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Macroinvertebrates of the western Aures massif: Taxonomy; Ecology and Conservation

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ABSTRACT

This work aims to highlight the biodiversity of macroinvertebrates in the Aures; 17 sites comprehend a wide variety of running water were sampled for almost two years. The study area included Belezma National Park (Biosphere Reserve) and the Western Aures Massif. These stations are at altitudes ranging from 300 m to 1800 m. Four classes, seven Orders, and thirty-nine families were counted on this study.

The region comprises practically two types of climate and consequently a wide variety of aquatic habitats. The abundance of taxa varies from station to station; it oscillates between a minimum of 63 individuals collected at El Kantra station and a maximum of 2311 individuals collected at Rhaouat station.

The distribution of Fauna Orders in Aures Includes Mayflies' dominance more than other orders by a percentage of 42%; at the second row,, the Diptera are positioned 29%; The Trichoptera presented by 12% in the third position, followed by Amphipods by 7% abundance. The rest of the others' orders are occupied by the percentage of 2 to 3% of the total abundance.

The dendrogram of hierarchical ascending classification visualizes the relationships between the sites, Where the variation of physicochemical parameters of desert regions is clear, unlike other mountainous sites.

The taxonomic study on certain taxonomic groups shows presentative results. Trichoptera is particularly poorly studied in the country; our study indicates that the Aures is a diversified region in this order, 18 species of 10 families of Trichoptera; we have identified Three species reported for the first time in Algeria.

The order of Diptera is present 29% of the total abundance of the harvested fauna, and It also occupies the first place concerning the family biodiversity of the aquatic fauna in the Aures region with 11 identified families.

The Simuliidae represents the most abundant family of all Diptera with a percentage of 68; this family's systematic study shows that the Aures comprising eight nominal, among them four species collected for the first time region of the Aures. The redundancy analysis (ADR) was to explain the distribution of the different species of Simuliidae at the level of all the sites.

Chironomidae is ranked second on the total abundance of fauna harvested in this study with 25%, a checklist of 48 species of Chironomidae set up as part of this work, practically this was the first study on Chironomidae in the Aures region, and all these species are reported for the first time in the Aures.

Word keys: Biodiversity, Freshwater, Aures, Macroinvertebrats, Algeria.

ABSTRACT

Ce travail vise à mettre en évidence la biodiversité des macroinvertébrées dans les Aurès, 16 sites comprenant une grande variété d'eaux courantes ont été échantillonnés pendant une période de deux années. La zone d'étude comprenait le Parc National de Belezma (Réserve de Biosphère) et le Massif des Aurès occidentales. Ces stations sont situées à des altitudes allant de 300 m à 1800 m. Quatre classes, sept Ordres et trente-neuf familles ont été dénombrés.

La région d'étude comprend pratiquement deux types de climat et par conséquent une vaste variété d'habitats aquatique. L'abondance de taxons varie d'une station à l’autre ; entre un minimum de 63 spécimens collectés à El Kantra station, et un maximum de 2311 spécimens récoltés à la station de Rhaouat.

La taille de la population au niveau des Ordres au Aurès est dominée par les Ephémères par rapport aux autres avec un pourcentage de 42% ; les Diptères sont positionnées avec 29%, Les Trichoptères sont présentes par 12% en troisième position, suive par les Amphipodes avec 7% d'abondance, le reste des Ordres est occupés avec un pourcentage de 2 à 3 % de l'ensemble de l'abondance totale.

Le dendrogramme de classification ascendante hiérarchique visualiese les relations entre les sites en fonction des facteurs physico-chimiques de l’eau, montre une distinction claire des régions désertiques contrairement à d'autres sites montagneux.

L'étude taxonomique sur certaines groupes taxonomiques montre des résultats intéressants. L’Ordre des Trichoptères est pratiquement peu étudie dans le pays d'une manière générale. Notre étude indique que l'Aures est une région diversifiée dans cet ordre : 18 espèces de 10 familles de Trichoptères; dont trois espèces signalées pour la première fois en Algérie.

L'ordre de Diptère est représenté par 29% de la totalité de l'abondance de la faune récolté et il occupe également la première place concernant la biodiversité familiale de la faune aquatique dans la région des Aurès avec 12 familles identifies.

Les Simuliidae représentent la famille la plus abondante de l'ensemble des Diptères avec un pourcentage de 68% ; l'étude systématique de cette famille montre que les Aurès comprenent Huit groupes en complexe d’espèces. Parmi eux, quatre collectés pour la première fois dans la région des Aurès. L'analyse de redondance (ADR) donne une explication claire sur la distribution des différentes espèces de Simuliidae en fonction des facteurs environnementaux.

ABSTRACT

Les Chironomidae est la classe qui vient en deuxième position du point de vue d'abondance dans l'order de Diptère avec 25% de l'abondance totale. Une checklist de 48 espèces de Chironomidae a été établiées, pour la première fois dans la région des Aurès.

Mots clés : Algérie, Biodiversité, cours d'eau, Aurès , Macroinvertébrés.

ABSTRACT

يهدف هذا العمل إلى إبراز التنوع البيولوجي للافقاريات الكبيرة في الأوراس، حيث وخلال فترة عامين تم أخذ عينات من 16 موقعًا تشمل مجموعة متنوعة من المياه الجارية في المنطقة. تضمنت منطقة الدراسة منتزه بلزمة الوطني (محمية تنوع الحي) وجبل الأوراس الغربية. تقع هذه المحطات على ارتفاعات تتراوح من 300 م إلى 1800 م. تم إحصاء أربع فئات وسبع تراتيب وتسعة وثلاثين عائلة حيوانية

تضم منطقة الدراسة عمليًا نوعين من المناخ وبالتالي مجموعة متنوعة من الموائل المائية. تختلف وفرة الأصناف من محطة إلى أخرى؛ يتأرجح بين ما لا يقل عن 63 فردًا تم جمعهم في محطة القنطرة، و2311 فردًا كحد أقصى تم جمعهم في محطة رحاوات

يشمل توزيع ترتيب الحيوانات في الأوراس عن طريق هيمنة ذبابة مايو على الآخرين بنسبة 42٪، وفي الصف الثاني، تم تموضع ثنائيات الأجنحة بنسبة 29٪، وتحتل شعريات الأجنحة بنسبة 12٪ في المرتبة الثالثة، تليها المزدوجات الأرجل بنسبة 7٪ وفرة، أما باقي الرتب فتحتل النسب بين 2 إلى 3٪ من إجمالي الوفرة.

يصور مخطط شجر التصنيف التصاعدي الهرمي العلاقات بين المواقع، حيث يكون تباين المعلمات الفيزيائية والكيميائية للمناطق الصحراوية واضحًا، على عكس المواقع الجبلية الأخرى.

تظهر الدراسة التصنيفية على مجموعات تصنيفية معينة نتائج عرضية. ان دراسات المنجزة على ترتيب شعريات الأجنحة قليلة بشكل عام في الجزائر، تشير دراستنا إلى أن الأوراس هي منطقة متنوعة بهذا الترتيب ، 18 نوعًا من 10 عائلات من Trichoptera ؛ لقد حددنا ثلاث أنواع تم الإبلاغ عنها لأول مرة في الجزائر.

يمثل ترتيب ثنائية الاجنحة 29 ٪ من إجمالي وفرة الحيوانات المحصودة، كما يحتل المرتبة الأولى فيما يتعلق بالتنوع البيولوجي العائلي للحيوانات المائية في منطقة الأوراس مع 11 عائلة محددة.

تمثل Simuliidae الأسرة الأكثر وفرة من جميع ثنائية الاجنحة بنسبة 68؛ تظهر الدراسة المنهجية لهذه العائلة أن الأوراس تتألف من ثمانية اسمية، من بينها أربعة أنواع تم جمعها لأول مرة في منطقة الأوراس. كان تحليل التكرار (ADR) لإعطاء تفسير واضح لتوزيع الأنواع المختلفة من قرسيات على مستوى جميع المواقع.

احتلت Chironomidae المرتبة الثانية من حيث الوفرة في الحيوانات التي تم حصادها في هذه الدراسة بنسبة 25٪ ، وتم إعداد قائمة مرجعية من 48 نوعًا من Chironomidae كجزء من هذا العمل ، وكانت هذه هي الدراسة الأولى عمليًا على هذه الحيوانات في منطقة الأوراس ، تم الإبلاغ عن جميع هذه الأنواع لأول مرة في الأوراس.

الكلمات المفتاحية : التنوع البيئي , المجاري المائية, الاوراس, الجزائر,اللافقاريات المائية

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Abreviation list

A.fuscus : Agapeus fuscus

A. incertulus : Agapetus incertulus

Ablab sp : Ablabesmyia sp.

Agapetus sp: Agapetus sp.

Agraylea sp: Agraylea sp

Allotrichia sp: Allotrichia sp

BNP: Belezma National Park

Bryophae sp : Bryophaenocladius sp.

C. bicinctus : Cricotopus bicinctus

C. pallidula : Conchapelopia pallidula

C. riparius : Chironomus riparius

C. rufiventris : Cricotopus rufiventris

C. sylvestris : Cricotopus sylvestris

C. thummi: Chironomus thummi gr

C. vierriensis : Cricotopus vierriensis

Cardio sp : Cardiocladius sp.

Chaeto sp : Chaetocladius sp.

Cheumatopsyche sp: Cheumatopsyche sp

Cladota sp : Cladotanytarsus sp.

Con sp : Conchapelopia sp.

Cryptochiro sp : Cryptochironomus sp.

D. insignipes : Diamesa insignipes

Demicrypt sp : Demicryptochironomus sp.

E. bedmari : Eukiefferiella bedmari

E. claripennis : Eukiefferiella claripennis

E. lobifera : Eukiefferiella lobifera

E. minor : Eukiefferiella minor

Endochiro sp : Endochironomus sp.

H marcidus : Heterotrissocladius marcidus

H. vectis : Hydroptila vectis

Hydro. Contubernalis: Hydropsyche contubernalis

Abreviation list

H.marrocana: Hydropsyche marrocana

Hydro. Sp: Hydropsyche sp

L. bipunctatus : Limnephilus bipunctatus

Limno sp : Limnophyes sp.

M. atrofasciata : Micropsectra atrofasciata

M. aspersus : Mesophylex aspersus

O. ashei : Orthocladius ashei

O. excavates : Orthocladius excavatus

O. oblidens : Orthocladius oblidens

O. rivicola : Orthocladius rivicola

O. rubicundus : Orthocladius rubicundus

O. : Oued

P acifer : Polypedilum acifer

P albicorne: Polypedilum albicorne

P convictum : Polypedilum convictum

P nubeculosum : Polypedilum nubeculosum

P scalaenum : Polypedilum scalaenum

P. conspersa : Plectrocnemia conspersa

Parata sp : Paratanytarsus sp.

Pdeudo sp : Pseudosmittia sp.

Pro sp : Procladius sp.

R atripes: Rheocricotopus atripes

R chalybeatus : Rheocricotopus chalybeatus

R dispar : Rheocricotopus dispar

R meridionalis : Rheocricotopus meridionalis

Rhyaco sp: Rhyacophila sp

S. aurata : Silonella aurata

S.acutus : Setodes acutus

Saeth sp: Saetheria sp.

S.: Simulium

T .dives : Tinodes dives

Abreviation list

T. palettaris : Tanytarsus palettaris

Tany sp: Tanypus sp.

Tanytars sp : Tanytarsus sp.

Thienema sp: Thienemanniella sp.

Virgata sp : Virgatanytarsus sp.

W. occipitalis : Wormaldia occipitalis

Zav sp : Zavrelimyia sp

Freshwater represents 0.01% of the World's water (0.8% of the Earth's surface) (**Dudgeon et *al*., 2006**). This area supports at least 125, 000 species, almost 10% of all animals species on Earth (**Balian et *al*., 2007; Strayer& Dudgeon, 2010; Dijkstra et *al*., 2014**).

Freshwater ecosystems are hotspots; besides being biodiversity, it is also area human activities such as urban development or utility on agriculture and industry. Those ecosystems provide goods and services of critical importance to human societies, but it may the most damaged in the world; declines in biodiversity are far greater in freshwaters than in the most affected terrestrial or marine ecosystems (**Sala et *al*., 2000**). Both ecosystems and their species are exhausted by several human acts, including dams that alter flows and overexploitation, water pollution, fragmentation, destruction or degradation of habitat and invasions by non-native species, fishing pressure (**Collen et *al*., 2014**).

Among the serious factors affecting freshwater ecosystems is climate change, fluctuation in temperature and precipitation regimes will definitely affect freshwater biodiversity, and the relative effects will vary according to the area condition **(Ramulifho, 2020)**; for instance, the temperature strongly influences the physiology and fitness of fishes in temperate and high elevation regions (**Whitney et *al*., 2016**).

Pollution is a severe problem for every worldwide and freshwater are affected gravely by a range of pollution sources due to industry, treated or untreated sewage discharge, mining operations, and agrochemicals. In contrast, Freshwater organisms distinguished remarkably in their ability to survive in polluted waters. Resistant species can survive in water of degraded quality (e.g., low dissolved oxygen concentrations or high concentrations of nitrite). The species are sensitive to pollutants it suffered to development, growth, survival, and reproduction. The Algae, aquatic invertebrates, and fishes are sometimes considered "resistant" or "sensitive" species used in calculating biotic integrity indices.

Streams and Rivers hold the highest proportion of benthic organisms, and these ecosystems very sensitive to anthropogenic activities, which cause a loss of species diversity, and ultimately altering the ecosystem (**Bunn & Arthington, 2002; Dallas & Rivers-Moore, 2014; Ramulifho et *al*., 2020**).

The benthic invertebrate taxonomic richness and diversity is various in variable environments, and they also show high spatial and temporal variation in their community structure and composition over different scales; all this is primarily determined by hydrological variation and local habitat factors of lotic ecosystems is high. (**Boyer, 2003; Boulton et *al*., 2008; Karaouzas et *al*., 2019**).

Although, the assessment of the status of freshwater biodiversity indeed challenged because aquatic ecosystems are difficult to survey, and many species in local communities are rare consequently, the estimation of species richness is imprecise. For that, a pattern of spatial variation in species distribution are requisite to many fundamental questions in macro-ecology and conservation biology in these environments **(Ramulifho et *al*., 2020)**.

The communities of macroinvertebrate are characterized by a remarkable heterogeneity, with various phyla, and trophic levels ramify. Thus any probability of lost some of these organisms will be very high with any change in environmental conditions (**France, 1990**).

As well as that, the bio-assessment of the lentic system was tested by using aquatic macroinvertebrates as bio-indicators (**Cranston, 1995; Usseglio-Polatera et *al*., 2000; Waringer & Graf, 2002; Raunio et *al*., 2011; Cañedo-Argüelles et *al*., 2016; Romero et *al*., 2017**). Then a comprehension process of interaction and functional presents a goal for the scientist to preserve and conserve these ecosystems by addressing the interactions between abiotic and biotic factors of organization qualitatively and quantitatively (**Geist, 2011**).

Physical factors related to habitat have been widely proved as significant distribution contributors to species of the benthic community; flow rate and water velocity, temperature, altitude, and other factors all contribute profoundly to the composition of aquatic macroinvertebrates (**Garrido et *al*. 1994; Vought et *al*., 1998; Nelson & Lieberman, 2002; Jiang et *al*., 2010; Yadamsuren et *al*., 2020**).

Therefore, several technologies developed, and various fundamental issues include the modeling of processes in aquatic habitats and their functionalities based on the identification and quantification of species through different factors (**Camargo et *al*., 2004; Munné & Prat, 2009**). In these senses, the purpose of understanding the mechanisms controlling the spatial and temporal distribution of biodiversity and productivity in aquatic ecosystems in many zones, including Mediterranean areas (**Acuña et al., 2005; Bonada et *al*., 2006; Boix et *al*., 2010; Benetti et *al*., 2012; Garcia et al., 2017**).

The Mediterranean lotic systems depict by high hydrological instability and marked seasonality, they have a seasonal flow and some floods in winter with severe droughts in summer, from another view there are other factors that affected these ecosystems like urbanization and climate change (**Bonada et *al*., 2007; Mas-Martí et *al*., 2010**), In North Africa, numerous studies have focused on the assessment of different taxonomic levels of macroinvertebrates as bioindicators on stream's water quality, but also on the taxonomy of fauna or hydrology and habitats structures(**Dakki, 1979 ; Boumaiza & Laville, 1988; Samraoui et *al*., 1993, 1998; Kettani & Langton, 2011; Adler et *al*., 2015; Belqat et *al*., 2018; Slimani et *al*., 2019**).

Since the 1980's the research in Limnology began, several works have been done in different places in Algeria country, focused on overall.

Aspects as for ecological and taxonomic richness (**Lounaci, 1987; Gagneur et *al*., 1988; AitMouloud, 1988; Arab, 1989 ; Lounaci-Daoudi, 1996; Samraoui & Menai, 1999; Samraoui & Corbet, 2000a-b; Arab et *al*., 2004; Zouggaghe & Moali, 2009; Yasri et *al*., 2013; Moubayed-Breil & Lounaci, 2013; Sellam et *al*., 2016; Benzina & Si Bachir, 2018, Bouhala et *al*., 2019; Benhadji et *al*., 2020**).

