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FLOOD EFFECTS ON ALGAL BIODIVERSITY IN A MEDITERRANEAN RIVER

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Abstract

The effect of flood event on the algal biodiversity of the Siurana river, in 10 october 1994, has been studied. The algal flora, the chemical and physical data and the diatom diversity index were compared before the perturbation with equivalent data sampled after this event. As a consequence of the flood, the physical and the chemical characteristics of the water changed, and an alteration of the phytobenthos was observed. Before the flood, the diatom comunities had been dominated by: *Achnanthes affinis, Achnanthes flexella, Cymbella perpusilla, Denticula tenuis, Diatoma vulgare, Fragilaria capucina, Fragilaria intermedia, Melosira varians, Navicula lanceolata* and *Nitzschia palea*; in this case, the communities were well structurated, with a relatively high diversity index (H': 1.8-3.7 bits). However, after the perturbation, the communities were less structurated (H'= 0.3-2.1 bits) and dominated by r-strategists as: *Achnanthes minutissima, Cocconeis pediculus, Epithemia sorex, Fragilaria ulna* and *Rhopalodia* gibba. Nevertheless, nine months later, the macroalgae assemblages were similar to those which were before the flood. However, there is an increase of filamentous green algae (especially *Cladophora glomerata* and *Spirogyra* sp.) was observed, though the characean populations were less important.

Introduction

Disturbances on river algae following flooding have been studied in several countries (POWER & STEWART, 1987; VAN DEN BRINK et al., 1994; ENGLE & MELAK, 1993; DOKULIL, 1993; ELBER & SCHANZ, 1990; SCRIMGEOUR & WINTERBOURN, 1989). However, in the Mediterranean rivers there is a lack of information about the flooding effects on the algal assemblages. In such rivers, the flow changes are closely related to the precipitation periods (spring and autumn), especially those with a relatively small bassin. The flow is low all over the year and the river is nearly dryed in summer. Many algae are adapted to this kind of fluctuations, producing spores, zygotes or vegetative structures which resist the dry periods (ABOAL, 1987; CAMBRA, 1989; CAMBRA & ABOAL, 1992; SABATER, 1987). Occasionally, the water flow could increase drastically its volume in a very short time. This fact occurs inmediately after strong storms, producing dramatic floods and a very important perturbations on the river biocenosis.

The Siurana river is located at the south of Catalonia (N.E. of Spain); its bassin has 629.4 km^2, 50 km long and a small reservoir. The substrate is calcareus at the upper part, with a little proportion of sulphates; the rest of the river bed is siliceus. It is a typically Mediterranean river, with a severe dry period during summer.

Our phycological research on the flora and communities of this river started in 1993 and, in october of 1994 a very strong storm affected this area. Within a period of 24 hours, 400 l/m^2 of precipitation were recorded in the upper area of the river. The soil, already saturared due to previous autumn Mediterranean rainfalls, was unable to absorb this great amount of water. So, the river became a rushing torrent, overflowing its banks, broken some bridges, flooding the valley with mud and silt-laden, and causing enormous damage. Because of it, some of the studied stations; were disturbed by two perturbations: firstly the flood and secondly by the human channellizing of the river bed. The aim of this work is to report the effects of this strong flooding on the algal biodiversity after a nine months of an algal recolonization period.

Materials and Methods

The sampling points (Fig. 1) were distributed throughout the bassin, in order to know the algal flora and to describe the main algal communities. Before the flood, seasonal samples were collected and one sampling was done nine months after the flood, with the aim to know the flood perturbation on the algal biodiversity and the population structure. Filamentous algae, sediments and scraping stones were collected from each sampling point and fixed with formalin (4%). All this material was studied under a Nikon Labophot microscop using the classic algal taxonomic monographs. In order to calculate the diatom diversity index, 400 cells were counted from each glass-

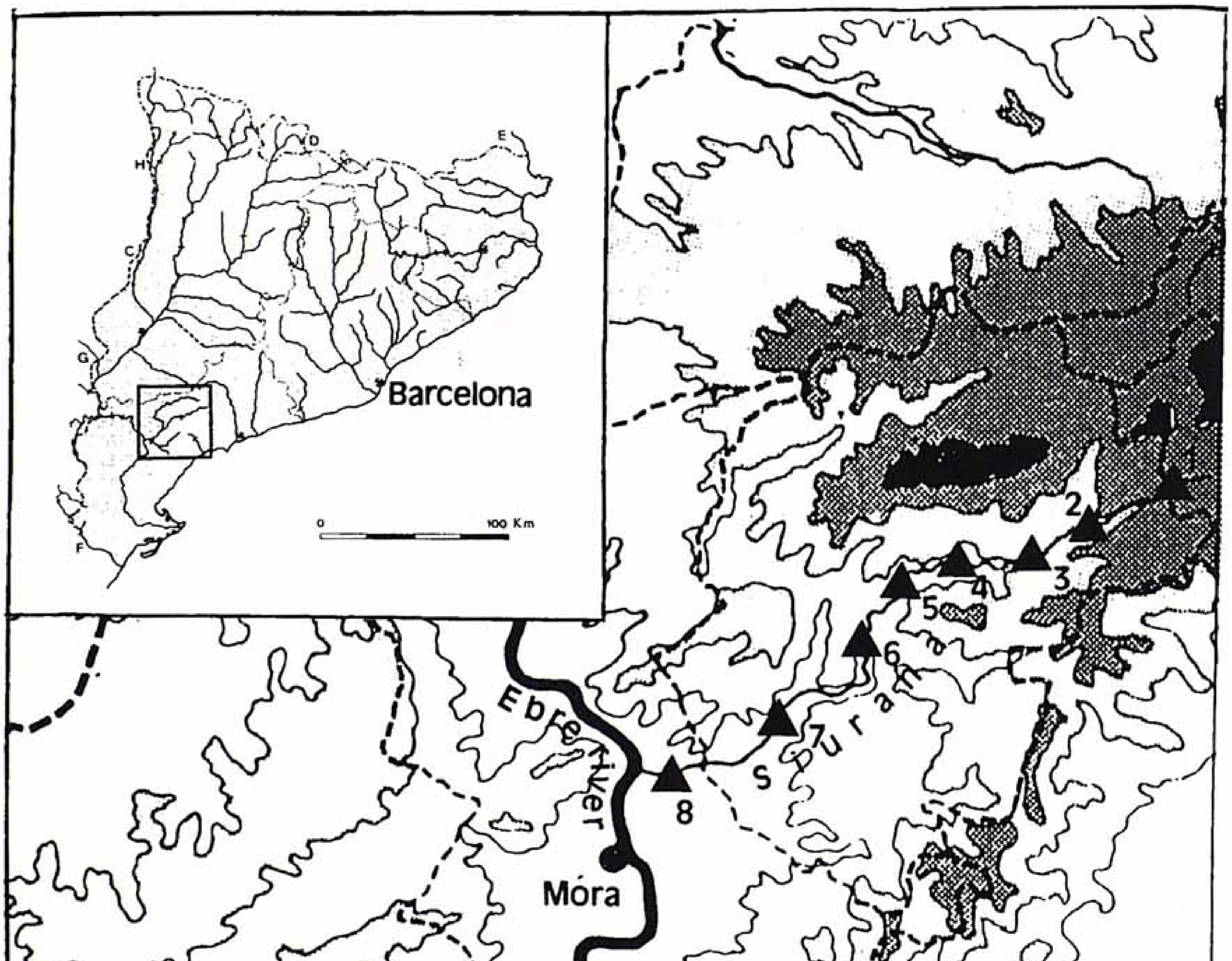


Fig. 1. Studied area and sampling points: 1. La Febró; 2: Toll de la Palla; 3: Toll del Coco; 4: Poboleda; 5: Torroja; 6: Gratallops; 7: Masroig; 8: García.

slide and the relative frequency (*rf*) of each diatom species was calculated using the following equation: $rf = N_i/N$ (were N_i means the number of individuals of a given species, and N the total number of recorded individuals in the glass-slide). As a mesure of the diatom diversity index, the next equation was used: $H' = - \Sigma N_i/N \times \ln N_i/N$ (Shannon & Weaver's). The macroalgal abundance (only performed after the flood) was sampled from 5 to 10 transects in which the relatively frequency of the algae was estimated. Water temperature, electrical conductivity, pH and nitrate values were measured in situ and in the laboratory.

