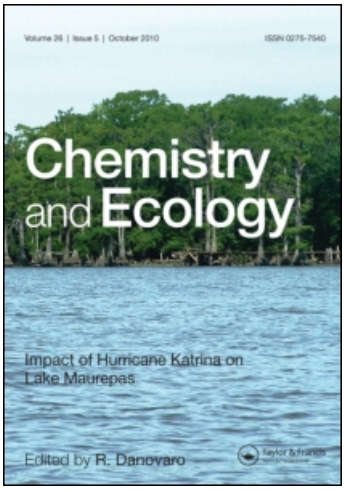

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The Contribution by the Study of the Algae Forms (Phytoplankton and Periphyton) as Integrators of Physicochemical and Microbiological Data in the Varenna Stream

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The Contribution by the Study of the Algae Forms (Phytoplankton and Periphyton) as Integrators of Physicochemical and Microbiological Data in the Varenna Stream

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Physico-chemical, microbiological, ichthyotoxicological conditions and microalgae of Varenna stream were studied in samples taken in 12 collecting stations. The data reported indicate a marked deterioration proceeding downstream e.g. an increase of bacterial population, concentration of suspended solids, COD and variations in the composition and abundance of phytoplankton and periphyton.

INTRODUCTION

Article 1 (point e) of the law n° 319/1976, Italian common law in relation to water pollution, lays down the systematic survey of the qualitative and quantitative characteristics of water bodies. Even though there is a consolidated habit of using a chemical control to decide whether water is polluted in relation to the different needs of utilisation, the tendency more recently is to associate chemical control of the water quality by checking the effects of pollution on animal and plant communities (Ghetti and Bonazzi, 1980).

A complete and detailed study of all the organisms which live in a stream is a very complex task. Therefore, on the basis of previous specific experiences, for this study concerning the assessment of the biological load, only a particular part of the biotic community, the microalgae population, was studied.

DESCRIPTION OF SITES STUDIED

The samples taken for examination in this particular work came from 12 collecting stations located along the Varenna stream and its tributaries. The Varenna stream occupies an area (about 22 km^2) situated within the western part of the city of Genoa and rises from the confluence of the Vaccarezza stream and the Grillo stream. As far as the lithological aspects are concerned they show two main components (Figure 1).

The flow rate of the Varenna stream is usually small on the average of 0.5 m^3/sec. The bed width is about 10 m, and the streamflow is remarkable for the high difference in altitude from source to embouchure, and the water is not deep (20–40 cm). The ground is made of pebbles and thick gravel in the upper and middle reaches, while downstream there are deposits of fine sediments. The side on which the Vaccarezza stream flows, already geologically an alpine area, has a marked calcarecus component, while the Grillo stream is composed of serpentine and is therefore characterised by a silicon-magnesium substratum.

Pollution load

The Varenna stream carries only waste water from the rural population of the catchment basin to Tre Ponti (500 m from the

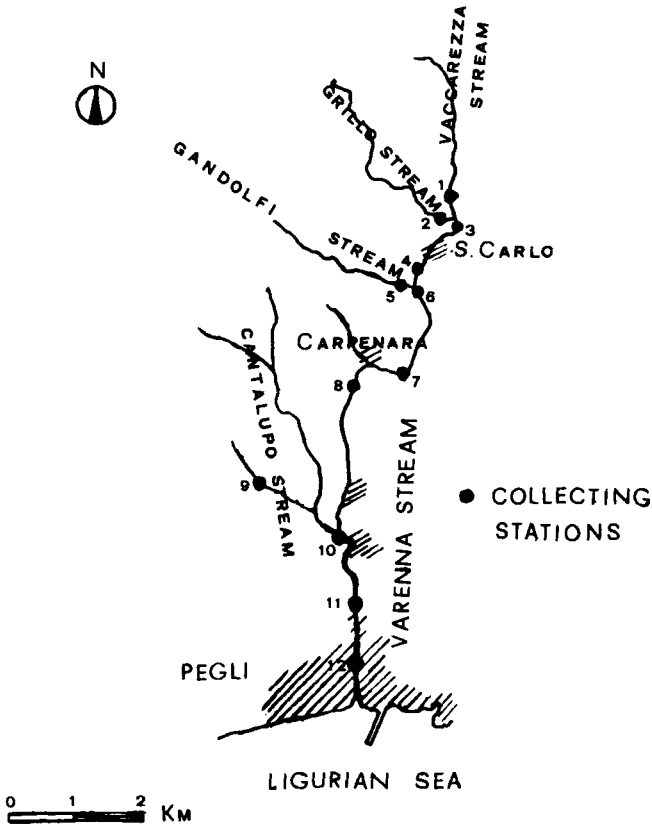

FIGURE 1 Sampling stations on the Varenna stream.

estuary) where the municipal sanitary sewer begins. This population is about 550 inhabitants with a slight increase in summer time.

