

Littoral Trichoptera of volcanic lakes Vico and Bolsena (Central Italy)

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The first list of Trichoptera from lakes Vico and Bolsena is reported. It is the result of research carried out in 1955 and 1971-1979 in lake Vico, and in 1957 and 1959-1990 in lake Bolsena. The distribution of caddisflies around the littoral zone depends on the environmental characteristics of the microhabitats. Overall, 16 species from 7 families were collected, 8 of which were found in both lakes, whereas 5 were only collected in Lake Vico, and 3 only occurred in Lake Bolsena. *Hydroptila aegyptia* and *Ecnomus tenellus* were the most abundant species in Vico, *Tinodes waeneri* and *T. maclachlani* in Bolsena. The trophic categories of the larvae and their gregarines were identified.

Keywords : Trichoptera, checklist, ecology, zoogeography, trophic categories, gregarines.

Introduction

Information on Trichoptera of volcanic lakes in Lazio derives from a study of Lake Monterosi (Moretti et al. 1967, 1968), from a short paper on Lake Vico (Moretti & Tucciarelli 1978), and from research carried out on the dietary regime of fish in Lake Bolsena (Gattaponi & Corallini Sorcetti 1988). The faunistic list of the invertebrate composition in the littoral zone of Lake Vico (Mastrantuono 2000) reported the presence of Trichoptera. Our paper reports findings on Trichoptera collected in Lake Vico (1955, 1971-79) and Lake Bolsena (1957, 1959-90) by Moretti, his collaborators and undergraduate students. Examination of aquatic stages and adults, supplemented by ecological, zoogeographical and biological information, led to the compilation of the first checklist of Trichoptera from the two lakes. The specimens were classified by Moretti and they are in the G.P. Moretti Collection in the Dipartimento di Biologia Animale ed Ecologia dell'Università degli Studi di Perugia, Italy.

Study area, material and methods

Lake Vico and Lake Bolsena are located in northern Lazio-VT, central Italy (Fig. 1). They differ in altitude

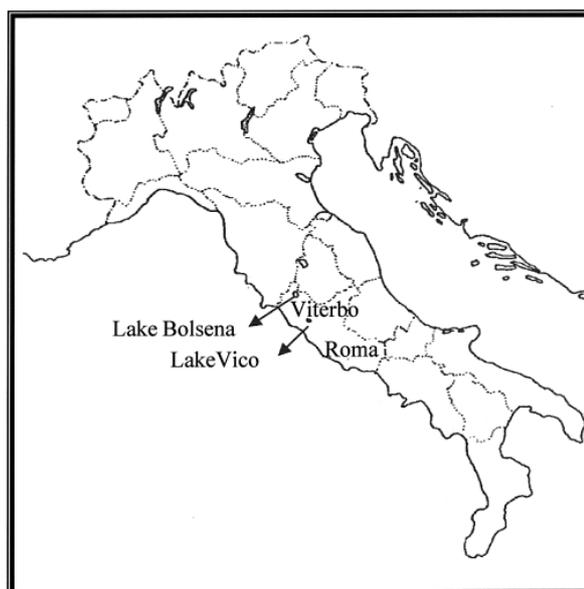


Fig. 1. Location of the two volcanic lakes, Bolsena and Vico, in central Italy.

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(Vico = 510 m a.s.l.; Bolsena = 305 m a.s.l.), surface area (Vico = 12.08 km²; Bolsena = 113.55 km²), average depth (Vico = 21 m; Bolsena = 81 m), and perimeter (Vico = 18.8 km; Bolsena = 43 km). Water level depends on the inflow from precipitation and springs and the outflow from Rio Vicano and Fiume Marta. In some zones water is taken for irrigation and some tracts of the perimeter are used for bathing.

Investigation on the Trichopteran fauna was limited to the qualitative composition. For each lake, 21 sampling stations were located in the littoral zone to collect aquatic stages (larvae, pre-pupae, pupae) in microhabitats which varied in type of substrate, depth, vegetation (*Phragmites australis* (Cav.) Steud. and hydrophytes) and in the presence of inlets. Empty cases were also sampled, and they proved the sedimentation of the larval building in the littoral. Adult Trichoptera were collected during the day using kick nets or aspirators in the littoral vegetation and in summer, with light traps in Lake Vico. Samples were taken over one year in different months representatives of the four seasons. The physico-chemical variables were measured for some sample sites.

