3. Albanian water resources

3.1. General description

Due to the climatic conditions, mainly to the heavy rainfall and the hilly mountain relief, Albania is rich in water resources. Since the topographical drainage system does not correspond to the Albanian border with neighboring countries, a considerable amount of water from other countries drains through Albania. From the whole watershed of 43´905 km^2, only 65% is within the national borders (Figs. 3-1 and 3-2). Therefore, Albania is among the top countries in Europe related to the water quantity per capita; it amounts for, up to 13´000 m^3 per inhabitant per year.

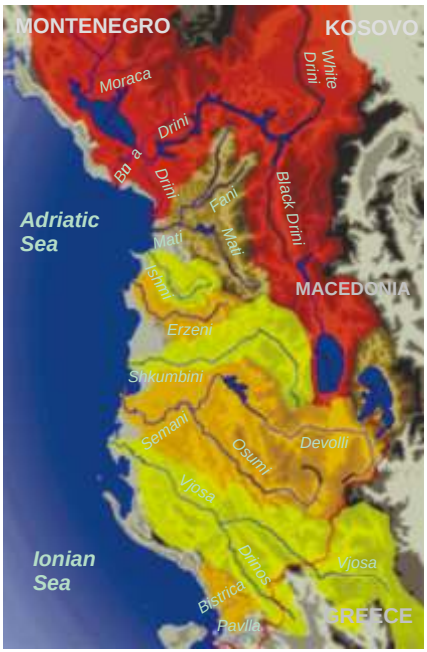

Figure 3-1: The most important river watersheds in Albania (modified after http://en.wikipedia.org/wiki/File:Albanian_Rivers.png).

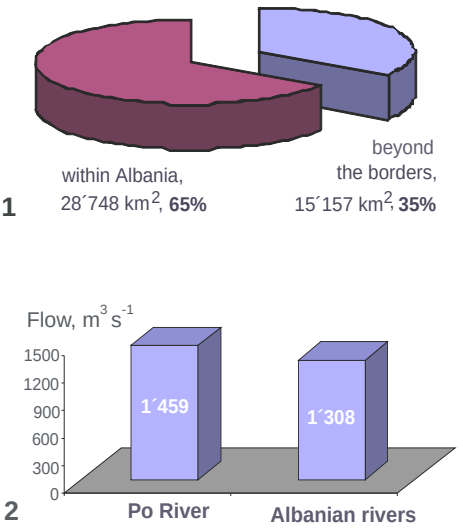

Figure 3-2: 1: Assignment of the whole Albanian watershed in km^2; **2:** flow of Albanian rivers into the Adriatic sea in m^{3}s^{-1}, compared with the River Po in Italy (Data from Stanners & Bouredau (1995); Kabo (1990-1991)

Before 1960, wetlands covered more than 2300 km^2, equal to about 8% of the Albanian territory. Large reclaimation processes for agricultural purposes strongly reduced the total area of the wetlands since then to less than half. Nevertheless, more than 1300 aquatic sites are still scattered throughout the country: marine habitats, coastal lagoons, fluvial deltas, rivers, springs, lakes and ponds. Wetlands cover a total surface of 970 km^2, equal to about 3% of the whole national territory. The lakes, the coastal lagoons and the reservoirs represent the largest part of these aquatic habitats (Tab. 3-1). All these feature a high diversity of sensitive habitats and biological species, which are rather poorly known and remain exposed to a significant impact of human activity.

Table 3-1: Total area (km ^{2}) and total number of aquatic sites in Albania (modified after Mima *et al*, 2003)

Natural wetlands	**Surface, km ^{2}**	**Number of sites**
Brackish lakes	24.2	2
Brackish marshes	8.6	2
Estuaries	88	9
Freshwater marshes	6.4	6
Freshwater springs	6	110
Glacier lakes	2.4	96
Lagoons	252.4	9
Lakes	335.7	228
Rivers and streams	27.1	152
Salt marshes	0.3	1
Sea bays	17.8	1
Wetland forests	4.8	1
Total natural wetlands	**773.7**	**617**
Man made wetlands		
Aquaculture ponds	6.4	3
Excavations	0.3	3
Reservoirs	178.8	700
Temporary wetlands	9.1	1
Total man made wetlands	**194.6**	**707**
Total wetlands in Albania	**968.3**	**1324**

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In this chapter we shortly describe the most important groups, excluding the transitional habitats which will cover the main part of the book.