The stream also receives effluent from two oil deposits, one anodic oxidation laboratory and one dye factory, all with sewage disposal plants. Furthermore, a rubble crushing plant has a high output.

The activity concerned with agriculture in the basin is operating on a limited scale with a small amount of fertilizers and pesticides. There are no discharges from industrial and non-industrial sources,

not even from the small number of inhabitants. However, the industrial and non-industrial pollution load, as BOD/5, is ca 40 kg O_2/d.

MATERIAL AND METHODS

All phytoplankton samples were collected with a 17 cm wide conical net of 10 μmesh, and periphyton sampled with the usual needleless syringe. The samples were preserved in the field with 2% formalin. Samples were examined in the laboratory to determine the species present with a Wild M 40 microscope using 1000 × magnification.

All chemical and microbiological examinations to determine the sanitary quality of water samples were performed according to "Standard methods for the examination of water and wastewater (Ed. A.P.H.A, 1980).

EXPERIMENTAL RESULTS

The data resulting from the analysis of the phytoplankton and the periphyton samples will be compared to the physico-chemical and microbiological data (Table I). The situation of the microalgae population at the stations above the village of S. Carlo di Cese and the tributaries Gandolfi and Cantalupo streams appears to be more of an oligotrophic environment, and no dominant species exist. Even downstream below the village of Carpenara the results concerning the self-depuration of the watercourse are good. In the station downstream from the villages of S. Carlo di Cese, Carpenara, Cantalupo and especially in the last two downstream from the confluence of the Cantalupo stream, near the estuary, the situation appears have deteriorated markedly because the biota are characterised by large numbers of a few species which are typical of polluted waters. The algae population is, on the whole, peculiar to alkaline waters: for example, *Synedra ulna* and *Synedra acus* together with *Diatoma vulgare* are generally species characteristic of environments with a pH between 6 and 9 and, at times, even higher values. *Surirella ovata* together with *Diatoma elongatum* could be

TABLE I
The microalgal population of the Varenna stream

	Station											
	1	2	3	4	5	6	7	8	9	10	11	12
Diatomophyceae												
Centrophycidae												
Melosira ambigua									×	×		
Melosira dikiei	×	×	×									
Melosira granulata	×	×	×	×	×	×	×		×	×		
Melosira italica								×				×
Melosira varians	×		×	×	×	×	×		×	×		
Pennatophycidae												
Tabellaria flocculosa		×	×			×						
Diatoma elongatum	×	×	×	×	×	×	×	×	×	×	×	×
Diatoma hiemale	×	×	×	×			×	×	×			
Diatoma vulgare	×	×	×	×	×	×	×	×	×	×	×	×
Meridion circulare	×	×	×	×				×			×	×
Ceratoneis arcus		×	×	×	×	×	×	×	×	×	×	×
Fragilaria intermedia	×		×	×	×	×			×			
Fragilaria virescens		×					×	×		×	×	×
Synedra acus											×	
Synedra berolinensis		×	×		×		×		×	×	×	
Synedra ulna	×	×	×	×	×	×		×	×	×	×	×
Synedra vaucheriae						×	×					
Eunotia sp.				×	×						×	
Cocconeis pediculus	×	×	×						×			
Cocconeis placentula	×	×	×	×	×	×	×		×	×	×	×
Achnanthes affinis	×		×	×	×	×	×		×			
Achnanthes hungarica				×	×							
Achnanthes lanceolata					×							
Achnanthes linearis	×	×	×									
Achnanthes minutissima		×	×				×	×	×	×	×	×
Rhoicosphenia curvata			×	×		×	×		×			
Diploneis elliptica	×	×	×		×	×						
Stauroneis phoenicenteron		×										×
Navicula spp.	×	×	×	×	×	×	×	×	×	×	×	×
Pinnularia brebissonii								×	×	×	×	×
Pinnularia major	×											
Pinnularia viridis	×	×	×	×	×	×	×	×			×	×
Cymbella affinis	×		×	×	×	×	×	×	×	×	×	
Cymbella amphycefala	×											
Cymbella aspera		×										
Cymbella sp.		×	×	×	×	×	×					×
Amphora minutissima		×	×									
Gomphonema constrictum	×	×	×	×	×		×	×				
Gomphonema gracile									×			
Gomphonema sp.		×										

TABLE I (*continued*)

	Station											
	1	2	3	4	5	6	7	8	9	10	11	12
Rhopalodia gibba									×	×		
Nitzschia linearis	×	×	×	×	×	×		×	×	×	×	×
Nitzschia palea	×	×	×	×	×	×	×	×	×	×	×	
Nitzschia sigmoidea	×						×				×	×
Surirella ovata	×		×	×				×	×	×	×	×
Cyanophyceae												
Aphanocapsa virescens				×								
Gloeocapsa aeruginosa							×					×
Rivularis sp.								×			×	
Oscillatoria limosa					×						×	
Oscillatoria rubescens					×				×			
Oscillatoria tenuis	×	×			×	×						
Phormidium sp.					×							
Chlorophyceae												
Ulothrix tenuis								×	×			×
Oedogonium sp.					×	×	×	×	×			
Cladophora glomerata					×						×	
Zygnema cruciatum								×	×			×
Zygogonium conspicuum					×							
Desmidium grevillii	×	×	×		×							

taken as a basis for the study of the rate of pollution, as they are species typical of polluted waters.

