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Distribution of the Dipper *(Cinclus cinclus)* in the Mugello valley (Florence, Italy) in relation to the environmental characteristics of the streams

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Abstract - A survey of the presence of European Dippers (*Cinclus cinclus)* in the breeding season was carried out in the streams of the weakly-polluted Mugello valley (Tuscany, Italy) in the spring of 1999 together with environmental and macrobenthos data. 49 locations were examined. The discriminant analysis carried out on the data-set made possible the identification of six principal factors determining the presence/absence of dippers in the study area. The availability of suitable nesting-sites (man-made or natural) resulted to be the most important factor. The water-flow speed and the abundance of some macrobenthos taxa were other important factors. No significant correlations with the Extended Biotic Index (EBI) or with human disturbance were detected.

Introduction

The European Dipper *(Cinclus cinclus)* is a bird that is diffusely present in freshwater streams of the western Palaearctic (Cramp, 1988). It is present in rhytron streams of peninsular Italy and Sicily. The species eats almost exclusively aquatic invertebrates, and prefers streams with slopes (2.5-20 m/km; Marchant and Hyde, 1980) and abundant macrobenthos (mainly Trichoptera, Ephemeroptera, and Plecoptera; Ormerod *et al.* 1984). In suitable environments the bird is common, and reaches a breeding density of 10-15 pairs per 10 km of river (Peris *et al.* 1991). Ormerod and Tyler (1991) identified a preference for Trichoptera during the breeding period. The same authors showed that the breeding density was found to be positively correlated to the slope of the stream and to the presence of shallow pools alternated with riffles. In some cases, the absence of suitable breeding sites was a limiting factor to the presence of breeding dippers at least in lentic rivers (Rockenbauch; 1985; Price and Bock, 1983): the introduction of artificial nests could increase the breeding density of the birds by a factor of 10 (Staedler and Bremshey, 1988; Kaiser, 1988).

Studies carried out in streams running over siliceous rocks showed a reduced density of breeding pairs in acidified streams, caused by a reduced abundance of macrobenthos (Ormerod and Tyler, 1987). The correlation between water pH and Dipper abundance has been widely studied in Western Europe, where water acidification is generally not buffered by the river bedrocks. Rivers in calcareous areas are usually richer in macrobenthos, being potentially more suitable for Dippers (Sadler and Lynam, 1985). In the Mediterranean area the periodic summer drought of many streams limits the presence of stable Dipper populations to permanent streams. When compared with the number of studies carried out on Dippers in siliceous environments, the lack of data from calcareous areas is evident. Peris *et al.* (1991) showed that, in calcareous areas, the density of breeding Dippers is positively correlated to the stream slope, and secondarily to pH. Even if the Dipper is widely considered a good bio-indicator, this assumption is not based on a sufficient body of data. In Tuscany, only a few data about Dippers are available (Tellini *et al.* 1997), and it is not clear whether the Dipper distribution is dominated by natural factors (climate, physiogeographic factors, vegetation, river flow, etc.) or by antrophic factors such as disturbance, river-bank clearings, water captation, or pollution.

In this work, a survey of the Mugello streams was carried out in order to obtain a picture of the distribution of the Dipper during the breeding season. The "map" obtained was statistically correlated to environmental, macrobenthos and chemical-physical parameters. The research was intended to evidence the main factors affecting the distribution of the breeding Dipper in the valley.

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Methods

a) The study area

The Mugello valley, which is travelled by the Sieve river, is located 20 km north-east of Florence (I), with a bottom-height of ~200 m a.s.l.. It is bounded by the Apennine mountain chain to the north-east, by Monte Morello and Monte Giovi to the west. Climate is temperate, mesaxeric C (Tomaselli *et al.* 1973), with a De Martonne climatic index of 50 on the mountains and 40 in the valley.