The Aures massif is a protective wall of the high plains of Constantine, in Eastern Algeria; it includes the Belezma National Park. It is characterized by a Northeast-Southwest orientation that follows the central valleys (wadis El-Hai, Labiod and El-Arab). It contains a varied climate. The study of macro-invertebrates of this region is poorly done (**Arigue et *al*.,2016 ; Benzina& Si bachir, 2018; Benzina et *al*., 2019; Ghougali et *al*.,2019; Sekhi et *al*.,2019**); Therefore, this work is mainly based on this region, especially with Through standards and dimensions different from what was previously applied.

Freshwater ecosystems provide a home to 60% of aquatic insects (**Dijkstra et *al*., 2014)**. Accordingly, We anchored and grounded specifically on this phylum at the Aures region with focusing on two important taxa, Trichoptera and Diptera (Simuliidae & Chironomidae).

Diptera is the most spread order in the freshwater ecosystems "three times more than Trichoptera and Coleoptera", the order characterized by a high ecological diversity and flexibility from any other aquatic fauna (**Adler & Courtney, 2019).**

Non-biting midges are the most abundant and diverse family of Diptera order at freshwater, with their estimated diversity amounting to 20,000 species worldwide; they occupied both lentic and lotic ecosystems, dating back to the Triassic (**Giller & Malmqvist, 1998; Ferrington, 2007; Armitage et *al*., 2012**). The knowledge of biological and ecological traits of Chironomidae and either her wealth on species used as indicators of quality conditions in freshwater ecosystems (**Usseglio-Polatera et *al*., 2000; Cranston, 2004; Raunio et *al*., 2011; Arguelles et *al*., 2016**). The only free-living insects have colonized the aquatic environment on all continents. In effect, two species inhabit Antarctica (**Allegrucci et *al*., 2006**).

The Palearctic region is considered the most richness on chironomidae species Followed by Nearctic Region (**Ferrington, 2007**).

Chironmidae fauna has been studied in many regions in North Africa, especially in Algeria (**Boumaiza, 1988; Kettani & Langton, 2011; Chaib et *al*., 2013 a-b; Boulaaba et *al*., 2014; Zerguine et *al*., 2018**), but the knowledge of the biotic components in Aures wadis is relatively low (**Bebba et *al*., 2015; Benzina et *al*., 2019; Ghougali et *al*., 2019**).

The Simuliidae appears as the second diversified family and the most abundant in lotic ecosystems (**Adler & Courtney, 2019**). More than 2,200 species have reported worldwide colonized all continents except Antarctica(**Adler & Crosskey, 2018**). Their females are hematophagous, several species private as vectors and take a role in transmitting parasites (e.g. *Leucocytozoon spp*., *Onchocerca spp*.). Algeria is not on the list of countries that include the disease vectors (31 countries of sub-Saharan Africa, Yemen and six countries in Latin America). However, the studies completed so far did not cover all parts of the country.

It identified 34 nominal species in Algeria (**Belquat et *al*., 2018**). Since the beginning of the eighties of the last century, several studies have been completed on blackfly (**Belazzoug & Tabet-Derraz 1980; Gagneur & Clergue-Gazeau 1988; Clergue-Gazeau et *al*., 1991**).

More recent studies have provided knowledge about Kabylie Mountains in northern (**Lounaci et *al*., 2000a-b**), in Tafna River Basin in northwestern Algeria (**Chaoui Boudghane-Bendiouis et *al*., 2012**), and The Seybouse River Basin northeastern (**Cherairia et al., 2014**), on central Sahara desert (**Cherairia & Adler, 2018**).

In the Aures region, only one study achieved on the biodiversity of black flies in the Oued El Hai at El kantra region (**Arigue et *al*., 2016**).

Trichoptera placed on the third arrangement at the most taxa diversified on freshwater ecosystems next to Coleoptera and Diptera (**Mores, 2009**). The caddisfly colonized all continents except Antarctica, the Oriental Region (Southern Asia) appropriated to the greatest number and the high-density species (5854 spp); the East Palearctic Region has characterized by less diversity and minimum density (1200 spp) (**Mores et *al*., 2019**).

Reports have proven that Trichoptera is among the most varied taxon Threatened in the natural, almost 74% of the species cited in decline or are extinct by the effect of the principal causes as well as the loss of habitat, pollution, pathogens, and introduced species, and climate change (**Sánchez-Bayo & Wyckhuys, 2019**).

In Algeria, this fauna is poorly known, and some intermittent studies available were carried out decades ago. The first studies are carried out1880's from McLachlan and Morton when they described several Trichoptera species from Algeria: *Tinodes algiricus* **McLachlan 1880**, *Hydroptila campanulata* **Morton 1896**, and *Hydroptila serrata* **Morton 1898**.

Then keep tracked by Ulmer (*Triaenodes albicornis* **Ulmer 1905**), Navás (*Polycentropus variatus* **Navás 1917**, *Hydropsyche obscura* **Navás 1928**), Lestage (*Wormaldia algirica* **Lestage 1925**), and Vaillant (*Stactobia algira* **Vaillant 1951**, *Stactobia maculata***Vaillant 1951**, *Beraea auresi* **Vaillant 1953a**, *Ecnomus relictus* **Vaillant 1953b,** *Agapetus fuscus* **Vaillant 1954**, *Agapetus numidicus* **Vaillant 1954)**, *Silonella aurata* **Hagen 1864).**

Offyears later, Schmid described the first species of Limnephilidae from Algeria, *Micropterna malatesta* **Schmid 1957** (= *Stenophylax malatestus*).

The next studies are relatively recent by **Malicky & Lounaci (1987)**, who described four new Trichoptera taxa (*Athripsodes ygramul*, *Oecetis uyulala*, *Rhyacophila urgl*, and *Thremma sardoum africanum*).

More recent studies are very few, and the most notably by sekhi were described new species of Aures region (*Limnephilus Barbagenusis* **Sekhi et *al.*, 2019**).

This present work has the following objectives:

- ❖ Enrich knowledge on the taxonomy and ecology of benthic macroinvertebras in the freshwater of the Aures region.
- ❖ In ambition to establish families checklist of the largest orders of macroinvertebrates on these sites.
- ❖ In purpose to establish the checklist of Trichoptera species of Aures region and census, the different species of this order in Algeria and englobe their distribution in the country.
- ❖ Establish the first checklist of chironomidae of Aures region Chironomidae of the status of Simuliidae in the area with new records from new sites.
- ❖ Follower and measured specific environmental parameters of the Aures region watercourses and give a preliminary visualization of these ecosystems ecology and dynamic in the Aures region.

This manuscript is divided into chapters. In the first chapter, we have defined the Aures region, where we present the limits of Aures mountains and the Belezma national Park. We also mentioned some details about the region's general bio-geomorphology, and we did climatological data that prevailed during the period 2000 - 2016.

The second chapter then specified the biology and ecology of benthos macroinvertebrates with a specific description of everything related to Trichoptera, for instance, morphologically or taxonomically characterized, which will be an overview of this order.

A third chapter is devoted to describing our sampling stations and materials and methods used to develop this study. The following chapter will be consecrated to results and discussion, and we closed this work with a general conclusion.

Chapter I: Description of Aures region

L'arbre suit sa racine.

Proverbe Berbère

1.1.The limits of the Aures Mountains:

Aures Mountains is the highest massif in Eastern Berber. It is located around 35 ° North latitude and 6-7° East longitude and with peaks exceeding the 2,000 m and highest in Algeria northern.

The meaning of the word Aures or Aoures as the natives pronounce it has not determined; it is probably a name of Berber origin, which we find, given to other mountains, particularly to the mountain Aoures near Khenchela. On the other hand, the Roman studies in the region induce that the Romans called this country "MY AURASIUS"(**Lartigue, 1904**).

The limits of the Aures Mountains were determined by numerous ancient documents (**Blayac, 1899; Busson, 1900; Lartigue, 1904; Mitard, 1941**). The Aures is included in the Batna, Biskra, Khanga-Sidi-Nadji, Khenchela quaternary region. It is preceded to the North by a series of foothills which for height compete with the prominent peaks of Algeria and which are inhabited just like him by populations of Berber race “CHAOUIA”. (**Fig Mitard 1941**).

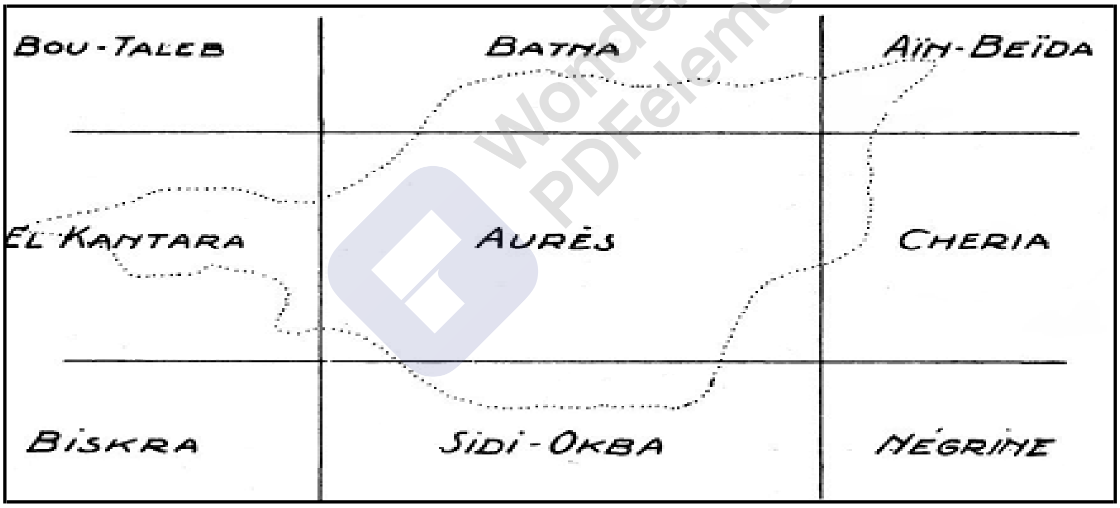


Fig1: The borders of Aures according to Mitard (1941)

The borders of the massif proper are marked to the west by Oued El Kantara (the bridge) and the Roman road from Lambiridis (El-Biar) to Ad Miscinam (Biskra), which separates it from the Zab Mountains. To the South by the Chott Melghir steppe and the road from Biskra to Nègrine by Zéribet El Oued. To the East by Oued El Arab which separates it from Djebel Cherchar (mount of Waterfalls) in Khenchela. In the North by the steppe of Sebkha Djendli and Garaa El Tarf that follows the road from Batna to Khenchela **(Fig2).**

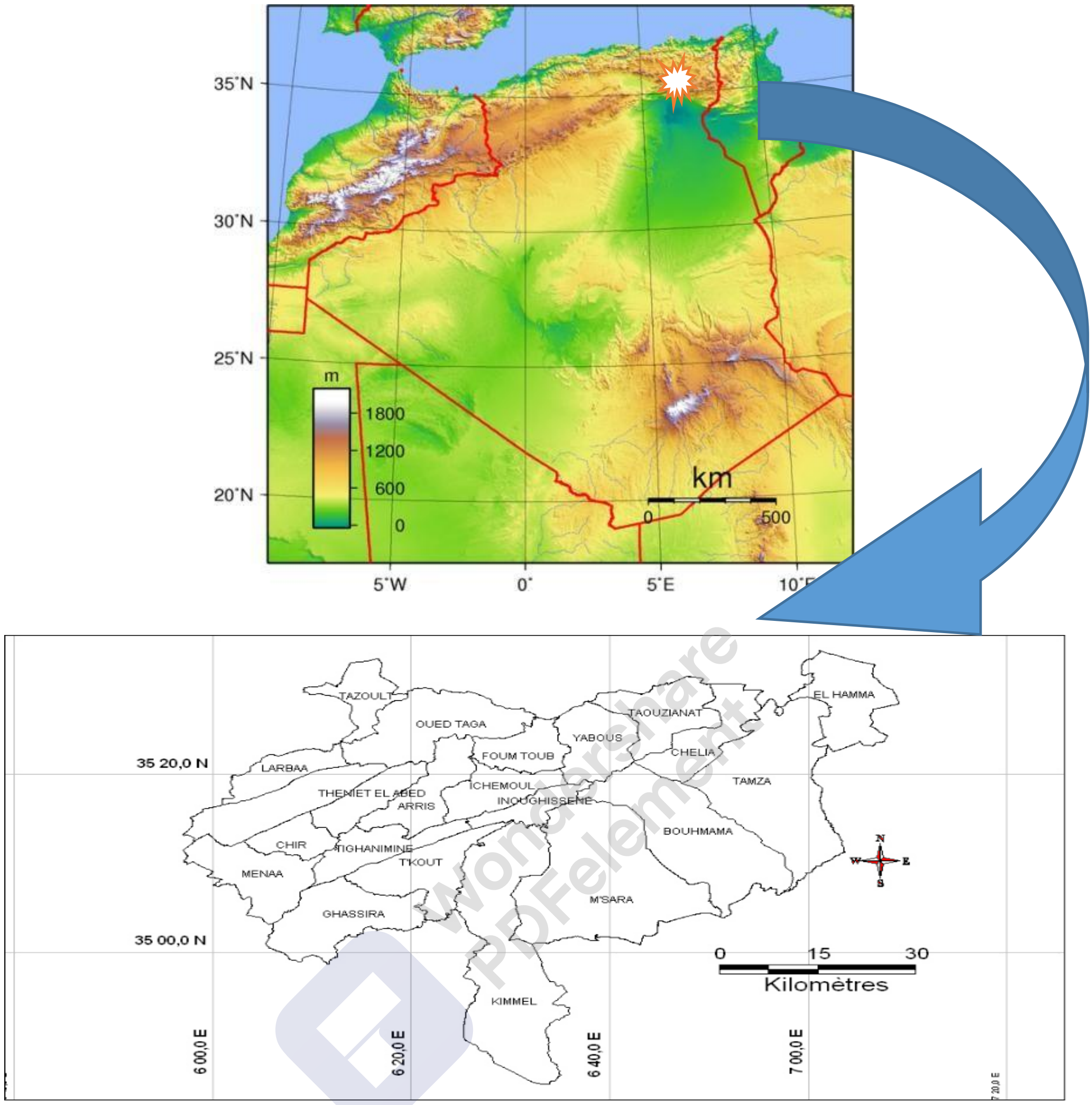


Fig2: Borders of Aures Mountains (Beghami, 2013)

For a general description, according to **Laffite (1939)**, the Aures massif presents a simple structure: the anticline dome rubs shoulders with the syncline basin, and it is thus all along the massif where the forms are oriented S.W.-N.E.

1.1.Physical characteristics of the environment:

1.2.1. Location and geographical setting:

Our study's choice fell on the Aures massif, which stands out as a homogeneous whole in terms of relief where the boundaries are very clear with the high plains to the North and the pre-Sahara to the South.

The Northern edge is a region of temperate crops; the Southern edge is more similar to the desert than to the steppe. Despite the relatively how close together are in the valleys and on the Auras crests, the environment here contains the most distinct climates and the most disparate vegetation. The structure of the Aures makes this juxtaposition even more sensitive and curious. The climate is specifically, both of North and the South borders so differ greatly, the temperature is much higher, and the rains are much less abundant in Biskra than in Batna and Khenchela.

1.2.2. The geographical features of the Aures:

The Aures massif generally made up of folded and dislocated sedimentary layers. The important part formation of the Aures builder at Cretaceous age (**Fig 3,4**), having undergone folds whose axis oriented from the North and southwest, at the geological scale a series of modifications makes up the Aures formation **(Busson, 1900; Bureau, 1971; Ballais & Vogat, 1979):**

1. The bumps in the primitive crust correspond to the oldest stratified soils. They are in Batna (Triassic, Jurassic), which outcrops in the Chellalah and East in El Outaya.
2. Most of the other lands are of more recent formation, and the dominant level is the Cretaceous in which largely belong the Aures, Tarbent, Kasrou, Tafrent, Metlili, Chelia and Fedjouj.
3. In Tertiary, Lower Miocene, and Lower Eocene, where the ridges and buttresses of these massifs are formed, which extend in broad bands: the 1 ° East and West of Batna, the 2 ° South- East of Batna (Southern and Northern slopes of the Aures).
4. Quaternary, alluvium and calcareous or gypsum crusts, dunes of the Sahara (Sahara, South of the Aures valley of El Kantara).

With all this, a Valley's parallel to this direction was dug by erosions filled by more recent deposits (Eocene, Oligocene), which gave this region the topographical aspect it presents.

The tectonics' dominant features are spotted SW-NE, and the relief is sufficiently developed than its main lines, valleys, and consequently, ridges are positioned in the same direction.