The study of physico-chemical, microbiological and ichthyotoxicological conditions in the Varenna stream waters is based on 12 samplings taken at the same stations where previously the microalgae samples were obtained (Table II).

DISCUSSION AND CONCLUSION

On the basis of the information collected the following considerations are possible: the waters of the Grillo and Vaccarezza streams have very good physico-chemical and microbiological characteristics. In fact, they run across zones practically devoid of built up areas; they show a different residue according to the different origin of the soils.

Similar characteristics to those found in the Grillo stream are

TABLE II
Varenna stream: physical, chemical, microbiological, biotoxicological characteristics

Physical characteristics	Stations											
	1	2	3	4	5	6	7	8	9	10	11	12
pH	8.3	8.25	8.2	8.2	7.9	8.1	8.1	8.1	8.0	7.9	8.2	8.9
Temperature °C	12	12	12	12	10	10	10	10	12	12	12	12
Odour	absent		absent		absent		absent		absent		absent	
Colour	idem		idem		idem		idem		idem			

TABLE II (*continued*)

Chemical characteristics	1	2	3	4	5	6	7	8	9	10	11	12
Residue at 105°C (mg/l)	237	125	173	180	169	158	138	140	136	166	168	207
Residue at 180°C (mg/l)							absent	absent	absent	absent	absent	absent
Suspended solids (mg/l)	absent	absent	absent	absent	absent	absent	absent	absent	absent	4	4269	345
B.O.D.$_5$(mgO_2/l)	2.8	2.6	2	2	2.1	2.4	2.3	2.8	2.4	5	9	10
C.O.D.$_5$(mgO_2/l)	6.4	6.4	6.4	7.2	3.2	2.4	3.2	4.4	4.8	48	19	17
Ammonium ion (ppm)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<	absent
Nitrite ion (ppm)	absent		absent		<5	<5	<5	<5	<5	<5	<5	absent
Ether extract (ppm)												37
Hardness °F	17.0	6.8	11.2	11.5	5.2	9.5	10.6	11.2	13.0	13.0	13.2	13.7
Cyanides												absent
On Filtered Water												
Iron (ppm)												0.5
Chromium (ppm)												0.2
Nickel (ppm)												0.2
Stannum (ppm)												absent
On Suspended Matter												
Iron (ppm)												50
Chromium (ppm)												1
Nickel (ppm)												0.5
Stannum (ppm)												absent

TABLE II (*continued*)

Microbiological characteristics	1	2	3	4	5	6	7	8	9	10	11	12
Total coliform/ 100 ml (MPN)	460	0	4300	46,000	43	9300	200	24,000	150	110,000	> 110,000	> 1100
E. coli (fecals)/ 100 cc. (MPN)	93	0	idem	24,000	4	2300	150	1100	0	15,000	110,000	1100

Biotoxiocological characteristics	1	2	3	4	5	6	7	8	9	10	11	12
Ichthyotoxicological test with *Carassius auratus* at 72 hours	neg.	neg.	neg.	neg.	neg.	neg.	neg.	Positive: undiluted water kills 10% of fish	neg.	neg.	neg.	neg.

observed in the Gandolfi and Cantalupo streams. With distance down the Varenna stream a progressive deterioration occurs, especially from the microbiological point of view, despite a contribution of pure water from the Gandolfi stream as a natural self cleansing component.

On the whole the Varenna stream shows good conditions until it reaches the village of Carpenara. Here the condition of the waters deteriorates markedly, as indicated by the high bacterial content, the level of substances in suspension, the COD and the animal and vegetable oily matters and hydrocarbons.

The most important physico-chemical differences in the head waters arise from the saline residues of the Grillo and Molinaro streams, deriving from territories with different lithology. This situation can be compared with the characteristics of the microalgae population, which in station 2 on the Grillo stream, although well represented from the point of view of the species, is modest in its number of individuals which is typical of oligotrophic environments.

The chemical-microbiological data from the lower valley portion of the Varenna stream indicates a worsening of the situation at station 4, which is immediately downstream from S. Carlo di Cese. This is typified by the microbiological components which influence the algae present.

The self-depuration process which operates in the area of stations 6 and 7 is evident from the biological data. This indicates the presence of a large number of species in accordance with the improvement observed in the microbiological characteristics.

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