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Research Article

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Identification of the self-purification stretches of the Pinios River, Central Greece

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Abstract

The Pinios River basin in Thessaly, Greece, is intensively farmed and heavily polluted with poorly treated domestic and industrial waste. The river was divided into 35 homogenous stretches. We investigated the self-purification capacity along the different stretches of the Pinios based on the responses of the benthic macroinvertebrate community to municipal, industrial and agricultural pollution in the basin. Water quality was assessed by the performance of six diversity and biotic indices and scores for assessing water quality. Self-purification found by the downstream amelioration of water quality was evident at five stretches. These stretches should be safeguarded and priority should be given to restoration projects along the most water-quality-degraded stretches that lack the capacity for self-purification.

Keywords: Self-purification; Benthic macroinvertebrates; Pinios (Thessaly).

Introduction

As stated by LAFONT (2001) in the Ecological Ambience System concept (EASY) if the river ecosystem is viewed as a mosaic, its overall ‘ecological defenses’ will also depend on self-purification capacity. Self-purification is the complex phenomenon that underlies the waste assimilation capacity of rivers and streams; it is a dynamic phenomenon reflecting hydrologic and biologic variations (VELZ, 1970). In highly polluted rivers the composition of the biological community changes rapidly due to lack of oxygen, which is consumed by waste assimilative bacteria for the degradation of organic matter (HARPER, 1995). Depleted oxygen results in the dominance of pollution-tolerant species, such as the alga *Cladophora glomerata* and the macroinvertebrate oligochaets, and the elimination of clean water species, such as the pollution-sensitive stone flies and the majority of fish (HYNES, 1966). Benthic macroinvertebrates can contribute to the regulation of processes associated with the eutrophication of water bodies and mass blooming of toxic plankton species. A demonstration of self-purification (e.g. control of eutrophic conditions) is water filtering by the removal of algal cells from the water column by bivalve mollusks (OSTROUMOV, 2002a).

Shifts in the benthic macroinvertebrate community structure reflect even relatively small variations in water chemistry induced by organic pollution (including nutrients) (ARMITAGE *et al.,* 1983; WIEDERHOLM, 1984; CAIRNS & PRATT, 1993) and also reflect the impacts from various pollutants (heavy metal and pesticide contamination) (CLEMENTS *et al.,* 1992; ANDERSON *et al.,* 2003). Macroinvertebrates have lifecycles of suitable length for short-term seasonal or annual investigations and are commonly used to evaluate water quality (e.g. DE BILLY *et al.,* 2000; PARR & MASON, 2003; AZRINA *et al.,* 2006). While much research has been undertaken on the exact mechanisms and factors that control self-purification (e.g. COOPER *et al.,* 1919; STREETER & PHELPS, 1926; POCH *et al.,* 1986; SKURLATOV, 1988; OSTROUMOV, 2002a; OSTROUMOV, 2002b; SABATER *et al.,* 2002; TEISSIER *et al.,* 2002; OSTROUMOV, 2005) few studies exist so far that assess the manifestation of self-purification by utilizing benthic macroinvertebrate responses.

The aim of the study was (i) to assess water quality in the Pinios River and (ii) to identify the segments of the polluted Pinios River where self-purification (SP) of pollution inputs was under process through the use of benthic macroinvertebrates.

Study area

The River Pinios rises in the Pindos mountains in central Greece. Its length is 235 km with a mean slope of 6.92‰ and it drains 11318 km^2 (Fig. 1) in the Thessaly