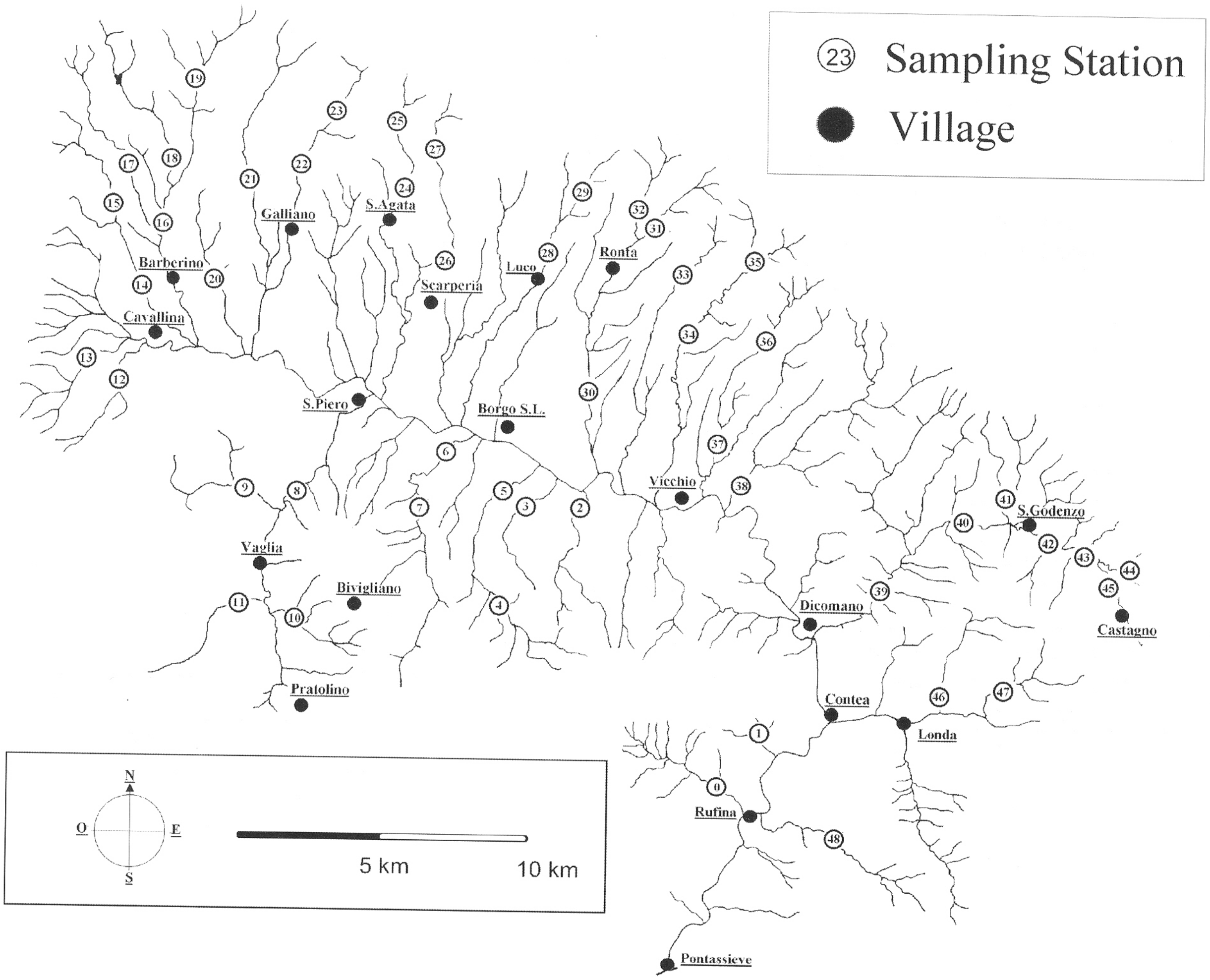
Soils consist of lake sediments of quaternary origin in the valley, with clay, sand and gravel deposits on the slopes of the Apennines. Recent sediments are common near the Sieve river. On the mountains, outcrops of *marnoso-arenacea* rocks are common. Limestone rocks are present in the Monte Morello massif. Broadleaved trees (mainly *Quercus* sp.) dominate the forestry vegetation of the valley, while beeches (*Fagus selvatica)* dominate the Apennine mountain tops. Chestnut (*Castanea sativa*) cultivations and reforestations of conifers are common. Alder (*Alnus glutinosa*), hazel nut (*Corylus avellanus*), and willow (*Salix* sp.) trees dominate the riparian vegetation, replaced by elder (*Sambucus nigra*), Lombardy poplar (*Populus nigra*), white willow (*Salix alba)*, and *Robinia pseudoacacia* in the low valley. Industrial activities affecting the water quality are practically absent. In fact the water pollution consists of civil and agricoltural wastes.

b) Choice of the streams.

The main river (the Sieve) and the temporary streams that dry up in the late spring were arbitrarily excluded from this study. The permanent streams (Tab. 1 and Fig. 1) were visited randomly in March-June 1999, without following any order suggested by the geography of the valley. This way, the temporal lag between the samplings did not result in a spurious geographical trend that could arise because of the change with time of the chemical-physical parameters and of the macrobenthos composition. In fact, many macroinvertebrates finished their aquatic stage during the study period (Salmoiraghi *et al.* 1991), and river flow diminished in the whole area in the same period. By randomising the samplings, the temporal trend of these parameters became statistical noise. During the survey, each stream was walked along by the author in search of Dippers and of their traces. Longer streams were divided into several segments. A representative sampling station was located in each of the 49 segments (Tab. 1). Each sampling station, in which physical-chemical and biological samplings were performed, was numbered with the same number as the corresponding stream segment.