Results

The Siurana river has a moderate water temperature (8-17°) and a neutral pH (6.9-8.2). The electric conductivity was relatively high, ranging between 477-1395 µS/cm before the flood and 573-1540 µS/cm after the flood (Fig. 2). Among the nutrients, the nitrate concentration previous to the flood was between 0.085-0.8 mg/l; after the perturbation, the nitrate values rised to 1.02-5.89 mg/l (Fig. 3). Probably, this increase of the electric conductivity and the nitrates was produced by the remouving sediments of the river bed. Flood waters transport large amounts of suspended solids and nutrients. In most cases, an increase in nutrient input causes a consequent rapid increase in algal biomass (ELBER & SCHANZ, 1990).

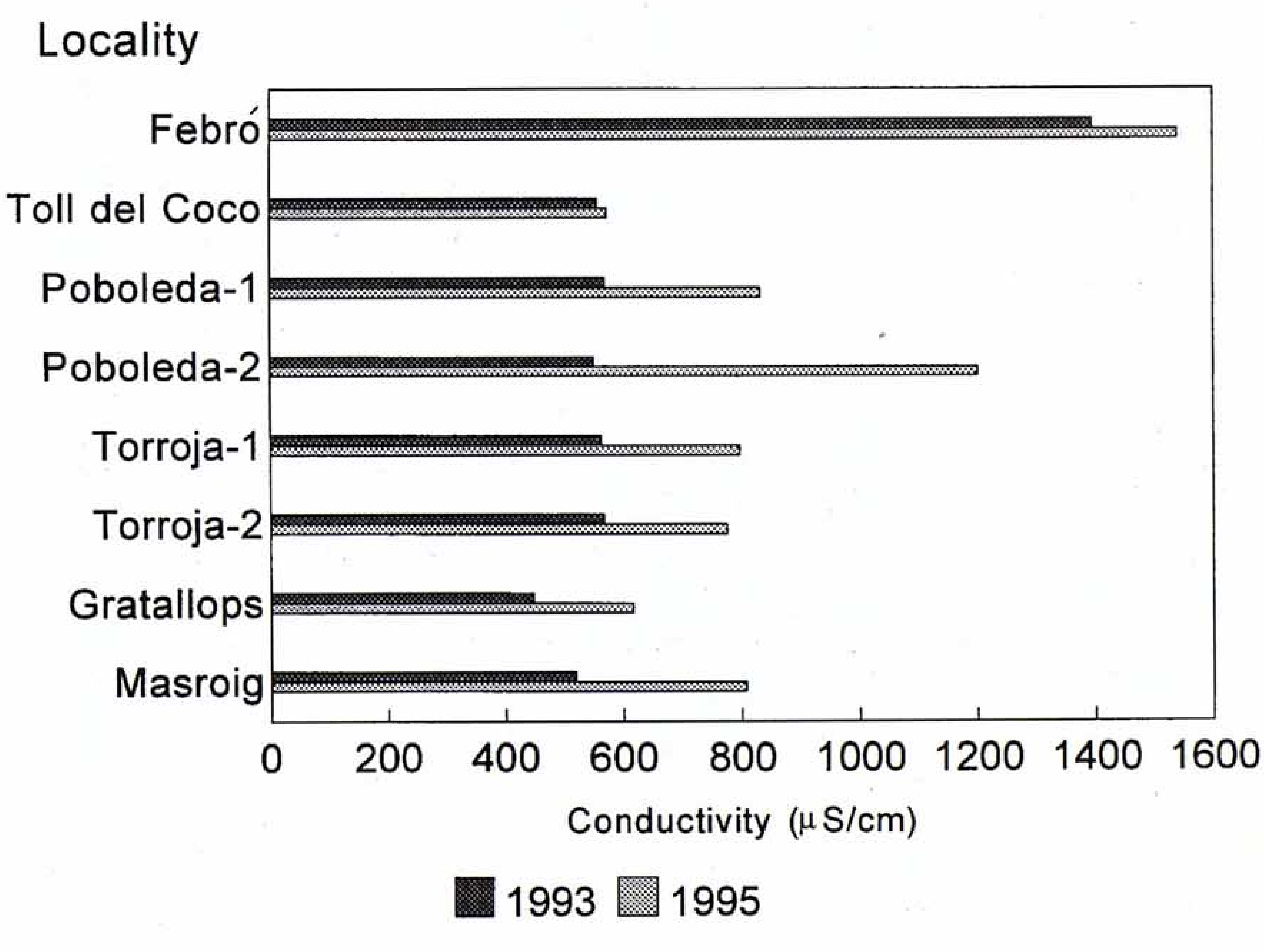


Fig. 2. Water electric conductivity values (µS/cm) in 1993/1995.

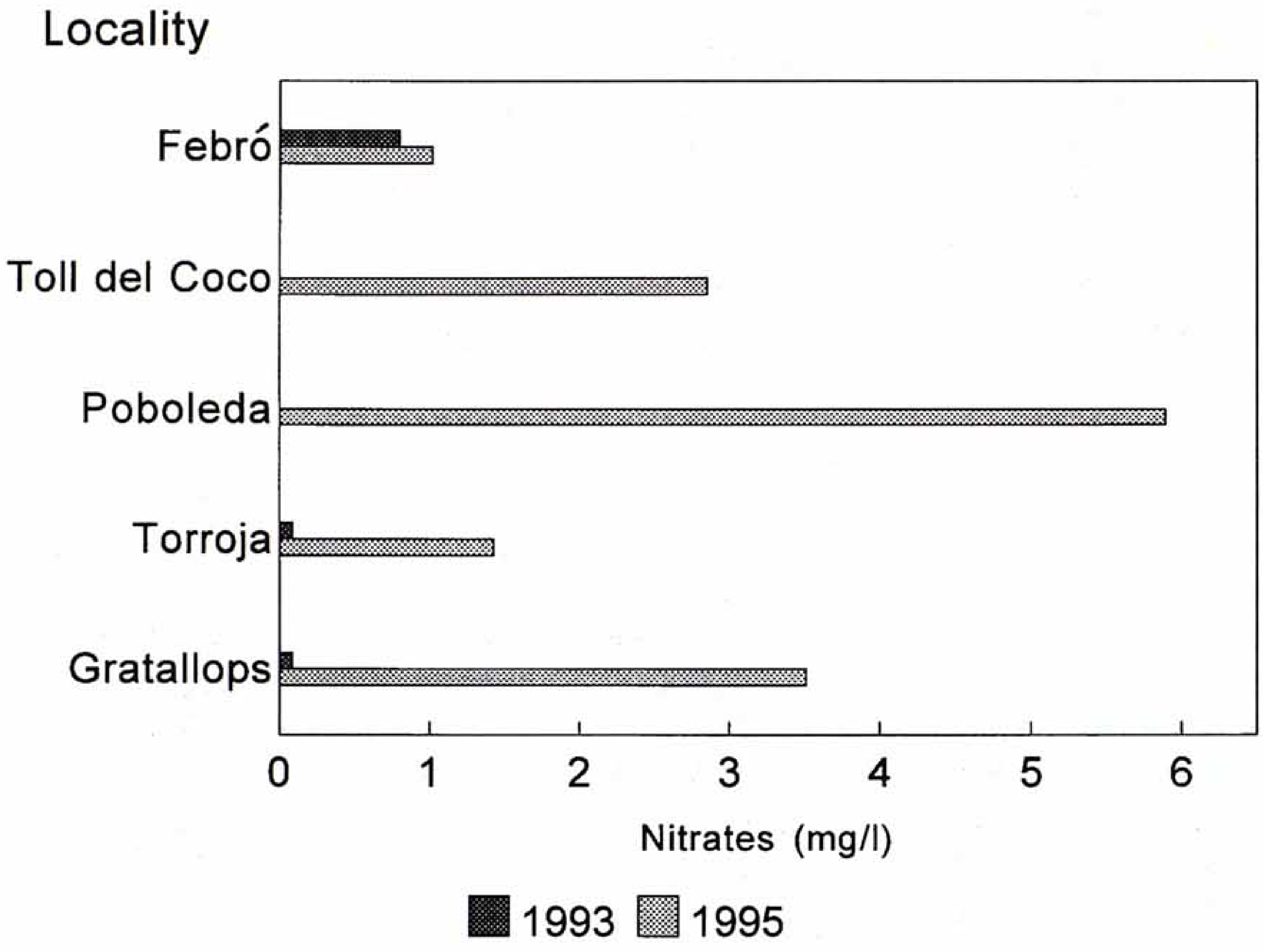


Fig. 3. Water nitrate values (mg/l) in 1993/1995.