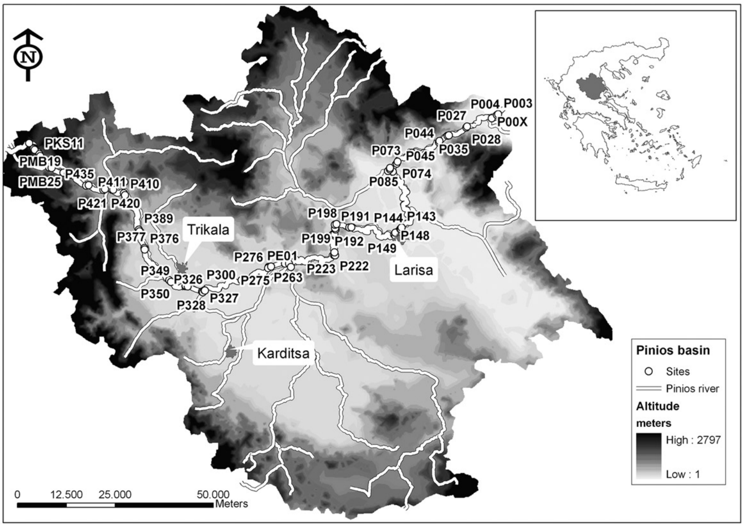

Fig. 1: The 80 sampling sites for benthic macroinvertebrates located in the main Pinios river and the downstream end of its tributaries and canals.

basin. The average annual discharge at the river mouth is 108 m^3/sec (FYTIANOS *et al.,* 2005). It runs for about a quarter of its length over a mixed zone of Eocene flysch, mesozoic limestones and basic and ultra-basic rocks (ophioliths). At Kalambaka it enters the Thessaly plain, which consists of Holocene alluvial deposits (STAMATIS, 1999). Three soil types were identified in the catchment basin and classified into recent alluvial Entisols and Inceptisols and hilly region Entisols (FYTIANOS *et al.,* 2002). The climate is continental Mediterranean with a mean annual rainfall of 700 mm (LOUKAS & VASILIADES, 2004). 529244 inhabitants live in the Pinios basin (GSNSSG, 2002) of which 40.6% are served by Waste Water Treatment Plantations (personal communication to local Environmental Agencies). 96% of the used water concerns the agricultural uses, 3.3% the water supply and 0.2% industrial uses (HMEPPPW, 2005). Important point sources of pollution are the localized industries situated close to the cities of Larissa, Trikala, Karditsa and Farsala. The agricultural cultivations located in the plain (main produce: cotton, sugar and corn) compete with animal husbandry, at the expense of a diminishing riparian buffer strip in the Pinios floodplain. The plain of the river basin is designated as a 'nitrate vulnerable zone' according to criteria 91/676/EC Directive (EC DIRECTORATE-GENERAL FOR ENVIRONMENT, 2002).

Materials and Methods

In order to obtain basic information on pollution removal rate through the rivers' self-purification, a monitoring scheme was applied during the end of the low flow period, September-October 2002, since pollution problems and water abstraction are most likely to occur during the low flow period (TITTIZER & KOTHE, 1979; DE PAUW *et al.,* 1986; CHATZINIKOLAOU *et al.,* 2006). Although SP may also take place during the high flow, the relative importance of SP processes is higher during low flow because effects of dispersion, for instance, are less important.

The main stem of the river was split into homogenous segments hereafter named stretches. Initially the river was divided into 500 m reaches, numbered from the river mouth to the furthermost source and coded according to a previous study in the Axios-Vardar River by CHATZINIKOLAOU *et al.* (2006). The criteria and the means used to merge the successive 500 m reaches in order to form homogenous stretches, were based on an extension of the 'fluvial hydrosystems approach' (i.e. confluence of tributaries) (AMOROS, 1987). A single stretch can vary from 0.5 km to 27.5 km, has only one geological underlying type according to a 1:1000000 scale hydrolithological map (1996) from the Hellenic Ministry of Development, has no tributary confluence or draining channel and no dramatic shift in slope gradient according to 1:50000 (1970) topographic maps from the Hellenic Military Geographical Service, a similar land use according to 1:30000 air-photographs (1995) from the Hellenic Military Geographical Service (natural: forested area, rocks and scree, sand dunes; semi-natural: pasture land, shrubs, olive trees; non-natural: intensive agricultural, urban development, roads etc.) and no discontinuity from human induced alterations to the channel flow according to a 2002 pre-sampling field survey.

Benthic macroinvertebrate samples

were taken only once from both the upstream and downstream end of each stretch during the period from 21/09/2002 to 14/10/2002. Samples were also taken from tributaries and canals.

