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# Reservoir management and its effects on the trophic organization of the macrobenthic community in a river in central Italy

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**Abstract**

The Chiascio River (central Italy) macrobenthic invertebrate community is analysed in relation to the management of a recently constructed reservoir located about halfway along the watercourse. The dam was originally planned for irrigation purposes, but since 2005 has only been used to regulate the minimum flow of the river, with partial filling in spring and total discharge in autumn. Seasonal sampling surveys, conducted from 1996 to 1999 at 13 stations along the river, yielded 45,744 specimens of benthic macroinvertebrates belonging to 109 taxa. The functional feeding analysis revealed a zone of discontinuity downstream of the dam, with high values of shredders and low values of collectors. The discontinuity is probably due to the reintroduction, in autumn, of the stored particulate organic matter. This altered the trophic structure of the benthic community just downstream of the dam, moving it towards a facies of lower stream order.

**Keywords:** *Macroinvertebrates, stream ecosystem, reservoir management, functional feeding groups*

## Introduction

Freshwater invertebrate assemblages are characteristic of stream habitats (Cushing et al. 1983), and can be rapidly altered by human activities, such as the construction of a dam on a stream (Ward & Voelz 1988; Goretti et al. 1995). The mechanisms of colonization and the movement patterns of benthic populations allow their continuous redistribution on the river bed (Williams 1980; Fenoglio et al. 2002), leading to a rapid restructuring of the community in response to new environmental conditions (Armitage et al. 1987; Mackay 1992).

In running water habitats, macroinvertebrates play a significant role in processing autochthonous and allochthonous organic matter, partly through direct consumption and partly through fragmentation into smaller particles more easily consumed by the microbial component (Vannote et al. 1980).

The amount of coarse particulate organic matter (CPOM, particles >1 mm in diameter), which is predominant in low-order streams, decreases along the longitudinal profile of the river, whereas the amount of fine particulate organic matter (FPOM, <1 mm) becomes predominant in high-order streams (Minshall et al. 1985; Cushing et al. 1993).

The influence of impoundment on the structural and functional organization of the macroinvertebrate community becomes evident as ecological discontinuity in the site downstream from the reservoir, giving rise to a regulated stretch of the river (Verneaux et al. 2003). This regulated stretch usually shows an altered trophic condition in addition to a reduction of the number of taxa due to the loss of the coarse allochthonous detritus, which is accumulated on the submerged part of the dam (Ward & Voelz 1988).

Aquatic invertebrate community structure in various parts of a river is determined by the different morphological characteristics occurring from the source to the mouth (e.g. near-bed hydraulic variables, substratum properties and food resources) (Cummins et al. 1984). Hence, there is a succession of longitudinal changes in community metabolism, benthic diversity and size of particulate organic matter, according to the River Continuum Concept (Vannote et al. 1980).

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During the present analysis, the alterations of the structure and functions of benthic communities were studied in relation to the management of a reservoir recently constructed along an Apennine river in central Italy (Chiascio River, a tributary of the Tiber River). The dam was built as part of a large irrigation project involving 60,000 hectares in central Italy (E.A.B.I.V.F. 1991; Di Giovanni et al. 1996). To protect the stream biota, the reservoir water will also be released for environmental purposes.

In this initial phase, an assessment of the current environmental impact of the reservoir will provide reliable reference data concerning its future effects on the aquatic ecosystem. Indeed, the water released from the dam (periodic discharge, deep release, superficial release) produces a change in the size of the organic matter available for the benthic macroinvertebrate community, which represents an important component for water quality assessment. In addition, this community constitutes the main feeding source for fish (Rosenburg & Resh 1993).

## Materials and methods

The Chiascio River, a tributary of the Tiber River, is 95 km long and has a watershed of 1956 $km^2$, entirely within Umbria (a region of central Italy); 63% of the watershed belongs to its main tributary, the Topino River (Figure 1).