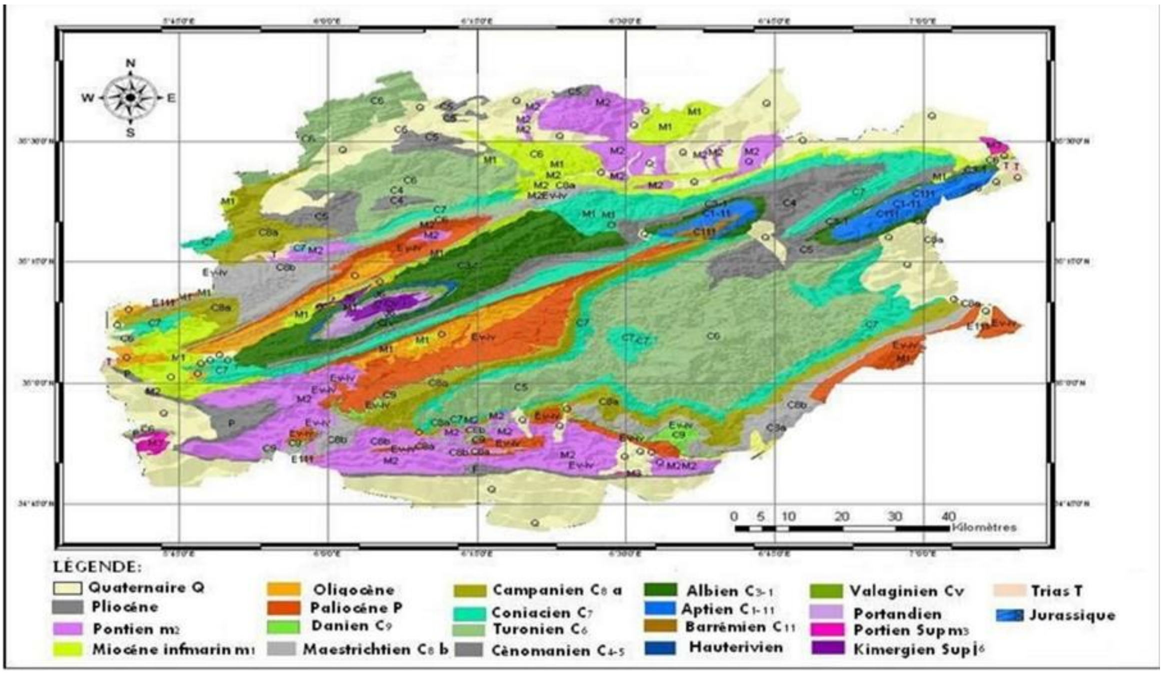


Fig 3: Geological map of Aures (Laffitte, 1939; Benmessaoud, 2010)

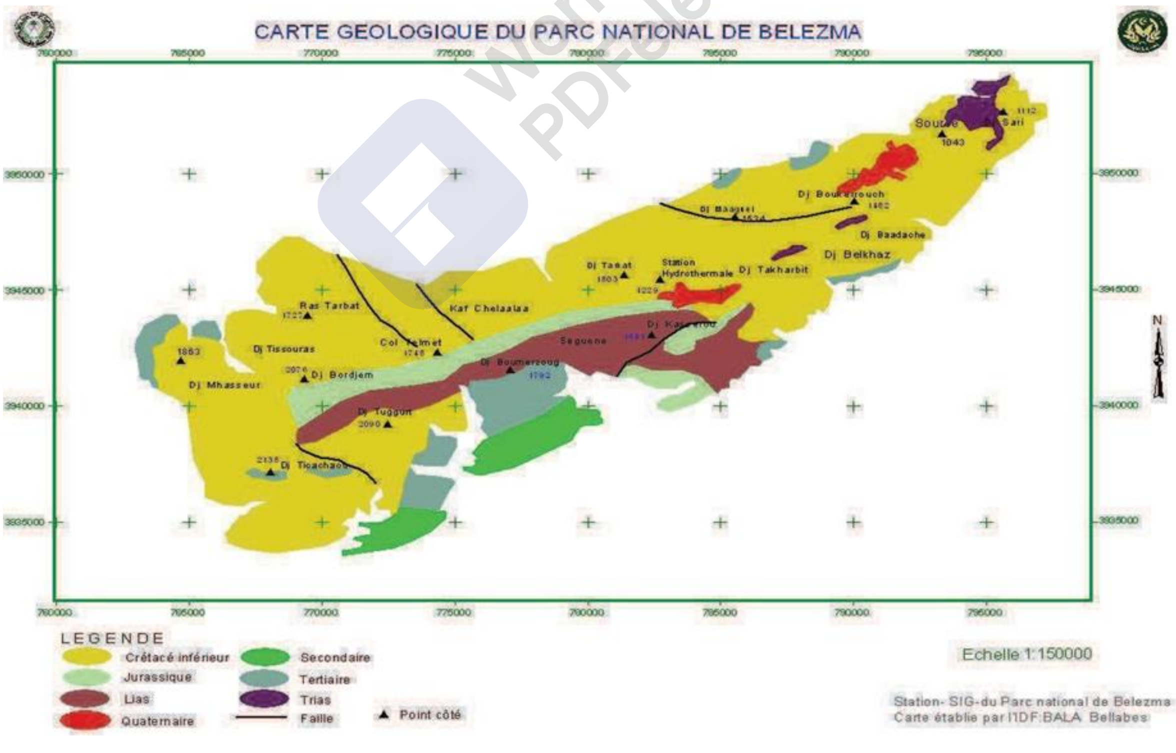


Fig 4: Geological map of Belezma park (GIS station - PNB Bala Belabes)

The region of Aures characterized by three types of facies are different **(Lartigue, 1904)**:

1. The massif is dominated in the North plateaus, comprising the entire North facade and the West facades' Northern parts. The entire base is mashed by strips of alluvium, separate from the neighboring massifs (Belezma, Bou Arif). With altitudinal degrees of (800 -1000 m), between Khenchela and Tamagra, and Douffana up to halfway between Lambiridi.
2. The semi-desert subaurasian arc, in the South West and in the South, alternates three deep depressions (Plain of Hodna, Plain of Outayas, and Eastern Zibans, from Biskra to Khanga-Sidi-Nadji) with two regions of less clear limits. Indeed, in the West, the Aures folds sometimes get bored under Hodna and Outayas, sometimes (between these two plains and South of the Outayas) are extended by the long thin and divergent ridges of the mountains of Zab.
3. In the southern part of the eastern edge, between Bled Kalaa -et-Trab and Khanga-Sidi-Nadji: there Cherchar Mountain, where the connection between the altitudes and the resemblance of the forms make the distinction between what is the Aures and what is artificial which is not the Aures.

If we look more closely at the composition of the core of the Aures, we found differentiation in geographical regions; by combining the nuances of the climate and the relief **(Djebaili, 1978; Ballais, 1982; Meharzi, 2010),** we can come to distinguish:

- the North, subdivided in turn to:

1 ° In the West, the isolated massif of Metlili.

2° The Northwest divided to:

- A Northern part (Ich Ali forest, Stah plateau, Oued Fedhala valleys and its tributaries);
- The region of Maafa, very original, with its clear rocks, full of manganese salts, transitions to the South.

3 ° The pure North includes:

- The Northern flank to the west: at the foot of the large perched clinal and the stripped anticline dome of the Temagoult; the great valley of Oued Taga follows out, separated from the Marcouna plain by a open glaze.
- The North flank to the East side: series of ridges and plains, directed W-E.
- The Heights Chelia: set of well-characterized summits (Mahmel, Ichmoul, Chelia) separated by plains or valleys.

4 ° The Northeast is made up of two very distinct regions:

- The plain of Mellagou is somewhat difficult to access by the North; either the side of the Chelia it leads to the SE.
- The Northeast ridges, almost entirely isolated by this plain, except in the North, and formed by large NE-SW alignments, cut by North-South valleys.

5 ° The center subdivides:

- The syncline cradle of Bouzma, is transitions to the South, is almost entirely closed except that the gorges, which emerge towards Maafa to the NW.
- The Oued Abdi's monoclinal valley upstream of Menaa makes an admirable transition from the Heights (Guerza) to the S (Chir and Menaa) by the region of Teniet-el-Abed.
- The Massive Azreg (ridges between Oued Abedi and Oued Abiod), thin upstream of Tirhanimine that widens to behind

6 ° The Northern part of the S-E: region of a northern character paradoxically separated from the others by the cradle of Rassira, widens considerably in the Cherchar where the Chelia located.

- In the South:
  - The region of confused relief and desert appearance of Dekhlat and Guergit, in the Southern part of the Southeastern massifs.
  - The Southwest, wide open on the Zab Mountains depressions and the Outayas comprises the synclinal cradle of El Kantara.
- In the West:

Northwest of Batna Province found the Belezma National Park, bordered by the plain of Merouana and from Ain Djasser to the North, the plain of El-Madher to the East, and to the West by the Oued Barika **(Chohra& Ferchiche, 2019)**.

1.2.3. Soil of the region:

The Aures formed lithologically of limestones dating from the Cretaceous and the Eocene, for that the soil is clay with rocky blocks made of limestone. It can be a homogeneous or shell limestone, or even a pudding with blocks whose disintegration results in clay soil with gravels **(Gouat & Gouat, 1983)**. Likewise,the sandstone and dolomitic is general formations in the region. For that, the principal categories of soils that can found in the Aures are:

- Limestone brown soil:

Exist in the cedar forest of Djbal Faraoun " Khenchela" and in Belezma where lower altitudinal limit, from 1500 to 2000 m.

- Rendosol:

These soils occur nearly on cracked limestone substrate or on dolomites and more or less altered dolomitic limestones. Following the very extensive degradation of the environment, this soil has become very rare. According to **Abdessemed (1981)**, we can find it in Belezma and under the most southern cedar forests.

- orthents:

This soil is impoverished; it has covered with sandstone slabs and rolled pebbles. With marly or clay and limestone composition, this soil requires a lot of fertilizer, and we have seen this type at Mchounech and Ghassira or El Kantra regions.

1.2.4. Vegetable cover:

The forests of Aures are quite ample, and the various species which inhabit are:

Juniperus communis (with local language "Taga"), *Juniperus phoenicea* (Arar), *Juniperus oxycedrus*, *Quercus ilex* (Kerrouch), Fraxinus (Touszelt), *Pinus halepensis* (Snouber), *cederus atlantica (*Begnoune), *Taxus baccata* (Tiffouzel).

A Cedar forest begins at 1,400 height, but we do not see them at any altitude on the south face exposed to the breath of the desert. The pines are after the cedars, the natural accessory of the Aures.

The Aures massif recognized among the 21 Zip (important area for Algeria plants) (**Benhouhou et al., 2010; Yahi et al., 2011**). Plant biodiversity in the mountains of the Aures and Belezma parc form forests of cedar, holm oak, and Aleppo pine, playing a geographical barrier and real biological ramparts against the great desert from the southern Biskra region.

1.2. Belezma National Park :

Geographically, the Belezma massif is located in the western region of the Aures, located between latitudes 35.699050 ° and 35.699708 ° north and between longitudes 5.897582 ° west and 6.301778 ° East. It includes an estimated area of 26,250 ha of forest. It was created in 1984 by a Presidential Decree N° 84/326 to protect the northern endemic vegetarian species African Cedrus atlantica. In June 2015; they attributed this classification to it because of the enormous expanses of Cedar Atlas in the area. It falls in the Batna province (Fig5). It is surrounded by eight settlements located at the foothills of these mountains: Batna, Oued-Chaaba, Merouana, Hidoussa, Oued el-ma, Seriana, Djerma, and Fesdis (**personal information direction of PNB).**

Belezma National Park characterized by an exciting flora, composed of 447 plant species including, 18 protected species, 9 endemic species, 14 weakly rare species, 21 moderately rare species, 19 scarce species, and 150 medicinal plants (**Chohra & Ferchichi, 2019**).

The rugged terrain of Belezma includes mountains of medium and high altitudes (Tichaou, 2136 m; Kassrou 1641 m) which form in together two parallel ridgelines separated by deep valleys. Regarding the vegetation, we find hardwood species (*Quercus ilex, Olea europaea, Pistacia lentiscus*), coniferous evergreen (*Cedrus atlantica, Pinus halepensis, Juniperus oxycedrus, Juniperus phoenicea*) and deciduous species (*Acer monspessulanum, Ilex aquifolium*). In terms of lithology, the park rests mainly marlstone, dolomitic limestones and limestone sandstones (**Fig6).**

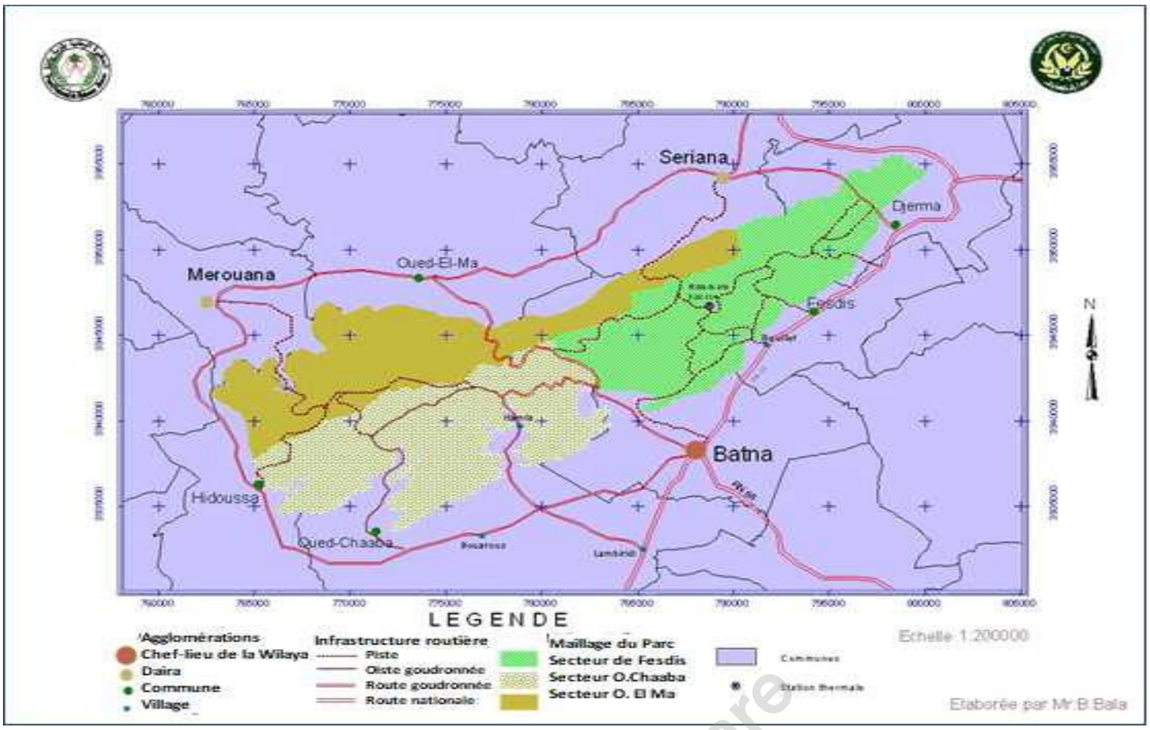


Fig 5: Location and division of Belezma National Park (Batna, North-East Algeria) (PNB, 2015

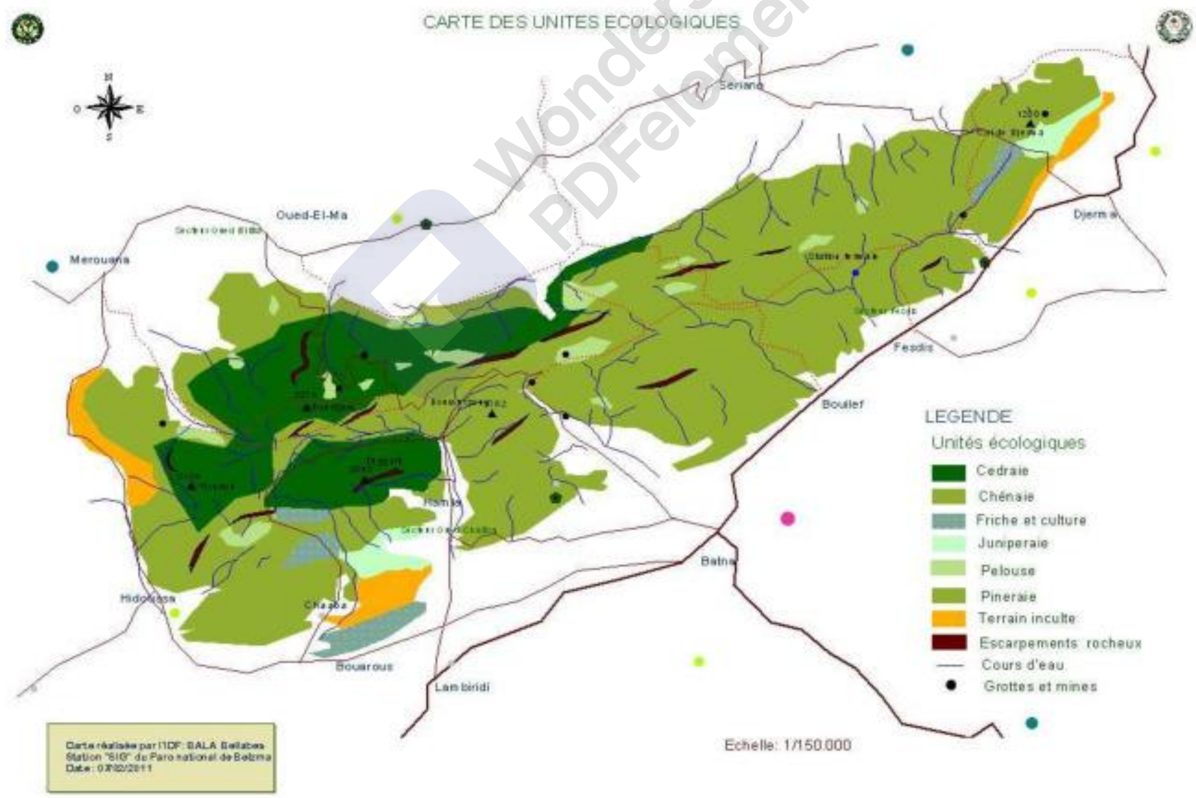


Fig 6: Map of the main ecological units described in Belezma National Park (PNB, 2015).