A total of 198 taxa were identified (see the appendix), being the diatoms the most diversified group (Figs. 4, 5). Among the flora, some species were interesting by their scarce geographic knowledgement, as *Achnanthes trinodis, Chroodactylon ramosum, Pleurotaenium trabecula, Spirogyra borgeana, Surirella angusta* and *Tetraspora gelatinosa*. However, the taxa number of each algal group (Fig. 6) is different between 1993 and 1995.

Before the flood, the dominant macroalgae were: *Chara vulgaris* var. *longibracteata, C. vulgaris* var. *hispidula* and *C. hispida*, especially at the upper part of the river, being *Cladophora* and *Spirogyra* more important in the lower part of the river. After the flood, all the benthic macroalgae disappeared and after nine months of recolonization some changes have been observed. The river is dominated by dense growings of filamentous green algae. They produce dense assemblages, reaching the 100% of covering (Fig. 7). The major biomass was produced by *Cladophora glomerata* and *Spirogyra* sp. On the other hand, the characean populations were relegated to small areas in the river side or in deeper stagnant water of some localities (Toll del Coco, Poboleda, Masroig). Then, the flood perturbation on the macroalgae assemblages produces a decrease on the characean populations and a clear increase of filamentous green algae. This effect is related to the inrease of nutrients (ENGLE & MELAK, 1993; ELBER & SCHANZ, 1990). However, many of the riparian vegetation dominated by *Salix* sp. pl. disappered at all,

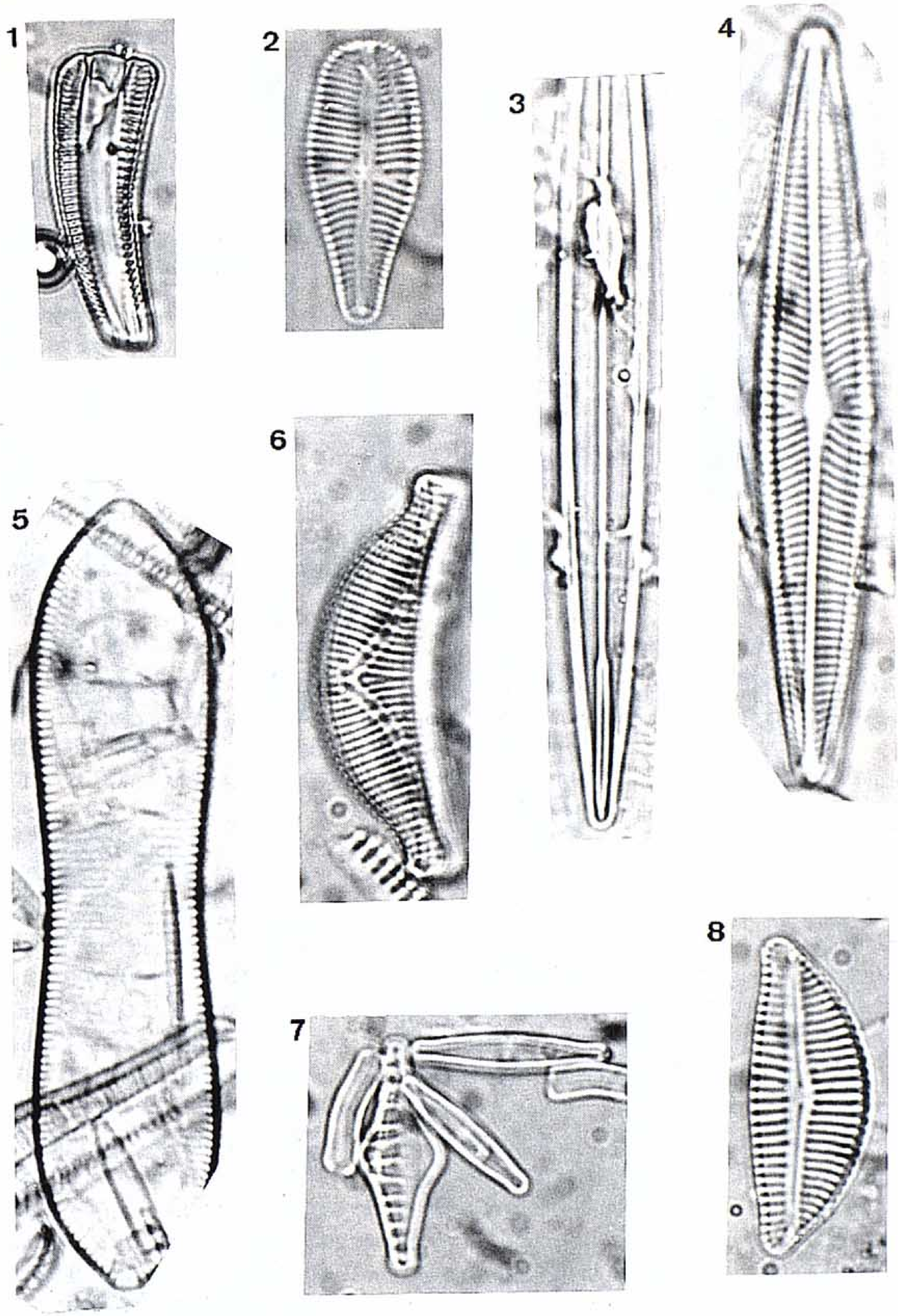


Fig. 4. 1, *Rhoicosphenia abbreviata* Lange-Bertalot; 2, *Gomphonema truncatum* Ehrenberg; 3, *Amphipleura pellucida* (Kützing) Kützing; 4, *Navicula lanceolata* (Agardh) W. Smith; 5, *Cymatopleura solea* var. *solea* (Bréb.) W. Smith; 6, *Epithemia turgida* (Ehrenberg) Kützing; 7, *Nitzschia sinuata* Grunow and some frustules of *Achnanthes minutissima* Kützing; 8, *Cymbella ventricosa* Kützing.