Tab. 1. List of the streams and of related sampling stations.

Sampling Site N°	Stream name	Closest locality
0	ARGOMENNA	MULINO
1	USCIOLI	MULINO USCIOLI
2	COROLLA	SAGGINALE
3	STRULLA	PALAZZO DI STRULLA
4	FISTONA	S. ANSANO (downstream)
5	FISTONA	VILLA VITARETA
6	FALTONA	FALTONA (downstream)
7	FALTONA	I CINI
8	CARZA	T.A.V. CARLONE (upstream)
9	CARLONE	MULINO CARLONE
10	RISECCIONI	RISECCIONI
11	CARZOLA	CAMPOLUNGO
12	RITORTOLO	POGGIO DELLE DONNE
13	MULINACCIA	MULINO DEL BOSCO
14	LORA	CASA MEZZASTRADA
15	LORA	MOLINUCCIO
16	STURA	LA RUZZA
17	AGLIO	VIADOTTO A1
18	NAVALE	ACQUATESA
19	STURA	MULINO DI BUTTOLI
20	CALECCHIO	TIGNANO
21	SORCELLA	MULINO DI RIBATTA
22	TAVAIANO	REMOLI
23	TAVAIANO	PONTE ALL'OLMO
24	CORNOCCHIO	S. AGATA (upstream)
25	CORNOCCHIO	ISOLA
26	LEVISONE	MULINO LEVISONE
27	LEVISONE	MOLINUCCIO (downstream)
28	BOSSO	GREZZANO (downstream)
29	BOSSO	RISOLAIA
30	ENSA	PIAZZANO
31	ENSA	MADONNA TRE FIUMI
32	FARFARETA	ACQUEDOTTO
33	PESCIOLA	GREZZANELLO
34	MUCCIONE	MOLEZZANO
35	MUCCIONE	T. ACERELLA
36	ARSELLA	MALNOME
37	ARSELLA	MULINO RITORSOLI
38	BOTENA	LA GINESTRA
39	COMANO	CARBONILE
40	COMANO	S. BAVELLO
41	CASTAGNETO	PONTE DEL CICALETO
42	CASTAGNO	MULINO VALITOLI
43	CASTAGNO	MULINO ONDA
44	PRETELLA	CASCATA DELLA PRETELLA
45	FALTERONA	ONTANETA
46	CORNIA	MULINO DEL PINO
47	RINCINE	RINCINE (downstream)
48	RUFINA	MULINO PESCI



c) Determining the presence of Dippers

We mapped the presence/absence of Dippers during the breeding season without carrying out a quantitative assessment of the population density. By walking quietly along the stream banks, it was possible to contact the bird directly. The bird is easily dazzled when approaching fishing pools or curves of the stream. In this study, we considered as a positive index the observation of even a single bird. In the few cases in which direct contact did not occur, the presence of unmistakable signs of its presence was considered to be a positive prove. The white, liquid faeces found on the stones of the shore and recently abandoned nests were considered in this sense. As regards the suitable nesting sites, every natural or artificial waterfall, stone wall, stone bridges and their linear density were annotated and the segment was allocated in 3 classes (Tab. 2).

d)Sampling stations

Every sampling station was located in a site representative of the river environment. The following parameters were measured:

1) ***Physical-chemical and environmental parameters.*** Water temperature, speed and flow, width and depth of the stream, type and size of the substrate were measured. The water speed was measured by using float and chronometer, while the flow was estimated as the product of the speed and the stream cross section as measured with a tape measure. The substrate granulometry was measured in-situ in a representative section of the stream. Total hardness and nitrates were measured using AcquaMerck portable kits. The stream slope and the surface of the basin were determined on the 1:25000 map. The basin surface reported is the one upstream of the sampling site. The tree cover of the banks and the level of human disturbance were classified as in Tab. 2

Tab. 2. Codes used for the classification of environmental parameters.