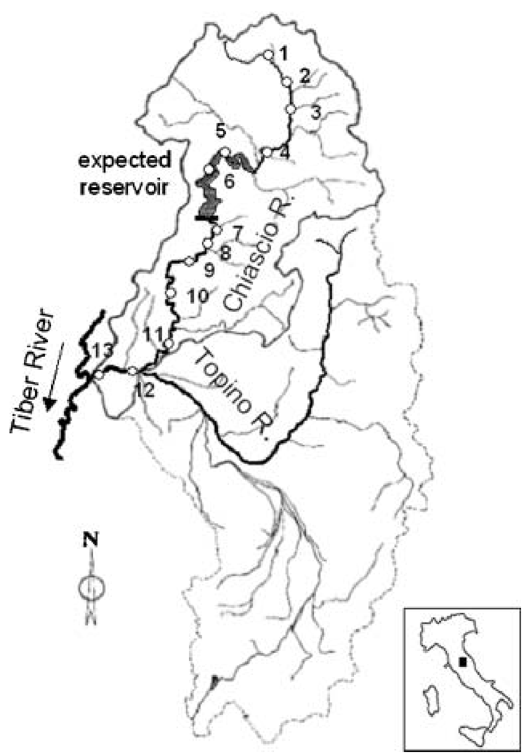


Figure 1. Chiascio River watershed and the 13 sampling stations.

The Chiascio River has a variable water regime, with mean flow-duration curve of 12.80 $m^3 s^{-1}$ over 182 days $year^{-1}$, a value very different from the extreme flows detected in 1959 and 1937 (1.31 $m^3 s^{-1}$ and 1063 $m^3 s^{-1}$, respectively; Mearelli et al. 2001). Several other tributaries of the River Tiber show a similar changeable regime.

A dam was recently built about 50 km along the watercourse at Valfabbrica (Province of Perugia). Originally intended for irrigation purposes, the reservoir has not completely filled yet (2005) and it has only been used to regulate the minimum flow of the stream. A partial filling (maximum depth 14 m) begins in May (Figure 2) and a complete discharge takes place in October (Figure 3). When it eventually works at full capacity, the reservoir will serve a watershed of 471 $km^2$, extending along the narrow valley of the stream for about 20 km, with a surface area of more than 9 $km^2$, an expected volume of about 0.224 $km^3$ and a maximum depth of 67 m (E.A.B.I.V.F. 1991).

Two seasonal sampling surveys (1996–97; 1998–99) were conducted at 13 stations (Figure 1) along the entire river, from an elevation of 447 m a.s.l.

Figure 2. Reservoir: partial filling in spring.

Figure 3. Reservoir: complete discharge in October.

(Station 1) to 173 m a.s.l. (Station 13) (Di Giovanni et al. 2003; Goretti et al. 2003, Abstract in Atti 64° Congr. Naz. U.Z.I.: 57). At each station, samples were collected with a dragnet (kick method) equipped with a 335-$\mu$m mesh, along an oblique bank-to-bank transect. The standardized sampling time was 10 min (Ghetti & Bonazzi 1981). The samples were put into appropriately aerated plastic containers, taken to the laboratory for sorting *in vivo*, and then fixed in 70% alcohol. Afterwards, the macroinvertebrates were classified to the lowest possible taxonomic level (Ruffo et al. 1977–1985).

The Shannon–Weaver index (*H*; Shannon & Weaver 1949) and the Evenness index (*E*; Pielou 1966) were used to estimate, respectively, biotic diversity and distribution among different taxa. A functional feeding analysis (Cummins & Wilzbach 1985) of the macrobenthic populations was performed, based on $\ln(x + 1)$-transformed percentages of the following functional groups at each station: shredders (Sh), scrapers (Sc), filtering collectors (FC), gathering collectors (GC) and predators (P). This method seemed the most appropriate to investigate the trophism of the biocoenotic components in a situation where only semi-quantitative samples were available.

Data expressed as a percentage, after their arcsin transformation, were also processed by Correspondence Analysis (CA) to identify the ordering and possible associations of the functional feeding

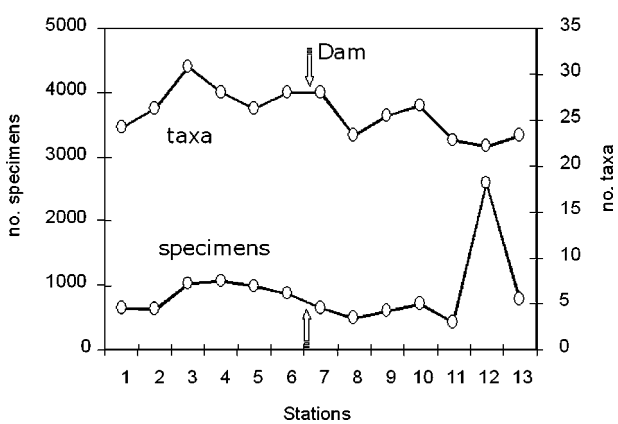


Figure 4. Mean number of specimens and taxa of benthic macroinvertebrates at each sampling station.