The dietary regime and symbionts of the larvae were also studied. Larvae of different species, fixed in 4% formalin, were dissected and the gut contents and symbionts were examined in diluted glycerine under light microscopy.

Results

The physico-chemical characteristics, derived from the average values of 91 samples in Lake Vico and 76 in Lake Bolsena, were within tolerance limits for littoral Trichopteran larvae (pH 7 to 7.3, total hardness 11 to 14 Fr. dgr., O₂ 97 to 110 %, organic matter 2 to 3.6 mg/l⁻¹). There was no remarkable differences between the two lakes, except for the marsh area of Lake Vico (St. 9) where lower concentrations of O₂ (78.2 %) and higher concentrations of organic matter (8.4 mg/l⁻¹) were registered (Table 1).

The total number of taxa recorded for the two lakes was 16 (15 species, 1 subspecies), belonging to 7 families. Taxa are listed in Tables 2 according to the systematic order of the Italian Trichoptera checklist (Moretti & Cianficconi 1995). Eight species (*Orthotrichia costalis*, *Oxyethira falcata*, *Hydroptila aegyptia*, *Tinodes waeneri*, *Ecnomus tenellus*, *Lepidostoma hirtum*, *Mystacides longicornis*, *Leptocerus tineiformis*) were found in both lakes, 3 (*Tinodes maclachlani*, *Mystacides azurea*, *Oecetis furva*) only occurred in lake Bolsena, and 5 (*Hydroptila sparsa*, *Lype reducta*, *Agrypnia varia*, *Limnephilus flavicornis*, *L. rhombicus reseri*) were only collected in lake Vico. In Lake Vico, a total of 149 samples yielded 761 adults (726 ♂, 35 ♀) and 410 aquatic stages. In Lake Bolsena, 151 samples yielded 3278 adults (2232 ♂, 1046 ♀) and 11566 aqua-

Table 1. Mean and standard deviation of variables in each lake (L), and in the stations representative of different microhabitats.

STATIONS	L		Lake Vico			
	1	3	7	9	19	
samplings number	91	16	12	10	11	
air temperature °C	17 (±7.6)	16.7 (±8)	16.3 (±7.5)	17.5 (±8.3)	16.3 (±7)	
water temperature °C	15.5 (±7.5)	15.2 (±8)	15.4 (±7.5)	14 (±8)	14.7 (±8.6)	
pH	7.3 (±0.5)	7.3 (±0.5)	7.4 (±0.7)	7.6 (±0.6)	7 (±0.6)	
O ₂ mg/l ⁻¹	9.5 (±3.8)	10.5 (±1.5)	10.5 (±1.3)	7.9 (±3)	7.4 (±4.5)	
O ₂ saturation (%)	97 (±27.5)	111 (±28)	109 (±21)	78.2 (±27)	91.5 (±41)	
organic matter mg/l ⁻¹	3.6 (±2.5)	2.78 (±1)	2.62 (±1)	8.4 (±5)	3.53 (±1.4)	
total hardness Fr.dgr.	11 (±1.5)	11.4 (±1.3)	11 (±1.1)	11.6 (±3)	11 (±1)	
permanent hardness Fr.dgr.	4 (±1)	4.5 (±0.7)	4.6 (±1.1)	4 (±1.9)	3.8 (±1)	