The three big trans-boundary lakes of Ohrid, Prespa and Shkodra are undoubtedly the most important and fascinating aquatic complexes, not only for Albania, but for the whole Balkan region (Tab. 3-2). Together with the Drini watershed they extend to a large area of 19'352 km^2, of which 257 km^2 belong to Greece, 3'583 km^2 to Macedonia, 4'152 km^2 to Montenegro, 4'360km^2 to Kosovo, and 7'000 km^2 to Albania. They form a cascade from Prespa Lake to the Buna/Bojana delta in the Adriatic Sea (*see* Fig. 5-1). More than one million people live within this complex, about 500'000 in Albania and Montenegro, 300'000 in Kosovo, 178'300 in Macedonia and 1500 in Greece. Furthermore several cultures have left their traces from prehistoric times to the present day.

With its geological origin of more than 2 million years and its special hydrology, the Ohrid-Prespa system represents an entity of international values. The water level of Prespa Lake is about 160 m higher than the one of Ohrid Lake (Tab. 3-2). The water from Prespa feeds Lake Ohrid by underground karstic tunnels which end in two large springs, the Driloni near Pogradeci and the Saint Naumi on the Macedonian side (Fig. 3-10).

Lake Ohrid is oligotrophic with a high transparency of up to 15-25 m (Figs. 3-3). The Black Drini is the only effluent from the Lake Ohrid, it joins the White Drini in Kukesi and forms there the Drini, one of the most important rivers of the Eastern Adriatic.

Table 3-2: The trans-boundary lakes of Ohrid, Prespa and Shkodra

Lakes	Watershed surface, km^2 (within Albania)	Lake surface, km^2 (within Albania)	Mean depth, m (maximum)	Water level above sea level, m
Ohrid	2610* (273)	358 (111.4)	155 (288)	693
Macro Prespa	1300 (276)	254 (38.8)	14 (48)	849
Micro Prespa	189 (51)	47.4 (3.9)	4.1 (8.4)	852
Shkodra	5179 (1027)	368–542 (149)	7–10 (44)	4.4–9.4

** together with Prespa watershed; ** together with Micro Prespa watershed.*

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River Drini water passes through five large reservoirs, Globocica and Debar or Spile (in the Macedonian territory), and Fierza (Fig. 3-7), Komani and Vau Deja (in Albania) (*see* Fig. 5-1); another dam has been recently constructed in Ashta, downstream of Vau Deja (Shkodra). All of these constructions are very important for the generation of hydroelectric power for the two neighboring countries.

Figure 3-3: 1: Lini village at the Ohrid lakeshore (Albanian part); **2:** Ohrid lakeshore in St. Naumi (Macedonian part); **3:** Albanian part of Micro Prespa, at Wolf Gorge (Bilishti) (Photos: A. Miho)

The Shkodra Lake near Shkodra town is the biggest lake, in terms of surface area, in the whole of Balkans; it has been formed by tectonic and karstic processes. Lake Shkodra is drained by the River Buna joining the Drini River on its way to the Adriatic Sea (*see* Figs. 5-1 and Fig. 3-4) (*see* also Chapter 6).

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Figure 3-4: 1: Southern Shkodra lakeshore in Shiroka (Albanian part); **2:** Sampling periphyton in Kamica, Northern Shkodra lakeshore (Kopliku); **3:** Karstic Lake of Merhoja (Dumre, Elbasani); **4:** Black Lake in Lura (Dibra) (Photos: L. Shuka, L. Kashta) and A. Miho).

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More than 90 karstic lakes, often smaller than 1 ha and shallower than 10 m, are loosely dispersed in regions with limestone or gypsum. Most famous are the lakes of Dumre, a region between the Shkumbini and the Devolli valleys in the Peqini district (Fig. 3-4). These lakes have neither inflows nor outflows and are filled by precipitation. As a consequence their water levels vary drastically during the seasons.

In the mountains of Central Albania (mountains of Lura, Ballgjaj, Dhoksi and Shebeniku) and in the Albanian Alps (Doberdoli, Jezerca), more than 130 glacial lakes are scattered at altitudes above 1500 m. Most of them are small, formed on magma formations (ultra-basics). These lakes are mainly oligotrophic and often located in beech or pine forests (Fig. 3-4). During the last two decades these forests have been heavily disturbed by woodcutting and fires.

