

Current knowledge of benthic invertebrate diversity in an Algerian stream : a species check-list of the Sébaou River basin (Tizi-Ouzou)

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ABSTRACT

This paper catalogues stream invertebrates of the Sébaou Basin (Algeria). We provide a faunistic list realised on the basis of more than ten years of research on 23 sites in both Sébaou River and tributaries ranging between elevations of 1680 m and 20 m. 429 taxa belonging to 14 taxonomic groups were identified. Within these taxa, 74 are first records in Algeria, and 7 are recently described new species.

Keywords : stream invertebrates, faunistic list, Algeria.

RÉSUMÉ

Cet article constitue une synthèse de la diversité des invertébrés aquatiques du bassin de l'oued Sébaou (Algérie). Nous présentons une liste faunistique obtenue après plus de dix ans de recherches sur 23 sites distribués sur le cours principal et les affluents de l'oued Sébaou. Ces sites sont situés à des altitudes variant de 1680 à 20 mètres au-dessus de la mer. 429 taxa appartenant à 14 groupes taxonomiques ont été dénombrés, dont 74 espèces sont des premières citations pour l'Algérie et 7 sont des espèces nouvelles décrites récemment.

Mots-clés : Invertébrés aquatiques, liste faunistique, Algérie.

INTRODUCTION

Since the end of the 19th century, research has been conducted on the Algerian limnofauna by European zoologists travelling in North Africa, such as REICHE (1869), VEIDOVSKY (1891), BEDEL (1895, 1925), EATON (1899), SELYS-LONGCHAMPS (1902), PIC (1905), PEYERIMHOFF (1905, 1925), SAINTE-CLAIRE DEVILLE (1905, 1909), EDWARDS (1923), LESTAGE (1925), POISSON (1926), NAVAS (1929), SEURAT (1922, 1930), PARROT (1949), GRENIER (1953), AUBERT (1956).

During the first quarter of the 20th century, research was limited to a few streams located close to major urban areas such as Algiers, Oran, Annaba, Constantine and Biskra. Most of these studies were devoted to species identification and very few dealt with ecology or biogeography. Moreover, only two studies carried out between 1925 and 1960 provided a synthesis of the Algerian benthic fauna taxonomy and distribution (GAUTHIER 1928, VAILLANT 1955).

More recently, an increasing interest has been devoted to the study of stream invertebrates, with long term studies ini-

tiated by some Algerian universities such as the zoology departments of Tizi-Ouzou, Algiers and Tlemcen. The major studies are those of GAGNEUR *et al.* (1986) concerning Oligochaeta, KADDOURI (1986) concerning *Hydraena* beetles (Coleoptera), MALICKY & LOUNACI (1987) concerning caddisflies (Trichoptera), GAGNEUR & CLERGUE-GAZEAU (1988) concerning blackflies (Diptera : Simuliidae), GAGNEUR & THOMAS (1988) and THOMAS (1998) concerning mayflies (Ephemeroptera), MOUBAYED *et al.* (1992) concerning chironomids (Diptera : Chironomidae), GAGNEUR & ALIANE (1991) concerning stoneflies (Plecoptera), LOUNACI-DAOUDI (1996) concerning the benthic fauna of Sébaou wadi (i.e. river), LOUNACI (1987) and AIT MOULOUD (1988) concerning the benthic fauna of the Aïssi wadi basin, ARAB (1989) concerning aquatic invertebrates of Mouzaïa and Chiffa wadis. Some papers have given interesting insights concerning the taxonomy of the stream invertebrates and described several new species (SOLDAN & THOMAS 1983 a,b, SOLDAN & THOMAS 1985, SOLDAN & GAGNEUR 1985, THOMAS & LOUNACI 1989, THOMAS & GAGNEUR 1994). However, neither recent update or synthesis were given on the benthic

fauna, and most of the information is fragmentary and deals with only one taxonomic group.

In this study, we aimed to update our knowledge of stream invertebrate composition in the Sébaou River basin. From invertebrates samples collected between 1984 and 1996 in both main stream and tributaries, we provide the first comprehensive benthic invertebrate list of the Kabylie du Djurdjura (Tizi-Ouzou region, Algeria).

STUDY SITES AND METHODS

The Sébaou River basin is about 100 kilometres east from the city of Algiers. The area studied extends from the top of the Djurdjura Mountains (up to an altitude of 2308 metres) to the Sébaou River lowland plain near the city of Tizi-Ouzou. We investigated both the main channel of the Sébaou River, its main tributary (Aïssi wadi), and some other smaller tributaries (Thala-Guilef, Tikjda, Tizi-N'Kouilal, Mekla) (Fig. 1).

The Sébaou River flows for c.a. 110 km, from an elevation of 1750 m in the eastern part of the Djurdjura Mountains to the Mediterranean sea. The upstream part of the Sébaou River (altitude between 500 and 150 m) is known as the Boubhir wadi, and characterised by a mean slope of 1.5 % along a 23 km reach. The lowland part is called Sébaou wadi (*sensu stricto*) and constitutes a 70 km long reach, with a low slope. The Aïssi River flows for 50 km from an elevation of 1100 m in the middle part of the Djurdjura, to its confluence with the Sébaou at an elevation of 100 m, and exhibits a high slope in its upstream part (c.a. 10 %), with a torrential flow regime (Fig. 1).