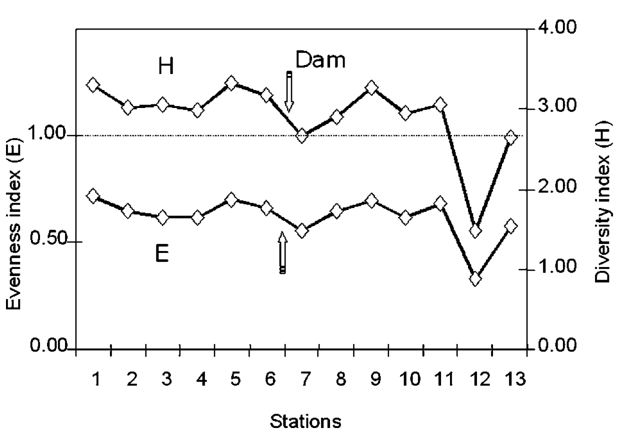


Figure 5. Mean values of the Shannon–Weaver Index (*H*) and Evenness Index (*E*) at each sampling station.

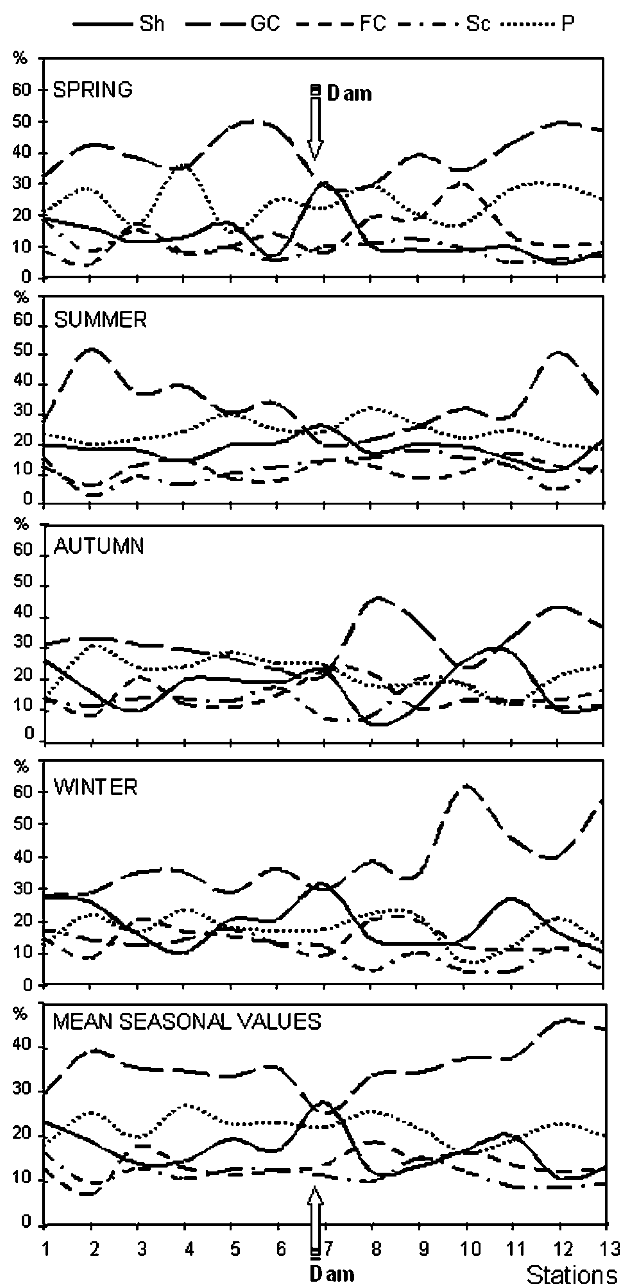


Figure 6. Percentage abundance of the functional feeding groups at the sampling stations expressed as seasonal values and annual mean values.

groups and sampling stations (Sneath & Sokal 1973; software used: STATISTICA, StatSoft Inc.).