STATIONS	Lake Bolsena									
	L	4	5	8	10	12	14	19	21	
samplings number	76	8	7	5	6	6	5	4	6	
air temperature °C	17 (±5)	15.3 (±5)	13.5 (±5.6)	19 (±3)	18.5 (±4)	17 (±2)	18 (±0.8)	17 (±9.4)	21 (±4)	
water temperature °C	16 (±5)	15 (±4.6)	9.5 (±5.2)	18 (±3.3)	19 (±3.4)	16 (±2.5)	17 (±0.4)	14 (±10)	19 (±5.6)	
pH	7 (±0)	7 (±0.2)	6.3 (±0.2)	7 (±0)	7 (±0)	7 (±0)	7 (±0)	7 (±0.5)	7 (±0.2)	
O ₂ mg/l ⁻¹	11 (±2)	10 (±2.5)	10.6 (±1.2)	10.5 (±3.7)	14 (±4)	11 (±2.9)	11 (±1.3)	11.8 (±1.4)	12 (±1.7)	
O ₂ saturation (%)	110 (±22)	99.5 (±24.6)	107 (±6)	102 (±31)	114 (±0.7)	97 (±20)	112 (±15)	116 (±32)	129 (±21.8)	
organic matter mg/l ⁻¹	2 (±1)	2.2 (±0.7)	1.9 (±0.9)	2.2 (±0.7)	2.3 (±0.1)	2.3 (±0.9)	3 (±0.9)	1.7 (±0.8)	2.2 (±1.2)	
total hardness Fr.dgr.	14 (±2)	14.3 (±2.4)	15 (±0.5)	12.3 (±0.6)	13 (±3.5)	13 (±1.6)	12 (±1.6)	15 (±2)	13 (±0.8)	
permanent hardness Fr.dgr.	6 (±3)	8.5 (±2.1)	5.5 (±0.5)	5.3 (±0.6)	7 (±4.2)	4.3 (±2.5)	6 (±2.5)	5 (±0.8)	5.5 (±0.5)	

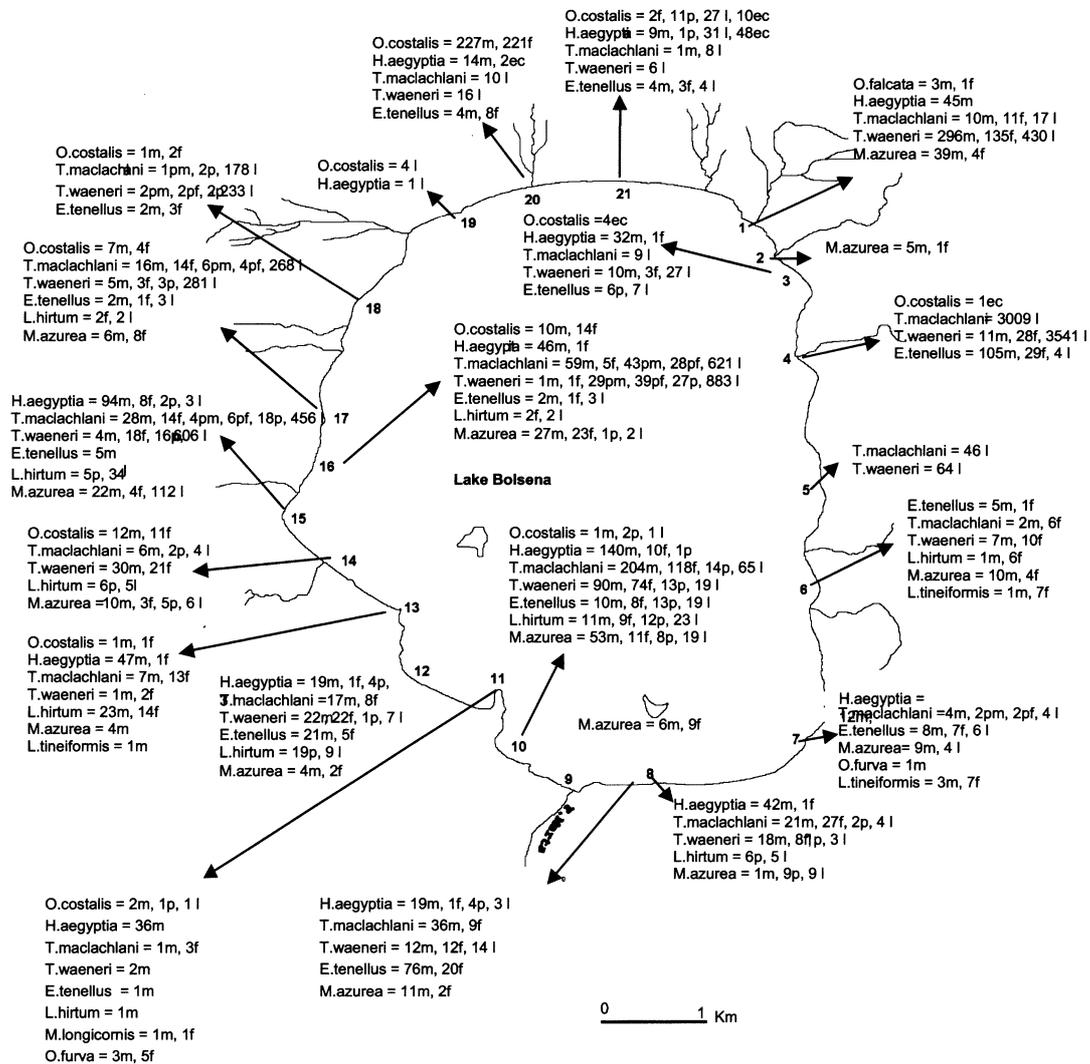


Fig. 2. Distribution of species at each station of Lake Bolsena. m=male; f=female; p=pupa; pp=pre-pupa; l=larva; pc=pupal case; ec=empty case.