Pollution inputs are difficult to detect by classical physical and chemical water quality monitoring, as the sampling frequency would have to be continuous to detect the chemical changes associated with these inputs (RUEDA *et al.,* 2002). The benthic macroinvertebrate sampling method employed was the semi-quantative 3-minute kick and sweep (ARMITAGE & HOGER, 1994), using a standard pond net (surface 575 cm^2, mesh size 0.9 mm, depth 40 cm). All existing instream habitat types at each site (macrophyte beds, woody snags, bars, natural or artificial substrates at riffles, runs and pools) were sampled, according to the Greek Habitat Richness Matrix (CHATZINIKOLAOU *et al.,* 2006). At non-wadeable sites both banks were sampled. Macroinvertebrate samples were preserved in a 4% formaldehyde solution and transferred to the laboratory where they were sorted and identified down to the taxonomic level of family, except Oligochaeta and Lepidoptera.

We used the Hellenic Evaluation System and its scores (HBMWP, HASPT) (ARTEMIADOU & LAZARIDOU, 2005) standardised for the sampled habitat quality according to the Greek Habitat Richness Matrix (CHATZINIKOLAOU *et al.,* 2008) as well as metrics and indices from the Inter-calibration Common Metrics (BUFFAGNI *et al.,* 2005) and various others presented in Table 1. Non parametrical Spearman correlation was used to test the consistency of the different biotic indices used. SP was assumed to take place at stretches where the downstream (output) water quality index presented an increase when compared to the upstream one (input) without the input of a tributary with a better water quality. Due to the lack of background information water quality improvement was assumed when all downstream indices and scores had concurrently rising values in comparison to the upstream ones.

Results

35 homogenous segments were produced from the main stem of the Pinios River (Table 2). 20069 individuals were

Table 1
Metrics and indices used in the water quality assessment of The Pinios River at the low flow period 2002. HBMWP is the Hellenic Biological Monitoring Working Party, HASPT is the Hellenic Average Score per Taxon, HES is the Hellenic Evaluation System, and EPTD is the Ephemeroptera, Plecoptera, Trichoptera and Diptera.

Indices, metrics & Scores	Reference
Total abundance	
Total number of families	e.g. OFENBÖCH *et al.,* 2004
HBMWP	ARTEMIADOU & LAZARIDOU, 2005
HASPT	ARTEMIADOU & LAZARIDOU, 2005
HES	ARTEMIADOU & LAZARIDOU, 2005
Log10(Selected EPTD+1)	BUFFAGNI *et al.,* 2004
Number of EPT families	e.g. OFENBÖCH *et al.,* 2004 ; BÖHMER *et al.,* 2004
H' Shannon-Weaver diversity	SHANNON & WEAVER, 1963

Table 2
The attributes of the 35 homogenous identified stretches of the Pinios River.
The 'Limit upstream' column defines the criteria for the split among the segments.
D: discontinuity, G: geology, L: land-use, S: slope, T: tributary.