## Results

The semi-quantitative samplings yielded 45,744 specimens of benthic macroinvertebrates, belonging to 109 taxa (see Appendix). Plecoptera were never collected in the terminal part of the river (stations 12 and 13) and were present in low numbers at station 4. Ephemeroptera, mainly *Baetis*, *Caenis* and *Serratella*, colonize all of the river, as do *Hydropsyche* (Trichoptera), Chironomidae, Simulidae and Limoniidae (Diptera), Tubificidae and Lumbricidae (Oligochaeta). The highest mean number of taxa was found at station 3 and the lowest at station 12; however, the latter station had the highest number of specimens (Figure 4).

Variations of biodiversity and equitability along the river are indicated by the mean values of $H$ and $E$, respectively (Figure 5). There is a reduction of biodiversity immediately downstream of the dam (Station 7), as well as an even more substantial reduction downstream of the confluence with the Topino River (Station 12).

The results of the functional feeding analysis reflect the variable spatial distribution of particulate organic matter along the river. Mean value seasonal analysis shows: higher percentages of shredders at the upstream stations; a marked increase of gathering collectors at the downstream stations; a fairly constant percentage of predators (around 20%) along all of the river. The bulk of the data is in agreement with the River Continuum Concept. However, an obvious zone of discontinuity can be observed just downstream of the dam (Station 7), with an anomalous maximum value of shredders (Crustacea, mainly represented by *Echinogammarus*) and a similarly anomalous minimum value of gathering collectors. This particular condition of the functional feeding groups is evident in all the seasonal samplings (Figure 6) together with a clear tendency to reduce the negative dam impact in the next downstream station (Station 8).

The CA of the transformed arcsin percentages of the functional feeding groups in relation to the sampling stations indicates the close positive associations between stations 7 and 1 and shredders, and likewise between stations 13 and 12 and gathering collectors. Predators, which do not depend on the particulate size of the available organic matter, are located close to the origin of the Cartesian axes (Figure 7).

## Discussion

The creation of a large reservoir with superficial discharge along a river usually results in sedimentation of most of the CPOM on its bed and the release into the stream of the minute organic fraction, i.e. FPOM (Lajczak 2003). This alters the trophic structure of the benthic community just downstream of the dam (Cortes et al. 1998), moving it towards a facies of higher stream order.

In contrast, the type of discontinuity just downstream of the dam in the central part of the Chiascio River indicates a typical facies of lower stream order, with a high mean value of the Sh/(GC+FC) ratio (Vannote et al. 1980) at station 7 (0.72) with respect to the values at the station immediately upstream (Station 6, 0.36) and that immediately downstream (Station 8, 0.25). This discontinuity zone (Perry & Schaeffer 1987), apparent in all the seasonal sampling carried out at station 7, shows a maximum abundance of shredders and a minimum abundance of collectors due to the current management of the dam that changes the macroinvertebrate community

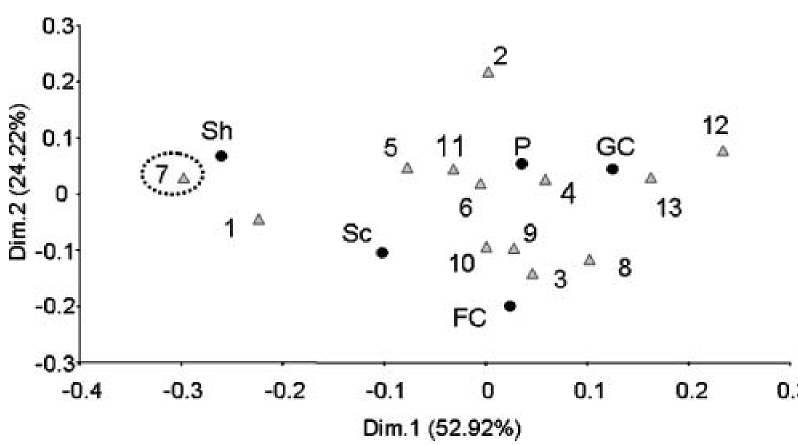


Figure 7. Correspondence analysis: mean seasonal values of the functional feeding groups (arcsin transformed percentages) in relation to the sampling stations.

structure (Armitage et al. 1987). In fact, most of the organic matter stored on the bed of the reservoir is abruptly reintroduced into the stream during the autumn discharge. In addition, during the period of partial filling (May–October), a deep-release from the reservoir occurs.

