CHAPTER VII: ABOUT ENVIRONMENTAL STATE OF THE ALBANIAN RIVERS UNDER THE STUDY *(an English summary)*

7.1. Aims of the study

Albania is rich in water resources (Staners and Bourdeaux, 1995) which continue to be endangered. Cullaj *et al.* (2004) in a review paper summarize the current situation regarding Albanian natural aquatic ecosystems, addressing also their environmental problems caused by human impact. In western Adriatic lowland areas, where most of the rivers run (fig. 1-2), the most inhabited and industrial centers, i.e. Tirana capital, Elbasani, Berati, Fieri, intense agriculture and tourism exist, as it is shown in figures 1-2. Urban wastewater and other industrial wastes are collected directly by canals in rivers and transported to the sea. Significantly, it is here that knowledge on water quality continues to be scarce. A hydrologic map with the different sources of pollution is shown in figure 4-1, drawn up with some modifications after UNEP (2000).

The control of water quality of the most important and most impacted rivers of Western Coastal Lowland (fig. 4-1; UNEP, 2000) (Mati and Fani, Ishmi, Lana and Tirana, Shkumbini, Semani, Osumi and Gjanica) was carried on during the period May 2002 – March 2004. According to the environmental assessment made by UNEP (2000), the nine river courses selected were the most polluted ones mainly as result of the former mining and industrial activities that existed during the former communist regime (before year 1991). Therefore, the study started to assess heavy metals (Pb, Cd, Cu, Zn, Mn, Fe, Cr, Ni and Hg) in waters, sediments and algae. Beside this, additional parameters were measured, like conductivity, dissolved matter, pH, temperature, oxygen, suspended solids, nitrates, nitrites, ammonium and phosphates. Moreover, the microscopic algae (diatoms - *Bacillariophyta*) were examined, and the trophic state was calculated from these data. A preliminary report has already been published by Cullaj *et al.* (2003).

The study was a cooperation between the sections of Analytical Chemistry, Botany, Tirana University, Department of Agronomy, Tirana Agricultural University, and Institute of Plant Biology, Institute of Environmental Sciences and Limnological Station, University of Zurich, Switzerland, as it is explained in the first paragraph of chapter III, and as it can be shown also in the photos of the plates 3-1 to 3-3. It was financially supported by the Swiss National Foundation for Research (SNSF), within the common project SCOPES (no. 7ALJ065583).

7.2. Working methodology

Sampling: Field trips in Albania were time consuming or at rainy and stormy days even impossible due to flooding of the roads. Furthermore, the laboratory infrastructure did not allow frequent sampling. These facts were combined with the goal to obtain the most accurate information about these rivers. Therefore only a restricted number of about 13 (14) sampling stations (fig. 4-1; tables 4-1 to 4-4) were chosen with sampling intervals of between 3 to 5 months.

The rivers, the stations and their respective codes were the following: Mati (Shkopeti: Ma1, Bushkashi: Ma1'; Miloti: Ma3) with the effluent Fani (Rubiku: Ma2); Ishmi (Fushe Kruja: Is3) with the effluents Tirana (Brari: Is1) and Lana (Kashari: Is2); Shkumbini (Labinoti: Sh1; Paperi: Sh2; Rrogozhina: Sh3); Semani (Mbrostari: Se4) with its effluents Gjanica (Fieri: Se3) and Osumi (Berati: Se1; Uravajgurore: Se2). Plates 4-1 to 4-10 show views form the rivers, the stations, the water quality or local disturbancies. The stations represent different levels of human impact, where the first one was considered less polluted. Seven trips were carried out between May 2002 and March 2004 (plates 4-1 to 4-4).

Physico-chemical parameters: conductivity, pH, temperature, suspended matter, nitrites, nitrates, ammonium and phosphates were analyzed after Hach (2001) and APHA (1985). Physico-chemical methods of analysis are summarized in table 4-5.

Nutrients: Nitrogen (NO_2-N, NO_3-N, NH_4-N) and phosphorus (PO_4-P) in water were measured (table 4-5) using UV-VIS spectrophotometry, following the standard methods recommended by APHA (1985).

Heavy metals: Pb, Cd, Cu, Zn, Mn, Fe, Cr, Ni and Hg were also analyzed and quantified in water, sediments and biota (thalli of *Cladophora* or of aquatic grasses). Heavy metals in all samples were analyzed by Atomic Absorption Spectrometry (AAS) using a Varian SpectrAA 10+ instrument. Water samples were analyzed using flame (Fe, Mn, Zn) and graphite furnace techniques (Cu, Pb, Cd, Cr, Ni) and cold vapor technique (Hg), mainly after Haswell (1991), Price (1985) and Welz (1985). Analysis of heavy metals in macrophyte algae and aquatic grass samples were carried out using the same absorption atomic techniques, whereas the analysis of sediment samples were carried out mainly by flame AAS. Digestion of plant samples and sediments were implemented by wet mineralisation procedures according to Haswell (1991).