tic stages. In Lake Bolsena (Fig. 2) all the sampling stations were inhabited by Trichoptera and the species were distributed almost homogeneously around the perimeter. In Lake Vico (Fig. 3), some sampling stations (2, 5, 7, 8, 16, 17), used for bathing, were uninhabited and the presence of different habitats resulted in non-uniform distributions and a higher number of species. The northern marsh area of this lake was characterized by the presence of large case building larvae (Phryganeidae, Limnephilidae) living in a reed belt. Their empty cases are conveyed to the southern area by the outflow. The species found in the highest num-

ber of stations with the highest number of specimens (Table 2) were *Hydroptila aegyptia* (10 stations, 718 specimens) and *Ecnomus tenellus* (10 stations, 283 specimens) in Lake Vico; *Tinodes waeneri* (18 stations, 7111 specimens) and *T. maclachlani* (17 stations, 5473 specimens) in Lake Bolsena. The majority of the adults belonged to the 5 species listed in Fig. 4, which shows the months of emergence. *Ecnomus tenellus* (Fig. 5 B) and *Hydroptila aegyptia* (Fig. 5 C, D) emerged mainly in summer. In Lake Bolsena, *Tinodes waeneri* had predominantly spring emergence, *T. maclachlani* (Fig. 5 A) predominantly autumnal emergen-

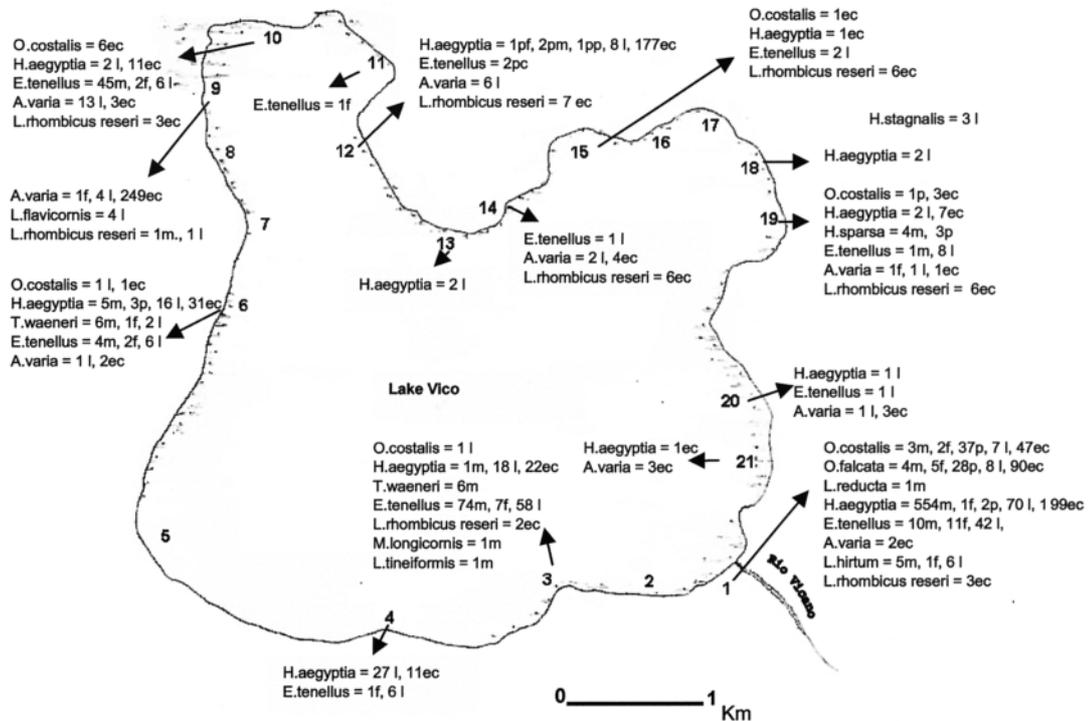


Fig. 3. Distribution of species in each station of Lake Vico. m=male; f=female; p=pupa; pp=pre-pupa; l=larva; pc=pupal case; ec=empty case.

ce, and *Mystacides azurea* (Fig. 5 E) emerged from spring to autumn. For these species, 78% of the adults were male, (e.g., *H. aegyptia* 27.08.1975: 331♂, 1♀ with light traps).