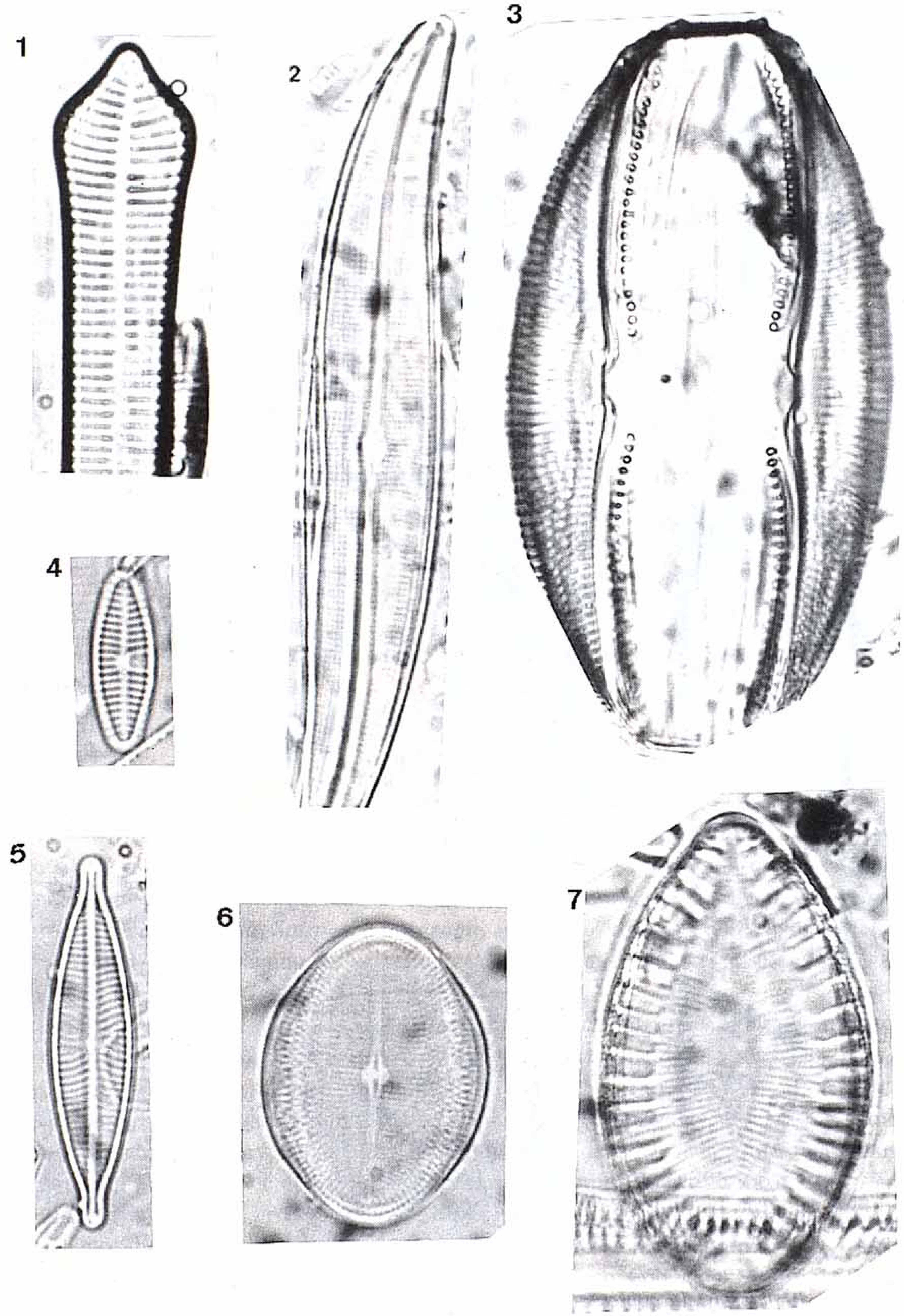


Fig. 5. 1, *Fragilaria dilatata* (Bréb.) Lange-Bertalot; 2, *Gyrosigma acuminatum* (Kützing) Rabenhorst; 3, *Amphora ovalis* (Kützing) Kützing; 4, *Achnanthes lanceolata* (Bréb.) Grunow; 5, *Navicula cryptocephala* Kützing; 6, *Cocconeis pediculus* Ehrenberg; 7, *Surirella ovata* Kützing.

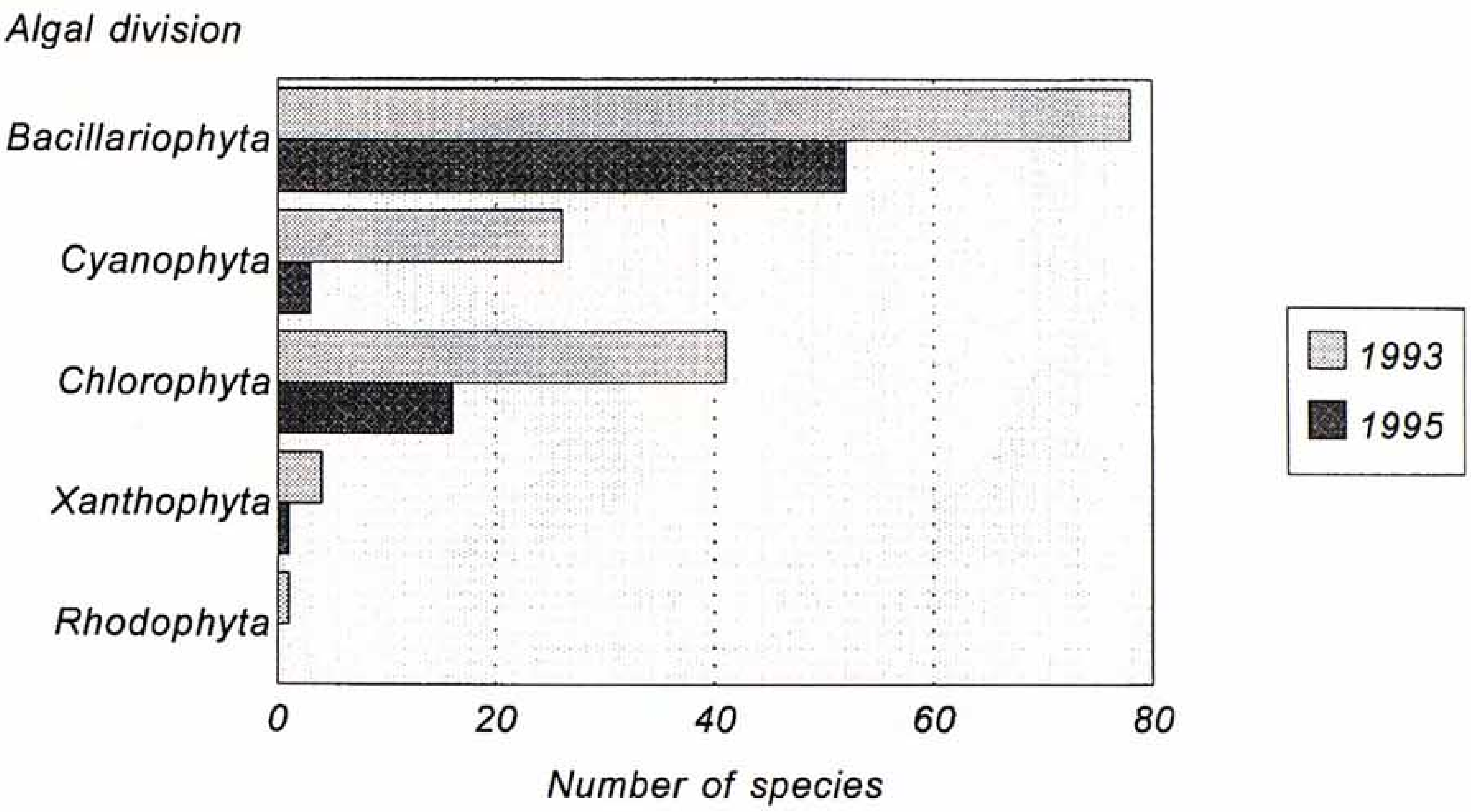
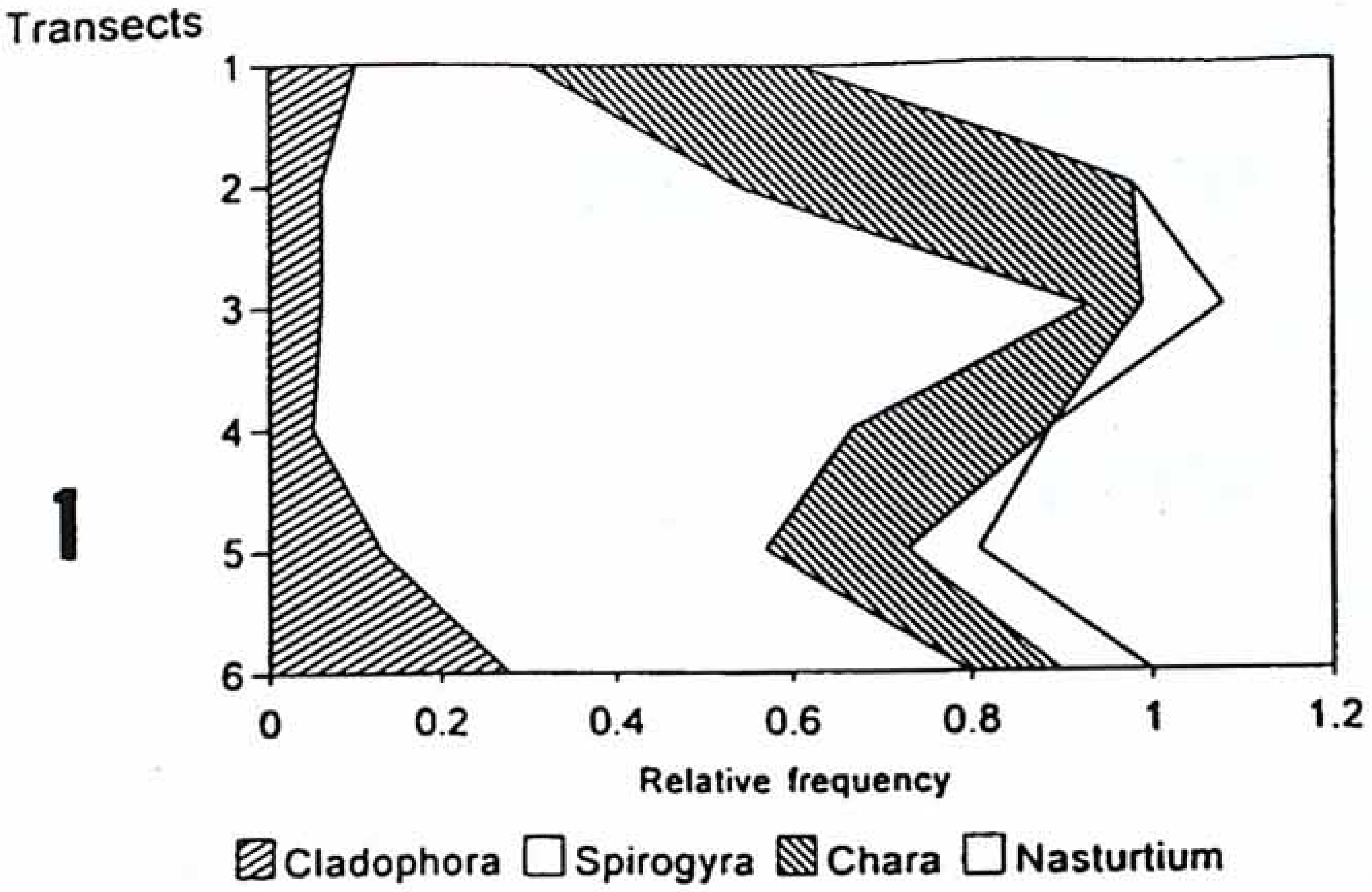