Biological investigation: Diatom communities, growing on thalli of *Cladophora*, on stones or other substrates and even in clay, were studied by light microscopy. Cleaning of diatom frustules was done boiling the material, first with HCl*cc* and then with H_2SO_4*cc*, as described by Krammer & Lange-Bertalot (1986-2001). Microscopic slides were prepared using Naphrax (index 1,69) and examined using a LEICA DML microscope (objective 63x PL APO). Determinations based on Krammer & Lange-Bertalot (1986-2001) keys. Former samples, permanent slides and photos were deposited in Section of Botany, Tirana University.

Trophic index: The trophic index for the diatoms (TI_{DIA}) was calculated using the formula (2.2) of Zelinka & Marvan (1961). The relative classes were taken using the classification made by Rott *et al*. (1999; and tab. 2-5). The diversity index (2.3) was calculated (Shannon

& Weaver, 1949). To obtain statistically reliable results(95 %), more than 400 valves were counted.

7.3. Results and discussion: chemistry

Not only in rivers Lana, Ishmi (Tirana region) and Gjanica (Fieri), but also in Mati, downstream Shkumbini (Elbasani, Rrogozhina) and Osumi (Berati) **nutrients** were higher than the EC guide values for *Cyprinid* waters, fixed in the EC Directive 78/659 of quality fresh waters (tab. 5-11 to 5-15; fig. 5-15 to 5-22); i.e. the nitrite and ammonium values reached up to 4,0 mg NO_2/l in Lana (November 03), up to 42,1 mg NH_4/l in Lana (November 02). The high level of ammonium and nitrites indicates reducing conditions in Lana and Ishmi due to a high organic load. It is a direct consequence of untreated liquid wastes from Tirana, Elbasani, Rrogozhina, Berati, Kucova, and Fieri towns.

The EC guide values for nitrites for high quality fresh water are <0.01 mg/l (*Salmonid* waters) and <0.03 mg/l (*Cyprinid* waters) respectively; the EC guide and the mandatory values for total ammonia are <0.04 and <1 mg/l (*Salmonid* waters), <0.2 and 1 (4) mg/l (*Cyprinid* waters), respectively (BMZ, 1995; table 2-2). We can see from the figures 5-18 and 5-19 that not only in rivers Lana, Ishmi, and Gjanica, but also in Mati, downstream Shkumbini (Sh2) and Osumi (Se1) the respective values were several fold higher. Nitrates in Shkumbini (Sh3, November 02) exceeded the EC guide values of 25 mg/l given for surface water. Both nitrogen and phosphorus are main nutrients which strongly influence the growth of photosynthetic organisms in the rivers (cyanobacteria and algae). Furthermore the concentrations of O_2 in Lana and Ishmi were below the BE limits (fig. 5-11 to 5-13). In these rivers an unpleasant smell from the water was present, indicating a high content of decaying organic compounds or chemicals such as phenols. The bacterial content was also very high. Lastly, solid waste deposited along the riverbanks, beside its harmful effects, changed the scenery of the fluvial landscape, decreasing its attractiveness.

High contents of **suspended solids** (SS) were found in Semani, Ishmi and Shkumbini (tab. 5-8; fig. 5-9). Except for Mati (Ma1), SS often exceeded by several fold the value of 25 mg/l, the EC Directive 78/659 of the third class limit on the quality of fresh water needing protection or improvement in order to support fish life (BMZ, 1995; tab. 2-2). This situation was observed not only during the wet season in autumn, but also in late spring at low water level. It shows the high rates of soil erosion, which were a direct consequence of the large deforestations in the respective watershed areas, which leads to massive depositions of solid material in the coastal areas, especially in the coastal lagoons. This also results in unfavorable conditions for the aquatic life in rivers and at the marine coast, as well as for the related activities, such as agriculture, fishing and tourism.

7.4. Results and discussion: heavy metals

The quantity of **heavy metals in water** (tab. 5-20- 5-23), sediments (tab. 5-25 to 5-28) or in biota (tab. 5-30 to 5-36) was unexpectedly low; therefore, the effect of heavy metals on the water quality seems to be negligible today, as a consequence of a low impact from the abandoned mining industry. However, after a general view based in the classification made for Norwegian waters (tab. 2-3; Bratli, 2000), most of the samples belong to the II-nd and III-d class. The highest values were measured in Lana, Ishmi and Gjanica (Is2, Is3 and Se3), which belong to class IV (tab. 5-24). Relatively high values were measured for Pb, where all stations belong to classes III or IV; for Cd all stations belong even to class V. The main source of these high values of Pb and Cd is probably of urban origin.