More than 150 small rivers and torrents cross the country from the South-East to the North-West and enter the Western Adriatic Coastal Lowlands where they combine with the 8 big rivers: Buna, Drini, Mati, Ishmi, Erzeni, Shkumbini, Semani and Vjosa (Tab. 3-3). The combined total flow of these 8 main rivers amounts to 1300 $m^3 s^{-1}$. Together with the River Po in Italy, they contribute a significant amount of fresh water to the Adriatic Sea (Fig. 3-2). The rivers exhibit an extreme torrential and erosive regime, especially in the eastern mountain part and form large meandering beds in the Western Coastal Lowlands (*see* Figs. 2-3 and 3-5).

Table 3-3: The main rivers of Albania (Kabo, 1990–91)

River	Length, km	Watershed, km^2	Mean flow, $m^3 s^{-1}$	Ratio of flow rate, maximum to minimum
Buna	41	5187	320	5.3
Drini	285	14173	352	5.1
Mati	115	2441	103	9.3
Ishmi	74	673	21.5	5.9
Erzeni	109	760	18.1	11.2
Shkumbini	181	2445	61.5	13.2
Semani	281	5649	95.7	13.7
Vjosa	272	6706	195	7.2

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Figure 3-5: 1: Thethi waterfall (Shkodra); **2:** Vjosa River and the karstic spring Cold Water in the Kelcyra gorge (Permeti); **3:** Mati River joining with Fani River in Miloti (Photos: A. Miho and L. Shuka).

The rivers are fed mainly by precipitation (69%) and follow the typical Mediterranean regime with a high flow during October to May, resulting in 73% of the total annual water for the Bistrica River at Delvina to up to 93% for the Drini River at Gjirokastra within these months.

The rivers represent an enormous resource for the economy of Albania in agriculture for irrigation, in industry for hydroelectric power generation, for drinking water supply and for fishery.

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Figure 3-6: Effects of gravel excavation in the riverbeds: **1:** in Terkuza river (Bovilla); **2:** in Tirana river (Brari) (Photos: A. Miho and L. Shuka).

However, the riverbeds are nowadays often misused for gravel excavation. This enhances river instability, increases flooding risks and poses sedimentation problems. Some riverbeds have now become lowered by 3 to 5 m while crossing the plains of Tirana and Durresi (Fig. 3-6). The situation is even more critical close to the Adriatic Sea, where the average river gradient is almost negligible causing the river to find a new profile by meandering or moving laterally and cutting the river banks, thereby strongly enhancing erosion.

The torrential character of the rivers accompained by long dry periods in summer forced the administration to construct dams in the rivers to retain the water for flood control and irrigation and also for the production of electricity, drinking water supply and fisheries. Accordingly, in the whole country there are more than 700 reservoirs with surface areas between 10 and 40 ha (Tab. 3-1); they cover a total surface area 180 km^2 and accumulate a water volume of 400 million m^3 (Fig. 3-7). Most important are the big reservoirs in the Drini cascade (Fierza, 295 m a.s.l., 72.5 km^2, maximal depth 128 m; Komani, 170 m a.s.l., 13 km^2, 96 m depth; and Vau Deja, 74 m a.s.l., 24.7 km^2, 52 m depth), in the Mati river (Uleza, 117-129.5 m a.s.l., 13.5 km^2, 61 m depth, and Shkopeti) and in the Bistrica river. Since 1998 the Bovilla reservoir, constructed by damming the Terkuza river (a tributary of Ishmi), is the main drinking water supply for Tirana town and its suburbs with about 760'000 inhabitants (Fig. 3-8).

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Figure 3-7: 1: Fierza dam and the reservoir at the Drini river in Bajram Curri; immediately downstream is the beginning of the Komani reservoir (June 2006); **2:** the Shkopeti reservoir at Mati River in Miloti; **3:** Bistrica Reservoir (Delvina) (Photos: A. Miho & L. Shuka).

More than 85% of the totally installed power generation capacity in Albania is covered by about 290 hydroelectric power plants (HECs) constructed on rivers, with an average capacity of 2.6 MW. About 270 HECs are small with less than 15 MW and an annual production of 600'000 kWh. Only 18 HECs are larger than 15 MW with an annual production of about 2 million kWh, i. e. the Drini - Fierza, Komani and Vau-Deja, the Mati – Uleza and Shkopeti and the Bistrica. Together they yielded 1446 MW in 2005. There is an increasing energy demand in Albania. Therefore, during 2006-2011, the Ministry of Economy, Trade and Energy (METE) submitted 110 contracts to construct about 300 hydropower stations with a capacity of 1.3 million MW, for 73 construction started in 2012. It is foreseen that up to 450 new hydroelectric power plants will be constructed on rivers in the whole Albanian territory. Besides their positive economic benefits, their combined effects will probably have a significant negative impact on the natural state of water courses and coastal deltas.

