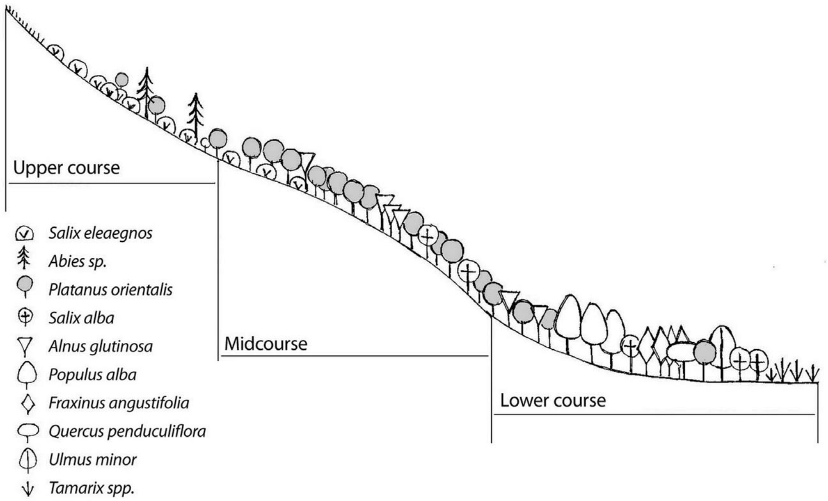

Fig. 7: Schematic generalization of riparian natural riparian vegetation patterns along an elevation gradient based on personal observations along river courses of the Acheloos, Arachthos and Alfios. Species distribution is given for hypothetical riverine stands in natural state. *Platanus orientalis* tends to dominate the midcourse but is also present in smaller densities in the upper and lower courses. Today lower course plant communities in natural state are extremely rare and highly fragmented due to anthropogenic pressures. In the present study no sampling was undertaken in the lower river courses.

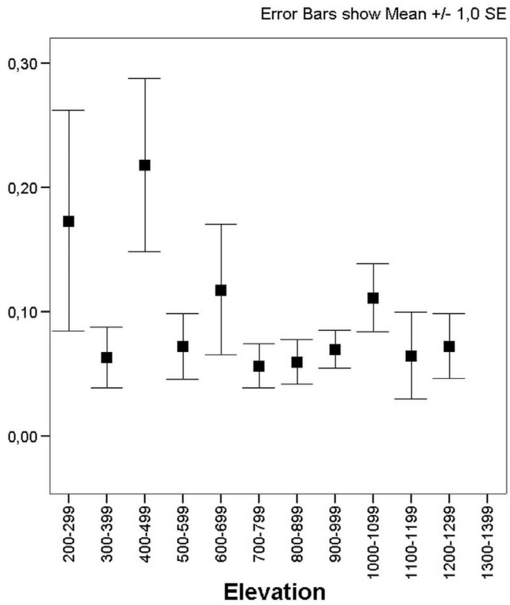

Fig. 8: Salix alba relative percentage cover per elevation class (n = 218).

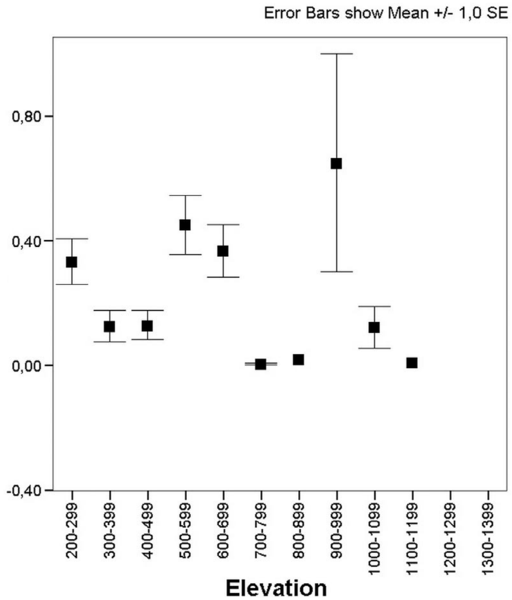

Fig. 9: *Alnus glutinosa* relative percentage cover per elevation class (n = 218).

trees and small stands are now widely established along many parts of the Arachthos basin's mid course (e.g. the Arachthos and Kalaritikos Gorges). However, the overall occurrence of alien phanerophytes in the upland streams of Western Greece is substantially lower than has been recorded in other areas of Mediterranean and Western Europe (e.g. AGUIAR *et al.,* 2000).

Conclusion and Recommendations

Rapid assessment schemes of riparian vegetation are challenging because riparian zones are considered 'among the biosphere's most complex ecological systems' (NAIMAN *et al.,* 2000). One of the problems encountered when striving to monitor and manage riparian zones is that they are often very heterogeneous, often unstable systems, difficult to classify into predictable systemic entities (NAIMAN *et al.,* 2005). Misunderstanding and neglect have very often led to mismanagement of riparian zones and to the degradation of their vulnerable woodland formations.

A comprehensive operational definition for practical delineation of riparian zones and their woodlands must derive from our understanding of the region-specific river corridor environment and its biota. In order to apply a rapid floristic riparian survey along rivers we defined a strictly stream-side 'riparian woodland plot' as a wooded subset within the wider riparian zone. The wider riparian zone usually includes the riverbed's active channel and non-wooded parts of the upland immediately adjacent and influenced by the river's action (NAIMAN & DECAMPS, 1997) (Fig. 2). Assessments of riparian quality attributes should focus on the riparian zone as a whole; our woodland survey focuses strictly on streamside riparian woodland features within this zone.

Naturally, the survey method described here needs to be further tested, validated and refined. Its initial implementation does show minor weaknesses due to the exploratory and rapid nature of this particular survey. An important problem in wide-ranging surveys concerns sampling design constraints due to limitations of site inaccessibility or time-related constraints. In this way, this survey is by no means an objective comparison of the four river basins. Next, the rapidity of the procedure makes complete on-the-spot floral identifications and percent-coverage estimations difficult; extreme care is needed with the positive identification of all species. Percentage cover recordings made through the assessor's visual estimations should employ scaled categories such as the Braun-Banquet scale to increase rapidity and effectiveness (MUCINA *et al.,* 2000). Despite these minor concerns, the simplicity and effectiveness of this procedure supports its use in rapid vegetational surveys alongside aquatic ecological status assessment procedures. Furthermore, every effort must be made to promote the development of effective tools for the assessment of riparian zone integrity within the framework of policy-relevant river monitoring and restoration.

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