Discussion

The Trichoptera fauna of these two lakes is far from being well known. Nevertheless, the present list including 11 species from Lake Bolsena, and 13 species from Lake Vico allowed us to bring out some ecological, biogeographical and biological considerations. Under the ecological perspective, two Trichoptera communities (limnophilous and rheophilous) were identified, confirming previous results from Lake Monterosi (Moretti & Tucciarelli 1968). The limnophilous species *Orthotrichia costalis*, *Hydroptila aegyptia*, *Tinodes waeneri*, *Ecnomus tenellus* are well represented in both lakes, as reported in the lacustrine waters of central Italy: Lake Trasimeno (Moretti et al. 1993), Lake Piediluco (Moretti et al. 1981), lakes Lungo and Ripa Sottile (Moretti et al. 1985). Conversely, the leptocerids *Mystacides longicornis* and *Leptocerus*

tineiformis were sporadically collected; the first species typically occurs in lakes and ponds of the preAlps and Central Apennines (Moretti et al. 1991), whereas the second species produces consistent populations on the littoral hydrophytes of the lakes in central Italy (Cianficconi et al. 1988). It must be pointed out that *Mystacides azurea* and *Oecetis furva*, which are widespread in lentic waters of the Italian Peninsula, were only found in Lake Bolsena. *Agrypnia varia*, *Limnophilus flavicornis*, *L. rhombicus reseri* are exclusive to the marsh area of Lake Vico. The high number (249) of sedimented empty cases of *A. varia*, proved the presence of a large population of this species that is usually uncommon in marsh environments in central Italy (Cianficconi et al. 2000). *L. rhombicus reseri* was found for the first time in Italy in this lake. Indeed, in 1977, Moretti attributed some specimens from Lake Vico to *L. rhombicus* n. ssp. because the characteristics of male genitalia (parameres) were different from those of the type species. Afterwards, Malicky (1985) described the subspecies *reseri* from specimens collected in the Southern Alps. A comparison between the unpublished drawings of Moretti with those of Malicky revealed that the specimens identified as *L. rhombi-*

Table 2. List of species and number of specimens found.
 - a s = aquatic stage ; ° = rheophilous species.

TAXA	BOLSENA				VICO			
	♂	♀	a s	Total	♂	♀	a s	Total
HYDROPTILIDAE								
1- <i>Orthotrichia costalis</i> (Curtis, 1834)	261	255	47	563	3	2	47	52
2- <i>Oxyethira falcata</i> Morton, 1893	3	1		4	4	5	36	45
3- <i>Hydroptila aegyptia</i> Ulmer, 1963	555	24	53	632	560	1	157	718
4- <i>Hydroptila sparsa</i> Curtis, 1834 °					4	3		7
PSYCHOMYIDAE								
5- <i>Lype reducta</i> (Hagen, 1868) °					1			1
6- <i>Tinodes maclachlani</i> Kimmins, 1966 °	412	228	4833	5473				
7- <i>Tinodes waeneri</i> (Linnaeus, 1758)	509	337	6265	7111	12	1	2	15
ECNOMIDAE								
8- <i>Ecnomus tenellus</i> (Rambur, 1842)	245	86	65	396	134	23	126	283
PHRYGANEIDAE								
9- <i>Agrypnia varia</i> (Fabricius, 1793)						2	28	30
LIMNephILIDAE								
10- <i>Limnephilus flavicornis</i> (Fabricius, 1787)							4	4
11- <i>Limnephilus rhombicus reseri</i> Malicky, 1985					1		1	2
LEPIDOSTOMATIDAE								
12- <i>Lepidostoma hirtum</i> (Fabricius, 1775)°	36	33	128	197	5	1	6	12
LEPTOCERIDAE								
13- <i>Mystacides azurea</i> (Linnaeus, 1761)	201	62	175	438				
14- <i>Mystacides longicornis</i> (Linnaeus, 1758)	1	1		2	1			1
15- <i>Oecetis furva</i> (Rambur, 1842)	4	5		9				
16- <i>Leptocerus tineiformis</i> Curtis, 1834	5	14		19	1			1
Total	2232	1046	11566	14844	726	35	410	1171