Fig. 6. Algal flora of the Siurana river 1993/1995.

and all the river bed becomes much better iluminated. This environmental changes, with better light intensity and more nutrients are very advantageous for the intense growth of filamentous green algae as *Cladophora* and *Spirogyra*.

The diatom assemblages before the flood were well structurated. In this case, the diversity index was relatively high (H'=1.8-3.7 bits) in all sampling points (Fig. 8). Many species were relatively abundant, such as: *Achnanthes affinis, Achnanthes flexella, Cymbella perpusilla, Denticula tenuis, Diatoma vulgare, Fragilaria capucina* var. *rumpens*, var. *vaucheriae* and var. *mesolepta, Fragilaria intermedia, Melosira varians, Navicula lanceolata and Nitzschia palea*. On the other hand, the diversity index after the flood was smaller (H'=0.3-2.1 bits). Mainly, the diatom populations were formed by many species but very few of them were highly abundant, such as: *Achnanthes minutissima, Cocconeis pediculus, Epithemia sorex, Fragilaria ulna* and *Rhopalodia gibba*. This data indicates that in nine months many diatom species were present again and the biomass of populations were almost the same. However, the structure of the community is not yet restored, being the r-strategists species the most abundant. This dynamics is not the same described by the phytoplankton and the diatom population changes after a flood. In the case of the lakes or reservoirs, there is a dilution of the diatom population and a consequent decline of the total phytoplankton assemblages (ANTOINE, 1995). In our case, the flood produces a mechanical transport which strongly disturbs the diatom assemblages. After nine months, these diatom communities do not reached the diversity index values which were observed before the flood.


Transects
1
2
3
4
5
6
0
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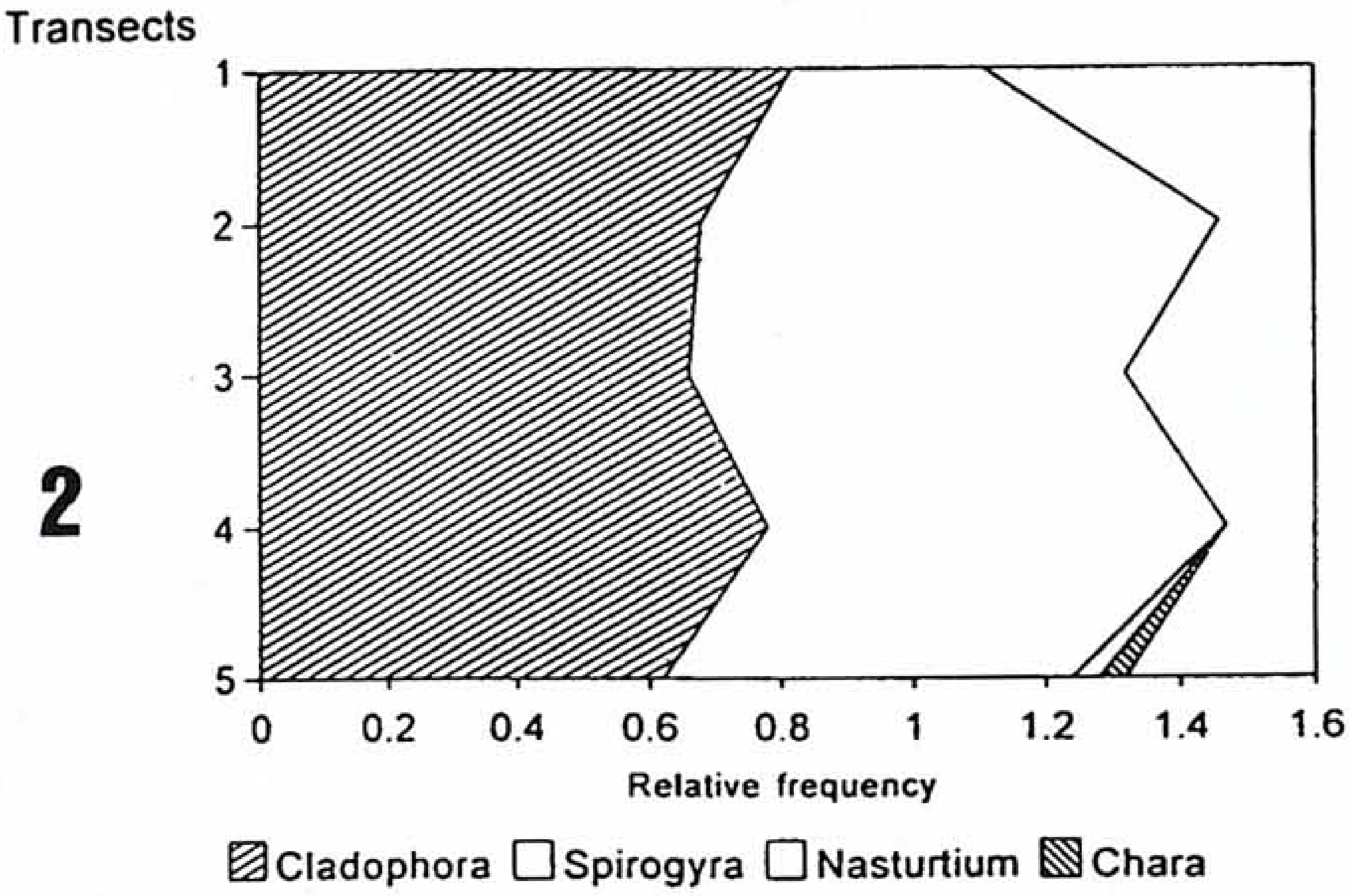
1
1.2
Relative frequency
Cladophora
Spirogyra
Chara
Nasturtium