From a climatic point of view, the Sébaou River basin experiences an accentuated Mediterranean climate with a hot and dry summer, followed by a cold and wet winter. However, within the altitudinal range, both rainfall and temperature show different patterns: in the Djurdjura mountains, annual precipitation is about 1500 mm, whereas in the lowland plain, it is only 900 mm. Therefore, numerous streams experience a dry summer period, with partial or total drying between June and September. Also, due to scarce hard rains and the clayey geological characteristics, violent flooding events occur during winter which cause a major perturbation for the benthic fauna.

The 23 selected sampling sites were located on both the Sébaou River and its tributaries, with the aim being to cover a large range of altitudinal, discharge and topographical features. Twelve sites are located on the main channel of the Sébaou River and its main tributary (Aïssi wadi: 7 sites, Boubhir wadi: 2 sites, Sébaou wadi: 3 sites), and the 11 remaining sites are located on small tributaries (Thala-Guilef: 4 sites, Tikjda: 5, Tizi-N'Kouilal: 1, Mekla: 1).

The environmental characteristics at each sampling site, and the code of each site (bold characters) are given below. The following notation was used: *A*: altitude in meters above sea level, *P*: slope in %, *D*: distance from the source in

km, *L*: mean stream width in m, *H*: mean stream depth in cm, *V*: current velocity, *T*: annual water temperature amplitude in °C (minimal and maximal values), *S*: substratum.

Aïssi wadi:

A1: *A*: 920; *P*: 10; *D*: 0.5; *L*: 1; *H*: 20; *V*: fast to very fast; *T*: 8-14; *S*: boulders, pebbles, gravel, algae, organic matter.

A2: *A*: 810; *P*: 10; *D*: 1; *L*: 0.5; *H*: 10; *V*: medium to fast; *T*: 10-16; *S*: boulders, pebbles, gravel, algae, vegetal debris.

A3: *A*: 480; *P*: 10; *D*: 3; *L*: 1.5; *H*: 20; *V*: medium to fast; *T*: 9-16; *S*: boulders, pebbles, gravel, algae, vegetal debris.

A4: *A*: 380; *P*: 2.5; *D*: 4.5; *L*: 4; *H*: 30; *V*: medium to fast; *T*: 11-28; *S*: pebbles, sand, algae, vegetal debris.

A5: *A*: 300; *P*: 1.5; *D*: 11; *L*: 5; *H*: 30; *V*: medium to fast; *T*: 11-27; *S*: pebbles, sand, algae, vegetal debris, organic matter.

A6: *A*: 2000; *P*: 1.4; *D*: 20; *L*: 8; *H*: 30; *V*: medium to fast; *T*: 11-27; *S*: pebbles, sand, algae, vegetal debris, organic matter.

A7: *A*: 140; *P*: 0.8; *D*: 30; *L*: 10; *H*: 30; *V*: low to medium; *T*: 11-31; *S*: pebbles, sand, algae, vegetal debris, organic matter.

Boubhir wadi:

B1: *A*: 220; *P*: 2.5; *D*: 25; *L*: 2; *H*: 30; *V*: medium to fast; *T*: 9-30; *S*: pebbles, sand, algae, organic matter.

B2: *A*: 160; *P*: 1.2; *D*: 40; *L*: 5; *H*: 20; *V*: medium to fast; *T*: 11-30; *S*: pebbles, sand, algae, organic matter, aquatic vegetation.

Sébaou wadi:

S1: *A*: 100; *P*: 0.2; *D*: 45; *L*: 10; *H*: 30; *V*: low to medium; *T*: 11-32; *S*: pebbles, sand, algae, organic matter, aquatic vegetation.

S2: *A*: 60; *P*: 0.6; *D*: 75; *L*: 15; *H*: 30; *V*: low to medium; *T*: 12-33; *S*: pebbles, sand, algae, organic matter, aquatic vegetation.

S3: *A*: 200; *P*: 0.5; *D*: 90; *L*: 20; *H*: 30; *V*: low to medium; *T*: 13-33; *S*: pebbles, sand, algae, organic matter, aquatic vegetation.

Mekla:

M1: *A*: 940; *P*: 30; *D*: 0.4; *L*: 0.5; *H*: 10; *V*: low to medium; *T*: 5-13; *S*: pebbles, silt.

Tizi-N'kouilal:

TK1: *A*: 1300; *P*: 40; *D*: 0.5; *L*: 0.5; *H*: 10; *V*: low to medium; *T*: 5-12; *S*: pebbles, gravel.

Tikjda:

TS1: *A*: 1600; *P*: 40; *D*: 0.4; *L*: 0.3; *H*: 5; *V*: medium to fast; *T*: 5-14; *S*: pebbles, gravel.