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Figure 3-8: 1: Bovilla Reservoir (Tirana); **2:** Dam of the Bovilla Reservoir with the water inlet to the Treatment Plant (Photos: A. Miho and L. Shuka).

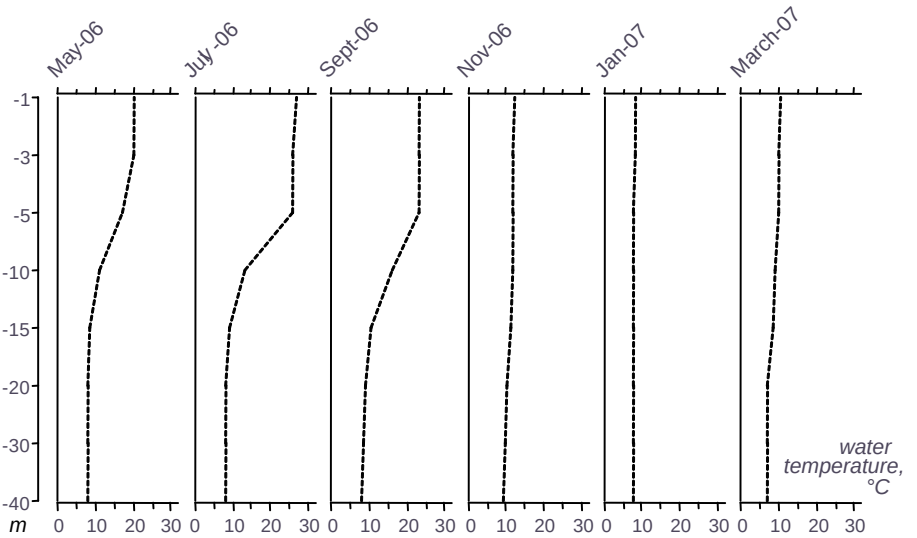

Figure 3-9: Profiles of water temperature (°C) in the Bovilla Reservoir (Tirana) at the deepest site between May 2006 and March 2007 (Miho *et* al., 2009).

Most of the lakes and reservoirs are located within the zone of the subhilly Mediterranean climate with two climate sub-zones: the hilly Mediterranean (up to 700-800 m a.s.l.) and the pre-mountain Mediterranean zone (above 800 m).

Data on the hydrology or hydrochemistry of most of the lakes and reservoirs is lacking; it is assumed that deep water bodies are warm monomictic (these lakes don't freeze in winter and stratify with high stability during summer). In the Bovilla reservoir, a thermocline was evident in summer between 10 and 15 m (Fig. 3-9), while in winter the whole water body was completely mixed. Only glacial lakes at higher altitudes (above 1000 m a.s.l.) are influenced by the mountain Mediterranean climate.

In the karstic zones, there are about 110 freshwater springs with a mean flow of more than 0.1 m^3s^{-1}. The biggest springs are the ones of Bistrica (Delvina) with a total mean flow of 18 m^3s^{-1} (*see* Fig. 13-16), Driloni (Pogradeci) with 16.3 m^3s^{-1}, of Cold Water (Tepelena), Borshi (Saranda), Dajti (Tirana) and Llogora (Vlora) (Figs. 3-5 and 3-10). Besides their economic importance as sources of water supply and recreation, these springs are interesting for their rich aquatic flora and fauna, especially for water birds and endangered fish species.

As a conclusion, the Albanian wetlands are, however, very sensitive ecosystems that were under strong impact in the past due to the extensive agricultural reclamation and unsustainable industry. At present, the Western Lowland supports densely populated industrial centres, intensive agriculture and tourism (*see* also Chapter 14). Therefore, some rivers (i.e., of Ishmi, Tirana, Lana and Gjanica) are heavily loaded with urban and industrial sewage discharged directly into rivers that transport this load to the sea. Moreover, high levels of heavy metals have been found in the Vlora and Durresi bays, and the Mati delta. Increasing energy demand in Albania is mainly based on water energy from rivers. Industrial and harbor activities are also increasing along the coastal zone. Petroleum industry in Fieri and Vlora also result in an adverse ecological impact on the Semani and Vjosa deltas and their related lagoons. Coastal dune forests are under pressure of touristic development. Also, the high rate of erosion caused by the poor land use practices in watershed areas – deforestation, overgrazing, firing, gravel mining in river beds in relative shallow water basins, further increases the amount of suspended matter transported to the sea by the rivers.