1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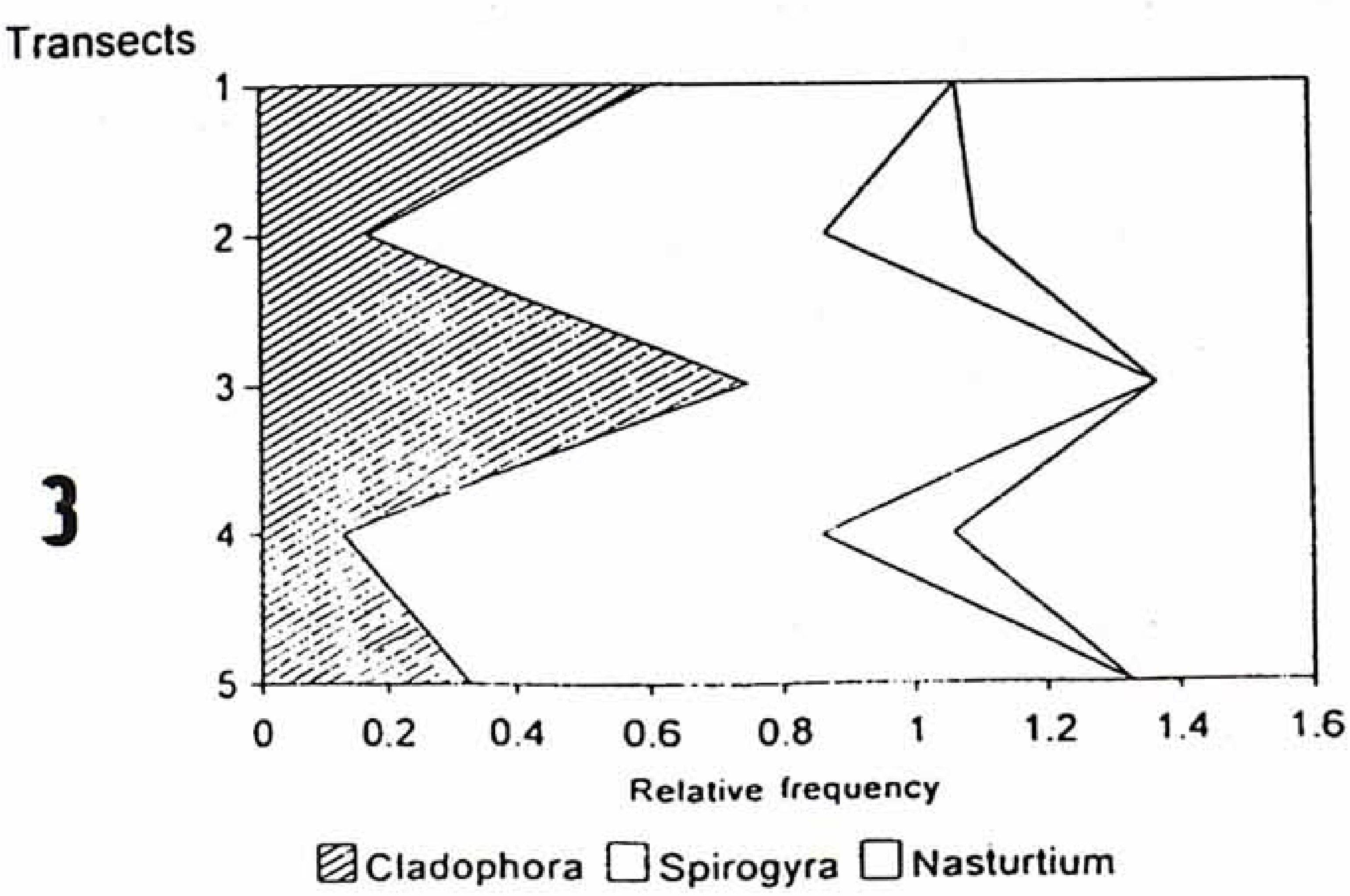
Cladophora
Spirogyra
Nasturtium
Chara

2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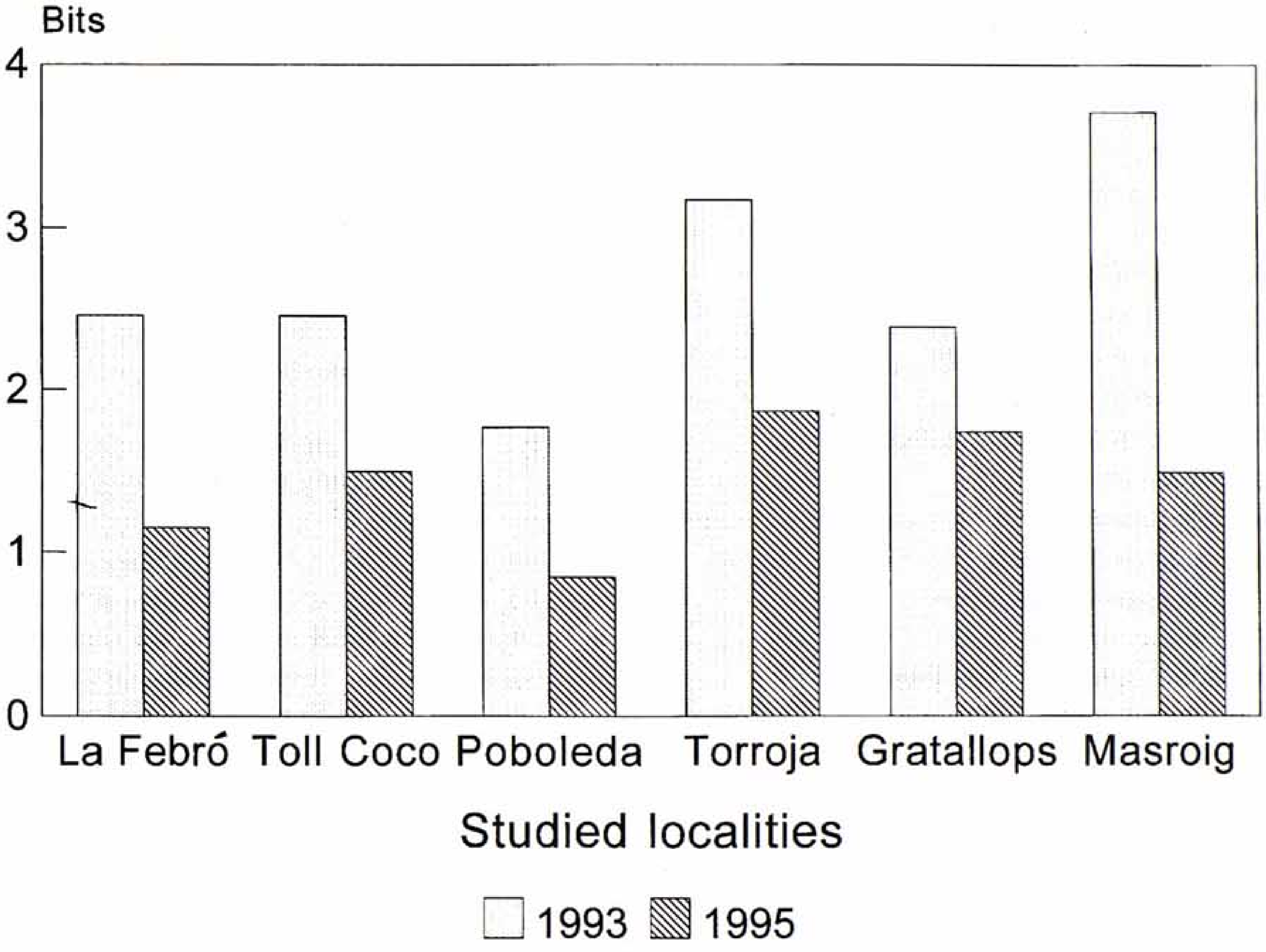

Fig. 8. Diatom diversity index in the studied localities 1993/1995.