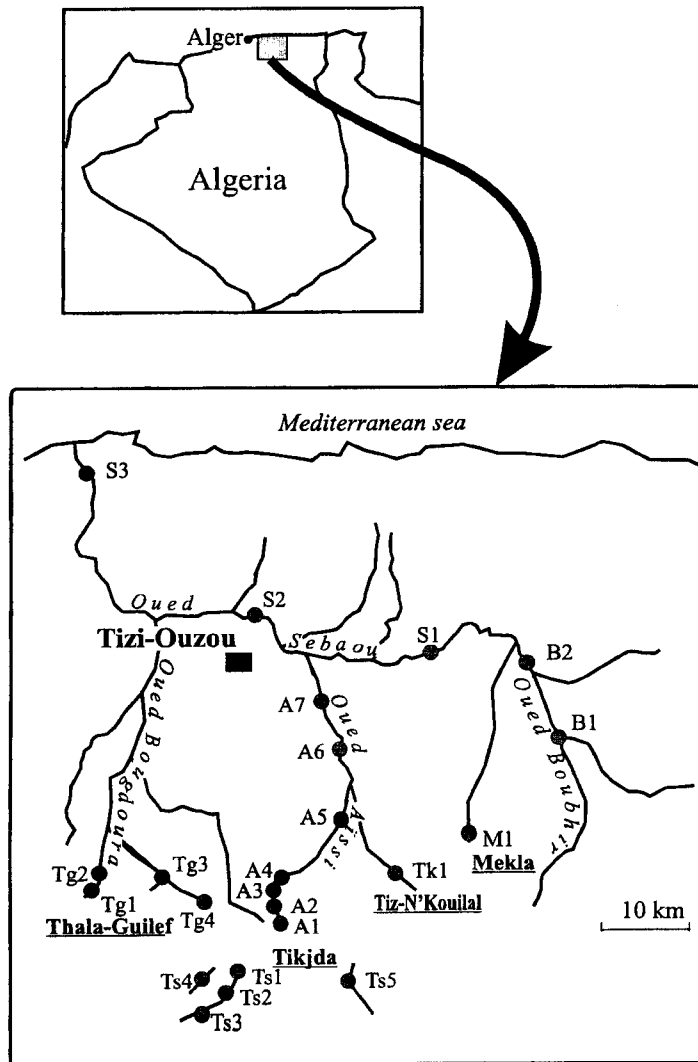


Fig. 1.

TS2 : *A* : 1460; *P* : 27; *D* : 0.8; *L* : 0.4; *H* : 10; *V* : medium to fast; *T* : 6-17; *S* : pebbles, gravel.

TS4 : *A* : 1460; *P* : 40; *D* : 0.8; *L* : 1.5; *H* : 10; *V* : medium to fast; *T* : 7-16; *S* : pebbles, gravel, silt.

TS5 : *A* : 1360; *P* : 20; *D* : 1.2; *L* : 2; *H* : 20; *V* : medium to fast; *T* : 6-19; *S* : pebbles, gravel.

Thala-Guilef :

TG1 : *A* : 1480; *P* : 30; *D* : 0.5; *L* : 0.5; *H* : 5; *V* : medium to fast; *T* : 4-14; *S* : boulders, pebbles, gravel.

TG2 : *A* : 1200; *P* : 20; *D* : 0.8; *L* : 1; *H* : 10; *V* : medium to fast; *T* : 6-18; *S* : boulders, pebbles, gravel.

TG3 : *A* : 1680; *P* : 30; *D* : 1; *L* : 0.5; *H* : 5; *V* : medium to fast; *T* : 6-19; *S* : boulders, pebbles, gravel.

TG4 : *A* : 1680; *P* : 40; *D* : 0.1; *L* : 0.4; *H* : 5; *V* : medium to fast; *T* : 5-13; *S* : boulders, pebbles, gravel.

Benthic macroinvertebrates samples were performed from 1984 to 1996 using a standard surber net (mesh size 250 μm , surface sampled 0.09 m^2). As a complement, drift nets, day visual samples and nocturnal light traps were used to catch larvae, nymphs and flying adults at each sampling occasion. These additional sampling methods were incorporated to check that the whole fauna was collected using the surber net, and to provide further information for the specific determination of the larvae. The samples were fixed using five-percent formaldehyde for further analyses. In the laboratory, all the invertebrates were sorted out and determined to species level. When species level identification was not possible (i.e. no identification key available), identification was conducted to the lowest possible taxonomic level and reference individuals were sent to taxonomic experts for further analyses.

Species	Sampling sites
Tricladida: 2 species	
DugesIIDae	
<i>Dugesia gonoccephala</i> (Dugès)	A4, A5, A7
Planariidae	
<i>Polycelis felina</i> (Dalvell)	A2
Oligochaeta: 35 species	
Lumbriculidae	
<i>Trichodrilus allebrogum</i> Claparède	A2
<i>Trichodrilus</i> sp.	A3, A5, A7
Haplotaenidae	
<i>Haplotaenix gordioides</i> Hartmann	A3, A4, A5, A6
Tubificidae	
* <i>Tubifex tubifex</i> f. <i>bergi</i> Hrabe	A4
<i>T. tubifex</i> f. <i>tubifex</i> Müller	A4
Tubificidae gen. Sp.	A2, A4, A5
* <i>Psammoryctides barbatus</i> Grube	A2
<i>Limnodrilus claparedeianus</i> Ratzel	A4
<i>L. hoffmeisteri</i> Claparède	A4
<i>L. udekemianus</i> Claparède	A4
<i>Limnodrilus</i> sp.	A4
* <i>Rhyacodrilus falciformis</i> Bretsch	A1, A3
<i>Rhyacodrilus</i> sp.	A3
* <i>Epirodillus michaelsoni</i> Hrabe	A2, A3
Naididae	
<i>Nais communis</i> Piguet	A3, A4, A5, A6, A7
<i>N. elinguis</i> Müller	A2, A3, A4, A5, A6, A7
<i>N. pardalis</i> Piguet	A6, A7
<i>N. variabilis</i> Piguet	A2, A3, A4, A5, A6, A7
<i>Slavina appendiculata</i> d'Udekem	A7
<i>Pristina aequisetata</i> Bourne	A3, A5, A6
* <i>Pristinella idrensis</i> Sperbe	A5, A6, A7
<i>P. menoni</i> Aiyer	A1, A2, A3, A4, A5, A6, A7
* <i>P. rosea</i> Piguet	A4
<i>P. sima</i> (Marcus)	A7
Enchytraeidae	
* <i>Buchholzia appendiculata</i> Buchholz	A3, A4
<i>Buchholzia</i> sp.	A1, A2, A3, A4, A5
<i>Cognettia</i> sp.	A1