No	Section	Tributary	Length (km)	Mean Elevation (m)	Geology	Mean Slope (m/km)	Land Use	Limit Upstream
35	PKS23-16		4	860	ophiolite	4.52	Natural	S
-	PRA01	Kriasa			ophiolite		Natural	
34	PKS15-11		2.5	715	ophiolite	16.45	Semi-natural	T & S
-	PCH01	Anilio			ophiolite		Semi-natural	
33	PKS10-05		3	573	limestone	21.59	Semi-natural	T
32	PKS04-01		2	455	ophiolite	17.22	Semi-natural	G
-	PMB26	Malakasiotiko			flysch		Semi-natural	
31	PMB25-20		3	405	flysch	3.29	Semi-natural	T
30	PMB19-16		2	375	flysch	2.16	Semi-natural	S
29	PMB15-01		7.5	320	flysch	7.74	Semi-natural	S
-	P436	Kastaniotiko			flysch		Natural	
28	P435-425		5.5	270	alluviums	3.27	Semi-natural	T & S
27	P424-421		2	254	alluviums	6.75	Non-natural	L & S
26	P420-411		5	239	alluviums	3.3	Non-natural	T & S
-	PHP01	Tranos Lakkos			sandstones		Non-natural	
25	P410-389		11	197	alluviums	5.96	Non-natural	T
24	P388-377		6	147	alluviums	5.36	Non-natural	D
23	P376-350		13.5	119	alluviums	2.73	Non-natural	D & S
22	P349-340		5.5	106	alluviums	1.52	Non-natural	D & S
-	PTR01	Lithaios			alluviums		Non-natural	
21	P339-328		6	101	alluviums	0.93	Non-natural	T
-	PPM01	Pamisos			alluviums		Non-natural	
20	P326-301		13	96	alluviums	0.64	Non-natural	T
19	P300-276		12.5	91	alluviums	0.47	Non-natural	D
-	PCE01	Canal			alluviums		Non- natural	
18	P275-267		4.5	89	alluviums	0.41	Non-natural	T
17	P266-264		1.5	88	alluviums	0.39	Non-natural	D
-	PE01	Enippeas			alluviums		Non-natural	
16	P263-223		20.5	86	alluviums	0.44	Non-natural	T
-	PVU01	canal			alluviums		Non-natural	
15	P222-206		8.5	82	alluviums	0.47	Non-natural	T
14	P205-202		2	81	limestone	0.44	Semi-natural	G & L
13	P201-199		1.5	81	alluviums	0.43	Non natural	G & L
12	P198-192		3.5	80	limestone	0.42	Semi-natural	G & L
11	P191-149		21.5	76	alluviums	0.48	Non-natural	G & L
10	P148-144		2.5	72	alluviums	0.53	Non-natural	D

(continued)

Table 2 (continued)

No	Section	Tributary	Length (km)	Mean Elevation (m)	Geology	Mean Slope (m/km)	Land Use	Limit Upstream
-	P144a	canal			alluviums		Non-natural	
9	P143-088		27.5	62	alluviums	0.54	Non-natural	T
-	PT01	Titarisios			alluviums		Non-natural	
	P086		0.5	48	schists	0.67	Non-natural	T
8	P085-074		6	44	schists	0.77	Semi-natural	L
7	P073-069		2.5	39	schists	1.26	Semi-natural	S
6	P068-062		3.5	34	alluviums	1.35	Non-natural	G & L
5	P061-045		8.5	26	alluviums	1.38	Non-natural	D
4	P044-036		4.5	18	schists	1.29	Non-natural	G
3	P035-028		4	14	marbles	1.21	Natural	G & L
2	P027-004		11.5	7	alluviums	0.77	Non-natural	S & L
1	P003-001		2	1	alluviums	0.54	Semi-natural	L

found and identified as belonging to 68 different taxonomic families.

Despite the pristine state of the river close to its source, the water quality according to the HES values was not excellent. The hyper-alkaline ophiolithic geology seems to have had an impact on pH (STAMATIS, 1999) and limits the presence of sensitive macroinvertebrates which cannot tolerate hyper-alkaline water conditions. Nevertheless, the EPT taxa values were high in comparison to the lowlands (Table 3), since sensitive-to-pollution families such as the Plecoptera Chloroperlidae, Leuctridae, Perlodidae, Perlidae and the Trichoptera Beraeidae and Sericostomatidae were present. According to the various benthic macroinvertebrate metrics and indices used, the water quality of the Pinios River declined in the plain of Thessaly (site P411). The land-use progressively shifts from forested areas to intensive agricultural use. The land-use shift coincided with a drop in the abundance of the Chrysomelidae family beetle, the caddis fly Sericostomatidae and the stone fly Nemouridae family. Total abundance peaked in the area P411-P377, including the tributary Tranos Lakkos (PHP01), due to an increase of the medium-tolerant to pollution (according to HES) families of Gammaridae, Baetidae and Hydropsychidae. The degradation of water quality was not as dramatic as in the immediate upstream part (Table 3). At the point where the Trikala municipality's sewage treatment plant discharges (PTR01) the tolerant-to-pollution family of Chironomidae were found in their highest abundance. In the P339-276 section, down to the Klokotos canal confluence, (PCE01) the first demonstration of self-purification occurred at segment P326-300 (Figure 2). Further downstream, bank water quality improved and thus self-purification was considered to be taking place at segment P275-266. Next, in the city of Larissa (126076 inh.) flood protection works such as embankments and a resection of the channel (by flood protection diversion) occurs. At P148 a newly established weir caused scouring of the river bed and generated suspended parti-

Table 3
Metrics and indices at the studied sites (N=80) in the Pinios River during the period from 21/09/2002 to 14/10/2002.