This management practice also markedly decreases the diversity (Cortes et al. 1998), even though it is still higher than at station 12. Here, the diversity shows its minimum, probably owing to the organic pollution conveyed by the Topino River tributary (Mearelli et al. 2001), and the macroinvertebrate community is typically dominated by Chironomidae and Tubificidae, which constitute 58% and 31% of taxa, respectively. By contrast, at Station 7, the complex of these two taxa, indicators of pollution, accounts for only 17%. Therefore, the variations in diversity reflect both pollution and the impact on the benthic community of temporary, extreme discharge fluctuations (Morgan et al. 1991; Nelson & Lieberman 2002).

This situation will change in the next few years when the reservoir becomes fully operative, without periodic discharges. It is expected that the continuous superficial release will result in a benthic fauna downstream of the dam with the typical trophic structure of a higher stream order.

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Appendix I. Abundance and functional feeding groups (in parenthesis the secondary role) of macroinvertebrate taxa at the sampling site. Abundance: −, absent; +, very rare (1–2 individuals); ++, rare (3–10 individuals); +++, not abundant (11–100); ++++, abundant (101–1000); +++++, very abundant (>1000). Functional feeding groups (FFGs): Sh, shredders; Sc, scrapers; FC, filtering collectors; GC, gathering collectors; P, predators.

| | | Stations | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa/Stations | F.F.G. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Turbellaria | | | | | | | | | | | | | | |
| *Dugesia* sp. | P | − | − | − | ++ | + | − | +++ | − | ++++ | + | − | +++ | − |
| *Dendrocoelum* sp. | P | − | − | − | − | − | − | − | − | − | ++ | − | − | + |
| Nematoda | | | | | | | | | | | | | | |
| Mermithidae indet. | P | − | − | ++ | + | − | − | − | − | + | + | +++ | − | − |
| Gastropoda | | | | | | | | | | | | | | |
| *Bithynia tentaculata* (Linnaeus, 1758) | Sc(Sh) | − | − | − | − | +++ | +++ | − | − | +++ | +++ | ++ | +++ | ++++ |
| *Physa acuta* Draparnaud, 1805 | Sc(Sh) | − | − | − | − | − | − | − | − | + | ++ | + | +++ | ++ |
| *Lymnaea* sp. | Sc(Sh) | − | − | − | − | − | ++ | − | − | − | ++ | − | + | −−− |
| *Ancylus fluviatilis* O.F. Müller, 1774 | Sc | − | − | +++ | ++ | + | − | − | − | − | − | − | − | ++ |
| Bivalvia | | | | | | | | | | | | | | |
| *Unio elongatulus* C. Pfeiffer, 1825 | FC | − | − | − | − | + | − | − | − | − | + | − | − | − |