1.3. Climatology of Aures:

1.3.1. Generality:

The sensitivity of the physical environment in North Africa and consequently in Algeria is aggravated by the pluviometric and thermal oscillations where the amplitudes were always (on the Spatio-temporal plane) very marked **(Quezel & Barbero, 1990)**. The Aures have glared differences between northern piedmont and the south and also, between the east and the west, whether in terms of precipitation or heat.

Compared to its immediate surroundings and its southern location, the Aures massif is experiencing a diversity of climates; the central controller of the distribution of rain in this region comply with two parameters **(Seltzer, 1946; Meharzi, 1994)**:

- Hypsometric distribution: the most watered are the highest,
- Available in the NE-SW relief, therefore perpendicular to the disturbed NW flow.

Accord to this the region can divided to three distinct rain sectors **(Meharzi, 1994)**:

- Wet sector: corresponds to mountains that high close to 1800 m above sea level with exposure to the flow from the northwest, Ichemoul, Condorssi, Berbaga, Hidoussa.
- Average precipitation sector: it spreads deeper to the west and peaks culminating with altitudes less than 1300 m above sea level, Timgad, Bouailef.
- The dry sector: Interests the NE-SW oriented corridor located south of the Aurès massif, in other words each of the stations of El Kantara, Maffa and the eastern zone concerns the auras fallout where the rainfall decreases rapidly to 200 mm or even 150 mm / an Ghoufi & M'chouneche, Were the altitudes marginal to 800m above sea level.

1.3.2. Climate study of the Study area:

According to **Mutin (1977)**, **Duvigneaud (1980)** and **Dajoz (2000)**, the Ombrothermal diagram of Bagnouls and Gaussen makes it possible to define the bioclimatic conditions of a region by the importance of the dry season. Where (**Bagnouls & Gaussen, 1953)**, represent a dry month as one in which precipitation, expressed in millimeters, is fewer than or equal to twice the average temperature in degrees Celsius.

In this study, Whereas, The climate of Batna and Khenchela are similar in terms of climates. The data for the Khenchela region are inaccessible; emphasis was placed on the difference between the region of Biskra and Batna, considering that the sites of Khenchela are very close to Batna, which have approximately the same annual precipitations and temperatures.

1.3.2.1.Climate study of Biskra region:

- **Temperature:**

Table1: Monthly average temperatures of the Biskra region during the period 2000-2016

Mois	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
Maximum Temperature (°C)	17	19,14	22,85	27,14	32,7	37,38	41,76	40	35	29,8	22	17
Minimum Temperature (°C)	6,7	7,61	10,91	15	19,95	23,14	27,94	29	23	19	13	9
Mean Temperature (°C)	11,86	13,3	16	23	26,36	30,9	34,81	34	29	24	16,6	13

- **Precipitation**:

Table2: Monthly average precipitation of the Biskra region during the period 2000 - 2016

Mois	Jan	Feb	Mar	Avr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
precipitation (mm)	20,33	5,87	12,16	11,55	10.68	0.84	0,80	2,04	15,10	10,91	11	15,61

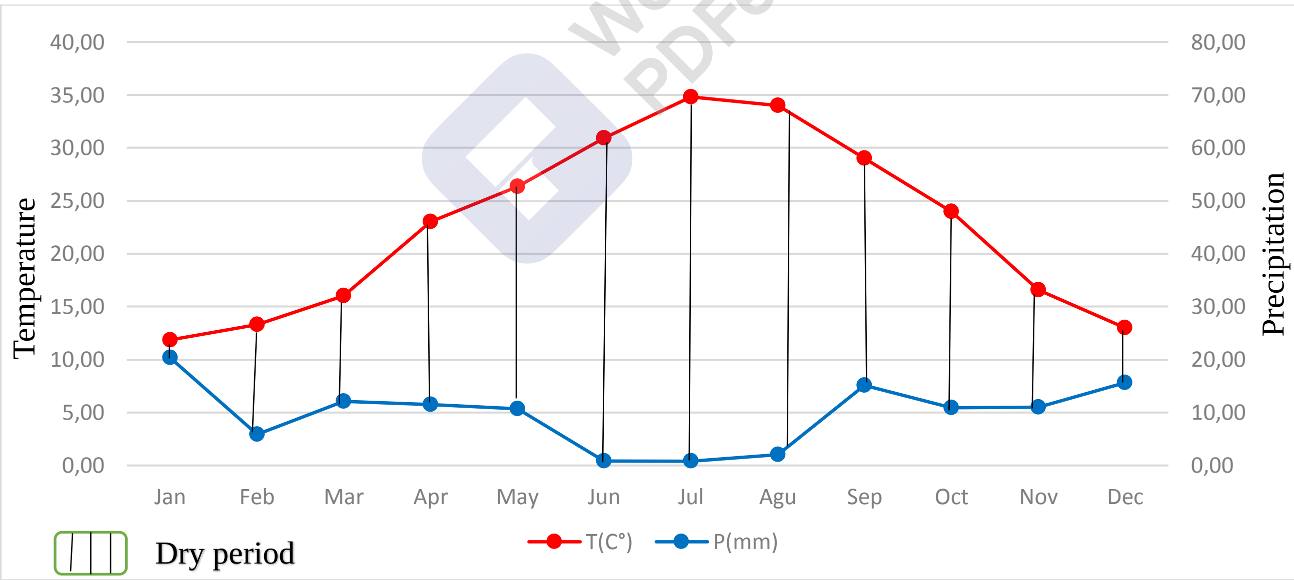


Fig 7.1: Gaussen temperature diagram of Biskra region

1.3.2.2.Climate study of Batna region:

- **Temperature**:

Table 3: Monthly average temperatures of the Batna region during the period 2000-2016.

Month	Jan	Feb	Mar	Apr	May	Jun	jul	Agu	Sep	Oct	Nov	Dec
Maximum Temperature (°C)	12,4	13,73	17,53	21,29	26,2	32,23	36,53	35,69	29,44	24,93	17,55	13,22
Minimum Temperature (°C)	0,23	0,62	2,86	6	9,92	14,2	17,35	17,22	13,97	10,42	4,43	0,93
Mean Temperature(°C)	6,315	7,175	10,195	13,645	18,06	23,215	26,94	26,455	21,705	17,675	10,99	7,075

- **Precipitation:**

Table 4: Monthly average precipitation of the Batna region during the period 2000 - 2016.

Month	Jan	Feb	Mar	Apr	May	Jun	jul	Agu	Sep	Oct	Nov	Dec
precipetation (mm)	51,09	20,58	32,78	40,22	46,65	22,72	3,98	12,3	35,11	20,04	24,95	31,49

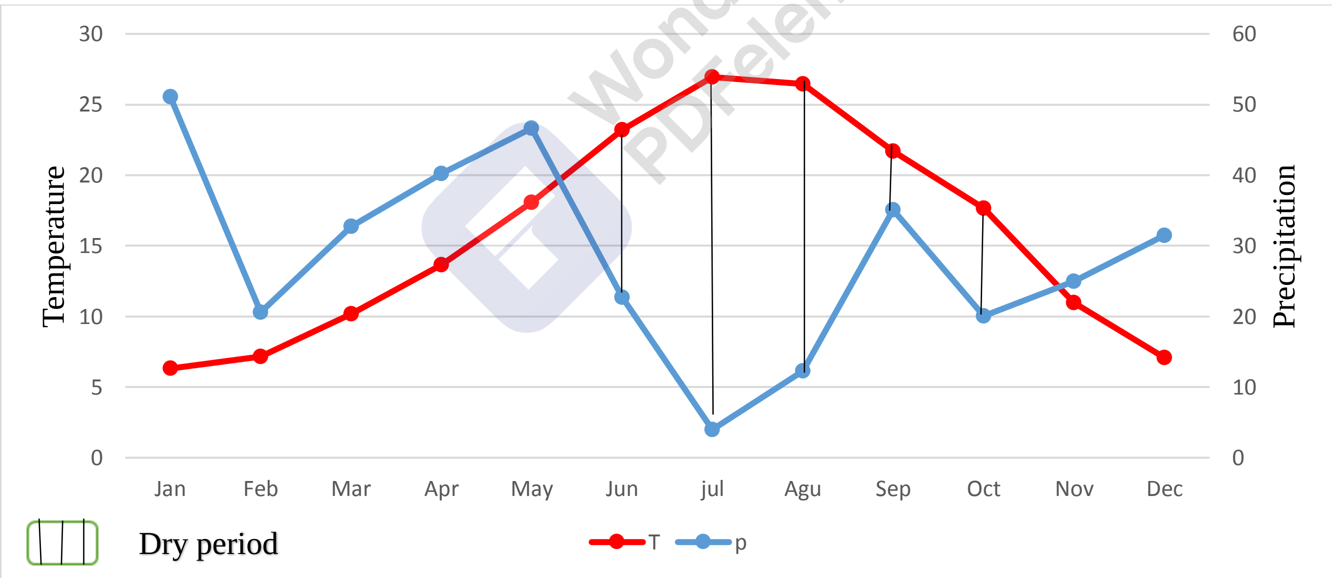


Fig 7.2: Gaussen temperature diagram of Batna region

1.3.2.3.Emberger climagram:

Emberger system allows the classification of different Mediterranean climates (**Dajoz, 1985-2006**).

This computation is a function of the maximum average temperature (M) of the hottest month, the minimum average (m) of the coldest month and the average annual rainfall (P). This quotient is higher when the region is more humid (**Stewart, 1969**). It is calculated by the following formula:

$$Q= 1000*P/(((M+m)/2)*(M-m))$$

Where:

- M: Maximum temperature of the hottest month.
- m: Minimum temperature of the coldest month.
- P: Average annual precipitation for the years taken.

This index is only established for the Mediterranean region and depending on the value of this coefficient, the following areas are distinguished:

- Wet for : Q> 100
- Damp for : 100> Q> 50
- Semi-arid for : 50> Q> 25
- Arid for : 25> Q> 10
- Deserts for : Q <10.

The **Table 5**, below shows the value of Q calculated for Batna and Biskra and the bioclimatic stage to which they belong.

Region	**P mm**	**M (°C)**	**m (°C)**	**Q2**	**Bioclimatic stage**
Batna	341,97	36,53	0,23	32,3	Semi-arid with fresh winter
Biskra	116,89	41,76	6,7	11,21	Saharan with temperate winter

These values show that the region of Batna is classified in the semi-arid bioclimatic stage in cool winter, the region of Biskra in the Saharan bioclimatic stage in temperate winter during the period 2000-2016 (**fig7.3**).

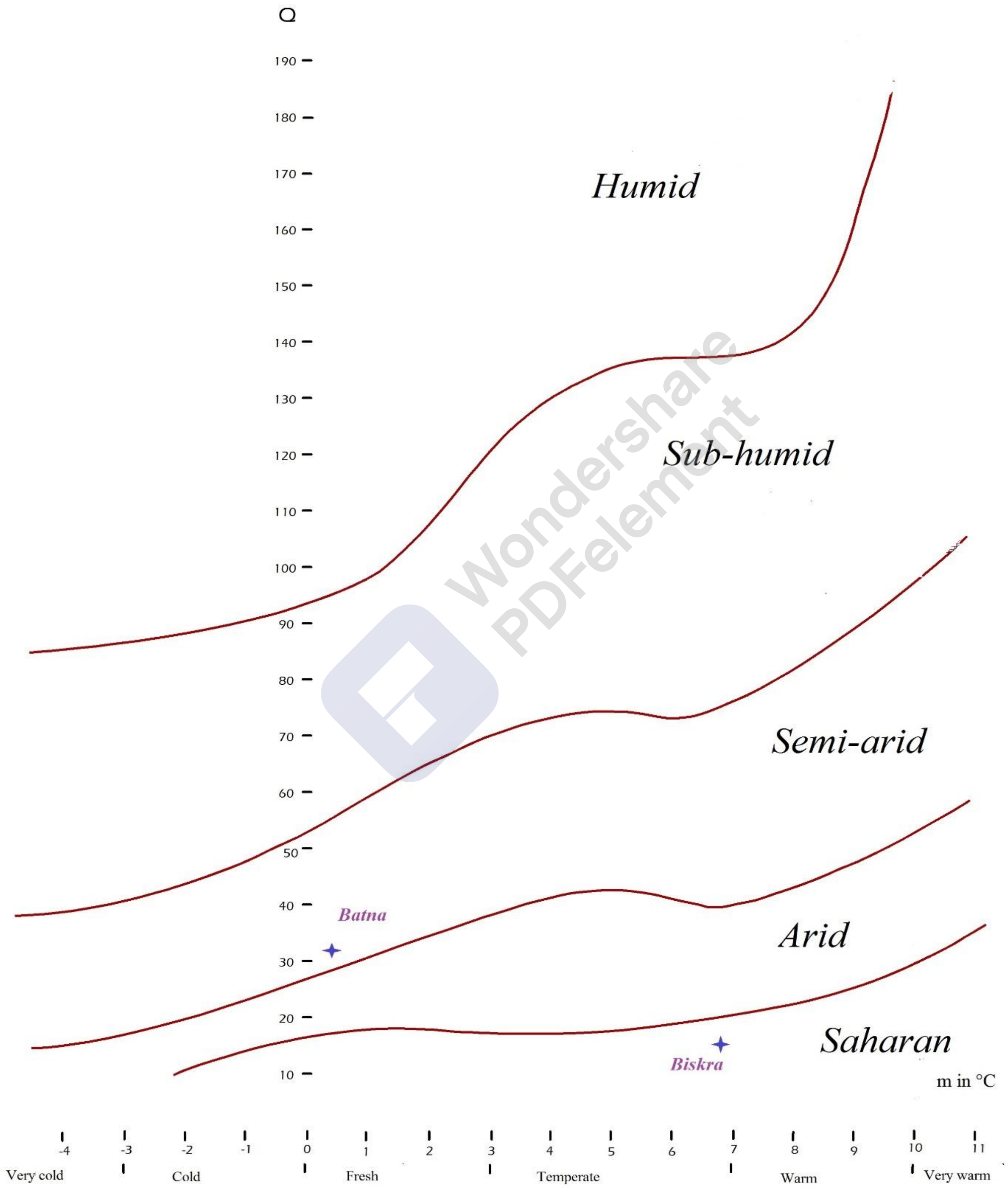


Fig 7.3: Emberger climagram of Aures area

1.4.Hydrographic Network:

On 7,000 km ² of space and mountainous structure, the Aures massif characterized by a very dense hydrographic network. Unlike the plains, where the watersheds are clearly defined, the Aures contains six watersheds, all with endorheic flow. Still, their hydrological actions are differentiated by their first extent and by the topography. These include streams with the permanent flow and temporary flow, but four principal directions, four in the South and three in the North **(Meharzi, 1994)**.

- Saharan side: Four valleys carve out this massif. They are those of Oued El Kantara, Oued Abdi, Oued El Abiod, Oued El Arab.
- In its Northern part: which are Oued Taga, Oued Boulefreis and Oued Issaoul
- The main rivers from the West are Oued El-Madher, Oued Chemora, Oued Foum El Gueiss.

Chapter II: Benthic invertebrates

La Nature est un somptueux théâtre où chaque jour est un spectacle.

1. Generality on macroinvertebrates:

Invertebrates' group represents the most diversity of species globally (**Martin & Davis, 2001; Giribet & Edgecomb, 2013**); around 107,259 species of freshwater invertebrates are known in the world (**Balian et al., 2008**).With an enormous diversity of forms and functions existing characterized in the animal kingdom. , the macroinvertebrates fauna plays a substantial role in the process of aquatic ecosystems; regardless of their functional trait role (**Tilman, 2001**); also, they get the part of a transformation of energy from producers (aquatic and terrestrial vegetation) to the up trophic levels (fish and waterfowl).

The invertebrate of freshwater divided into two types belonging on their way of life, planktonic they live suspended in the water belonged to mainly of Protozoa, Cladocera, Copepoda, Rotifera, and some crustaceans Ostracoda and Cnidaria;

benthic they live linked with the substrates at the bottom, some Protozoa, Porifera, Cnidaria, Annelida, Mollusca, Arthropoda, Tardigrada, and Bryozoa (**Allan & Flecker, 1993**).

At lotic ecosystems, the macroinvertebrates part of fauna communities, It is represented in a group of organisms that can be seen with the naked eye. The macroinvertebrates are Spends at least a period of their life in the water; They include species from distinct groups taxonomic. (**Balian et al., 2008**).

The study on benthic macroinvertebrates is extensive and broad. The time and data collected in our region allowed us to concentrate on the Trichoptera and the two families of Diptera.

2. The most important Macroinvertebrate types and classification:

2.1. Phylum: Mollusca

Phylum Mollusca is a remarkably varied phylum, with estimates of 80,000–100,000 described species worldwide. Total diversity it's possible appear to close to 200,000 species (**Strong et al.,2007**), is one of the lustrous phyla of aquatic invertebrates (**Dame, 1996; Strayer et al., 1999**), approximately of 4,998 species of Mollusca living in freshwater ecosystems (**Balian et al., 2008**). Five principal classes on this phylum all have the same body plan: a developed head, a big muscular ventral foot, and a dorsal visceral hump assure all the vital systems.