Site	Abundance	Families	HBMWP	HASPT	HES	HESII	Log10 (Sel_EPTD+1)	EPT taxa	H'-Shannon
PKS24	112	14	822	58.71	3	Moderate	1.398	7	1.933
PKS23	219	18	1244	69.11	4	Good	1.724	11	2.298
PKS16	197	15	830	55.33	3.5	Good	1.833	7	2.402
PRA01	21	9	516	57.33	3	Moderate	0.699	5	2.058
PKS15	96	13	901	69.31	4	Good	0.845	8	1.711
PKS11	480	17	971	57.12	3.5	Good	1.869	8	1.972
PCH01	55	5	284	56.80	2.5	Moderate	0.000	3	1.059
PKS05	261	13	691	53.15	2.5	Moderate	1.279	5	1.645
PKS04	564	14	754	53.86	2.5	Moderate	1.663	6	1.440
PKS01	306	16	873	54.56	3.5	Good	1.462	6	1.982
PMB26	104	4	244	61.00	2.5	Moderate	0.000	4	0.944
PMB25	46	8	513	64.13	3	Moderate	0.477	6	1.638
PMB20	84	12	803	66.92	3.5	Good	0.903	7	1.967
PKO01	33	7	416	59.43	3	Moderate	0.301	3	1.291
PMB19	165	12	655	54.58	3	Moderate	0.699	7	1.760
PMB16	150	9	481	53.44	3.5	Good	0.477	4	1.033
PMB15	395	21	1225	61.25	3.5	Good	1.505	9	1.814
P436	234	5	238	47.60	2	Poor	0.000	1	0.460
P435	473	8	537	67.13	3.5	Good	0.778	6	0.796
P425	481	14	830	59.29	3.5	Good	1.716	6	1.891
P424	278	9	647	71.89	3.5	Good	1.204	6	0.979
P421	102	8	561	70.13	3.5	Good	1.204	5	1.465
P420	595	10	666	66.60	3.5	Good	1.623	5	1.550
P411	622	14	761	54.36	2.5	Moderate	2.029	5	1.543
PHP01	1137	8	276	34.50	1.5	Poor	0.000	2	0.641
P410	449	10	524	52.40	2.5	Moderate	1.431	4	1.380
P389	1765	8	318	45.43	1.5	Poor	0.000	3	0.198
P388	816	3	115	38.33	1.5	Poor	0.000	1	0.027
P377	989	1	35	35.00	1.5	Poor	0.000	1	0.000
P376	416	2	88	44.00	1.5	Poor	0.000	1	0.075
P350	15	9	188	26.86	1	Bad	0.000	0	1.800
P349	33	8	259	37.00	1.5	Poor	0.301	1	1.371
P340	54	3	59	19.67	1	Bad	0.000	1	0.771
PTR01	59	8	304	38.00	2.5	Moderate	0.000	1	1.664
P339	62	4	100	25.00	1	Bad	0.000	0	0.416
P328	727	6	147	24.50	1	Bad	0.000	1	0.313
PPM01	20	7	210	35.00	1.5	Poor	0.000	0	1.691
P327	188	8	185	26.43	1	Bad	0.000	1	1.403
P326	688	11	227	22.70	1	Bad	0.000	1	1.463

(continued)

Table 3 (continued)