| *Pisidium* sp. | FC | − | − | ++ | + | − | − | − | − | − | − | + | − | − |
| Oligochaeta | | | | | | | | | | | | | | |
| Lumbriculidae indet. | GC | + | − | − | ++ | − | − | − | − | ++ | − | ++ | − | − |
| Haplotaxidae indet. | GC | − | − | − | ++ | − | − | − | − | +++ | +++ | − | − | − |
| Tubificidae indet. | GC | + | +++ | +++ | +++ | +++ | ++++ | +++ | ++ | ++ | +++ | +++ | +++++ | ++++ |
| Lumbricidae indet. | GC | ++ | +++ | +++ | ++ | +++ | ++ | +++ | +++ | +++ | ++++ | +++ | +++ | +++ |
| Irudinea | | | | | | | | | | | | | | |
| *Glossiphonia complanata* (Linnaeus, 1758) | P | − | − | − | + | − | − | − | − | − | − | − | − | + |
| *Helobdella stagnalis* (Linnaeus, 1758) | P | − | − | + | +++ | − | − | + | − | − | + | − | +++ | +++ |
| *Piscicola geometra* (Linnaeus, 1758) | P | − | − | − | − | − | − | − | − | − | + | − | − | + |
| *Haemopis sanguisuga* (Linnaeus, 1758) | P | − | − | − | − | − | − | − | − | − | − | − | − | ++ |
| *Dina lineata* (O.F. Müller, 1774) | P | − | + | +++ | ++++ | +++ | +++ | ++ | + | ++ | +++ | +++ | ++++ | ++++ |
| Crustacea | | | | | | | | | | | | | | |
| *Asellus aquaticus* (Linnaeus, 1758) | Sh | − | − | − | +++ | − | + | ++ | − | − | − | − | ++++ | +++ |
| *Proasellus coxalis* (Dollfus, 1892) | Sh | − | − | − | +++ | +++ | ++ | +++ | − | + | +++ | +++ | ++ | +++ |
| *Echinogammarus* sp. | Sh | + | +++ | +++ | + | +++ | +++ | +++++ | ++ | +++ | +++ | + | ++ | − |
| *Niphargus* sp. | Sh | − | − | − | − | − | − | − | − | − | − | + | − | − |
| *Potamon fluviatilis* (Herbst, 1785) | Sh(P) | − | − | − | − | − | − | + | − | − | − | − | − | − |
| Ephemeroptera | | | | | | | | | | | | | | |
| *Acentrella sinaica* Bogoescu,1931 | GC(Sc) | +++ | ++ | + | − | − | + | − | − | − | − | − | − | − |
| *Baetis rhodani* (Pictet, 1843) | GC(Sc) | ++++ | +++ | ++++ | ++++ | ++++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | ++++ |
| *Baetis* sp. | GC(Sc) | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | +++ | +++ | +++ | +++ | +++ | ++++ | +++ |
| *Caenis* gr. *macrura* | GC | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | +++ | ++++ | ++++ | ++++ | ++++ | +++ | +++ |
| *Serratella ignita* (Poda, 1761) | GC(Sc) | ++ | +++ | +++ | ++++ | +++ | +++ | +++ | +++ | +++ | +++ | ++ | +++ | +++ |
| *Ephemera* sp. | GC | − | − | ++ | − | − | − | − | − | − | + | − | − | − |
| *Ecdnyonurus* sp. | Sc−GC | ++++ | ++++ | ++++ | ++ | +++ | +++ | +++ | −−− | ++ | ++ | ++ | − | + |
| *Epeorus* sp. | Sc−GC | + | − | − | ++ | − | − | − | − | − | − | − | − | − |