Mollusca is classified to Amphineura, Gastropoda, Scaphopoda, Lamellibranchiata, and Cephalopoda. In freshwaters, two classes of Mollusca have successfully colonized those continental ecosystems:

2.1.1. Class: Gastropoda

They colonized all aquatic habitats from rivers, lakes, streams, swamps, underground aquifers and springs, and temporary ponds, drainage ditches, even if ephemeral and seasonal waters. Most Gastropods live submerging on the water. Others are capable of prolonged periods of aestivation in the soil during dry periods. Small groups (some rissooidean families) can live at habitats particularize by a highly saline; in general freshwater gastropods are micro-herbivorous and/or micro-omnivorous, feeding on bacterial films, algae, or diatoms. The freshwater gastropod fauna is dominant by two subclasses (Classification follows (**Bouchet et al., 2005**):

Subclass: Caenogastropoda:

Subclass: pulmonata (heterobranchs)

2.1.2. Class: Bivalvia

Called Pelecypoda or Lamellibranchiata, their appearance is known from the Lower Cambrianat a few localities in the United States, southern Australia, and China (**Bogan, 2007; Graf & Cummings, 2007**). This aquatic animals have a hull composed of two matching lateral valves united by a dorsal horny ligament; the mechanism of drawn the valves together made through by a pair of adductor muscles(reduced to one in some) against the opening counter-force of the ligament (**Haas, 1969 ; Heard & Guckert, 1970**).

2.2. Phylum: Arthropoda

The name Arthropoda is Greek original, its mean "jointed foot". In **2009, Thorp** estimates that the number of described terrestrial and aquatic species surpass a million though a total number of related and undescribed species could be 2 to 6 million. The estimates of current species between 100,000 and 110,000 species of aquatic Arthropods, with ~6% Mites, ~14% Crustaceans, and 80% Insects (**Reiger et al., 2004; Balian et al., 2008; Mittermeier et al., 2010; Dijkstra et al., 2014**).

The diversity in this phyla is results of the success of Arthropoda over the decades. It caused to the significant provided by three characteristics: (1) jointed appendages, (2) a metameric (segmented) body usually divided into fused segments, and (3) a hard exoskeleton, that what is characterized the Arthropoda from the other invertebrate is the fusion of segments into tagmata make a specializes functions (**Thorp & Rogers, 2015**).

From herbivore, high detritivore to a top aquatic predator in fact, the Arthropods occupy all trophic positions in aquatic environments..

2.2.1. Subphylum: Crustacea

Since Tertiary, the subphyla crustaceans adapted to freshwater habitats in their evolutionary history; from 40,000 extant species of crustacea in the world, 10% occur in the continent in the inland pools, lakes, and streams (**Bowman & Abele, 1982; Banarescu, 1990; Barnes & Harrison, 1992**). The crustaceans' body has two tagmata in effect; the middle and posterior tagmata are fused into a cephalothorax. The crustaceans are present everywhere in freshwater habitats; even some species have colonized saline environments. Crustaceans are most frequently scavenging predators or have a general omnivorous diet. Crustaceans have diversified into several presumed groups, the most important from them in the freshwater environments (**Thorp, 2009)**:

Class Maxillopoda

Class Ostracoda

Class Malacostraca

- Superorder Peracarida
  - Order Mysidacea
  - Order Amphipoda
  - Order Isopoda

2.2.2. Subphylum: Hexapoda

Hexapoda is mean (Hexa: six, poda: foot), this super class of Arthropoda phylum includes an enormous diversity of winged insects (class Insecta, subclass Dicondylia), phonologically they have a common physical body parts characters (head, thorax, abdomen) also six thoracic legs **(Thorp, 2009)**.

2.2.2.1. Class: Insecta

The one million described species in this class (**Erwin, 2004**) divided into 29 orders (**Misof et al., 2014**). Insecta included all winged invertebrates (in the subclass Dicondylic), two orders in Dicondylia have ancient winged insects (Ephemeroptera and Odonata);. However, the rest (27orders) contains modern folding-wings. The adults share some morphological characters. Most of them have 11 abdominal segments with head features, two antennae with compound eyes, and tracheae respiratory (**Adler & Foottit, 2009**). A nearly 102,141 species of aquatic insects, described from 15 orders, represents 60% of all animal species in these environments (**Morse, 2017**).

i. **Order**: Coleoptera

The beetles are the first on the dominant insect order, with an estimation of 40% of the total number of insects (**Nielsen & Mound 2000**). About 25,106 aquatic species in the world (**Arnett & Thomas, 2000; Arnett et al., 2002**). about 700 species of aquatic coleoptera diffuse in the Palearctic areas; Coleoptera is one of the most successful insects in colonizing both terrestrial and aquatic ecosystems for its association and adaptation with the rise of flowering plants (**Farrell, 1998**). The first fossils of this order are for the Permian and represent one of the oldest orders of holometabolous insects. (**Tachet et al., 2000**).

It must be admitted that Coleoptera is all of terrestrial origin, but many are adapted to aquatic life (**D'Haese, 2004**). Some species are strictly aquatic, i.e., the three stages of life pass in water (e.g., Elmidae), others only adults which are aquatic (e.g., Dryopidae, Hydraenidae), from other only eggs and larvae aquatic (e.g., Psephenidae); Most beetles are univoltine in but can have more than one generation per year on specific climates (**White et al., 2008**). The tolerance of Coleoptera to pollution is medium and used to evaluate water quality (**Bilton et al., 2019**).

ii. **Order**: Ephemeroptera

Ephemeroptera constructs as a small order of amphinotic insects; with fewer than 3,700 species famous, with origins more than 300 million years (**Kukalova-Peck, 1985**); the monophyly of Ephemeroptera is exact, but its relationship with Odonata and Neoptera is not very resolved (**Thomas et al,.2013; Cai et al., 2018**). Mayflies lived in freshwater ecosystems worldwide; in actuality, mayflies, insects have represented an essential operative for monitoring water quality in these ecosystems.

Mayflies have a distinct characteristic from the other insects, despite the significant similarity in appearance between the Adults and subadults; in the same species is constant. The distinction lies on the characters of The obscurity of wings also at fringe of setae forward wing margins; Tint of the abdomen, either the length of the cerci; The terminal filament; The length of the forelegs of the males **(Sartori & Brittain, 2015**).

The subimago Is the stage of passage from the aquatic to terrestrial parts of the mayfly. The most famous characteristics of Ephemeroptera are that it possesses non-functional mouthparts and digestive systems; it spans the adult life only to reproduce (**Jacobus et al., 2019**).

Mayfly larvae are outstanding and easy to identifed, the long of body (without terminal filaments) of greater number of species fall between about 2 to 30 mm; the most of the larvae generally have terminal filaments. Larvae have prominent forewing pads; the abdominal compose of ten segments, with pairs of articulated gills on at most segments one through seven (**Sartori & Brittain, 2015**).

iii. **Order**: Hemiptera

Although the most arrangements in the Hemiptera order are terrestrial life, several families in the suborder Heteroptera are formally associated with freshwater habitats; probably they evolved an aquatic lifestyle to five infraorder (**Carver et al., 1991**):

1. some species of (Cicadelloidea) feed on the emergent portions of freshwater vascular plants;
2. betwixt the Hemiptera-Heteroptera, the Dipsocoroidea are shore-dwelling burrowers under stones;
3. the Gerromorpha are all habitat at water-surface
4. the Leptopodomorpha are shore-dwelling climbers and burrowers;
5. the Nepomorpha mostly swim beneath the water surface.

Most of the species diversity for aquatic Heteroptera is in the two infraorders Gerromorpha and Nepomorpha. Larvae resemble adults morphologically, but they lack wings and reproductive structures and live commonly at the same habitats (**Foottit & Adler, 2009**); Mostly the larva stage take five instars, usually with one generation each year for the majority of species, although some are multivoltine (**Sanderson, 1982)**

Surface-dwelling and semi-aquatic families are most common in late summer, whereas Nepomorpha families ultimately frequent in late fall (**Foottit & Adler, 2009**)

iv. **Order:** Diptera

Forty-six thousand Diptera species, "nearly 1/3 of total", have apart from their developmental attached to aquatic environment, considered the most dominant group from macroinvertebrates in freshwater. Besides, 30% of species of the total of 20 families throughout the dipteran phylogeny are aquatic in at least the larval stage (**Wiegmann & Yeates, 2015**); that's what makes true flies more aquatic representatives than any other order of insects (three times higher than the Coleoptera and Trichoptera) (**Adler & Courtney, 2019**). Moreover, Diptera has the most remarkable ecological diversity and flexibility of any aquatic order, while it is the only insect that has colonized the freshwater on all continents (**Allegrucci et al., 2006**).

Both aquatic larvae and adults of Diptera accord different ecological services; at various levels of relations in aquatic ecosystems, occupy different roles as predators or herbivores, and can serve as biological control agents, that's why it can tool as indicators of water quality (**Courtney & Merritt 2008; Wagner et al., 2008**).

Diptera is holometabolous insect; in most aquatic taxa, the last stage of the larva to adult is visible and well-encountered (**Courtney et al., 2017**). The eggs are usually laid singly; in small clusters attached to substrates in or near the water, all larval instars usually occur in the same habitat, for pupae generally fall into one of this following category **(Adler & Courtney, 2019)**:

1) Free-swimming pupae that rise to the surface (e.g., Culicidae, and most Chironomidae)

2) Pupae attached to benthic substrates (e.g., Simuliidae and some Psychodidae)

3) Pupae that burrow into marginal substrates (e.g., Tabanidae)

4) Pupariation, which is a special form intrapupation of the last larval instar (**Barros-Cordeiro et al. 2014)** (e.g., Sciomyzidae, Stratiomyidae).

Concerning adults, the most aquatic Diptera occur around or near water, except the species that cause a blood meal for ovarian development (e.g., Culicidae, Simuliidae, and Tabanidae) it can move many kilometers from the water source(**Courtney et al., 2017**).

Commonly, Diptera phylogeny divided into suborders;

With approximately 40 families and more than 55,000 species worldwide(**Pape et al., 2011**). Nematocera ("lower" Diptera) is a convenient term for this paraphyletic assemblage of families, Larvae nematocerans frequently have a well-developed, sclerotized head capsule. Their mandibles generally rotate at a horizontal or oblique angle, the adults have long, multisegmented antennae. Additionally, they are generally slender, delicate, long-legged flies; Nonetheless, the group also includes a bit stout-bodied flies (e.g., Ceratopogonidae) (**Merritt et al., 2009**).

Approximately 24,000 species in 20 families are assigned to three infraorders (Stratiomyomorpha, Tabanomorpha, and Xylophagomorpha) on this suborder (**Yeates et al., 2007**). Brachycera ("higher" Diptera); the larvae have a hemicephalic or acephalic head capsule and consisting mostly of slender, sclerotized rods that slightly or retreated into the thorax. The adults are described by the short, three-segmented antennae, the last segment of her is usually one stylate or aristate (e.g Muscidae) (**Merritt et al., 2009**).

1. **Simuliidae:**

Blackflies is one of the blood feeding insects; with 2,200 species Widespread (**Adler & Crosskey, 2018**); they are bloodsuckers and vectors of several pathogens and parasite, diseases viral, protozoan, and nematode pathogens, is consists of a dangerous vector for mammals health. Onchocercias is the most human disease transmitted by the black fly addressed by feeding type of the females; they have not a capillary feeder like a mosquito (**Crosskey, 1990; Adler et al., 2004**).

Females cut and injure the skin by the serrated mandibles and imbibe the blood oozing from the wound (Blood is not taken directly from a capillary as with mosquito).

The Black flies are attached jointly with clean and neat running waters, where their immature stages develop and the female adult's retrieval for oviposition; Streams and rivers in various environments are the habitats of the immature stages of Simuliidae **(Dobson, 2013)**. The rearing occupation includes streams in natural and artificial streams in the agricultural watering if they are clean and are swiftly running. Types and sizes of streams preferred by the immature stages of black flies differ from one species to another, and typically, they are considered good indicators of water quality (**Docile et al., 2015; Cuadrado et al., 2019**).

Black flies are distinguished from other Diptera by the following characters:

The adult stage by the short, cigar-like antennae with 11 segments and relatively broad wings with distinct venations confined anteriorly. body length in the order of 1.5–6.0 mm, whatsoever body of black flies is different from species to species, the color is mostly black or dark brown; other species can be with a yellow or orange body. The female featured from the male by eyes regions, almost entirely in the male, while incompletely for females **(Crosskey, 1990; Coscarón & Arias, 2007).**

At the pupal stage, the Simulies enclosure in a cocoon on the substrate and the paired gills arising from both sides of the thorax, larvae of Black flies are an excellent architect; the cocoons vary in shape depending on species. The pupal gills are diverse in distinct styles (**Fig 8.1**), and they are the most used as one of the key characteristics for species identification **(Crosskey, 1990; Rubtsov, 1990; Coscarón & Arias, 2007)**.

(a)

(b)

Fig 8.1: Pupa of Simuliidae: (a) *Simulium pseudequinum*; (b) *Simulium velutinum* Complex

Usually, the larvae stage of Simuliidae consists of seven instars stages (**Fig 8.**2). Similes' differencing on others dipteran larvae by the sausage-shaped body with a well-sclerotized head capsule that reunite a pair of labral fans, witch curve back upstream,

and also serve to catch small food to transfer to the mouth. Both prologs, were one in the thorax and the other in the posterior tip of the abdomen, where this latter one prolog serves as an attachment organ to fixed the larvae on the substrate. The larvae possess glands that produce a silken protein, which used to hold the abdomen onto the substrate **(Crosskey, 1990; Rubtsov, 1990; Coscarón & Arias, 2007)**.

Fig 8.2: larvae *Simulium velutinum* complex.

2. **Chironomidae:**

This family was deemed in aquatic ecosystems as the most abundant organisms in both numbers and biomass; it can be especially important in ecosystem functioning (**Armitage et al. 1995**). With 7,090 Aquatic species (**Adler et al., 2019**), the Chironomidae colonized all the different freshwater ecosystems; Including the estuarine marshes and intertidal pools either in the saline environment (**Courtney & Cranston, 2015**) and Groundwater zones (**Courtney et al., 2017**). All of the continents with two species inhabit Antarctica (**Allegrucci et al., 2006**).

The Chironomidae are a Diptera family that is part of the Culiciforme morphological group, which is to say their general appearance is that of a mosquito. They are Nematocera for larva stage the head is Eucephalic; the body is subcylindrical; In the thorax, it is found a Parapods are paired as bear crochets. The larvae of Chironomidae feed on decaying, fine organic matter and associated microorganisms (**Courtney et al., 2017).**

The pupa of Chironomidae shows features of both larva and adult or appears relatively formless. As nematocera's, Chironomidae pupae have a three body parts head distinct and thorax, and abdominal segments. Generally, they are mobile, using locomotors structures to swimming free in the water (**Courtney & Cranston, 2015**), the emergence stage varies from a taxon to other and conditioner with several factors, but this can be a day in very small Chironomidae (**Courtney & Cranston, 2015**).

The adults are characterized by long antennae (less as long as the head). Their oral apparatus is much regressed, and the atrophy of the mandibles in the adult stage does not allow them to bite. Their development cycle comprises three morphologically very different states that exhibit automatic variations that constitute essential bases of systematics while having an identical general appearance from one subfamily to another. (**Zerguine, 2010**).

v. **Order:** Trichopera

Trichoptera insecta are intimately related to Lepidoptera group, and form the monophyletic taxa Amphiesmenoptera (**Kristensen, 1981, 1989**). The trichopteran divergences appeared in the early Jurassic to late Triassic (**Grimaldi & Engel, 2005**). Modern Caddisflies fauna likely originated during the early Cretaceous to the late Jurassic and diversified in the Tertiary (**Ulmer, 1912; Grimaldi & Engel, 2005**).

At the seventh arrangement, Caddisfly are the most speciose order in insecta world; With 16,266 extant species belong to 613 genera in 46 families, caddisfly are the third order have more known freshwater species after Coleoptera and Diptera. This high species diversity is associated with a curious broad range of specialization of microhabitats (**Mores et al., 2019**).

the order Subdivided into two suborders Annulipalpia and Integripalpia with application of basis of the hierarchical classification system developed by the Morphological, molecular and behavioural features of the adults, larvae and pupae have been used to assess specific and higher taxonomic relationships between taxa (**Holzenthal et al., 2007**):

V.1.1 **Suborder Annulipalpia**:

With ten families, larvae of this suborder are indicated as fixed retreat makers, stationary construction shelters of fiber and particles of minerals, and often bits of plant material. These retreats are mostly attached to larger stones, woody debris, exposed roots of riparian plants, woody debris, or other relatively stable substrates and aquatic plants, frequently in streams or the wave-washed shores of large lakes. These retreats, functions as portable cases, are physical cover against predation and transmit oxygenated water past the body, usually from anterior to posterior (**Mores et al., 2019**);

Hydropsychidae, typically is reborn as the first divergence and a sister to the rest of Annulipalpia suborder. The next diverging covered both of Philopotamidae and Stenopsychidae; then an arrangement of the rest of the families in the suborder is the subject of some disagreement, but which was with light relationships between Psychomyiidae and Xiphocentronidae and between Economidae and Polycentropodidae **(Mores et al., 2019**).