DIPPER PRESENCE	
1 = Dipper present 0 = Dipper absent	
ABUNDANCE OF POTENTIAL NEST-SITES	
0 = Absence of potentially suitable sites. 1 = Presence of few potentially suitable sites (less than 1 / km of stream) 2 = Abundant presence of suitable nest-sites (more than 1 site/ km of stream)	
ABUNDANCE OF MACROBENTHOS TAXA	
0 = Taxa is absent **1** = 1-2 individuals collected in a 5-min sampling **2** = 3-10 individuals collected in a 5-min sampling **3** = more than 10 individuals collected	
RIPARIAN TREE VEGETATION	
0 = No trees (only bush vegetation) 1 = Irregular presence of trees. The riverbed is scarcely shaded 2 = Continuously tree-lined streams, but the tree bands are thin and let sunlight enter the canopy 3 = Continuously tree-lined streams, the tree band is thick enough to shade the stream. Gallery-like tree vegetation	
DISTURBANCE	
0 = no disturbance, stream scarcely frequented by fishermen/hikers. Absence of roads or building yards. 1 = Disturbance limited to short periods or limited to short segments, less than 500 meters each 2 = Continuous disturbance on segments longer than 500 meters (e.g. cities, streams drained for irrigation, building yards, numerous presence of fishermen/ hikers.	
RIVER BED TYPE	**GEOLOGICAL CLASSIFICATION**
1 = rock 2 = big stones (size>26 cm) 3 = stones (6.4 cm<d<26 cm) 4 = gravel (2 mm<d<6.4 cm) 5 = sand or clay (d<2 mm)	1 = Mte Cervarola-Falterona turbidites 2 = Mte Senario turbidites (macigno) 3 = fluvial deposits (sands, gravel, silt) 4 = Monte Morello limestone 5 = "romagnola marnoso-arenacea" turbidites

2) ***Macrobenthos sampling.*** Macrobenthos was collected in each site over a 5-10 min period with a net of 0.5 mm mesh size. For the identification of the samples, the works of Sansoni (1988), Tachet *et al.* (1980), and the C.N.R. guides to the Italian freshwater were used (Ruffo, 1977-1985). The taxonomic level of the determination was the one suggested by the Extended Biotic Index (EBI; Ghetti, 1986). In this work, the two Plecoptera genus *Leuctra* and *Capnia* were joined in the same taxa: the two genus have different ecological spectra, but are seemingly not distinguishable for the Dipper. This choice simplified the determination of the material, which was almost completely carried out in the field. The abundance of each taxa was estimated in the field and classified as in Tab. 2. No diversity or absolute abundance indices were computed, since these indices are of doubtful accuracy in the study area (CRIP, 1993). Over the relatively long study period, the sudden disappearance of some taxa from the macrobenthos (mainly Ephemeroptera and Trichoptera (Salmoiraghi *et al.* 1991)) was expected.

Results

The data collected are listed in Tab. 3, while a map of the sampling sites is reported in Fig. 1. Data of Tab. 3 were analysed by means of STATISTICA software. A preliminary reduction in the number of variables was made automatically by the software for the sake of consistency. The remaining variables used in the statistical analysis were those labelled with a number in the first column of Tab. 3. As a first analysis, a correlation between the presence/absence of dippers and the other variables was searched for by using the Spearman rank correlation test. The significant correlations with $p < 0.05$ are listed in Tab. 4.
The only variable greatly correlated to the presence of Dippers was found to be the abundance of nest-sites. The correlation is less relevant ($R \sim 0.3$) for the other variables of Tab. 4. The positive correlation to the tree-coverage of the stream, water speed, and the abundance of some Trichoptera genus is consistent with ecological data found in the literature (Tyler and Ormerod, 1994). Hydropsychidae and Limnephilidae

Tab. 3. Synthesis of all data from sites 1-48.