* <i>Enchytraeus buchholzi</i> Michaelsen	A1, A3, A4
<i>Enchytraeus</i> sp.	A1, A2, A3, A4, A5, A7
<i>Fridericia</i> sp.	A1, A2, A3, A4, A5, A6
<i>Henlea</i> sp.	A1, A3, A4, A5, A6
<i>Marionina riparia</i> Bretsch augm. Cernosvitov	A4
<i>Marionina</i> sp.	A2, A4, A5, A7
Lumbricidae	
<i>Eiseniella tetraedra</i> Savigny	A1, A2, A3, A4, A5, A7
Lumbricidae gen. sp.	A1, A2, A5
Hirudinea: 3 species	
Erpobdellidae	
* <i>Erpobdella octoculata</i> (Linne)	A1, A3
* <i>Dina lineata</i> (Müller)	A1, A2
* <i>Trocheta bykowskii</i> Gedroyc	A1, A2, A3
Mollusca: 7 species	
Hydrobiidae	
<i>Pseudamnicola conovula</i> Frauenfeld	A1, A2
Orientaliidae	
* <i>Belgrandiella saxatilis</i> (De Reynies)	A2
<i>Sadleriana fluminensis</i> (Klüster)	A1, A2, A3, A5
Lymnaeidae	
<i>Galba truncatula</i> Müller	A2, A5
<i>Radix peregra</i> Müller	A4
Ancylidae	
<i>Ancylus fluviatilis</i> (Müller)	A1, A2, A3, A4, A5
Sphaeriidae	
<i>Pisidium casertanum</i> Poli	A1, A2, A4
Hydracarina: 20 species	
Hydryphantidae	
<i>Protzia rotunda</i> Walter	A1, A2, A3
<i>Protzia</i> sp.	A1
Sperchonidae	
<i>Sperchon clupeifer</i> Piersig	A2
* <i>S. compactilis</i> Koenike	A1, A2, A3, A4
Lebertiidae	
<i>Lebertia</i> sp.	A4
Torrenticolidae	
<i>Torrenticola algeriensis</i> Lundblad	A3
<i>T. anomala</i> (Koch)	A3, A4, A6

FAUNISTIC LIST

(*) first record in Algeria (**) new species

<i>T. larivalvata</i> Viets * <i>T. stadleri</i> (Walter)	A1, A2, A3, A4, A5, A6, A7 A7	<i>Ecdyonurus rothschildi</i> Navas <i>Ecdyonurus</i> sp.	A5, A6, A7 TS1, TS2, TS3, TS4, TS5
Limnesiidae <i>Limnesia</i> sp.	A1	Caenidae <i>Caenis luctuosa</i> (Burmeister)	TG1, TG3, TS2, TS3, TS5, A3, A4, A5, A6, A7, B1, B2, S1, S2, S3 A3, A4, A5, A6, A7 S3
Hydrobatidae <i>Hygrobatas calliger</i> Piersig <i>Atractides algeriensis</i> Lundblad	A4, A7 A1, A3	<i>C. pusilla</i> Navas <i>Caenis</i> sp.	A5, A7, B1, B2 TS2, TS3, B1, S1
* <i>A. gibberipalpis</i> Piersig * <i>A. inflatus</i> (Walter)	A4, A5, A7 A1, A3, A4	Leptophlebiidae <i>Choroterpes (C.) atlas</i> Soldan & Thomas <i>C. (E.) lindrothi</i> Peters	TG1, TG3, TS1, TS2, TS3, TS4, TS5, A2, A3, A4
<i>A. nodipalpis</i> (Thor)	A4, A5	<i>Habrophlebia gr. fusca</i>	A2, A4, A5, A6, A7, B1, B2, S1, S2, S3
* <i>A. pavesii</i> Maglio	A3	<i>Potamanthus luteus</i> (L.)	
Feltriidae * <i>Feltria</i> sp.	A2	Plecoptera (stoneflies): 19 species	
Pionidae * <i>Piona rotundra</i> Walter	A3, A4 A3	Taeniopterygidae * <i>Brachyptera auberii</i> (Consiglio)	TG2, TK1, M1
Aturidae * <i>Ljania macilenta</i> Koenike * <i>Kongsbergia</i> sp.		Nemouridae * <i>Nemoura lacustris</i> Pictet <i>Nemoura</i> sp.	TK1 TG4, TS5 A3
Ephemeroptera (mayflies): 23 species		<i>Amphinemura chiffensis</i> (Aubert) <i>Protonemura algerica</i> (Aubert) <i>P. ruffoi</i> Consiglio <i>Protonemura</i> sp.	TG2, TS2, TS4, TS5, M1, A1, A3 TG3, TS1, TS2, M1, A3 TG1, TG2, TS1, TS3, TS5, TK1
Baetidae <i>Alainites gr. muticus</i> <i>Acentrella gr. sinaica</i> Bogescu <i>Afrotiptulum atmorphicum</i> Soldan & Thomas <i>Baetis maurus</i> Kimmins <i>B. numidicus</i> Soldan & Thomas <i>B. pavidus</i> Grandi	TG1, TS1, TS2, TS3, TS5, TK1, A7, B1 A4, A6, B1, B2 B1, B2, S1 TK1 A7	Leuctridae <i>Leuctra geniculata</i> (Stephens) * <i>L. medjerdensis</i> Vinçon & Pardo <i>Leuctra</i> sp. <i>Tyrrhenoleuctra minuta</i> (Klapálek) <i>Tyrrhenoleuctra</i> sp.	TS4, TS5 TS1, TS2, TS5 TG2, A1, A2, A4 S2 A6
<i>B. punicus</i> Thomas, Boumaiza & Soldan	TG1, TS2, TS4, A4, A5, A6, A7, B1, B2, S1, S2, S3	Capniidae * <i>Capnia nigra</i> (Pictet) <i>Capnionemura petitpierreae</i> Aubert <i>Capnionemura</i> sp. * <i>Capniopsis schilleri</i> (Rostock)	TS5 TK1, M1 A1 TK1
<i>B. gr. rhodani</i>	TS5, A1, A2, A3, A4, A5, A6, A7, B1, B2, S1, S3	Perlodidae <i>Afroperlodes lecerfi</i> (Navas) <i>Eoperla ochracea</i> (Kolbe)	TG2, TS4, TS5, TK1, A1, A3, A4 TK1, A5, A6, A7
<i>Nigrobaetis rhithralis</i> (Soldan & Thomas)	TG1, TG2, TG3, TG4, TS1, TS2, TS4, TS5, M1, A1, A2, A3, A4, A5, A6, A7, B1, B2, S1, S2, S3	<i>Perla marginata</i> (Panzer)	TS4, A1, A2, A3
<i>Cloeon dipterum</i> (Linne)	A4	Odonata: 2 species	
<i>C. gr. simile</i>	TG1		
<i>Procleon stagnicola</i> Soldan & Thomas	B1, B2, S1 A7, B1, B2, S1		
Heptageniidae <i>Rhithrogena gr. germanica</i> <i>Rhithrogena</i> sp.	TS2, A1, A2, A3, A4, B1, B2 A5, A6		