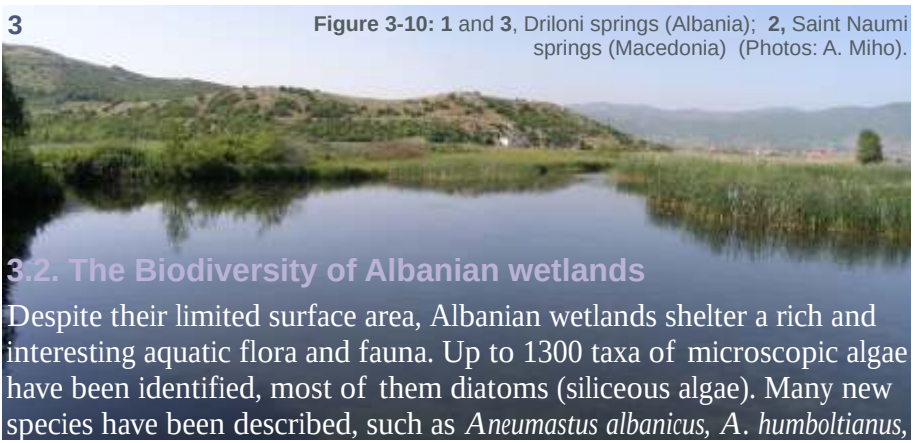

Figure 3-10: 1 and **3**, Driloni springs (Albania); **2,** Saint Naumi springs (Macedonia) (Photos: A. Miho).

3.2. The Biodiversity of Albanian wetlands

Despite their limited surface area, Albanian wetlands shelter a rich and interesting aquatic flora and fauna. Up to 1300 taxa of microscopic algae have been identified, most of them diatoms (siliceous algae). Many new species have been described, such as *Aneumastus albanicus, A. humboltianus, A. rosettae, Cymbopleura albanica, C. lata* var. *lura, C. lura, Navicula pseudopugnata, N. hastatula, N. parahasta, Placoneis neoexigua* and *P. juriljii*. In Ohrid Lake about ¼ of the diatoms are rare, endemic or tertiary relicts (Fig. 3-11).

The large lakes in the country are also important areas for the wintering of migratory water birds; about 70 species of water-birds with a total population of 180'000 individuals winter in the coastal wetlands and in Shkodra and Ohrid and Prespa lakes. Albania is an important crossing road for the migration of birds, bats and insects. It is a country of special importance for the Dalmatian pelican (*Pelecanus crispus*), the Pygmy cormorant (*Phalacrocorax pygmaeus*) and the Sturgeon (*Acipenser sturio*).