Appendix

Algal flora and sampling points: *La Febró: 1993 - 1, 1995 - 2; *Toll de la Palla: 1993 - 3, 1995 (not sampled); *Toll del Coco: 1993 - 4, 1995 - 5; *Poboleda: 1993 - 6, 1995 - 7; *Torroja: 1993 - 8, 1995 - 9; *Gratallops: 1993 - 10, 1995 - 11: *Masroig: 1993 - 12, 1995 - 13; *Garcia: 1993 - 14, 1995 (dry); *Siurana Reservoir: 1993 - 15, 1995 (not sampled).

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Achnanthes affinis Grunow	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
A. flexella (Kützing) Brun	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–
A. lanceolata (Bréb.) Grunow	–	–	+	+	–	+	–	–	+	–	+	+	+	–	–
var. *rostrata* (Oest.) Lange-Bertalot	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
A. minutissima Kützing	+	+	+	+	+	+	+	+	+	+	+	–	+	–	–
A. rupestoides Hohn	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
A. trinodis (W. Smith) Grunow	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–

Fig. 7. Relative frequency of macroalgae and macrophytes in some sampling points in 1995. 1, Toll del Coco; 2, Torroja-2; 3, Torroja-1.

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Amphipleura pellucida (Kützing) Kützing	+	–	+	–	–	–	–	+	–	–	–	–	+	–	–
Amphora pediculus (Kützing) Grunow	–	–	+	+	–	–	–	–	–	–	–	–	–	+	–
A. ovalis (Kützing) Kützing	–	–	–	+	–	+	+	+	–	+	+	+	+	–	–
A. veneta Kützing	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Anabaena aequalis Borge	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
A. cylindrica Lemm.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
A. constricta (Szafer) Geitler	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Anabaena sp.	–	–	+	–	–	–	–	–	+	–	–	+	+	–	+
Ankistrodesmus fusiformis Corda	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
A. stipitatus (Chodat) Komarková-Legnerová	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Ankistrodesmus sp.	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Aphanochaete repens A. Braun	–	–	–	+	–	–	–	+	–	+	+	–	–	–	–
Aphanocapsa muscicola (Menegh.) Wille	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Apiocystis brauniana Nägeli	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
Asterionella formosa Hassall	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Binuclearia tectorum (Kützing) Beger	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Bulbochaete sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Caloneis permagna (Bailey) Cleve	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
C. silicula (Ehrenberg) Cleve	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–
Calothrix stellaris Born.	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Calothrix sp.	–	–	–	+	–	–	–	+	–	+	–	–	–	–	–
Campylodiscus hibernicus Ehrenberg	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Ceratium hirundinella (Müller) Schrank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Chara hispida L.	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–
C. vulgaris var. *hispidula* (A. Br.) R.D. Wood	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–
var. *longibracteata* (Küt.) Grov. & Bull.	+	+	–	–	–	–	–	+	+	–	–	+	–	–	–
Characidiopsis elephantipes Ettl	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Chroococcus minutus (Kützing) Nägeli	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
C. turgidus (Kützing) Nägeli	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Chroodactylon ramosum (Thw.) Hansg.	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Chlorella sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Cladophora glomerata (L.) Kützing	–	–	–	+	+	–	+	+	+	+	+	+	+	+	–
Closterium moniliferum (Bory) Ehrenberg	–	–	–	–	–	–	+	+	+	+	–	+	–	–	–
C. parvulum Nägeli	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
C. strigosum Bréb.	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Closterium sp.	–	–	+	–	+	–	–	+	–	+	–	+	–	–	–
Cocconeis pediculus Ehrenberg	–	+	+	+	+	+	+	+	+	+	+	+	–	+	–
Cocconeis placentula Ehrenberg	–	–	+	+	+	+	+	+	+	+	+	+	+	–	–
Coelosphaerium kuetzingianum Nägeli	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Coenocystis planctonica Kors.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Coleochaete scutata Bréb.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Cosmarium botrytis (Meneghini) Ralfs	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–
C. granatum (Bréb.) Ralfs	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
C. margaritatum (Lund) Roy & Bisset	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–
Cosmarium sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Cryptomonas sp.	–	–	–	–	+	–	–	–	+	–	–	–	–	–	–
Cyclotella kuetzingiana Kützing	–	+	+	–	–	–	–	+	+	–	–	–	–	–	–
C. meneghiniana Kützing	–	–	–	–	–	–	+	–	+	–	–	+	–	+	+
Cymatopleura elliptica (Bréb.) W. Smith	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
C. solea var. *solea* (Bréb) W. Smith	–	–	–	–	–	–	+	–	–	–	–	+	–	–	–
Cymbella amphicephala Nägeli	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–
C. aspera (Ehrenberg) Peragallo	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–
C. cymbiformis Agardh	+	+	+	+	–	–	–	+	+	+	–	+	–	+	–
C. helvetica Kützing	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
C. lanceolata (Ehrenberg) Kirchnner	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
C. leptoceros (Ehrenberg) Kützing	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
C. microcephala Grunow	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. parva W. Smith	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–
C. perpusilla Cleve-Euler	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
var. *striatior* (Kalbe) Krammer	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–
C. tumidula var. *tumidula* Grunow	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. ventricosa Kützing	+	–	+	+	+	+	+	+	+	+	+	+	–	+	–
Denticula kuetzingii Grunow	–	+	+	+	–	–	–	+	–	–	–	–	–	–	–
D. tenuis Kützing	–	–	+	+	–	–	+	+	–	–	–	–	–	–	–
Diatoma elongatum (Lyngbye) Agardh	–	–	–	+	+	–	+	–	+	+	–	+	–	+	–
D. vulgaris Bory	–	–	+	+	–	–	–	–	–	+	–	+	–	+	–
Dinobryon sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Diploneis oblongella (Nägeli) Cleve-Euler	–	–	–	+	–	+	+	+	–	–	–	–	+	–	–
D. ovalis (Hilse) Cleve	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Epithemia adnata (Kützing) Bréb.	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
E. argus (Ehrenberg) Kützing	–	–	–	+	–	–	–	–	–	+	–	+	–	–	–
E. sorex Kützing	–	–	+	–	–	–	–	+	+	+	+	+	–	–	–
E. turgida (Ehrenberg) Kützing	–	–	–	–	–	–	–	+	–	+	+	–	+	+	–
Euglena sp.	–	–	–	+	–	–	–	+	–	–	–	–	–	–	+
Eunotia arcus Ehrenberg	–	–	+	–	–	–	–	+	+	–	–	–	–	–	–

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
E. pectinalis (Dillwyn) Rabenhorst	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Fragilaria brevistriata Grunow	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. capucina Desmazières	–	–	+	–	–	+	–	–	–	+	–	–	–	–	–
var. *mesolepta* (Rabenh.) Rabenhorst	–	–	+	–	–	–	–	+	–	+	–	–	–	–	–
var. *rumpens* (Kütz.) Lange-Bertalot	–	–	+	–	–	–	–	+	+	–	–	+	–	+	–
var. *vaucheriae* (Kütz.) Lange-Bertalot	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–
F. construens (Ehrenberg) Grunow	–	–	–	+	–	+	–	–	–	–	–	+	–	–	–
F. crotonensis Kitton	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+
F. dilatata (Bréb.) Lange Bertalot	–	–	+	+	–	–	–	+	–	+	–	–	–	–	–
F. intermedia Grunow	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–
F. ulna (Kützing) Lange-Bertalot	–	–	+	+	+	+	+	+	+	+	–	+	+	+	–
var. *acus* (Kützing) Lange-Bertalot	–	–	–	+	+	+	+	+	+	+	+	–	+	–	–
Fragilaria sp.	–	–	–	–	–	–	–	+	–	–	–	–	–	+	–
Frustulia vulgaris (Thwaites) De Toni	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Geminella interrupta (Turpin) Lagerheim	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–
Gleocapsa minor Kützing	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Gleocapsa muralis Kützing	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
G. nigrescens Kützing	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Gomphonema acuminatum Ehrenberg	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
G. angustatum (Kützing) Rabenhorst	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–
G. augur Ehrenberg	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
var. *augur* Ehrenberg	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
G. capitatum Ehrenberg	–	–	–	–	+	–	–	–	+	–	–	–	–	–	–
G. constrictum Ehrenberg	–	–	+	+	–	–	–	+	–	+	+	+	–	–	–
Gomphonema parvulum (Kützing) Kützing	+	–	+	+	+	+	+	–	+	+	–	–	+	+	–
G. truncatum Ehrenberg	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Gonium pectorale O.F. Müller	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Gymnodinium sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	+
Gyrosigma acuminatum (Kütz.) Rabenhorst	–	–	+	–	–	+	+	–	–	–	–	–	–	–	–
Hantzschia amphioxys (Ehrenb.) Grunow	–	–	–	–	–	+	–	–	–	–	–	+	–	+	–
Homeothrix balearica (Born. & Flah.) Lemm.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Lyngbya epiphytica Wille	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
L. perelegans Lemm.	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–
Lyngbya sp.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Mastogloia smithii *var. amphicephala* Grunow	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Melosira varians Agardh	–	–	+	–	–	+	+	–	+	+	–	+	–	+	–