FAUNISTIC LIST (continued)

(*) first record in Algeria (**) new species

SYNTHESIS

The benthic fauna of the Sébaou River basin is composed of 429 taxa belonging to 14 zoological groups. Seventy-four species were new records for Algeria and seven new species were identified. Detailed information about these species will be published elsewhere. Following the species list, a short synthesis is given for each group.

Tricladida

Tricladids were represented by only two species previously known in Algeria: *Dugesia gonocephala* and *Polycelis felina*. The first one is rheophilous and commonly found in the middle reach of the Aïssi wadi. The second one has a more restricted distribution and was mainly found in the springs, testifying its crenophilous habitat use characteristics.

Mollusca

The Sébaou River basin showed a low Molluscan diversity: six gastropods and one lamellibranch. *Belgrandiella saxatilis* is a new species record in Algeria. These seven species were occurring and abundant in the upstream parts of Aïssi wadi (stations A1, A2, A3), however, only *Ancylus fluviatilis* was found in a large range of habitats.

Oligochaeta

Thirty-five Oligochaeta species belonging to 19 genera and six families were found in the Sébaou. Within these species, 8 are new records in Algeria: *Tubifex tubifex f. bergi*, *Psammoryctides barbatus*, *Rhyacodrilus falciformis*, *Epirodrius michaelseni*, *Pristinella idrensis*, *Pristinella rissae*, *Buchholzia appendiculata* and *Enchytraeus buchholzi*. Naïdidae (10 species) and Enchytraeidae (9 species) were found abundant in most of the Aïssi wadi sampling sites. By contrast, Tubificidae, were found in few sites, mainly in the piedmont areas, and only in low abundance.

Hirudinea

The three Hirudinea species belonging to Erpobdellidae family are new records in Algeria and were only found in the Aïssi wadi. This low diversity is characteristic of the North African fauna (LOUNACI-DAOUDI 1996). These species were found in the upstream part of Aïssi wadi, in low abundance and low occurrence.

Hydracarina

Twenty hydracarian taxa belonging to 11 genera and nine families were found. Eight species are new records in Algeria. Sites with the greatest diversity (up to ten species per site) were located in low mountain and piedmont areas, however, five species were only found in the upstream areas, and one species (*Torrenticola lativalvata*) is widely distributed.

Ephemeroptera (mayflies)

According to a recent synthesis on North African mayflies (THOMAS 1998), 50 species and three sub-species are known in Algeria. In the Sébaou basin, we found about half of the

entire Algerian mayfly species richness: 23 species belonging to 12 genera and six families. Most of the families were represented by a few species (three or less), with the exception of the Baetidae which was the most diverse family with 12 species. *Baetis* was found in all the sampling sites, with two widespread eurythermous species: *Baetis punicus* and *Baetis gr. rhodani*. However, 11 mayflies species with a more restricted spatial distribution were found in the upstream mountain areas of the Sébaou (altitude between 800 and 1680 m). Within these species, four (*Alainites gr. muticus*, *Baetis maurus*, *Cloeon dipterum*, *Ecdyonurus* sp.) were only found in the highest altitude sites. Similarly, within the 19 species colonising low mountain and piedmont sites, ten were unique to these areas. Most of these species colonise heterogeneous habitats with medium or high water current velocity. Finally in the lowland sites, 14 species were recorded, and only *Caenis* sp. was found characteristic of these areas.