The accumulation of **heavy metals in aquatic biota** is a suitable tool for monitoring the average load. However, except for *Cladophora glomerata*, macroscopic algae were not found during the whole year along the rivers in the coastal lowland. This may be due to the different seasons for sampling, examplified by the high biomass of *Cladophora* usually present from May to July. The turbidity was high due to a increased content in solid matter and, in some cases, it even originated from a high organic pollution, i.e. in rivers Ishmi, Lana, Gjanica and

Osumi. This may also have suppressed algal growth. Therefore, metal accumulation by macroscopic algae could not be used to measure the average annual fluctuations of heavy metals in the rivers of the western lowland region.

7.5. Results and discussion: biological approach

More than 275 species of **diatoms** were determined in total, with only 15 belonging to centrics (table 5-44). The number of species in each expedition varied from 103 species (November 03) to 169 (May 03) (tab. 5-36; fig. 5-40). However, the average number of species in each sample varied between 25 and 45 (tables 5-37 to 5-43). Mati River in its upstream part (Ma1) was the richest in species, with more than 60 species in November 02, May, July and September 03. The poorest stations in species were Lana (Is2) and Ishmi (Is3). In Lana River, only 8 species were found in July 03 and 10 species in September 03. In plates 5-1 to 5-13 about 179 microscopic photos are reported, which cover about 118 species of diatoms, common in riverine samples.

The **diversity index** values (tab. 5-36; fig. 5-41) lay mainly between 2.5 and 3.5 and were relatively higher (more than 3,5) in Shkumbini (mainly in Paperi and Rrogozhina), and in Osumi and Semani. In Semani (Se4) the diversity index reached at 4.53 (May 02) and 4.30 in Shkumbini (Paperi). The lowest diversity values were found at Lana and Ishmi stations, 0.32 and 0.91 in July 03, and 0.38 and 0.89 in September 03, respectively.

Most of the species were common and taxonomically not interesting. However, it is worth mentioning the presence of *Caloneis* sp. nov. (Plate 5-4: fig. 13-15) that was often found in rivers in the less polluted parts as epiphyte over *Cladophora*. It is probably a new species, the taxonomic description will be published elsewhere.

Achnanthes minutissima var. minutissima, Amphora pediculus, Cocconeis pediculus, Diatoma moniliformis, Fragilaria capucina, Gomphonema olivaceum, G. tergestinum, Navicula cryptotenella, Nitzschia palea var. palea, N. dissipata, N. incospicua were the most widespread and the most abundant species (tab. 5-37 to 5-43; plates 5-1 to 5-13). In one small tributary of Mati (Bushkashi river), *A. minutissima* var. *minutissima* dominated up to 72.8 % of the population (May 02). It was also dominant in other stations of Mati (Shkopeti and Miloti) and often found as epiphyte on *Cladophora*. It reached 43% (Ma3, May 02), 52.9% and 88.7% (respectively in Ma1 and Ma3, May 03), 84 % and 61.6 % (respectively in Ma1 and Ma3, September 03). This species was found also abundant in other rivers like in Osumi (37.3%, Uravajgurore, May 02), in Shkumbini (33,8%, Labinoti, July 03), in Tirana River (48.4%, Brari, September 03).

A. minutissima, considered to be a tolerant species (Hofmann, 1994), was found in almost all stations, and during all seasons (tab. 5-37 to 5-43). However, a high density was observed during the warm period, spring and summer, and especially in the less polluted part of the rivers, i.e. in their upstream parts. It was often accompanied with *Cocconeis pediculus* (34% in Is1, May 02; 52% in Se1, May 03), *Gomphonema tergestinum* (until 43.4% in Se2, July 03), *Fragilaria capucina* (until 40.1% in Ma3, July 03). In September, *A. mnutissima* was substituted/accompanied by *A. exilis* (until 42.8% in Ma3, September 03).

The less polluted parts of the rivers during the winter period were inhabited mainly by *Diatoma moniliformis* (tab. 5-37 to 5-43), found in November 02 very dense in Osumi (65.8% in Se1; 86.5% in Se2), Semani (84.3% in Se4) and Mati. During the winter period, *Gomphonema olivaceum* (until 52.5% in Sh3, November 03), *Nitzschia dissipata* (until 45.1% in Sh1, November 03) were observed.