(*Continued.*)

| Taxa/Stations | F.F.G. | Stations 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Heptagenia* sp. | Sc−GC | + | + | − | + | − | − | + | +++ | ++++ | ++++ | +++ | − | + |
| *Choroterpes picteti* (Eaton, 1871) | GC | − | − | − | − | − | − | − | ++ | +++ | ++ | ++ | ++ | − |
| *Habroleptoides* sp. | GC | +++ | ++ | +++ | + | − | + | + | − | − | − | − | − | − |
| *Habrophlebia eldae* (Jacob & Sartori, 1984) | GC | +++ | +++ | +++ | +++ | ++ | +++ | − | − | + | − | − | − | − |
| *Paraleptophlebia submarginata* (Stephens, 1835) | GC | − | − | − | − | − | − | − | − | − | + | − | − | − |
| Odonata | | | | | | | | | | | | | | |
| *Calopteryx* sp. | P | − | ++ | + | − | + | − | + | ++ | − | − | − | + | + |
| *Platycnemis pennipes (*Pallas, 1771) | P | − | ++ | − | − | + | + | − | +++ | ++ | + | + | − | − |
| *Gomphus vulgatissimus* (Linnaeus, 1758) | P | − | − | − | − | − | + | + | ++ | + | − | − | − | − |
| *Onychogompus forcipatus unguiculatus* (Van del Linden, 1820) | P | +++ | ++ | + | ++ | − | + | − | + | + | − | − | + | + |
| *Orthetrum* sp. | P | − | − | − | − | − | − | − | − | − | − | − | + | + |
| Plecoptera | | | | | | | | | | | | | | |
| *Isoperla* sp. | P | +++ | +++ | +++ | − | + | − | + | + | − | − | − | − | − |
| *Perla marginata* (Panzer, 1799) | P | − | − | − | − | − | − | + | − | − | − | − | − | − |
| *Brachyptera risi* (Morton, 1836) | Sc | ++++ | +++ | +++ | ++ | + | − | + | − | + | − | − | − | − |
| *Nemoura* sp. | Sh | + | − | − | − | − | − | − | − | − | − | − | − | − |
| *Protonemoura* sp. | Sh | + | − | − | − | + | − | − | ++ | − | − | − | − | − |
| *Capnia* sp. | Sh | +++ | +++ | ++++ | − | +++ | − | − | − | − | − | + | − | − |
| *Leuctra* sp. | Sh | ++++ | +++ | + | +++ | − | +++ | − | ++ | +++ | +++ | ++ | − | − |
| Heteroptera | | | | | | | | | | | | | | |
| *Micronecta* sp. | Sc−P | − | − | − | − | − | − | +++ | + | − | − | − | − | − |
| *Aphelocheirus aestivalis* | P | − | − | − | − | − | + | − | ++ | ++ | ++ | − | +++ | + |
| *Gerris* sp. | P | ++ | − | − | − | − | − | − | − | − | − | − | − | − |
| *Mesovelia* sp. | P | − | − | − | − | − | − | − | + | − | − | − | − | − |
| Coleoptera | | | | | | | | | | | | | | |
| Gyrinidae indet. | P | +++ | + | + | + | − | − | − | − | − | − | + | − | + |
| Dytiscidae indet. | P | + | + | − | − | − | − | + | + | − | − | − | − | − |
| *Hydraena* sp. | Sc | ++++ | −−− | ++ | + | +++ | ++ | ++ | +++ | +++ | ++ | ++ | − | ++ |
| *Octhebius* sp. | Sc | − | − | + | − | − | + | − | − | − | − | − | − | − |
| Hydraenidae indet. | Sc | − | − | − | − | − | + | + | − | − | + | − | − | − |
| *Hydrochus* sp. | Sh | − | − | − | − | − | − | − | − | + | − | + | − | − |
| *Laccobius* sp. | Sh(P) | − | − | − | − | + | − | ++ | − | − | − | − | − | ++ |
| Hydrophilidae indet. | P;Sh(P)* | − | − | − | − | − | − | + | ++ | − | + | + | + | − |
| Helodidae indet. | Sc−Sh | + | − | − | − | − | − | − | − | − | − | − | − | − |
| *Helichus substriatus* (Ph. Müller, 1806) | Sh | ++++ | ++ | ++ | ++ | +++ | +++ | +++ | ++ | +++ | +++ | +++ | ++ | + |
| *Dryops* sp. | Sh | − | − | − | + | − | − | − | − | − | − | ++ | − | − |
| *Stenelmis* sp. | Sc−Sh | − | − | − | − | + | ++ | ++ | +++ | +++ | ++++ | +++ | ++ | − |
| *Elmis* sp. | Sc−Sh | +++ | ++ | +++ | ++++ | ++++ | ++++ | +++ | ++ | +++ | +++ | ++ | ++ | ++ |
| *Esolus* sp. | Sc−Sh | − | ++ | − | − | ++ | +++ | + | − | − | − | − | − | − |

(*Continued.*)