Plecoptera (stoneflies)

GAGNEUR et ALIANE (1991) recorded 31 stonefly species in North Africa and 17 species in Algeria. In this study, we found 19 species (12 genera and 6 families) in the Sébaou basin. Fourteen are already known in Algeria, and five are new records: *Brachyptera auberti*, *Nemoura lacustris*, *Leuctra medjerdensis*, *Capnia nigra*, *Capniopsis schilleri*. Therefore, the total number of Algerian stoneflies is updated to 22 species. All the stoneflies were characterised by a low occurrence and a low abundance. Moreover, all the species were found over 400 m above sea level, with the exception of *Eoperla ochracea* and *Tyrrhenoleuctra minuta* which were located between 140 and 200 m. Most of these species are stenothermous and were only recorded in cold waters. Some species such as *Protonemura ruffoi* and *Protonemura* sp. were found characteristic of high altitude streams. By contrast, *Protonemura algerica* and *Afroperlodes lecerfi* were recorded over a large range of altitudes. Finally, *Eoperla ochracea* was found in an unusual habitat for a stonefly: lowland areas with high water temperatures.

Odonata

Two Odonata species belonging to the dragonflies (Anisoptera) were collected in the Aïssi wadi: *Onychogomphus costae* and *Onychogomphus uncatius*. One colonised both lowland and mountain areas, whereas the other only occurred below an altitude of 140 m.

Heteroptera

Forty-four species and sub-species are known for Algeria and Tunisia together (AGUESSE *et al.* 1982). In the Sébaou River basin, ten species belonging to six genera and six families were recorded. These species were characterised by a low abundance and occurrence. The highest species richness (eight species) was found at moderate altitudes with dense riparian vegetation and heterogeneous substratum (station A3).

Coleoptera

Eighty-four species belonging to 38 genera and 17 families were recorded. Of these species, 18 are first records in Algeria. The three main families were Hydroporidae (19 species), Hydrobiidae (14 species) and Elmidae (11 species); all the other families were represented by less than eight species. The highest species richness was found in piedmont and middle reaches with up to 45 species per site (station A5). These sites are heterogeneous areas providing a large range of environmental features and therefore a large diversity of potential habitats. However, some families, such as the Hydraenidae, were mainly found in the upstream sites, whereas the downstream areas were preferentially colonised by Elmidae and Ochtebiidae species.

Trichoptera (caddisflies)

Thirty-three species belonging to 20 genera and 11 families were recorded. Of these species, six were new species (MALICKY & LOUNACI 1987) : *Rhyacophila urgl*, *Hydropsyche artax*, *Hydropsyche morla*, *Thremma sardoum africanum*, *Athripsodes ygramul* and *Oecetis uyulala*. Twenty-three species were found in the upstream areas, and eight were unique to upstream areas. Low altitude areas are less diversified with 19 species, five of which were found characteristic of the lowland and piedmont areas. Finally, three species (*Rhyacophila munda*, *Hydropsyche artax* and *Cheumatopsyche atlantis*) are widely distributed.

Diptera

Diptera are the most widely represented group with 191 taxa. They represent about half of the entire fauna. Within this group, chironomids account for 67 % of the species, simuliids for 12 %, and the remaining 19 families represent 21 % of the taxa.

Of the 27 species of blackflies (Simuliidae) known in Algeria, 23 were recorded in the Sébaou River basin. Four stenothermous species found in lotic mountain areas are first records in Algeria : *P.(P.) albense*, *P.(P.) rufipes*, *S.(E.) petricolum*, *S.(N.) brevidens*. The Algerian blackfly species richness therefore becomes 31 species. *S.(E.) velutinum*, *S.(S.) intermedium*, and *S.(W.) pseudequinum* are the most abundant and widespread species. They are eurythermous and polluo-resistant species, and are therefore able to colonise a large range of habitats.

Considering chironomids, the first faunistic inventory in Algeria was performed in 1992, and 101 species were identified in the Sébaou basin (MOUBAYED *et al.* 1992). In our study, we found 29 new species records in the Sébaou basin. Within these species, 26 are new records for Algeria and therefore, 130 species are now known in Algeria. We found 48 genera belonging to several sub-families : Tanyptodinae (15 species), Diamesinae (3 species), Prodiamesinae (1 species), Orthocladiinae (71 species) and Chironominae (18 Chironomini and 22 Tanytarsini). The highest species richness was recorded in the middle part of the river (78 species)

and decreased in both high mountain and lowland areas. However, the most abundant Chironominae species (e.g. *Chironomus piger*, *Chironomus riparius*, *Chryptochironomus supplicans*, *Tanytarsus heusdensis*, *Tanytarsus? palletaris*, *Virgatanytarsus arduennensis*, *Virgatanytarsus triangularis*) were found in the lowland areas. Within the less diversified chironomid families, the Tanyptodinae were found in piedmont and lowland areas, with four abundant species : *Conchapelopia* sp., *N. dubius*, *P. divisa*, *R. maculipennis*.

The other diptera (i.e. other than Chironomidae and Simuliidae) are much less known, and up to now, little study was devoted to these species in North Africa, hence our knowledge is meagre. Within the 38 taxa belonging to 18 families, Tipulidae (8 taxa) and Limoniidae (6 taxa) are the most diversified. The remaining families are represented by few species. Eight taxa were found widespread and abundant : Blephariceridae gen. sp., *Dicranota* sp., *Hexatoma* sp., Bezzinae gen. sp., *Oxycera* sp., Tabanidae gen. sp., Hemerodromiini gen. sp., Psychodidae gen. sp.