V.1.2 Suborder Integripalpia:

Include the all monophyletic families related with tube-case; the larvae's use of sand grains, small rocks, twigs, leaves, bark, etc., to created cases. containing 39 extant families; in the monophyletic tube-case-maker lineage, there are two infraorders Plenitentoria and Brevitentoria. In Plenitentoria, Phryganopsychidae is found as the first diverging lineage and as sister to the rest of the group (Apataniidae, Goeridae, Limnephilidae, Rossianidae, Thremmatidae, and Uenoidae). The relationships among families in Brevitentoria are less clear, with the families Atriplectidae, Limnocentropodidae, Tasimiidae, Calmoceratidae, Molannidae, Leptocerida (**Mores et al., 2019**).

V.1.3 Spicipalpia:

Sometimes it is excluded from suborder Integripalpia Four families Hydrobiosidae, Hydroptilidae, Glossosomatidae, and Rhyacophilidae controversial third group, phylogeny they are yet unknown but are apparently near in the base (.**Holzenthal & Thomson, 2015**).

V.2. Biology of Caddisfly:

Usually, most caddisfly species exhibit a univoltine, but some species have over one generation per year and some with one generation every 2 or 3 years. The females' deposit one to several egg masses; each mass includes about 12 – 636 eggs. the eggs are enveloped in a sticky, gelatinous polysaccharide called pumalin, and they have formed could be spherical, pyramidal or butterfly-shaped, in Annulipalpian families, the egg masses enclose little spumalin, are cemented to the underwater substrate and arranged in rows. In most Integripalpia, the eggs are ingrained in a large amount of spumalin and form distinctive egg masses. Overall, little information is known about the surface and structure of Trichoptera, as severely insects the Eggs may survive diapause for several months before larvae hatch, peculiarly during winter (**Wood et al., 1982; Wiggins & Wichard, 1989; Morse, 2009**).

I. The Larva stage:

Usually, bear five instars before pupation. The larvae usually is the longest stage of the life cycle, with development completed during may range from two months to nearly two years. The shape of the larva varies with the family or genus and depends on the habits and feeding strategy peculiar to that taxon (**Morse, 2009**).

Mature larvae field in size from minuscule (<2mm in some Hydroptilidae and Glossosomatidae) to giant (40mm in some Phryganeidae) (**Resh et al., 1981**), the form of body is elongate and cylindrical. Still, some Hydroptilidae may be dorsoventrally flattened **(Holzenthal & Thomson, 2015)**.

A. Head:

Capsule is very developed and sclerotized, is most rounded, but can be in some species elongated. The head can be almost black or very dark brown due to a degree of sclerotization, or it can be very pale and smooth in texture; Frontoclypeal apotome is a large triangular, described by the frontoclypeal sutures, is a dominant part of the dorsal head capsule. The ventral version of head is an expression of the ventral apotome, constantly divided into anterior and posterior parts (**Holzenthal & Thomson, 2015**).

The entire mandibulate mouthparts—labrum is completely developed. The labrum is a piece, more or less semicircular, sclerotized, a shutter that is bi-articulated at the anterodorsal end of the head. The mandibles consist of a collection of rounded or more pointed apical teeth, which depends on the larva if it is detritivores or predaceous (**Holzenthal, 2009; Holzenthal & Thomson, 2015**).

There is no blind cadissfly larvae, it could be very small for some species but in overall the eyes, composed of many individual stemmata occur laterally (**Holzenthal & Thomson, 2015).**

B. Thorax:

De facto, there not exist apodous Trichoptera larvae; a pair of pronotal sclerites, separated mesially by a mid-dorsal ecdysial line, coats the prothorax dorsally. The "pronotum" prolonged down the prothorax's sides where the trochantin appears, which is represented as a small lateral propleural sclerite. For the meso- and metathorax it could be or not there are dorsal sclerotized nota (**Holzenthal & Thomson, 2015**).

In most Annulipalpia (e.g., Polycentropodidae, Psychomyiidae) and in the former spicipalpian families as Rhyacophilidae or Glossosomatidae, these thoracic nota are membranous in all or nearly(Fig 9.7); But for the other annulipalpian families like Hydropsychidae, the meso- and metathorax bear a whole pair of notal sclerites (**Holzenthal & Thomson, 2015)**;

In the integripalpian, at most families, the mesonotum may be totally or partially sclerotized. Simultaneously, the metanotum can be membranous or partiallysclerites, at Hydroptilidae and Ptilocolepidae families, the meso- and meta nota are sclerotized(**Holzenthal & Thomson, 2015**).

C. **Legs:**

There are many roles used; for walking, gripping the substrate in current water, feeding, stridulating, and make cases. In most case-making families, the first leg is usually the shortest and stoutest, contrariwise the mid- and hind legs either about the same size, for some families the hind leg longer and thinner than the midleg (e.g., Leptoceridae); Still, in some families, the legs are equally sized (e.g., Philopotamidae) **(Holzenthal & Thomson, 2015)**.

Generally, several families have highly specific legs adapted with their way of life.

D. **Abdomen:**

The larval abdomen is composed of 10 segments, the last segment demeanor a pair of anal prolegs, each finished by terminal anal claw (**Holzenthal et al., 2007**). The filamentous tracheal abdominal gills, help larvae in the cuticular respiration. While both of the shape and number of these gills, and their location in the abdomen, varies from family to family and sometimes in the different species of the same family. So usually used to identify various genera and species(**Holzenthal & Thomson, 2015**).

E. Anal:

It is the abdomen terminales of caddisfly larval, Represented in segments IX and X. The dorsum of segment IX bears a dorsal sclerite in some families and ventral sclerites occur on segments VIII and IX in Hydropsychidae) Segment X bears, shortened or prolegs, each ending in a pair or a single anal claw, according to the family (**Holzenthal & Thomson, 2015**).

II. Pupa stage:

Caddisflies pupae are exarate, with free parts of head and thorax. All caddisflies pupate center on some fixed, sealed, protected shelter, within a silken cocoon or not. Pupae of the Spicipalpia and Annulipalpia poverty a lateral fringe, even in the rare genera where a single filament occur in larva stage, differently Pupae of the Integripalpia generally have a lateral fringe, either under form mixed with filaments that are single or apparently polyfid **(Kerr & Wiggins, 1995).**

III. Adult stage:

Caddisfly adults are terrestrial, winged, aerial insects a dressed-up wings, resembling «fragile mouths", frequently occurring in large numbers in edges of wetlands habitats. In Trichoptera, both pairs of wings are covered with dense clothing of scales or hairs or with patches of scales. Adult size varied between a minute species (2 mm or less, e.g., Hydroptilidae) and large species (with forewing length of ~4.5 cm) .While most are inconspicuously colored in shades of brown or gray, probably an adaptation to camouflage them during the day in riparian vegetation. Several species, however, have brightly colored with yellow, orange, green(**Holzenthal & Thomson, 2015**).

The male genitalia, localized at abdominal segments 9 and 10, are visible, complex, and contain the essential characters for delineating genera and identifying the species. Females miss a true ovipositor, rather have the terminal abdominal segments (segments 9–10 or 11) either elongated into a protrusible ‘oviscapt’ for deposit eggs or altered into a shorter apparatus for forming and holding the egg mass (**Holzenthal, 2009**)

V.3. Ecology and Behavior:

As one of the important groups of macroinvertebrates in freshwater, the Trichoptera plays a principal role in processing nutrients. The largest trophic relationship diversity is higher than any other aquatic order insects other than Diptera (**Morse et al., 2019**). Caddisflies have great functional traits in waterways. Collecting-gathering, collecting-filtering, and coarse organic materials into small particles help the invertebrate and vertebrate predators make the nutrients available as the fed. From another way, Larvae of Trichoptera used on biological monitoring of freshwater ecosystems, and many species used as indicators of water quality (**Morse, 2009; Morse et al., 2019**)

Like the rest of the other taxa (along with mayflies, stoneflies, and true flies), larvae and adults of caddisflies are included in the diet of many animals and fish, birds, bats (**Fig.9**). Ecologically, these trophic relationships have ensured a return of nutrients from freshwater ecosystems to the surrounding riparian environment and vice versa (**Jackson & Resh, 1989**).

Fig.9: Cinclus cinclus feeding by hydropsychidae larvae (picture taking by Salim Sadali at Skikda region, 2020)

Chapter III: Material & Methods

Si nous prenons la nature pour guide,
nous ne nous égarerons jamais.

Cicéron

3.1. In Field:

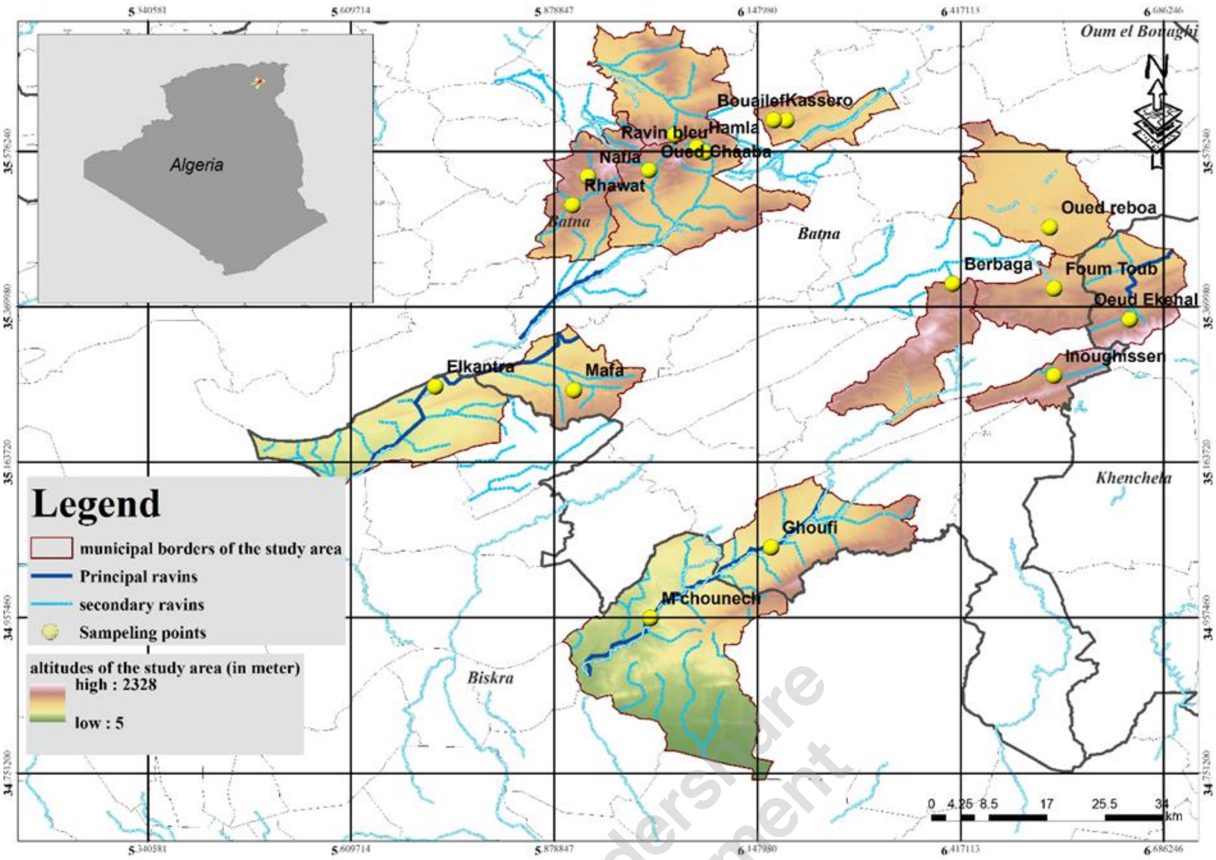
3. 1.1. Sampling sites:

On this work, we selected seventeen sites **(Table, 6)**, based on these criteria:

- ❖ The variability of the substrate in the original stations;
- ❖ The variety has regional and local parameters, mainly based on altitude;
- ❖ Type of environment, because the region is characterized by agricultural land and forests;
- ❖ More or less the accessibility of the stations because certain stations are plainly not accessible, therefore some of them were not visited regularly.

Table.6: Sampling sites for macroinvertebrates in the Aures region:

Locality	Substratum	Reparian environment	Hydoperiod	Number of samples
Bouailef	Silt-mud, gravel	Forest	Permanent	19
Berbaga	Silt-mud, Cobbles, gravel and boulders	Forest	Permanent	15
Inoughissen	Cobbles, gravel and boulders	Orchard	Temporary	17
Ghoufi	Sand and cobbles	Orchard	Temporary	12
Mchounech	Sand and cobbles and boulders	Urban	Temporary	12
Oeud Ekehal	Cobbles, gravel and boulders	Forest	Permanent	4
El Kantra	silt, Cobbles and boulders	Urban	Temporary	12
Maafa	Sand and cobbles	Orchard	Temporary	15
Rhawat	Silt-mud, gravel	Orchard	Permanent	16
Nafla	Silt-mud, gravel	Forest	Permanent	8
O.Chaaba	Silt-mud, gravel	Orchard	Temporary	7
Hamla	Silt-mud, gravel	Forest	Temporary	5
O. El Maa	Silt-mud, fine gravel	Forest	Temporary	1
Kasrou	Silt-mud, gravel and Cobbles	Forest	Temporary	2
Ravin Bleu	Silt-mud, fine gravel	Forest	Temporary	1
Foum Toub	Cobbles, gravel and boulders	Forest	Permanent	1
Oued Reboa	Silt-mud	Urban	Permanent	1



Map.1: Sampling stations at Aures hydrosystems

This biohydrological study relates to a set of streams in Aures. Our interest was mainly focused on the western region of the Aures and the Belezma National Park.

Among the stations surveyed, 17 were selected for this work. The distribution of these stations was achieved to consider specific parameters such as altitude, slope, diversity of biotopes, upstream and downstream of agglomerations to estimate the importance of the human impact, and the regularity of the distribution of stations along the rivers.

3.1.2. Study sites presentation:

The region of study located in the Aures, over an area of 2529 Km2, here where the origin of watercourses and the valleys are underground sources or which rely on melting mountain snow water, 17 sites selected it is distributed in various heights, between 1800 and 300 (ma.s.l.), It covers ten regions in 3 Department.

1- Oued Bouailef:

Longitude: 35°37’01”

Latitude: 06°11’17”

Altitude: 1060 (ma.s.l.)

Region: Fesdis

Wilaya: Batna

Fig10.1: Oued Bouailef

One of the sites in **BNP**. It is a locality dependent on the commune of Fesdis located to the West of the wilaya of Batna, limited to the SouthWest by the commune of Batna, to the North by Seriana, and the South by the commune of El Madher; the watercourse is warm and located in a pastoral forest with pine vegetation.

2- Oued Berbaga:

Longitude: 35°24’01”

Latitude: 06°24’31”

Altitude: 1445 (ma.s.l.)

Region: Oued Taga

Wilaya: Batna

Fig10.2: Oued Berbaga

Berbaga is located in a mountainous zone challenging to reach at Oued Taga common at Batna . Approximate of this watercourse, located the Capéletti cave; it was discovered in 1969 by the French-Italian man "Jean-Baptiste Capéletti", it is considered one of the oldest caves used by man in North Africa (Many specialists say that this cave hosted man between 7,000 and 3,000 years BC)(**Roubet, 2006**). Berbaga limited in South by Arris, in North Ouyoun El Assafir, and to the East by Foum Toub and West by Tazoult; the common tree in the forest or under the watercourse and the region, in general, is the *oxycedra juniper*.

- **Oued Abiod**:

The Oued Abiod is a stream that crosses the Aures massif in the North East of Algeria; it takes its source at about 2000 meters of altitude2, 3 near Chelia Mountain, and flows towards the Sahara (Biskra) along a North-East / South-West axis. In this stream, we have three stations:

3- Oued Inoughissen:

Longitude:35°16’42”

Latitude:06°32’34”

Altitude: 1670 (ma.s.l.)

Region: Ichmoul

Wilaya: Batna

Fig 10.3: Inoughissen station

O. Abiod first crosses Mountain Ichmoul where the Inoughissen resort is located, the region is predominantly Mediterranean mountain vegetation (cedars, holm oaks and pine) but also it is an agrecultural region based mainly on arboriculture. Inoughissen is limited to the south by the town of T'Kout, to the North West by Ichmoul, and to the east by the Bouhmama (Khenchela).

4- Oued Ghoufi:

Longitude: 35°03’02”

Latitude: 06°10’04”

Altitude: 625 (ma.s.l.)

Region: Arris

Wilaya: Batna

Fig10.4: Ghoufi station

O. Abiod, after having passed the town of Arris, it sinks into the gorges of Tighanimine, 3 km long, or crosses the passage through the village of Ghassira where the Ghoufi station is located. Ghoufi Canyon is a tourist site, eroded by the Abiod river and stretches for four kilometers. The balconies of Ghoufi are on the sides formed by a traditional Berber habitat as a staircase and on their steep walls, by troglodyte dwellings (in 2005 the site was restricted as a UNESCO national heritage)(**Hamzaoui, 2018**).

Ghoufi is limited to the South by Mchounech (Wilaya of Biskra, to the North East by the municipality of T'Kout, and West by the municipality of Mena

5- Oued Mchounech:

Longitude: 34°57’25”

Latitude: 06.00’29”

Altitude: 317 (ma.s.l.)