	Sampling site N°	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	*Leuctra/Capnia*	2	2	1	1	2	2	2	1	2	1	1	1	2	2	2	2	2	1	2	1	1	3	2	1	1
2	*Nemoura*		2			1		1	1		1										1			1	1	
	Anphinemura																									
3	*Perla*							1												1						
4	*Dinocras*																1	1	2	1	1				1	
5	*Isoperla*			1				1	2			1	1	1											1	
6	Hydropsychidae	3	2	2		2	1	1	1	1	1				2				1	1	1		1		2	
7	Rhyacophilidae	2		2	3		1	2	2	2			3	2	2	1						1	2	1		
8	Sericostomatidae	1	1	2	1	2		1	1	3		1		1	2	2	2		2	1		1		2	1	1
9	Polycentropodidae	3								1	2		1	1	3	2	3	1		1			2			
10	Philopotamidae			2	3	2	1	2	2	3	2		3	2	3	3	1	3	2	2	1	1		2		
11	Limnephilidae		1	3		2	2	2	2	3		2	3	3	3	2	3	1	2	1	1	1	1	2	2	1
12	Odontoceridae							1																		
13	Hydroptilidae	1														1						1				
14	Glossosomatidae		3	2		1	2	3	3			3				3	3	2	3	2	1	1	1	3	2	2
15	Beraeidae	1		1						1	2		1	1		1	1				2	3	1	2	1	
	Brachycentridae						1																			
	Lepidostomatidae								1																	
16	*Ephemera*		1	1					1		1															
17	*Baetis*		2	2	2	2	2	3	2	3	1	1	3		2	2	2	1		2	2	1	3	3	1	2
18	*Ephemerella*	1		2	1	1	3	2		3		1	1	2		2	1	1	2	1		1		1	1	
19	*Habrophlebia*	1		2	1	1	2	2	2	3	3	1		3	2	1	2	1	2	1	2	3	2	1		2
20	*Caenis*																1									
21	*Ecdyonurus*	1	1	2	1	2	1	3	3	1	2	2	1	1		2	1	1	2	1	1	1	1	1	3	
	Epeorus							3	3																	
22	*Rythrogena*					1	1	1	1			1							2	1	1		1	1		
	Siphlonurus																				1					
	Habroleptoides	1										1														
23	Dryopidae	1			1	1	1				1			1	1	1						1			1	
24	Elminthidae	1		1				2	1		1	1	1			1			1	1	1			1	1	1
25	Hydraenidae	1									1			1	1		1					1	1			
26	Helodidae		1		1		1							1		1	1		1	1				1	1	
27	Dytiscidae					1									1							1				
28	Gyrinidae	1																				1				
	Osmylus																									
29	*Caleopteryx*	2						1							1								1			
30	*Onychogomphus*												1													
	Lestes													2												
31	*Gerris*	1	1	1	2	1	1	2	1	2	2		1	2	1		1	1	2	1	1			1	1	1
32	*Velia*				1				1	1	1		1	1								1				

segue tabella 3

continua tabella 3

	Sampling site N°	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
33	*Hydrometra*	1						2		1			1						2						1	
34	*Nepa*							1	1																	
	Athericidae	1							1	1	1			1	1				1	1		1				1
35	Simuliidae	1				1		3	3	2					3	1	1	1	1	1	2		3	2	1	
36	Chironomidae	1		2		1	1	1	1	2	2	1	2	3	3	1	1		1		2	3	2	2	2	1
37	Ceratopogonidae					1												1								
	Tabanidae																									
38	Dixidae	1																				1				
	Stratiomydae													1												
39	Blephariceridae							1	1																	
	Psychodidae																									
40	Astropotamobius										1		1				1	1		1	1					
41	*Potamon*		1		1			1																		
42	*Gammarus*		2		2	1		1		1	2	1	3	1											1	
43	*Erpobdella*		1			1		1	1	1		1													1	
44	*Dugesia*	1								1	1			1		1									1	
	Gordius																									
45	*Ancylus*					1	1	1	1			1														
	Bithynella													1												
46	Lumbricidae						1	1					1								1	1	1			
47	Lumbriculidae	1												1										1		
48	Number of taxa	25	15	16	14	21	17	28	25	20	20	16	18	24	17	18	18	14	19	20	18	19	16	19	22	10
	E.B.I.	10	9	9	8	10-	9	11	11	9	10	10	9-	11	9	9	10	9	10	10	10	9	9	10	10	7
49	Stream width [m]	5	3	3	4	2.5	5	4	4	7	4.5	5	4.5	4	2	4	3	6	2.5	3	3	3	2.5	3	2	3
50	Stream depth [m]	0.14	0.15	0.1	0.1	0.2	0.2	0.3	0.25	0.1	0.1	0.15	0.1	0.05	0.1	0.12	0.1	0.15	0.12	0.2	0.2	0.05	0.15	0.25	0.15	0.3
51	Water speed [m/s]	0.2	0.8	0.8	0.5	1	1	0.9	1	0.5	0.5	0.2	1	0.2	0.4	0.5	0.2	0.6	0.6	0.3	0.3	0.1	0.7	0.6	1	0.2
52	Flow [m³/s]	0.14	0.4	0.25	0.2	0.5	1	1.1	1	0.35	0.22	0.2	0.4	0.04	0.08	0.3	0.07	0.74	0.17	0.2	0.2	0.02	0.3	0.4	0.3	0.2
53	Tree coverage	2	3	2	2	1	1	2	2	2	2	1	2	1	1	1	3	1	3	2	1	1	1	2	2	1
	NO3 [mg/l]	50	10	10	25-50	25-50	25-50	10	10	50-75	50	25	75	75-100	75	50	50	25-50	50	25	25	25	50	50	50	25
54	T. Hardness [°D]	16	16	16	17	14	15	14	14	16	17	15	17	16	14	18	18	14	15	14	14	17	11	13	13	15
55	Temperature [°C]	16	14.5	14	14	12.5	14.5	13.5	13.5	15.5	15	13	14.5	15.5	16	18.5	16	21.5	16	17.5	17	16	17.5	16	16	16
	River bed type	3	2	3	1-3	2-3	3	1-3	1-3	3	1-3	3-5	3	2-3	1-4	3	1-3	3	3-4	1-3	1-2	1-5	1-2	3-4	2-3	3-5
	Rock type	1	1	1-2	1	1	1-3	3	1	4	4	5	3-4	1-5	1-5	3	1	3	1	1	5	1	1-5	5	1-5	3
56	presence *Cinclus c.*	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	1	1
57	Nest sites *Cinclus c.*	1	2	1	0	1	1	2	2	2	1	0	1	0	2	1	2	1	2	2	0	0	0	1	2	1
58	Disturbance	1	1	1	0	3	3	2	2	2	2	2	2	2	2	2	0	3	0	0	0	2	1	1	1	2
	Date (1999)	12/6	2/5	22/5	22/5	23/5	17/5	4/5	4/5	10/6	10/6	24/5	10/6	13/6	13/6	6/6	6/6	1/6	6/6	1/6	1/6	13/6	6/6	1/6	1/6	22/5
59	Stream slope [m/km]	40	50	45	25	25	18	11	11	9	37	20	22	20	26	17	35	16	35	36	25	16	25	28	57	33
60	Basin surface [km²]	23.3	13.5	10.4	6.2	11	21.4	25	21	35	13.5	10	15.1	5.3	8.4	15	8	17.8	10	10.2	11.3	11.8	22	15	7	10
	Height a.s.l. [m]	155	160	200	195	270	206	223	230	253	285	300	290	282	310	269	307	303	350	312	400	260	324	326	440	340