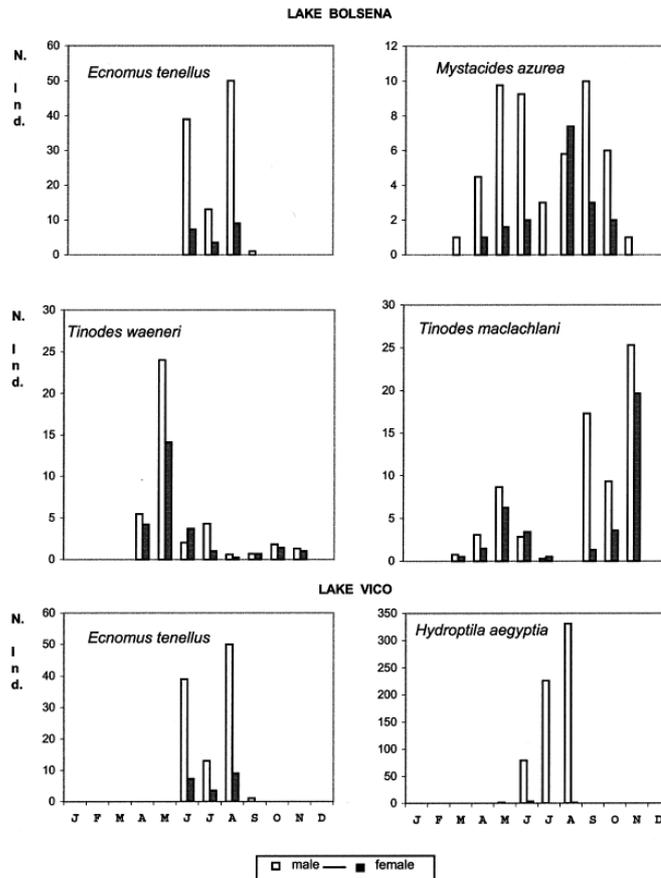


Fig. 4. Average monthly emergence of the five most common species

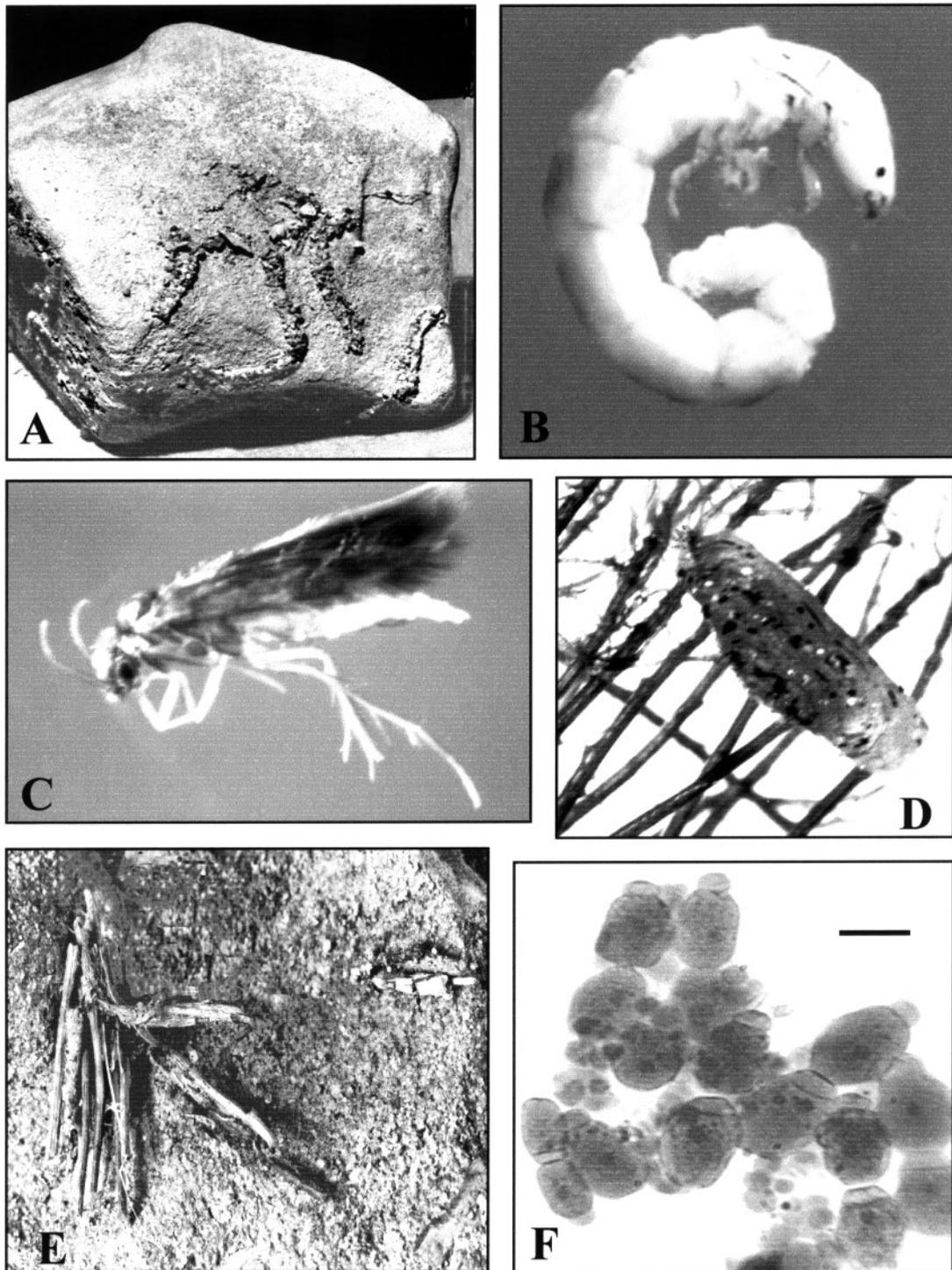


Fig. 5. Some caddisflies from the two lakes. A-*Tinodes maclachlani*, larval tunnels made of sand (length 15- 20 mm); B-*Ecnomus tenellus*, larva (8 mm long) extracted from its gallery; C - *Hydroptila aegyptia* ♂ (3 mm long) with pubescent wings; D- *H. aegyptia* larva