A particular structure of the diatom community was seen in the most polluted rivers, like Lana, Ishmi and Gjanica (tab. 5-37 to 5-43). *N. palea* var. *palea*, a saprotroph species (Hofmann, 1994), that grow even in polysaprobic habitats, were found to be very dense in Lana (up to 79.1 % in May 02; 95.5 % in July 03; 95,3 in September 03; 82.2% in November 02), in Ishmi (up to 87.3% in July 03; 86,8% in September 03; 64,6 % in November 03), in Gjanica (up to 73% in November 02; 65% in May 03; 59.8 % in July 03; 80.02% in September 03; 65.6% in November 03). The high prevalence of *N. palea* together with the scarce number of taxa (fig. 5-40) were the causes of the low values of

diversity index calculated in those stations (fig. 5-41). *N. palea* was mainly accompanied with other saprotroph or tolerant species, like *Navicula accomoda*, *Gomphonema parvulum*, *Navicula cryptotenella*, *Fragilaria ulna*, etc.

Considering the values of the **diatom index (TI_{DIA})**, the water quality in Mati, Fani, Shkumbini, Osumi and Semani was classified from mesoeutroph to eutroph, showing a certain pollution level. In table 5-36 and figure 5-42, the respective values of the trophic index of diatoms are shown. The lowest value (1,4, *oligo-mesotrophic*) was observed in Bushkashi (Mati tributary). As in this mountainous river, perhaps all the watercourses in the mountain part of Albania might be considered only minorly polluted. In two stations of Mati (Ma1 and Ma3) the trophy level was between mesotroph and meso-eutroph - except in November 02 where the water quality changed to eutroph and eu-polytroph, respectively. In Fani the trophy levels were higher probably due to pollution from Rubiku town.

The **trophy levels** in Shkumbini oscillate between meso-eutroph to eu-polytroph (tab. 5-36), with a slight tendency to increase from Labinoti (Sh1) to Paperi (Sh2). However, the impact from Librazhdi, Elbasani, Peqini and Rrogozhina towns are the main causes of such the high trophy level in Shkumbini. The same is observed for Osumi and Semani, caused by the impact of the inhabited centres of Berati, Kucova and Uravajgurore, which deal with oil and agriculture. The trophy level in the upstream part of Tirana River was mainly meso-eutroph, a slight pollution was observed from the surrounding urban area. This river, crossing Tirana Town, obtains the same impact as Lana and Ishmi rivers (tab. 5-36).

7.6. Conclusions

In conclusion, the composition of the diatom population (tab. 5-36) indicated medium organic and inorganic pollution (α/β-mesosaprobic) in Mati, upstream of the rivers of Tirana, Shkumbini and Osumi, as already suggested by the levels of nitrogen and phosphorous. However, most of the tributaries (**Lana** and **Ishmi**, **downstream Shkumbini** and **Gjanica**) were in a β-mesosaprobic to polysaprobic state. Ishmi River and its tributaries Tirana and Lana are extremely impacted, as evidenced by the photos in the plates 4-4 and 4-5.

Strong measures of restoration and protection of water quality must be taken as soon as possible. Tirana capital with more than 700’000 inhabitants is situated in the Ishmi, Lana and Tirana watershed. Industry, especially food industry, is growing rapidly in the Tirana plain (plate 4-4: fig. 1). Neither the wastewater from industry nor the one from the population is treated at all. Solid waste continues to be disposed abusively along the riverbanks. In contrast, much water is used from the rivers for irrigation, livestock, fishing, drinking through the wells in suburban areas or wells of food factories. Furthermore the Patoku lagoon (fig. 4-1), a very important site of high biodiversity in both flora and fauna, especially fishes and water birds, is situated close to Ishmi delta and will become deterioated.

It is a high priority to set up **an effective monitoring network** for the surface waters in Albania, including biomonitoring. Furthermore, the fields of experts should be broadened and also bacteriologists and organic chemists be involved. Such a development will further strengthen the monitoring groups in Albanian institutions. The Ministry of Environment will obtain more information on the environmental situation in those rivers and such activities will increase the responsibility to protect and use them properly. It will push further the process of public awareness, which has already started, aiming in improving water quality, waste treatment and responsibility towards water use.

The National Strategy and Action Plan of Biodiversity (NEA, 1999) was approved in 2000 and since 1991, Albania has signed more than 13 international conventions and agreements dealing with environmental

issues. Therefore, taking the appropriate measures in important and sensitive watershed areas will help to prevent further damage to biodiversity and humans, and help to regain the original beauty of the landscape. The Albanian territory is important for the water supply on the Eastern Adriatic coast as well. Sustainable watershed management would guarantee the fulfillment of related tasks on a regional and international level.