segue tabella 3

continua tabella 3

	Sampling site N°	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	*Leuctra/Capnia*	2	1	1	3	2	1	2	2	1	2	2	1	1	1	1	1	1	1	3	1	2	1	2	2
2	*Nemoura*			1		1		1	1	1			1					1		1	1			2	1
	Anphinemura																				1				
3	*Perla*																								1
4	*Dinocras*	2																							
5	*Isoperla*			1				1					1		2	1		1	1	1		1		1	
6	Hydropsychidae	1		2	3	1	1	3	1		1		2		1	3		1	3	1	1	1	2	3	1
7	Rhyacophilidae	2		1	2		3	3	1		1							2	3	1					1
8	Sericostomatidae		1		3	1	1	1	1	2	1	1	1		1	1	1				1		2	1	
9	Polycentropodidae							1		1												1	3		
10	Philopotamidae			1	1	3	1	3		2	1	1	1		1	1		1	1	1	1	2	3	2	1
11	Limnephilidae	1	1	1	3	2	3	3	2	2		1	2		2		3	1	3		2	3	3	3	2
12	Odontoceridae						1																		
13	Hydroptilidae							1			1						1			1	1			3	
14	Glossosomatidae	1			1	1		1				1		1		3	1			1		3	2	3	
15	Beraeidae				1	1			1	1												2	1	1	
	Brachycentridae																								
	Lepidostomatidae																								
16	*Ephemera*					1			1						1			1				1	1		
17	*Baetis*	2	1	2	3	2	3	3	2	1	3	2	2	1	3	1	2	2	2	2	2	2	2	2	1
18	*Ephemerella*		3	1	1	1	3	1		1	3		2	3	3	1	1		1			1	1		
19	*Habrophlebia*	1	2	3	2	2			2		1	1	2		3		1		1		1	2	2	3	
20	*Caenis*			1	1									1			1								
21	*Ecdyonurus*	1	1	1	2	2	1	2	2	1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
	Epeorus																								
22	*Rythrogena*	1				1		1											1						
	Siphlonurus																								
	Habroleptoides																								
23	Dryopidae				1	1		1	1				1										2	1	
24	Elminthidae				2	2	1	2		1		1	2		2	1	1	1	1	1	1	1	1		
25	Hydraenidae	1			1													1							
26	Helodidae				1	1		1	1		1	1	1	1		1				1	1	2	1	1	1
27	Dytiscidae																								
28	Gyrinidae		1											1											
	Osmylus																								
29	*Caleopteryx*		1						1																
30	*Onychogomphus*								1	1												1			
	Lestes																								
31	*Gerris*	1				1		1	1	1		1		1	1	1	1	1	1	1			1	1	1
32	*Velia*							1	1			1				1									