Region: Mchounech

Wilaya: Biskra

Fig10.5: Mchounech station

Further South, at the exit of the gorges where O. Abiod crosses Mchounech leaves the mountain in the region of Biskra where the landscape of the valley becomes frankly desert, and then the water is lost in the sands of the desert.

Mchounech is located to the east of the wilaya of Biskra, 30 km from Biskra city and 120 km from Batna; and limited to the south by Aïn Naga, to the north by the municipality of Manaa (Wilaya of Batna), and to the east El Mizaraa and west by Sidi Okba

6- Foum Toub:

Longitude: 35°23'39"

Latitude: 06°32'34"

Altitude: 1193 (ma.s.l.)

Region: Foum Toub

Wilaya: Batna

Fig10.6: Foum Toub station

The stream is a tributary that takes its source at the level of the snowmelt coming from the heights of the Chelia massif, head south to North through Oued Seba then Oued Reboa where a hill reservoir planned. Foum Toub is located at 49 km South-East of Batna, is limited to the north by the Timgad basin, to the east of the Chelia massif, to the west by Arris and to the south of Ichemoul.

7- Oued Ekehal:

Longitude: 35°21'11"

Latitude:06°38'35"

Altitude: 1420 (ma.s.l.)

Region: Yabous

Wilaya: Khenchela

Fig10.7: Yabous station

Yabous, located in the North East of Batna, bounded to the South by the commune of Echemoul, to the North-East by Bouhmama, and the west by Ouled fedala city ; the source of the O. Ekehal watercourse located at the top of the Chelia mountain in Bouhmama. The region characterized by agriculture is based mainly on arboriculture, in particular apple.

8- Oued Reboa:

Longitude : 35°28’30 »

Latitude : 06°32’14 »

Altitude : 850 (ma.s.l.)

Region: Timgad

Wilaya: Batna

Fig10.8: Oued Reboa

North of Timgad, it located O. Reboa is one of the main streams that drain the Northern flank of the Aures. Two tributaries essentially feed it: the Taga stream and O. Foum Toub. Here at the level of 1,000 of altitude we find there *quercus ilex* very often in association with the steppe vegetation.

9- Oued Maafa:

Longitude: 35°15’33”

Latitude:05°54’23”

Altitude: 932 (ma.s.l.)

Region: Ain Touta

Wilaya: Batna

Fig10.9: Maafa station

Maafa, located South of Batna. Limited to the South by Biskra, in the North by Ben Foudhala, East by Bouzina and the West by Ain touta. It is a mountainous region, with an average altitude of 1040 m, the region characterized by Agriculture based mainly on arboriculture, particularly apricot; Maafa station fed by a source called “Ikhef N ' oufe”.

In Belezma National Park, the hydrographic network is much-branched, consisting mainly of temporary streams; according to the two ridges of the Belezma mountains, two main watershed lines materialize, to the North and to the South; in this work, we have seven park sites: :

- ✓ In the North: Oued El Maa
- ✓ In the South: O. Bouailef, O. Nafla, O. Chaaba, O. Hamla, Ravin Bleu, Kasrou.

10- Oued Rhawat:

Longitude:35°30’16”

Latitude: 05°54’18”

Altitude: 1414 (ma.s.l.)

Region: Hidoussa

Wilaya: Batna

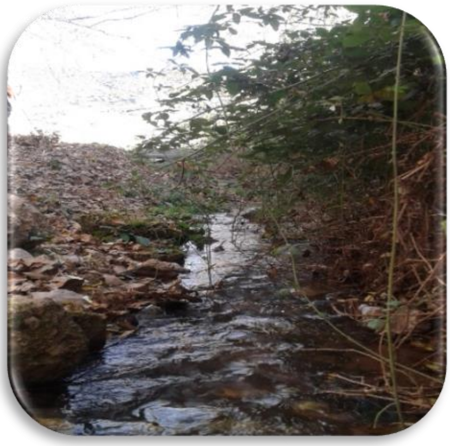


Fig10.10: Oued Rhawat

O. Rhawat, is a permanent watercourse, has its source locally in the Rhawat region; it's located in the middle of many agricultural lands for each apple and cherry trees. Rhawat took this name for "the water mills" the machine used to grind seeds and oils. Rhawat, like Nafla are located in the municipality of Hidoussa.

Besides height and with a distance of 20 km not too far from O. Rhawat, we find the Nafla site, a permanent stream and open to the air surrounded by herbaceous vegetation but near to the water located a forest *Quercus suber*.

11- Oued Nafla:

Longitude: 35°32’33”

Latitude: 05°55’30”

Altitude: 1428 (ma.s.l.)

Region: Hidoussa

Wilaya: Batna

Fig10.11: Oued Nafla

12- Oued Chaaba:

Longitude : 35°33’03”

Latitude : 06°00’22”

Altitude : 1262 (ma.s.l.)

Region: Oued Chaaba

Wilaya: Batna

Fig10.12: Oued Chaaba

O.Chaaba called "Lambiridi" in antiquity and “Victor-Duruy” during the colonial period, located East of the city of Batna, bordered to the North of Oued El Maa, to the South of Ben Foudhala and to the West of Hidoussa. The stream is temporaries cross a center of an agricultural region based mainly on arboriculture, in particular apple trees and raising cows.

O. Hamla, located in the village of Condorcet a few kilometers from the town of Batna, Located in the foothills of the mountain of Chlaâlaâ "the cedar peak", the landscape here offers a natural setting as beautiful as it is rare: Expanses of greenery punctuated of Atlas cedars, imposing, majestic, more and denser as you approach the stream. The site is permanent with a shallow flow especially in the dry years.

13- Oued Hamla:

Longitude : 35°34'52"

Latitude :06°04'10"

Altitude : 1154 (ma.s.l.)

Region: Condorcet

Wilaya: Batna

Fig 10.13: Oued Hamla

14- Oued El Maa:

Longitude: 35°35'52"

Latitude: 06°02'26"

Altitude: 1454 (ma.s.l.)

Region: Oued El Maa

Wilaya: Batna

Fig10.14: Oued El Maa

Oued El Maa called “Lomsotti” in Antiquity or “Bernelle” during the colonial period. The watercourse is temporaries and located in the center of a cedar forest. Oued El Maa located to the North West of Batna city.

15- Oued Kasrou:

Longitude : 35°37’03”

Latitude : 06°10’17”

Altitude : 1154 (ma.s.l.)

Region: Fisdis

Wilaya: Batna

Fig10.15: Kasrou station

16- Ravin Bleu:

Longitude: 35°35'29"

Latitude: 06°04'47"

Altitude: 1335 (ma.s.l.)

Region: Batna

Wilaya: Batna

Fig10.16: Ravin Bleu station

Kasrou and Ravin Blue are two water branches located above the Bouailef stream, in which the flow of water financed by snow water. They are small and relatively short.

17- Oued El Hai:

Longitude : 35°15'51"

Latitude : 05°43'23"

Altitude: 571 (ma.s.l.)

Region: El Kantra

Wilaya: Batna

Fig 10.17: El kantra station

El Kantara stream located between Batna and Biskra; it descends from the Chelala mountain pass (Belezma) which is located west of Batna. The hydrographic network here is characterized by the irregularity and the quality of the water in the Oued El Hai has experienced a great deterioration because the pollution in the site is very remarkable, due to the urban and industrial development (**Kerboub, 2012**). The landscape in El Kantara represented by oases.

3.1.2. Selection of samples:

Our research contributes to a better knowledge of the fauna of the freshwater common in Aures region; it aims to inventory and determine some specific Taxa in running water. To better understand their biodiversity and its relationship with environmental factors, with a difference in elevation in the Aures mountains.

Because this work was inclusive of many invertebrates, in the beginning, we took samples in the manner approved the research on macroinvertebrate benthic. Moreover, as one of the omnipresent aquatic insects living in a large diversity of freshwater habits, Diptera and Caddisflies collected by most of the standard methods and devices used in general aquatic macroinvertebrate surveys. Typically, the sampling technique in this work was tracking on the guidance of many works (**Malicky, 2004; Merritt et *al*.,2008; Cherairia et al., 2014; Adler et *al*., 2015; Karaouzas, 2015; Cherairia & Adler, 2018**; **Holzenthal &Thomson, 2015**).

For two years, samples were taken monthly in the sites selected in the Aures region; sampling taken by using a dip net 25 cm in diameter, mesh size 500 µm, all samples preserved in Ethanol 80–96%. Also, certain methods is used to take some focused taxa:

3.1.2.1 Sampling of Trichoptera:

The sampling aims to collect the most representative diversity of this order as well as larvae and adults at each site visited; the adults collected by sweeping the riparian plants using the same dip net.

3.1.2.2. Collection of Simuliidae:

The Simuliidae larvae and nymphs settle either on submerged supports (pebbles, rocks), or on living or dead plants, submerged, or on anchored or floating substrates (stems, roots) in effect they are strongly rheophilic, living in biotopes with currents, therefore the sampling consists in examining these supports. Individuals are gently removed using fine forceps and stored directly in alcohol or carnoy's solution (one; part acetic acid: three parts 95% Ethanol; **Adler et al. 2004**).

3.1.2.2. Collection of Chironomidae:

Under the guidance of Professor Boudjema Samraoui we have counted breeding for Chironomidae larvae from Bouailef site in successive intervals in order to get the adults, for the aim of clear a confusion concerning a larva of this site;

The larvae, along with a few algae and the components of the bottom of the waterway, were taken from the stream while they were alive and placed in plastic boxes and then transferred to aquariums equipped with air pumps; then when an adult has emerged, it is caught and placed in the Ethanol solution.

3.1.3. Measurement of physico-chemical parameters *in situ*:

To understand the dynamics and diversity of macroinvertebrate populations in the different sites, the Knowledge of the most important physicochemical parameters, it was necessary, for that, we used multi-probes. Both were measured: depth, width, current velocity; Conductivity, TDS, water temperature, measured by Adwa AD32 tester and HANNA HI1271 pH electrode.

Other chemical parameters have been measured only one time during the working at a private laboratory specialized for water quality control; they are mounted in the appendix. We measured all next parameters regularly throughout the sampling period:

3.1.3.1. Conductivity:

It is closely related to the concentration of dissolved substances and their nature. It’s measurement allows but very approximate evaluation of the overall mineralization of water (**Bounaceur, 1997**).

3.1.3.2. The temperature:

The temperature of the water plays a role in the solubility of salts and especially gases; in dissociating dissolved salts, therefore on electrical conductivity and determining pH. Other hand the temperature influences on oxygen, an increase in these causes a fall on the dissolved oxygen into the water (**Rodier, 1996**).

3.1.3. 3. The pH:

pH is a measure of acidity (predominance of h ions + oh-)or basic ions (inverse predominance) of an aqueous solution (Frontier and Pichod-viale, 1991). The tolerance level for aquatic organisms is between 4.5 and 9.5. So too acidic or too alkaline water can be fatal to aquatic life. Remember that enzyme proteins are likely to have their three-dimensional structure affected. Their biological activity will thus be disturbed (**Afnor, 1992**).

3.1.3.4. The Depth:

Depth is important environmental variant. The shallow depth allows all the layers of water to be under the action of solar radiation, as well as the air to diffuse widely and to mix well. The depth of the water influences the warming of the waters and therefore the distribution and proliferation of thermophilic fauna and flora (**Engelhardt et *al*., 1998**). This parameter noted by using a pole graduated.

3.1.3.5. Velocity:

In general, the fauna of running waters, differs from that of stagnant water and have adaptive characteristics that allow animals to protect themselves or to fight against this current, therefore The current of waters plays a particular role in determining the fauna inhabiting these environments (**Leveque, 2001; Angelier, 2000**).

We measure the speed of water by a simple technique, using a cork, from the which one determines the time (stopwatch) traveled by the stopper of 10 m distance, then it is calculated by the following mathematical relation:

$$V = d/t$$

3.1.3.6. Width:

The width of the bed of stream water is one factor affecting the speed of the current, the temperature and oxygenation of water (**Dajoz, 2000**).

3.1.3.7. Substratum:

The substrate is one from the important factors to aquatic populations dwell an environment specific (**Metallaoui, 1999**). It intervenes in the possibility of fixation or penetration of organisms (**Ozenda, 1982**). The different types of substrates in our study were listed in table 06.

3.2. in the laboratory:

The first identification is made by using the macroinvertebrates key (**Tachet et *al*., 2000).** Then for Simuliidae, we used **Clergue-Gazeau & Boumaiza (1986)**; subsequently, the samples are identified by Pr. Adler at the Department of Plant and Environmental Sciences, Clemson University.

For the Trichoptera, the identification done under supervision of Dr. Karaouzas during our traineeship at the Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research at Greece. We examined the collection by an Olympus SZX10 stereoscope using the taxonomic keys of **Zamora-Muñoz *et* al., 1995, De Pietro, 1999, Malicky, 2004, and Waringer & Graf, 2011.**

For Chironomidae it transported the collection to Italy, to Pr. Rossaro expert in taxonomy and ecology of Chironomidae at the University of Milan to identify the samples

3.3. Photography:

The photos of specimens of Trichoptera larvae used in this document taken in the forensic laboratory of the National Institute of Forensic Evidence and Criminology Bouchaoui in Algiers capital. We use both Dino-Lite digital microscopes (5 Megapixel resolution, 20-90x Magnification) and Leica EZ4 W Stereomicroscope (ntegrated 5 megapixel camera).

3.4 Stand structure analysis methods:

The first step consists in evaluating the general structure of the stands using the two variables of species richness and abundance (**Grall & hily, 2003**). These parameters provide a general visualization of the stand structure.

Taxonomic richness:

This index corresponds to the number of taxa present in each sample (**Ramade, 2003**).

• Abundance of species

Abundance is an important parameter for the description of a stand. It represents the number of individuals of taxon (i) present per unit of area or volume (**Ramade, 2003**).

$$Pi = ni / N$$

ni = number of individuals of species i

N = total number of individuals

3.5. Data analysis:

The main multivariate statistical methods used in this work are based on principal component analysis (PCA), factorial correspondence analysis (FCA) and hierarchical ascending classification (CAH) and Redundancy Analysis (RDA); we used in this study the XLSTAT 2020.5.1 version.

Principal component analysis is used for the description of physico-chemical characteristics (**Carrel et *al.*, 1986**). In this study, the principle of this analysis is to create, from linear combinations of the initial variables of physico-chemical parameters in the different sites to clearer status of conditions composing the various habitats.

The method of classification ascending hierarchical (CAH) are based on the measurement of the similarity between individuals or rather equivalently of their dissimilarity. For the ACH in this study carried out, to produce groupings of the sites described by a certain number of variables the similarity index used is that of the physico-chemicals various. The presentation made in the form of a root tree.

Factor analysis of correspondences (FCA) makes it possible to order the values of a table according to a certain number of axes corresponding to distribution factors (**Thioulouse & chessel, 1997**). It consists in seeking the best simultaneous representation of two sets Constituting the rows and columns of a contingency table, these two sets playing a symmetrical role. The goal of the FCA is to give a synthetic and graphic representation of the allocation of individuals of Chironomidae in a sampling spaces.

Redundancy analysis (RDA) was performed to relate community composition of macroinvertebrate to variation in the environment (**Borcard, et *al.*, 2011**). In this study Redundancy analysis (RDA) used to clarify the variation in the distribution of Simuliidae species according to the most important factors affecting the existence of this family we used two models:

(1) Included all environmental variables,

(2) Included forward selection to determine potential predictors from the environmental variables.

Chapter IV: Results & Discussion

C'est une triste chose de songer que la nature parle et que le genre humain n'écoute pas.

Victor Hugo

I. Global analysis of benthic fauna

Although this taxonomic work exists to determine the aquatic fauna of Aures region, the available keys and to shorten the time did not identify all the organizations. For that, all samples have been determined up to Family except Trichoptera and the two family of Diptera (Chironomidae, Simuliidae). The rest of Taxa, who identified at a family level, added in the **Table 7**:

Tab. 7: Checklist of macroinvertebrates from the Aures

Phylum						
	Arthropoda					
		Class				
			Crustacea			
				Order		
					Amphipoda	
					Family	
						Gammeridae
			Insecta			
					Heteroptera	
						Hydrometidae
						Notonectidae
						Veliidae
					Odonata	
						Libellulidae
					Coleoptera	
						Dytiscidae
						Hydrophilidae
						Elmidae
						Scirtidae
					Ephemeroptera	
						Heptageniidae
						Baetidae
						Caenidae
					Trichoptera	
						Rhyacophilidae
						Glossosomatidae
						Hydroptilidae
						Polycentropodidae
						Psychomyiidae
						Philopotamidae
						Limnephilidae

			Goeridae
			Leptoceridae
			Hydropsychidae
		Diptera	
			Simuiidae
			Chironmidae
			Dixidae
			Ceratopogonidae
			Culicidae
			Psychcodidae
			Empididae
			Limonidae
			Pedicidae
			Sciomyzidae
			Tabanidae
Mollusca			
	Gasteropoda		
		Basommatophora	
			Lymnaeidae
			Planorbidae
Annelida			
	Clitellata		
			Hirudinea

We note that Odonata and Plecoptera are two essential groups in the macroinvertebrate community in rivers, but their presence in our study site is very rare; during the sampling period, only a Libellulidae larva was founded in the Bouailef site.