in its case made of silk encrusted with sand (3.5 mm long) on *Ceratophyllum submersum* ; E- *Mystacides azurea*, larval cases (18 mm long) and pupal cases (10 mm long) on a pebble in lake Bolsena; F- *Gregarina pusilla*, symbiont of *T. maclachlani* and *T. waeneri*, bar = 50 μ m.

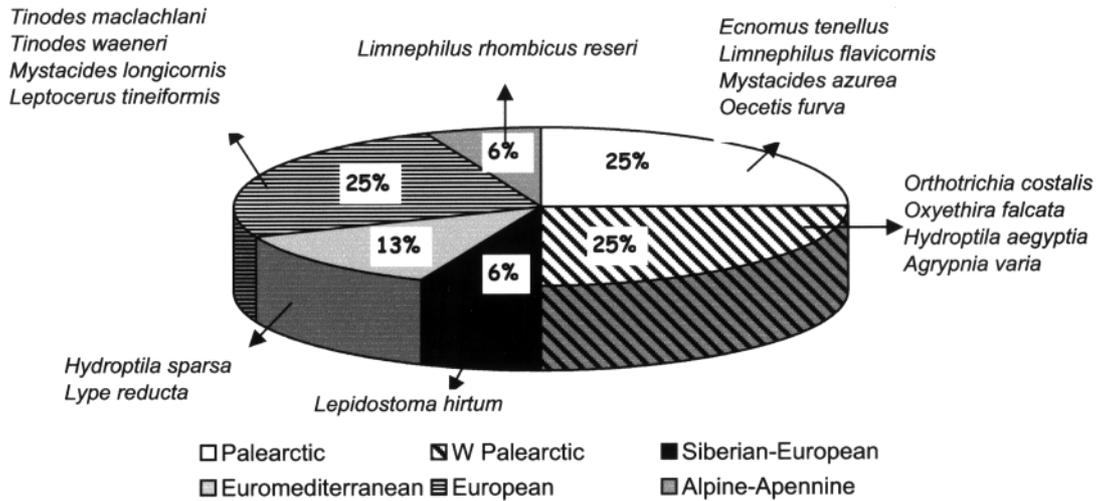


Fig. 6. Chorological categories of species found in lakes Vico and Bolsena.