segue tabella 3

continua tabella 3

	Sampling site N°	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
33	*Hydrometra*															1									1
34	*Nepa*																								
	Athericidae	1		1				1	1	1								1		1		1	1		
35	Simuliidae	1			2	1			1	1	2	1	1	3	1	2			1			2		1	1
36	Chironomidae	1	2	1	1	2	1	1	2	2	2		1	1	1	1	1		1	1	1	1	1	2	1
37	Ceratopogonidae				1											1									
	Tabanidae						1				1						1								
38	Dixidae															1								1	
	Stratiomydae															1									
39	Blephariceridae			1																					
	Psychodidae																1								
40	Astropotamobius					1			1								1			1					
41	*Potamon*															3									
42	*Gammarus*				1		1			1					1								1	1	
43	*Erpobdella*				1										1		1							1	
44	*Dugesia*		1					1		1			1	1		1	1	1					1	1	1
	Gordius		1																						
45	*Ancylus*			1	1						1									1		1			
	Bithynella						1				1														
46	Lumbricidae				1					1															1
47	Lumbriculidae			1	1			1		1	1					1			1			1	1		
48	Number of taxa	15	12	18	25	20	15	24	20	20	17	13	17	12	17	22	18	15	16	16	13	22	22	23	17
	E.B.I.	9	8	10	10	10	8	11	10	10	9	8	10	8	10	10	9	9	9	9	9	11	10	11	9
49	Stream width [m]	2	4	4	5	3.5	4.5	4.5	3	3	3	3.5	2.5	2	5	3	5	5	3	1.5	4	2	3	6	4
50	Stream depth [m]	0.2	0.2	0.3	0.15	0.2	0.2	0.2	0.2	0.1	0.15	0.18	0.1	0.2	0.15	0.1	0.12	0.1	0.3	0.3	0.16	0.15	0.13	0.17	0.15
51	Water speed [m/sec]	0.5	0.5	0.3	0.5	0.6	0.7	0.5	0.5	0.5	1	0.6	0.3	0.4	1	0.15	1	1	0.5	1	1	2	0.4	3.5	1
52	Flow [m³/sec]	0.2	0.4	0.4	0.4	0.4	0.6	0.4	0.3	0.15	0.4	0.4	0.05	0.15	0.8	0.05	0.6	0.5	0.5	0.5	0.6	0.5	0.16	0.6	0.5
53	Tree coverage	3	0	2	1	3	2	2	3	3	2	3	3	1	2	1	2	3	3	3	2	2	3	2	2
	NO3 (mg/l)	25	25	25	50	50	25	50	50	10	25	25	25	50	25	50	25-50	10	25	25	25	25	50	75	10-25
54	Total Hardness [°D]	17	16	16	12	12	16	14	16	19	15	14	18	18	16	14	14	16	14	14	14	14	16	14	15
55	Temperature [°C]	13.5	16.5	16	18	18	16.5	16	16	15	16	13.5	17	18.5	17	18.5	13.5	14	16	16	12.5	14	16	15.5	13.5
	River bed type	2-3	3-5	3-5	3	1-2	3-5	1-3	1-3	1-3	3-4	1-2	2-4	3-5	1	2-4	1-2	1-3	1-3	1	2-3	1-2	2-3	2-3	1-5
	Rock type	1	3	1	3	1-6	3	6	6	1-6	3	6	1	3	3	1	1-6	6	6	6	6	6	1	1	1
56	presence	0	0	0	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
57	Nest site abundance	0	0	0	2	2	1	2	3	2	2	3	1	0	1	1	2	2	3	3	2	2	2	1	2
58	Disturbance	0	3	1	2	1	2	2	2	0	1	2	0	3	0	2	2	1	0	0	2	2	1	2	1
	Date (1999)	21/5	11/5	21/5	7/6	7/6	25/5	6/6	6/6	25/5	25/5	25/5	28/5	28/5	28/5	29/5	15/5	15/5	29/5	29/5	24/6	24/6	12/6	12/6	18/4
59	Stream slope [m/km]	100	15	33	36	110	15	80	80	80	22	66	57	47	35	15	18	60	43	20	67	25	74	46	50
60	Basin surface [km²]	5	20	10	7	5	25	8	4.5	4.5	12	5	4	10	27	76	50	5	27	21	3.4	9	10	20.5	17
	Height a.s.l. [m]	580	260	410	320	420	231	415	410	400	295	540	336	185	198	217	251	350	360	420	520	500	260	400	320

Grey-scale reflects the codes of Tab. 2: 0 = white, 1 = light grey, 2 = dark grey, 3 = black.

Tab. 4. Significant Spearman correlations between the presence of Dippers and the other variables.