Site	Abundance	Families	HBMWP	HASPT	HES	HESII	Log10 (Sel_EPTD+1)	EPT taxa	H'-Shannon
P300	232	11	364	36.40	2	Poor	0.000	3	1.877
P276	67	11	321	32.10	1.5	Poor	0.000	0	2.092
PCE01	136	10	373	37.30	2	Poor	0.000	1	1.759
P275	98	7	166	27.67	1	Bad	0.000	1	1.194
P266	232	8	399	49.88	2.5	Moderate	0.000	3	1.129
P263	244	3	145	48.33	2	Poor	0.000	0	0.167
PE01	10	7	260	37.14	2.5	Moderate	0.000	0	1.887
P223	31	9	334	41.75	1.5	Poor	0.000	4	1.935
PVU01	1462	14	597	42.64	3	Moderate	0.301	3	1.337
P222	47	9	336	42.00	2.5	Moderate	0.000	0	1.255
P206	117	6	249	41.50	2.5	Moderate	0.000	1	0.838
P205	15	7	288	41.14	2.5	Moderate	0.000	2	1.732
P202	13	6	270	45.00	1.5	Poor	0.000	1	1.672
P201	17	6	250	41.67	2.5	Moderate	0.000	0	1.447
P199	29	7	266	38.00	2.5	Moderate	0.000	2	1.383
P198	208	12	550	45.83	2.5	Moderate	0.301	4	1.472
P192	11	6	174	29.00	1	Bad	0.000	1	1.720
P191	248	13	546	42.00	2	Poor	0.301	4	1.598
P149	128	3	146	48.67	2	Poor	0.000	0	0.091
P148	870	16	831	55.40	3.5	Good	0.954	4	0.472
P148a	136	2	86	43.00	2	Poor	0.000	0	0.043
P144	8	3	158	52.67	2.5	Moderate	0.301	1	0.736
P144a	6	2	59	29.50	1.5	Poor	0.000	0	0.451
P143	12	5	234	46.80	3	Moderate	0.000	1	1.474
P088	156	10	379	42.11	2	Poor	0.000	1	1.550
PT01	47	7	265	37.86	1.5	Poor	0.000	3	1.078
P086	11	3	37	18.50	1	Bad	0.000	1	0.760
P085	70	6	213	35.50	1.5	Poor	0.000	1	1.190
P074	113	9	426	47.33	2.5	Moderate	0.301	4	1.267
P073	37	7	234	33.43	1.5	Poor	0.000	3	1.552
P068	203	8	297	42.43	1.5	Poor	0.000	3	1.165
P062	26	8	374	46.75	2.5	Moderate	0.000	1	1.571
P061	21	8	236	33.71	1.5	Poor	0.000	2	1.831
P045	81	8	394	49.25	2.5	Moderate	0.301	3	1.566
P044	102	9	424	47.11	2.5	Moderate	0.000	1	1.870
P036	124	11	476	47.60	2.5	Moderate	0.301	6	1.833
P035	155	9	427	47.44	2.5	Moderate	0.903	3	1.593
P028	67	4	83	27.67	1.5	Poor	0.000	0	0.232
P027	604	2	96	48.00	2	Poor	0.000	1	0.040
P004	242	11	451	41.00	2	Poor	0.000	1	1.705
P003	142	8	322	40.25	2.5	Moderate	0.000	1	1.632

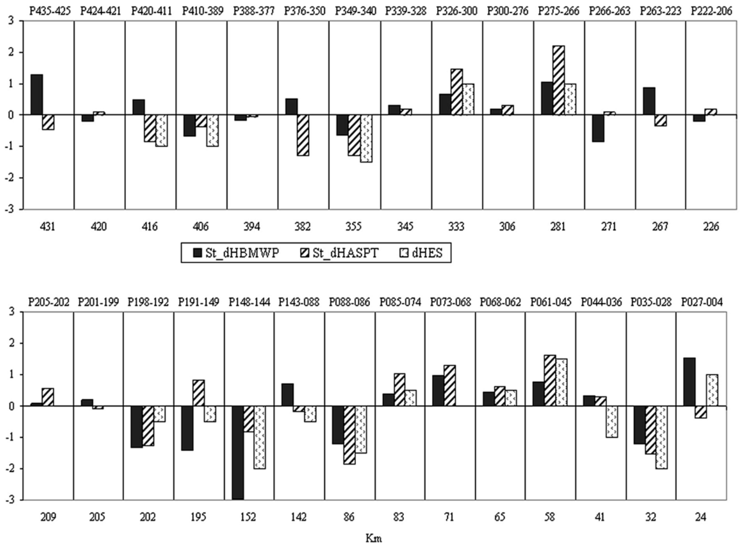

Fig. 2: Downstream water quality difference within stretches according to HBMWP, HASPT and HES biotic scores and indices. Bars represent standardized values of differences. Self-purification areas of the Pinios River are identified as the stretches where the water quality recovery is witnessed by positive values for all three indices and scores. Only the Pinios plain stretches are shown. The lower axis refers to the distance from the river mouth.