CONCLUSION

Within the 429 taxa recorded in the Sébaou River basin, more than 15 % of the species are new records in Algeria, and not much is known about the non-Simuliid and non-Chironomid diptera. This study therefore underlines the necessity of further studies to obtain a more accurate knowledge of the North African benthic fauna. From an ecological point of view, our results showed that diversity was highest, for most of the groups, in heterogeneous piedmont and low mountain areas. This finding sustains the main current ecological hypotheses concerning freshwater lotic ecosystems, such as the river continuum concept (VANNOTE *et al.* 1980), the habitat templet theory (TOWNSEND & HILDREW 1994) or the intermediate disturbance hypothesis (RESH *et al.* 1988) which stipulate that the most diversified areas are likely to be found in the middle part of the river course. However, up to now, these hypotheses were only validated in temperate European and North American river systems and according with VINSON & HAWKINS (1998) much more attention should be paid to benthic invertebrates of the others parts of the world. Indeed, precise information on the ecology of each taxa, family, or trophic group are very scarce for North Africa and a complete inventory of Algerian benthic fauna could constitute an essential step for further ecological studies.

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REFERENCES

- Aguesse (P.), Dakki (M.), Gheit (A.) & Ramdani (M.). 1982. — Les Héétéroptères aquatiques du Maroc. Inventaire commenté. *Bull. Inst. Scient.*, Rabat, 6 : 125-138.
- Ait Mouloud (S.). 1988. — Essais de recherches sur la dérive des macro-invertébrés dans l'oued Aïssi : faunistique, écologie et biogéographie. Thèse Magister, Université d'Alger, 118 p.
- Arab (A.). 1989. — Étude des peuplements d'invertébrés et de poissons appliquée à l'évaluation de la qualité des eaux et des ressources piscicoles des oueds Mouzaia et Chiffa. Thèse Magister, Université d'Alger, 139 p.
- Aubert (J.). 1956. — Contribution à l'étude des Plécoptères d'Afrique du Nord. *Mitt. Schweiz. Ent. Ges.*, 33, (4) : 213-232.
- Bedel (L.). 1895. — Catalogue raisonné des Coléoptères du Nord de l'Afrique (Maroc, Algérie, Tunisie et Tripolitaine) avec notes sur la faune des Iles Canaries et de Madère. Première partie. *Soc. Ent. Fr.* (ed.), Paris : 402 p.
- Bedel (L.). 1895. — Catalogue raisonné des Coléoptères du Nord de l'Afrique : Haliplidae, Hygrobiidae, Dytiscidae, Gyrididae. *Soc. Ent. Fr.*, 1-2 : 321-402.
- Eaton (A.E.). 1899. — List of Ephemeroidea hitherto observed in Algeria with localities. *Entomologist's mon. Mag.*, 35 : 4-5.
- Edwards (F.W.). 1923. — On some algerian species of *Simulium*. *Arch. Inst. Pasteur Algérie*, 1 (4) : 647-653.
- Gauthier (H.). 1928. — *Recherches sur la faune des eaux continentales de l'Algérie et de la Tunisie*. Minerva, Alger, 149 p.
- Gagneur (J.), Giani (N.) & Martinez-Ansemil (E.). 1986. — Les Oligochètes aquatiques d'Algérie. *Bull. Soc. Hist. Nat. Toulouse*, 122 : 119-124.
- Gagneur (J.) & Clergue-Gazeau (M.). 1988. — Les Simulies d'Algérie (Diptera : Simuliidae). I. Premières données biogéographiques et écologiques sur les espèces de l'ouest algérien. *Annls Limnol.*, 24 (3) : 275-284.
- Gagneur (J.) & Thomas (A.G.B.). 1988. — Contribution à la connaissance des Ephéméroptères d'Algérie. I. Répartition et écologie (1ère partie) (Insecta, Ephemeroptera). *Bull. Soc. Hist. Nat., Toulouse*, 124 : 213-223.
- Gagneur (J.) & Aliane (N.). 1991. — Contribution à la connaissance des Plécoptères d'Algérie in 'Overview and strategies of Ephemeroptera and Plecoptera'. Sandhill Press., Inc., Gainesville. Alba-Tercedor (J.) & Sanchez-Ortega (A.) eds. 311-324.
- Grenier (P.). 1953. — Simuliidae de France et d'Afrique du Nord. (Systématique, biologie, importance médicale). *Encyclop. Entomol.*, Série A. 29 : 1-170.
- Kaddouri (H.). 1986. — Révision des *Hydraena* du Maroc, d'Algérie et de Tunisie (Coleoptera, Hydraenidae). Thèse Doct. 3^{ème} cycle, Univ. Paul Sabatier, Toulouse, 115 p.
- Lestage (J.A.). 1925. — Ephéméroptères, Plécoptères et Trichoptères recueillis en Algérie par M.H. Gauthier et liste des espèces connues actuellement de l'Afrique du Nord. *Bull. Soc. Hist. Nat. Afr. N.*, 16 : 8-18.
- Lounaci (A.). 1987. — Recherches hydrobiologiques sur les peuplements d'invertébrés benthiques du bassin de l'oued Aïssi (Grande Kabylie). Thèse Magister, Université d'Alger, 133 p.