Variable	Spearman rank correlation	Significance level p
Hydropsychidae	0.31	0.03
Limnephilidae	0.3	0.04
Hydroptilidae	0.28	0.04
Helodidae	0.35	0.01
Chironomidae	–0.3	0.03
Water speed [m/sec]	0.38	0.01
Flow [m^3/sec]	0.32	0.02
Tree coverage	0.34	0.02
Nest-site abundance	0.65	0.00001

are among the most common and biggest caddisflies found in local streams. The negative correlation to Chironomidae is perhaps due to the small size of these preys together with the scarcity of these Diptera in the fast-flowing waters preferred by the bird for its feeding (Dudley and Feltrate, 1992).
The discriminant function analysis of STATISTICA, applied to the data of Tab. 3, was used in order to find a subset of the measured variables capable of discriminating between the two groups of stations in which the Dipper was, respectively, present or absent in 1999. The method used was the backward parametric one from. The elimination of redundant variables was performed with a tolerance value of 0.01, and reduced the number of variables from 60 to 47. In the discriminant analysis, a Fisher value of F = 4.5 was chosen for the variable elimination. The analysis led to the definition of a discriminant functions of six variables:

f = – 1.37 + 0.73* (Sericostomatidae) – 0.66* (Simuliidae) – 0.57* (Chironomidae) – 0.82* (*Gammarus*) + 1.23* (flow speed) + 1.15* (nest-site abundance code)

The centroids of the two "absence" and "presence" of Dippers groups resulted located, respectively, at f = –1.6 and f = + 1.15. The Fisher test resulted in F (6,42) = 13.9, with p < 0.00005. The Wilks l was 0.334, indicating that only 33% of the variance was unexplained by the statistical model. More useful than the discriminant functions (the meaning of which is quite obscure) are the classification functions, which give a "score" to each sampling station for the presence and absence of Dippers, respectively, on the basis of the six variables obtained in the discriminant analysis. The classification functions obtained in this study are:

Fc1 (Absence of Dippers) = 0.12* Sericostomatidae + 1.08* Simuliidae + 3.04* Chironomidae + 1.69* *Gammarus* + 0.71* (flow speed) + 0.99* (abundance of nest-sites)

Fc2 (Presence of Dippers) = 2.16*Sericostomatidae - 0.75* Simuliidae + 1.4* Chironomidae – 0.61* *Gammarus* + 4.18* (flow speed) + 4.22* (abundance of nest-sites)

The importance of nest-sites and water speed are evident. The abundance of Sericostomatidae (Trichoptera) and Chironomidae (Diptera) had some importance: Sericostomatidae increased the score for the presence of Dippers, while Chironomidae decreased it. Simuliidae and *Gammarus* increased the score, but showed a small weight in the functions.

Conclusions

In 1999, a first map of Dipper presence in the breeding season was carried out in the Mugello valley. The population was estimated, on the basis of the field observation of nests and birds, to be around 25 breeding pairs for a total of 35 streams. The correlation between the presence of Dippers and a wide range of parameters measured in 46 sampling stations randomly distributed in the Mugello showed that the presence of Dippers in the breeding season was enhanced by the abundance of potential nest-sites. 8 of the 11 nests found during the survey were built on old, small artificial dams. The inclusion of suitable, predator- and fool-proof cavities in the project of bridges or small dams would result in a very cheap and efficient help for this fascinating river bird.
Fast waters were preferred by the Dipper in the breeding season. A dense riparian canopy and the presence of large Trichoptera taxa (Sericostomatidae, Limnephilidae, Hydropsychidae) also encouraged its presence. The apparently strange absence of a correlation between Dipper presence and EBI index is explained by the fact that streams slightly polluted with organic matter (like those included in this study) often show a reduced EBI due to a reduced presence of sensitive taxa such as Plecoptera, but an increased biomass of some more tolerant Trichoptera and Ephemeroptera taxa, representing big and appreciable preys for the Dipper.
Among the streams showing the highest number of Dipper contacts, we highlight the Comano and Ensa streams. Comano is also one of the best Salmonidae game-fishing streams in the whole Tuscany (Prov. Firenze, 1985).
No statistically significant correlations between Dipper presence and disturbance were found during this study. Dippers were also present in small villages without any apparent stress. Nevertheless, the disappearance of Dippers from the Carlone stream and from the high course of the T.Carza was recently caused by

draining of water caused by the construction works of the "Alta Velocità" (T.A.V.) train line.
The discriminant analysis of the collected data made it possible to obtain a model for the prediction of Dipper presence in other streams in the same area, and hopefully in streams in areas geographically similar to the Mugello.

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