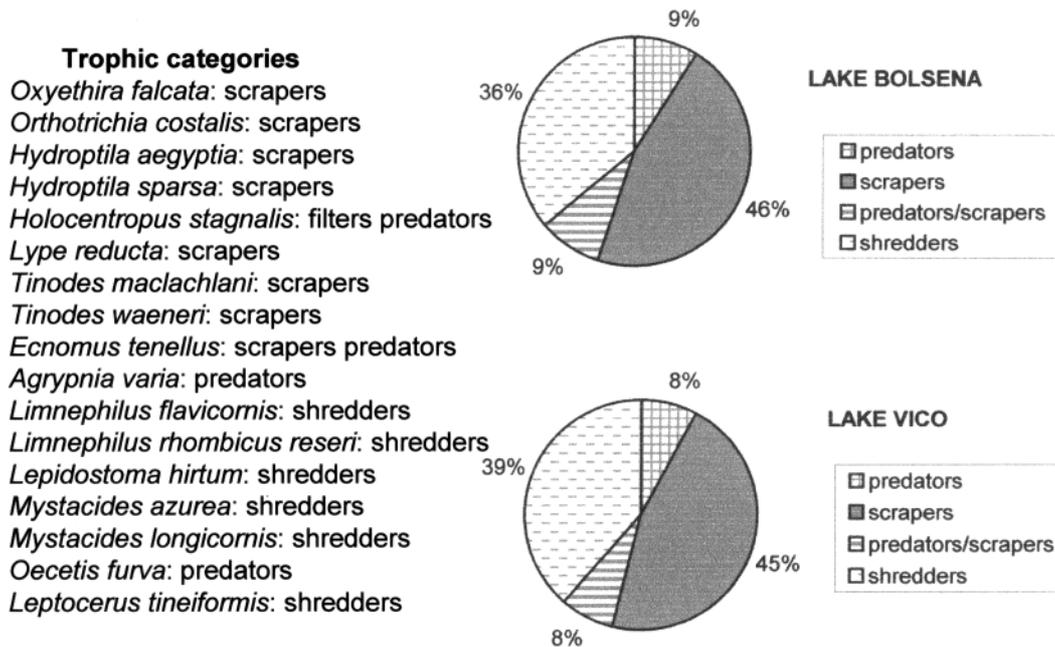


Fig. 7. Percentage of trophic categories in the two lakes

cus n. ssp. actually belong to *L. rhombicus reseri*. Note that larvae of *Holocentropus stagnalis* (Albarda, 1874), rare in Italy, were found in a drainage pond near Lake Vico. The rheophilous species are represented by: *Lype reducta*, found near the Rio Vicano, *Hydroptila sparsa* in Lake Vico, but limited to station 19, *Tinodes maclachlani* in lake Bolsena, in slowly mo-

ving water between pebbles submerged to a depth of up to 2 m, *Lepidostoma hirtum*, near the Rio Vicano and along the south-western area of Lake Bolsena. It must be pointed out that *T. maclachlani* lives in hygropetric habitats in Italy (Cianficconi Moretti 1998) and *L. hirtum* in running waters (Moretti et al. 1997).

The zoogeographical balance shows the coexistence of different chorological categories with northern distribution. Except for *Limnephilus rhombicus reseri* which is alpine-appennine, all the species have a wide distribution (4 Palearctic, 4 W-Palearctic, 1 Siberian-European, 2 Euromediterranean, 4 European) (Fig.6).

Under the biological perspective, the Trichoptera populations in both lakes belong to the same trophic category with almost identical percentages. The scrapers show the highest percentage, followed by that of the shredders (Fig. 7). The protozoa *Gregarina pusilla* Baudoin (Fig. 5 F) was the only parasite found in the gut of the larvae of *Tinodes waeneri* (69 % infestation) and *T. maclachlani* (81 % infestation).

In conclusion, our data show that the littoral zone of two volcanic lakes is very important for Trichoptera coenoses. Nevertheless, in order to have a complete picture of the faunistic composition, additional investigations should be extended to other volcanic lakes of Lazio.

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