- Lounaci-Daoudi (D.). 1996. — Travaux sur la faunistique, l'écologie et la biogéographie des insectes aquatiques du réseau hydrographique du Sébaou. Thèse Magister, Université de Tizi-Ouzou, 152 p.
- Malicky (H.) & Lounaci (A.). 1987. — Beitrag zur taxonomie und faunistik der cherrfliegen von Tunisien, Algerien und Morocco (Trichoptera). *Opusc. Zool. Flumin.*, 14 : 1-20.
- Moubayed (J.). 1987. — Description of *Chaetocladius algericus* sp. n. and *Smittia durandae* sp. n. (Dipt. Chironomidae, Orthoclaadiinae). *Hydrobiologia*, 185 : 91-94.
- Moubayed (J.), Ait-Mouloud (S.) & Lounaci (A.). 1992. — Les Chironomides (Diptera) d'Algérie. I. Bassin de l'oued Aïssi (Grande Kabylie). *NachrBl. Bayer. Ent.*, 41 (1) : 21-29.
- Navas (L.). 1929. — Insectes Névroptères et voisins de Barbarie (Septième série). *Bull. Soc. Hist. Nat. Afr. N.*, 20 : 57-60.
- Parrot (L.). 1949. — Quelques notes sur les Simulies d'Algérie. *Arch. Inst. Pasteur Algérie*, 27 (3) : 273-175.
- Peyerimhoff (P.) de. 1905. — Nouveaux Coléoptères du Nord Africain (première note). *Bull. Soc. Ent. Fr.*, 10 : 229.
- Peyerimhoff (P.) de. 1925. — Haliplidae, Dytiscidae, Girinidae in 'catalogue raisonné des Coléoptères du Nord de l'Afrique de Louis Bedel', Paris, 1 (2) : 321-402.
- Pic (M.). 1905. — Diagnoses de Coléoptères algériens. *L'échange*, 21 : 145-148.
- Poisson (R.). 1926. — Hémiptères aquatiques nouveaux ou peu connus de l'Afrique Nord. *Bull. Soc. Hist. Nat. Afr. N.*, 17 (8) : 237-247.
- Reiche (M.L.). 1869. — Catalogue des Coléoptères de l'Algérie et des contrées voisines avec description d'espèces nouvelles. *Mém. Soc. Limnol. Normandie*, 15 : 44.
- Resh (V.H.), Brown (A.V.), Covich (A.P.), Gurtz (M.E.), Li (H.W.), Minshall (G.W.), Reice (S.R.), Sheldon (A.L.), Wallace (J.B.) & Wissmar (R.C.). 1988. — The role of disturbance in stream ecology. *J. N. Am. Benthol. Soc.*, 7 : 433-455.
- Sainte-Claire Deville (J.). 1905. — Notes sur les *Hydraena* d'Algérie. Mémoire hors texte. *L'échange*, 248 : 4.
- Sainte-Claire Deville (J.). 1909. — Nouveaux Coléoptères du nord africain (Coleoptera, Hydrophilidae). *Bull. Soc. Ent. Fr.*, 7 : 39-41.
- Selys-Longchamps (E.) de. 1902. — Odonates d'Algérie recueillis en 1898 par le Professeur Lameere. (Travail posthume). *Annls Soc. Ent. Belg.*, 46 : 430-431.
- Seurat (L.G.). 1922. — Faune des eaux continentales de la Berbérie. *Bull. Soc. Hist. Nat. Afr. N.*, 13 : 43-60, 77-92, 109-140.
- Seurat (L.G.). 1930. — Exploration zoologique de l'Algérie de 1830 à 1930. Collection du centenaire de l'Algérie. Masson, Paris : 708 p.
- Soldan (T.) & Thomas (A.G.B.). 1983 a. — New and little-known species of mayflies (Ephemeroptera) from Algeria. *Acta Ent. Bohemoslov*, 80 : 356-376.
- Soldan (T.) & Thomas (A.G.B.). 1983 b. — *Baetis numidicus* n. sp. Ephéméroptère nouveau d'Algérie (Baetidae). *Annls Limnol.*, 19, (3) : 207-211.
- Soldan (T.) & Thomas (A.G.B.). 1985. — *Centroptilum dimorphicum* sp. n., a new species of mayfly (Ephemeroptera, Baetidae) from Algeria. *Acta Ent. Bohemoslov*, 82 : 180-186.
- Soldan (T.) & Gagneur (J.). 1985. — *Ecdyonurus rothschildi* Navas, 1929 : description de la larve (Ephemeroptera, Heptageniidae). *Annls Limnol.*, 21, (2) : 141-144.
- Thomas (A.G.B.) & Lounaci (A.). 1989. — Compléments et corrections à la faune des Ephémères d'Afrique du Nord). 4. Les stades ailés de *Baetis punicus* Thomas, Boumaiza et Soldan, 1983 (Baetidae). *Bull. Soc. Hist. Nat. Toulouse*, 125 : 27-29.
- Thomas (A.G.B.) & Gagneur (J.). 1994. — Compléments et corrections à la faune des Ephémères d'Afrique du Nord (Ephemeroptera, Baetidae). *Bull. Soc. Hist. Nat. Toulouse*, 130 : 43-45.
- Thomas (A.G.B.). 1998. — A provisional checklist of the Mayflies of North Africa (Ephemeroptera). *Bull. Soc. Hist. Nat. Toulouse*, 134 : 13-20.
- Townsend (C.R.) & Hildrew (A.G.). 1994. — Species traits in relation to a habitat template for river systems. *Freshwater Biol.*, 31 : 265-275.
- Vaillant (F.). 1955. — Recherches sur la faune madicole de France, de Corse et d'Afrique du Nord. *Mém. Mus. Hist. Nat. Paris, (Zool.)*, 11 : 1-258.
- Vannote (R.L.), Minshall (G.W.), Cummins (K.W.), Sedell (J.R.) & Cusfing (C.E.). 1980. — The river continuum concept. *Can. J. Fish. Aquat. Sci.*, 37 : 130-137.
- Vejdovsky (F.). 1891. — Note sur un *Tubifex* d'Algérie. *Mém. Soc. Zool. France*, 4 : 596-603.
- Vinson (M.R.) & Hawkins (C.P.). 1998. — Biodiversity of stream insects : variations at local, basin and regional scales. *Annu. Rev. Entomol.*, 43 : 271-293.