cles in the river water. As the river continues along the Thessaly plain significant amounts of pollution loads were flowing in from the industrial area located downstream of Larissa. The Titarisios tributary (PT01) receives the waste from the town of Tirnavos and nearby industries. Downstream of the Titarisios confluence, the Rhodia narrows are located (P086-062). At the segments P085-074, P068-062 and P061-045 according to HES values, SP occurred (Figure 2). In the forested area of the Tempi Gorge (P044-028) the significant pollution inputs from the untreated domestic waste from the Agia Paraskevi recreation area prevented the amelioration of water quality. Downstream of the Tempi Gorge, the river enters the delta area where intensive agriculture takes place.

Table 4
Non parametrical (Spearman) correlations of metrics and indices throughout the studied sites (N=80). Marked with a double asterisk are the significant correlations at the P<0.01 level.

	HBMWP	HASPT	HES	Number of taxa
HBMWP	-	0.730**	0.804**	0.894**
HASPT	0.730**	-	0.870**	0.424**
HES	0.804**	0.870**	-	0.543**
Number of taxa	0.894**	0.424**	0.543**	-
Log10(Sel_EPTD+1)	0.821**	0.746**	0.747**	0.697**
EPT taxa	0.830**	0.733**	0.688**	0.681**
H'-Shannon	0.596**	0.201	0.365**	0.681**

All indices and metrics used were significantly correlated ($p < 0.01$) to the 3 Greek indices (Table 4). Therefore the rest of the analysis was carried out solely with the use of family diversity, abundance, and the Greek index and scores.

Discussion

Self-purification is an important ecosystem function for rivers and should be regarded as an ecological aim for river restoration (LAFONT, 2001; AMOROS, 2001). The rapid yet extensive spatial coverage was an objective of the current study, since sampling the whole river offers among others an identification of the river reaches which have a retention capacity of nutrients, or an increased self-purification capacity (SALVIA *et al.,* 1999). The water quality of the Pinios River progressively degraded from the source to the mouth. According to HES, good water quality samples were taken only from the mountainous area close to the river's source. Forty kilometers downstream, at site P411, the river enters the large plain of Thessaly and the land-use shifts to non-natural. The HES values were low and indicate that medium-low water quality is sustained until the river mouth. However, five stretches of the Pinios (P326-300, P275-266, P085-074, P068-062 and P061-045) were identified as parts of the river where self-purification processes was evident.

Since 90% of the natural floodplain areas of european rivers has been reclaimed and now lacks river-riparian dynamics (PEDROLI *et al.,* 2002) the golden age of restoration science has arrived (ORMEROD, 2004). The perspective of process-oriented restoration approach has been recommended by several authors in the restoration of river systems (AMOROS, 2001; KONDOLF *et al.,* 2006) and self-purification is one of those processes. But, if restoration projects are to succeed and not further harm the riverine processes a comprehensive knowledge that can provide sound criteria for the best techniques must be achieved. Therefore, the impacts the restoration and rehabilitation works have on self-purification must be considered in the management of aquatic systems, particularly in the context of the Water Framework Directive (2000/60/EC) (EU, 2000) which emphasizes conservation or restoration of ecological quality (LAFONT, 2001).

In conclusion, benthic macroinvertebrates helped in the identification of the self-purification stretches of the Pinios river due to their life cycle and their low mobility. The use of biotic indices showed that although the Pinios River is heavily polluted (good or excellent quality is never achieved in the lowland part) self-purification processes do occur. Self-purification stretches must be safeguarded from unjustified works along the river that can harm this process. In order to achieve good water quality in the context of the Water Framework Directive (2000/60/EC) priority should be given to restoration projects along the most degraded stretches, lacking a self-purification capacity.

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