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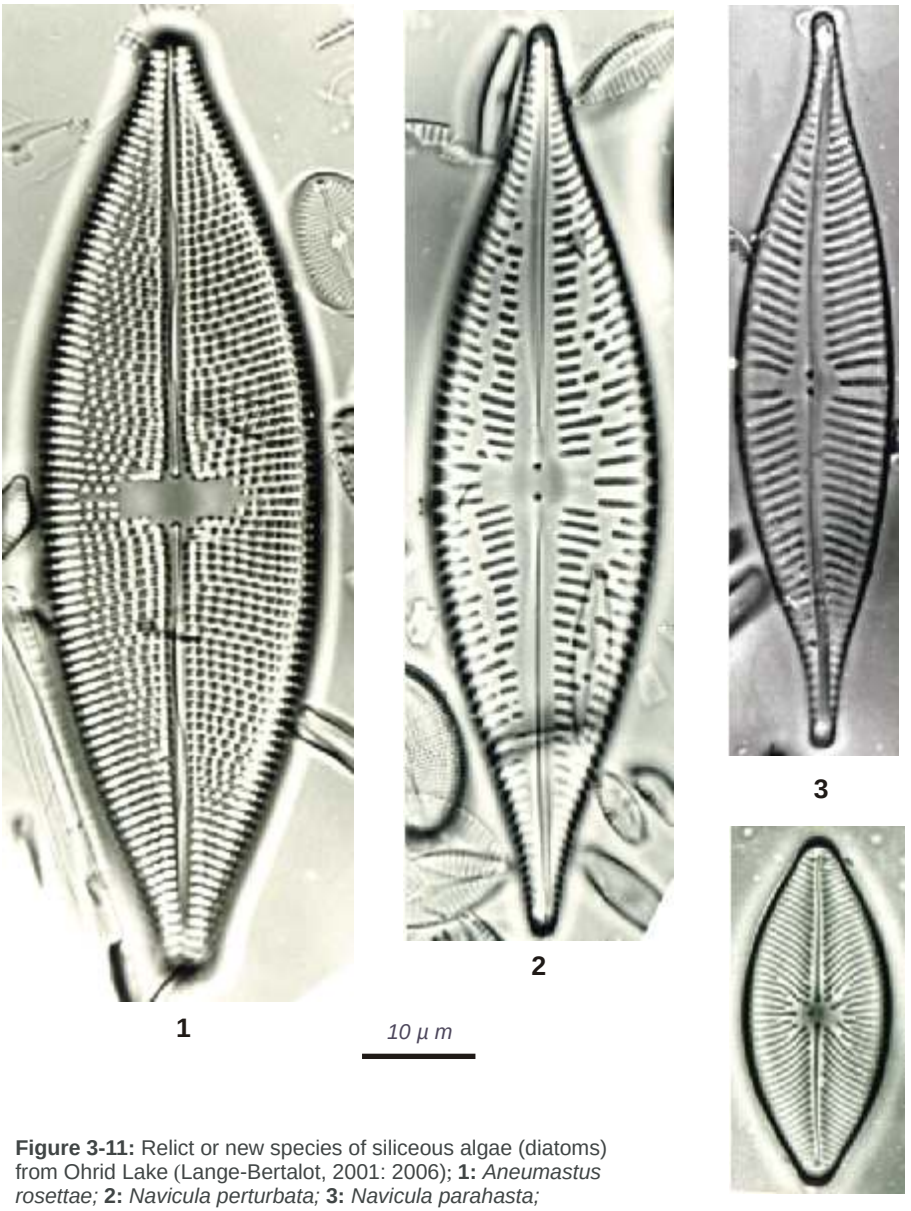

Figure 3-11: Relict or new species of siliceous algae (diatoms) from Ohrid Lake (Lange-Bertalot, 2001: 2006); **1:** *Aneumastus rosettae;* **2:** *Navicula perturbata;* **3:** *Navicula parahasta;* **4:** *Placoneis porifera* (Photos: A. Miho).

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Figure 3-12: ***Above:*** Brown trout (*Salmo trutta*) is globally endangered from Shkumbini river, Labinot Fushe, Elbasani; ***below:*** Ohrid trout (*Salmo letnica)*, endemic fish in Ohrid Lake (Photos: A. Cake and S. Beqiraj).

Both Ohrid Lake and Prespa Lake are characterized by a high biodiversity, especially concerning rare and endemic species, most of them being relicts of the tertiary period. About 70-80% of the invertebrate species in Lake Ohrid (e.g. annelids and gastropods) are endemics. This holds also for 10 of the 17 known fish species, such as the famous Ohrid trout (*Salmo letnica*; Fig. 3-12) and the Ohrid belvica (*Salmothymus ohridanus*). Prespa lakes also shelter endemic fish species such as *Barbus meridionalis* ssp. *prespensis*, *Alburnus albidus* ssp. *prespensis* and *Chondrostoma nasus* ssp. *prespensis*.

The rivers are also important for the aquatic flora and fauna. Recently more than 120 fish species have been recorded in mountain rivers and torrents, among them the Brown trout (*Salmo trutta*; Fig. 3-12), *Pachychilon pictum* (an endemic species in the Adriatic region), and *Gobio gobio* ssp. *albanicus* (Dhora *et al.*, 2008). Some endangered mammals live in the rivers, such as the European otter (*Lutra lutra*).

The Pheasant (*Phasianus colchicus*) has been introduced decades ago by the Directorate of Forestry and Pastures; it became acclimatized 1955 in the Rrushkulli forest, then in the Divjaka, Fushekuqe, Pishe-Poro, Belshi, and Velipoja region. Later it moved to Tale, Ishull-Lezha, Ndroqi and to Kopliku. However, today it is found only infrequently at the Ishmi River (Durresi) and the Maliqi wetlands (Korça).