| Taxa/Stations | F.F.G. | Stations 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Limnius* sp. | Sc−Sh | − | ++ | +++ | ++ | +++ | ++ | ++ | − | − | − | − | − | − |
| Megaloptera | | | | | | | | | | | | | | |
| *Sialis* sp. | P | − | ++ | ++ | − | − | ++ | + | − | ++ | + | + | − | − |
| Planipennia | | | | | | | | | | | | | | |
| Osmylidae indet. | P | − | − | − | − | − | − | − | − | − | − | − | − | + |
| Diptera | | | | | | | | | | | | | | |
| Limoniidae indet. | P(Sh) | +++ | +++ | ++ | ++++ | +++ | ++++ | +++ | ++++ | ++++ | ++++ | +++ | ++ | ++ |
| Tipulidae indet. | Sh | ++ | +++ | + | + | + | + | + | ++ | ++ | ++ | ++ | + | + |
| Psychodidae indet. | Sc | − | − | + | − | + | ++ | + | − | + | + | + | − | + |
| Dixidae indet. | Sc | + | − | − | − | − | − | − | + | − | − | − | − | − |
| Simuliidae indet. | FC | ++++ | ++++ | ++++ | ++++ | ++++ | +++ | +++ | +++ | ++++ | +++ | +++ | +++ | +++ |
| Ceratopogonidae indet. | Sh(P) | − | ++ | ++ | ++ | ++ | ++ | + | + | ++ | + | ++ | − | + |
| Chironomidae indet. | GC | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ | +++++ | ++++ |
| Stratiomyidae indet. | SC−P | + | − | + | − | − | +++ | ++ | − | ++ | − | + | − | − |
| Rhagionidae indet. | P | − | − | − | − | − | + | ++ | − | ++ | ++ | ++ | − | − |
| *Atherix* sp. | P | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | + | + | − |
| *Atrichops crassipes* (Meigen, 1820) | P | − | +++ | +++ | ++ | +++ | ++ | + | − | − | − | − | − | − |
| Athericidae indet. | P | − | − | + | + | − | − | − | − | − | +++ | +++ | − | + |
| Tabanidae indet. | P | + | +++ | ++ | ++ | + | ++ | − | − | ++ | − | − | + | − |
| Empididae indet. | P | − | ++ | − | − | + | ++ | ++ | − | − | − | − | − | − |
| *Limnophora* sp. | P | − | − | − | + | − | ++ | ++ | + | − | − | + | − | + |
| *Lispe* sp. | P | − | − | − | − | − | − | − | + | − | − | − | − | − |
| Anthomyidae indet. | P | − | − | − | − | − | − | − | − | − | − | − | − | + |
| Trichoptera | | | | | | | | | | | | | | |
| *Rhyacophila dorsalis acutidens* McLachlan, 1879 | P | − | − | − | +++ | − | − | − | +++ | +++ | +++ | +++ | + | − |
| *Rhyacophila rougemonti* McLachlan, 1880 | P | − | − | − | − | − | ++ | − | − | − | − | − | − | − |
| *Rhyacophila* sp. | P | +++ | +++ | ++++ | +++ | ++++ | +++ | +++ | − | − | − | − | − | + |
| *Hydroptila angulata* Mosely, 1922 | Sc | − | − | − | − | − | − | − | + | ++ | + | − | − | − |
| *Hydroptila* sp. | Sc | − | − | − | + | + | + | +++ | − | − | − | − | − | − |
| Philopotamidae indet. | FC | − | − | − | + | − | − | − | − | − | − | − | − | − |
| *Cheumatopsyche lepida* (Pictet, 1834) | FC | − | − | − | − | − | − | − | +++ | +++ | +++ | − | − | − |
| *Polycentropus flavomaculatus* (Pictet, 1834) | FC−P | − | − | − | − | − | − | − | − | − | − | − | − | + |
| *Polycentropus* sp. | FC−P | ++ | − | − | − | − | + | − | − | − | − | − | + | ++ |
| *Psychomyia fragilis* (Pictet, 1834) | Sc | − | + | − | − | − | − | − | + | + | + | − | ++ | + |
| *Limnephilus flavicornis* (Fabricius, 1787) | Sh | − | − | − | − | − | − | − | + | − | − | − | − | − |
| *Potamophylax gambaricus spinulifer* Moretti, 1994 | Sh | − | − | + | − | − | − | − | − | − | − | − | − | − |
| *Halesus appenninus* Moretti & Spinelli, 1979 | Sh | − | − | ++ | − | − | +++ | ++ | − | − | − | − | + | + |
| *Allogamus* sp. | Sh | − | ++ | ++ | ++ | + | + | + | − | − | − | − | − | − |
| Limnephilidae indet. | Sh | − | − | + | − | − | − | − | − | + | + | − | − | + |
| *Silo mediterraneus saturniae* Moretti, 1991 | Sc | − | − | ++ | − | − | − | − | − | − | − | − | − | − |
| Lepidostomatidae indet. | Sh | − | − | + | − | − | − | − | − | − | − | − | − | − |

(*Continued.*)

| | | Stations | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa/Stations | F.F.G. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Leptoceridae indet. | Sh–Sc | – | – | ++ | – | – | – | – | – | + | – | – | – | – |
| *Sericostoma* sp. | Sh | – | – | ++ | – | – | – | – | – | – | – | – | – | – |
| *Hydropsyche modesta* Navas, 1925 | FC | – | – | – | – | – | – | – | – | – | – | +++ | +++ | – |
| *Hydropsyche pellucidula* (Curtis, 1834) | FC | – | – | – | – | – | – | – | ++++ | ++++ | ++++ | ++++ | ++++ | ++++ |
| *Hydropsyche* sp. | FC | +++ | +++ | ++++ | ++++ | ++++ | ++++ | ++++ | – | – | – | – | – | – |
| *Odontocerum albicorne* (Scopoli, 1769) | Sh–P | – | – | + | ++ | – | – | – | – | – | – | – | – | – |

* P, larvae; Sh(P), adult.