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Merismopedia punctata Meyen	–	–	+	+	+	–	–	+	–	–	–	+	–	–	–
M. tenuissima Lemm.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Mesotaenium sp.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
Microspora pachyderma (Wille) Lagerheim	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Monoraphidium arcuatum (Kors.) Hind.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Mougeotia sp.	–	–	+	+	–	–	–	+	–	+	+	+	–	–	–
Navicula atomus var. *excelsa* Lange-Bert.	–	–	–	+	–	–	–	–	+	+	+	+	–	–	–
N. cryptocephala Kützing	–	–	+	+	–	–	+	+	+	+	+	+	+	+	–
N. cuspidata (Kützing) Kützing	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
N. gracilis Ehrenberg	–	–	–	+	–	+	–	–	+	–	–	+	–	+	–
N. lanceolata (Agardh) Ehrenberg	+	–	+	+	–	+	+	+	+	+	–	–	+	–	–
N. trivialis Lange-Bertalot	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–
N. veneta Kützing	–	–	+	–	–	–	+	–	–	–	–	–	+	–	–
Nitzschia acicularis (Kützing) W. Smith	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
N. dissipata (Kützing) Grunow	+	–	+	+	–	+	+	+	–	–	–	–	–	–	–
N. gracilis Hantzsch	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
N. linearis (Agardh) W. Smith	–	–	+	+	–	+	–	+	+	+	–	+	+	–	–
N. palea (Kützing) W. Smith	–	–	–	–	+	–	+	+	–	–	–	–	–	+	–
N. pusilla Grunow	–	–	+	–	–	–	+	+	+	+	–	+	+	–	–
N. romana Grunow	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
N. sinuata Grunow	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–
N. vermicularis (Kützing) Hantzsch	–	–	+	+	–	–	–	+	–	+	+	–	–	–	–
Nostoc sp.	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
N. paludosum Kützing	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
N. punctiforme (Kützing) Hariot	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–
N. verrucosum Vaucher	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
Oedogonium sp.	–	–	–	+	+	–	–	+	–	+	–	+	–	–	–
Oocystis nodulosa W. & G.S. West	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Oocystis sp.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Ophiocytium arbuscula Näg.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Oscillatoria amoena Gom.	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
O. bornetii Zukal	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
O. cf. *pristleyi* W. & G.S. West	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
O. sancta (Kützing) Gom.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Oscillatoria sp.	+	–	+	–	–	–	–	+	–	+	–	–	–	–	–
Pandorina morum (Müller) Bory	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Pediastrum boryanum (Turp.) Menegh.	–	–	+	–	–	–	–	+	+	+	–	+	–	+	+
var. *brevicorne* A. Br.	–	–	+	–	–	–	–	+	–	–	–	+	–	–	–
P. tetras (Ehrenber) Ralfs	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Peridinium sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Phormidium ambiguum Gom.	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–
Phormidium sp.	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Pinnularia brebissonii (Kützing) Rabenhorst	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–

Species Sampling point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pinnularia gibba Ehrenberg	–	–	+	–	–	–	–	+	+	–	–	–	–	–	–
P. microstauron (Ehrenberg) Cleve	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Pleurotaenium trabecula (Ehrenberg) Nägeli	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Rhoicosphenia abbreviata Lange-Bertalot	–	–	–	+	–	–	–	–	–	+	–	+	–	+	–
Rhopalodia gibba (Ehrenberg) O. Müller	–	–	+	–	–	–	+	+	+	+	+	+	+	+	–
Rivularia biasolettiana Menegh.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Scenedesmus acutus var. *acutus* Meyen	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
S. brevispina (G.M. Smith) Chod.	–	–	–	–	–	–	–	+	–	–	–	+	–	–	–
S. disciformis (Cjod.) Fott & Komarek	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
S. ecornis var. *ecornis* (Ehrenberg) Chod.	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–
S. ecornis var. *polymorphus* Chod.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
S. obliquus (Turp.) Kützing	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
S. obtusiusculus Chod.	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
S. ovalternus Chod.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
S. quadrispina Chod.	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
S. sempervirens Chod.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Scenedesmus sp.	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–
Scytonema myochrous (Dillw.) Agardh	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
S. obscurum Hansg.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Spirogyra borgeana Trans.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Spirogyra sp.	–	–	+	+	+	–	+	–	+	–	+	–	–	–	–
Stigeoclonium tenue (C.A. Ag.) Kützing	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
S. ovalis Bréb.	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
S. ovata Kützing	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–
Tetraedron minimum (A. Br.) Hansg.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Tetraselmis sp.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Tetraspora gelatinosa (Wahlb.) C.A. Ag.	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Tolypothrix distorta var. *penicillata* Lemm.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Tribonema aequale Pascher	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Tribonema sp.	–	–	–	–	–	–	–	+	–	+	–	+	–	–	+
Ulothrix subconstricta G.S. West	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
U. tenerrima (Kützing) Kützing	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–
Ulothrix sp.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Uronema sp.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
Vaucheria sp.	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Zygnema sp.	–	–	+	+	+	–	–	+	–	+	+	–	+	–	–

References

ABOAL, M. (1987). *Flora algal epicontinental de la cuenca del río Segura, S.E. de España*. Doctoral Thesis. Univ.of Murcia.

ANTOINE, S. E. (1995). Planktonic diatom population dynamics of the Al-Hammara Marsh Area, South Iraq. *Limnologica*, **25**: 81-85.

CAMBRA, J. (1989). Freshwater algae from the cape of Creus peninsula (N.E. of Spain). *Nova Hedwigia*, **49**: 281-321.

— & M. Aboal (1992). Filamentous green algae of Spain: Distribution and ecology. *Limnética*, **8**: 213-220.

DOKULIL, M. T. (1993). Long-term nutrient loading and biological response in a flood-water reservoir (Neue Donau) in Vienna, Austria. *Water Sci. Technol.,* **28**: 55-63.

ELBER, F. & F. SCHANZ (1990). The influence of a flood event on phytoplankton succession. *Aquatic Sc.,* **52**: 330-344.

ENGLE, D. L. & J. M. MELACK (1993). Consequences of riverine flooding for seston and the periphyton of floating meadows in an Amazon floodplain lake. *Limnol. Oceanogr.* **38**: 1500-1520.

POWER, M.E. & A. J. STEWART (1987). Disturbance and recovery of an algal assemblage following flooding in an Oklahoma stream. *Am. Midl. Nat.* **117**: 333-345.

SABATER, S. (1987). *Estudi de les poblacions d'algues del riu Ter*. Doctoral Thesis. Univ. of Barcelona.

SCRIMGEOUR, G. J. & M. J. WINTERBOURN (1989). Effects of floods on epilithon and benthic macroinvertebrate populations in an unstable New Zealand river. *Hydrobiologia* **171**: 33-44.

VAN DEN BRINK, F. W. B., VAN DER VELDE, G. & J. A. VAN DE KRAATS (1994). Impact of hydrology and water chemistry on floodplain lake communities along the lower Rhine and Meuse. *Water Sci. Technol.* **29**: 3.

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