I.1. Abundance of benthic fauna:

Of the 10,643 individuals of benthic invertebrates, (95%) are Arthropoda and (5 %) belong to other classes: Annelida, Molluscs (**Fig.11**)

The benthic population size shows that Ephemeroptera and Diptera are dominant (**Fig.12**). They represent respectively 42.55% (or 4,487 individuals) and 29% (or 3,124 individuals) of the total fauna.

Trichoptera, Crustaceans (Amphipoda), Gasteropoda, Coleoptera, Leech, Heteroptera and occupy respectively the 3rd, 4th, 5th, 6th, 7th, and 8th place in the order of digital abundance. They number respectively 12% (1,253 individuals), 7% (754 individuals), 3% (314 individuals), 3% (263 individuals), 2% (254 individuals) and 2% (194 individuals).

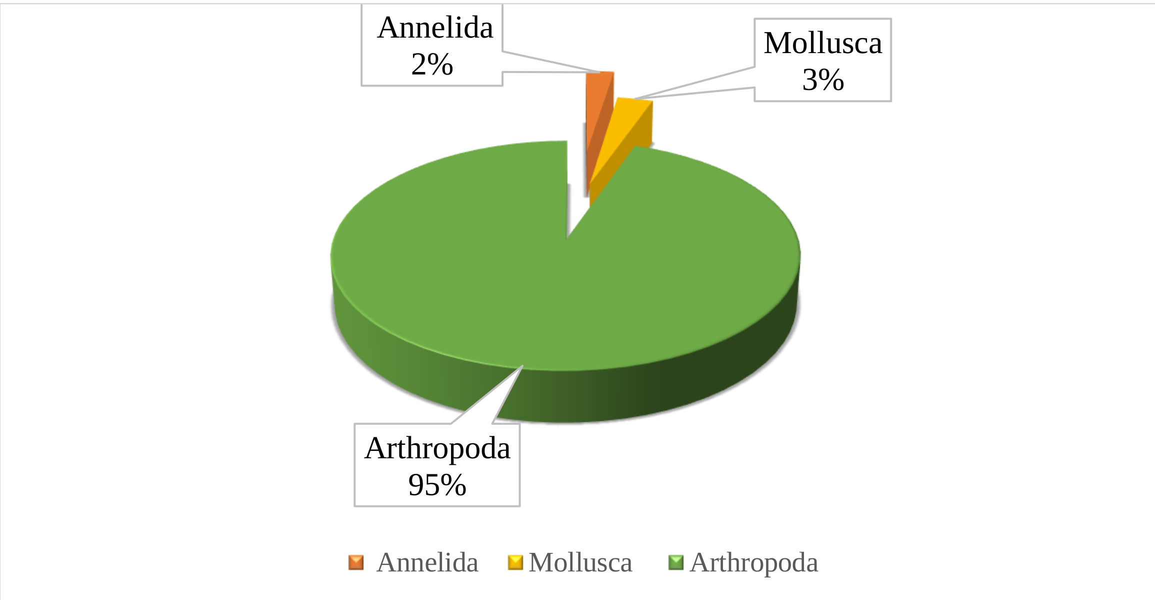


Fig.11: Percentages of faunistic phyla in the region studied

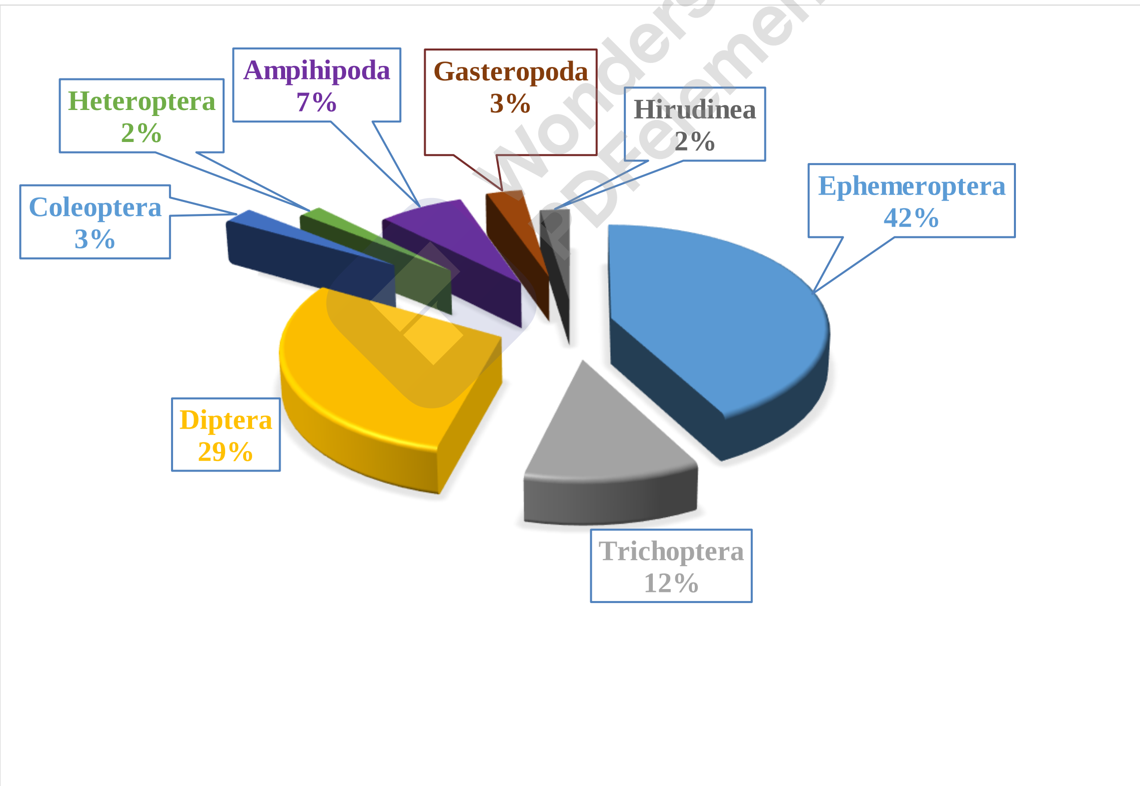


Fig.12: Relative abundance of faunistic groups in the streams studied

I.2. Abundance of Diptera families:

In this study, the order Diptera is represented by 12 families; we have sampled 3,124 individuals, of which 2,104 belong to the Simuliidae family, and which represent 68% of Diptera (**Fig.13**); the Chironomidae comes in the second position with 778 individuals. The Dixidae in the third position with 65 individuals either 2%, followed by 57individuals. The other families have numbers of individuals less than 50 and percentages less than 2%.

It should be noted that the abundance of Simuliidae here expresses those collected by dip net and not by the insect forceps.

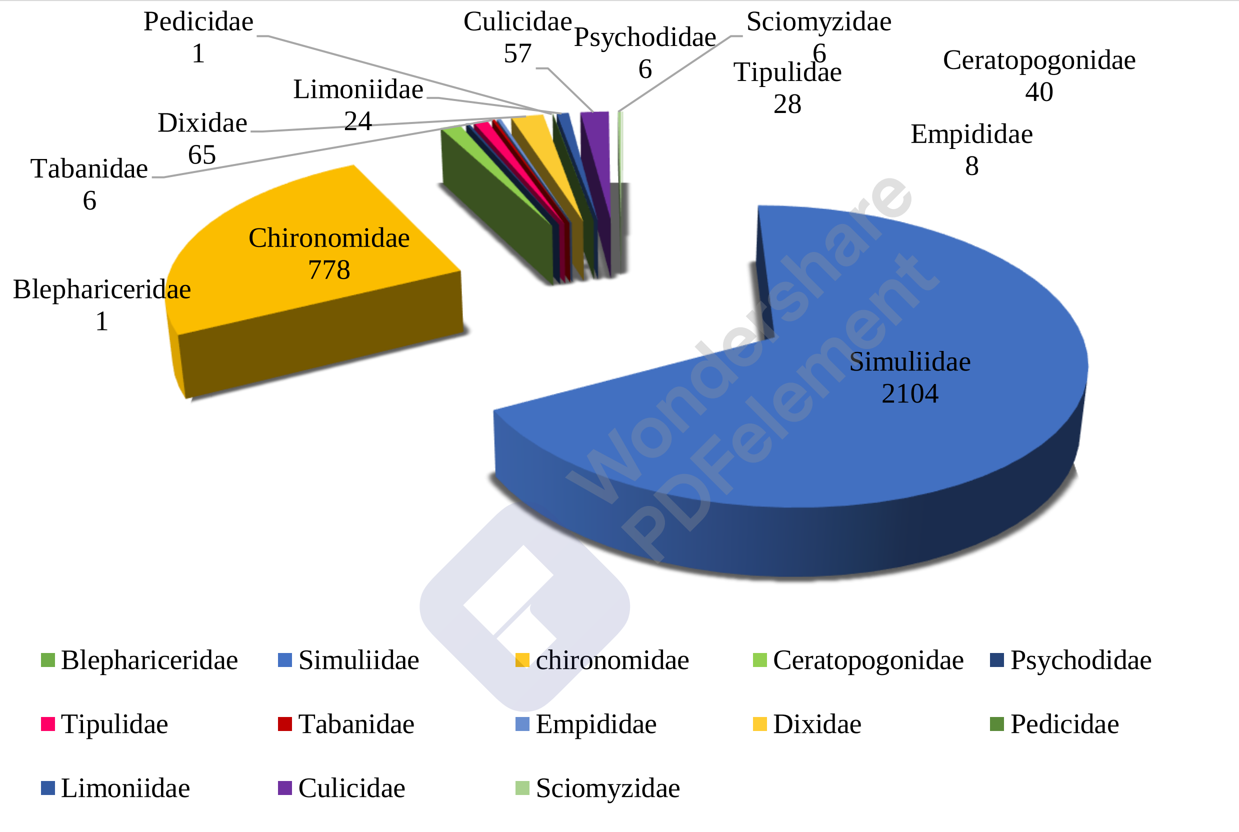


Fig.13: Abundance of Diptera families collected

1.3. Fauna distribution on sites:

In this study, not all sites were visited regularly, mainly because of the sites' difficulty. Therefore, the study was divided into two parts. On the one hand, it tried to count and know the diversity of taxonomies of the macro invertebrates in the Aures' various regions. Another aspect is tracking the biological dynamics and abundance in several sites that can be visited monthly.

The total of the macroinvertebrates captured, sorted, identified, and considered in the 11 sites studied regularly is 10,053 invertebrates. Each taxon's abundance per 0.4 m^2 fluctuates between stations, varying from 63 individuals to 2311 individuals. Indeed, the piedmont stations (Rhawat and Berbaga) have high abundances varying between 2311 individuals (Rhawat) and 1995 individuals (Berbaga)

The sites (Bouailef, Inoughissen, Nafla, and Maafa) have a completely high structure with abundances varying between 744 individuals (Maafa) and 1453 individuals (Inoughissen).

As for the low-altitude sites (El kantra, Ghoufi, and Mchounech) the most affected by organic and/or industrial pollution, they have an unbalanced structure with a lower abundance varying between 397 individuals (Mchounech) and 63 (El kantra); Regarding O. chaaba and Yabous, these sites have been visited less than eight times but, considerable abundances was observed (close to 500 individuals) (**Fig.14**).

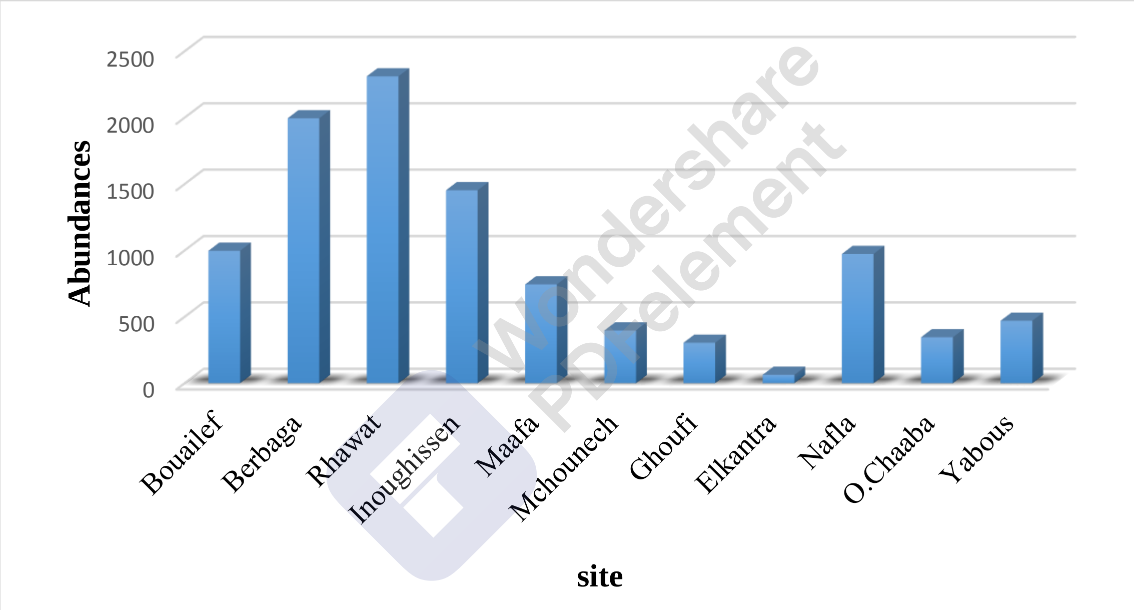


Fig.14: Abundance of overall fauna in the sites studied regularly

Eight environmental descriptors subdivided into modalities are taken into account to characterize each of the 11 stations (**Tab.8**). A certain number of parameters are linked between them because they represent the progressive evolution along with an equilibrium profile such as altitude and flow distance to the source and width of the minor bed of the watercourse, increasing summer temperatures. They reflect, directly or indirectly, the spatial distribution of river fauna.

I.4. Abiotic study of the environment:

Table.8: Environmental characteristics of the 11 stations studied regularly

	Alt m.a.s.l	PH Mean ± standard deviation	T°C Mean ± standard deviation	Con µS/cm Mean ± standard deviation	TDS ppm Mean ± standard deviation	Dep cm Mean ± standard deviation	Wid m Mean ± standard deviation	Velo m/s Mean ± standard deviation
Bouailef	1,445	(6.69±0.21)	(27.45±2.59)	(567.85±223.55)	(283.85±115.52)	(0.08±0.04)	(1.51±0.31)	(0.25±0.15)
Berbaga	1,060	(6.80±0.11)	(13.80±2.48)	(403.25±103.22)	(201.75±39.34)	(0.41±0.10)	(3.18±0.46)	(0.48±0.12)
Inoughissen	1,670	(6.73±0.14)	(13.33±5.18)	(452.83±143.67)	(228.83±75.33)	(0.18±0.08)	(3.16±0.76)	(0.39±0.19)
Maafa	932	(6.69±0.21)	(17.82±3.22)	(394.18±27.09)	(190.27±11.23)	(0.79±0.25)	(1.12±0.14)	(0.24±0.20)
Rhawat	1,414	(6.64±0.10)	(15.70±2.01)	(444.64±124.52)	(229.21±60.12)	(0.09±0.04)	(1.33±0.29)	(0.26±0.15)
Ghoufi	625	(6.40±0.09)	(15.36±4.73)	(1447.78±486.54)	(739.66±230.02)	(0.14±0.05)	(5,04±2.36)	(0.41±0.18)
Mchounech	317	(6.43±0.12)	(15.93±2.83)	(1153.50±403.66)	(577.87±111.95)	(0.14±0.06)	(4.03±1.24)	(0.42±0.27)
EL Kantara	571	(6.57±0.06)	(17.87±3.22)	(1051.56±621.74)	(520.33±316.76)	(0.11±0.08)	(2.56±1.51)	(0.21±0.29)
Nafla	1,428	(6.81±0.07)	(13.63±7.43)	(394.12±27.1)	(191.25±11.18)	(0.12±0.05)	(1.14±0.16)	(0.10±0.05)
Yabous	1,420	(6.64±0.10)	(14.27±2.80)	(497.50±100.02)	(247.00±50.61)	(0.17±0.09)	(1.54±0.32)	(0.32±0.07)
O.Chaaba	1,262	(6.87±0.59)	(12.97±7.61)	(373.00±87.27)	(180.42±42.30)	(0.21±0.15)	(1.39±0.91)	(0.24±0.20)

At some point, physicochemical characteristics of water are results of different land uses besides the climatic and geological conditions of the region (**Stewart et al. 2000; González-Sampériz et al. 2006**). Therefore, the study of environmental factors measured at stations visited regularly during the study period was approached using principal component analysis (PCA). This analysis shows clearly (**Fig.15**) in space, the two significant factors F1 (axis 1) and F2 (axis 2):

- The relationships between the sites on the one hand;

- The distribution of stations taking into account all of their characteristics environmental issues on the other hand.

Bouailef and El Kantara sites' temperature was high compared to the other streams; Berbaga stream characterized by higher depth. Both El kantara, Ghoufi and Mchouench streams record a very higher Conductivity, which means these sites hold very high ion concentration, which are located in regions constituted by sedimentary metamorphic rock composed of flint limestones, and they sometimes include gypsiferous. However, the rest of the sites somewhat similar in the environmental attribute.

Aures belong to semi-arid to arid climate. We consider the most water sources in these streams the subsoil of the ground or winter's snow water; there for the water system in these streams is irregular in terms of the speed of the water or width of course.

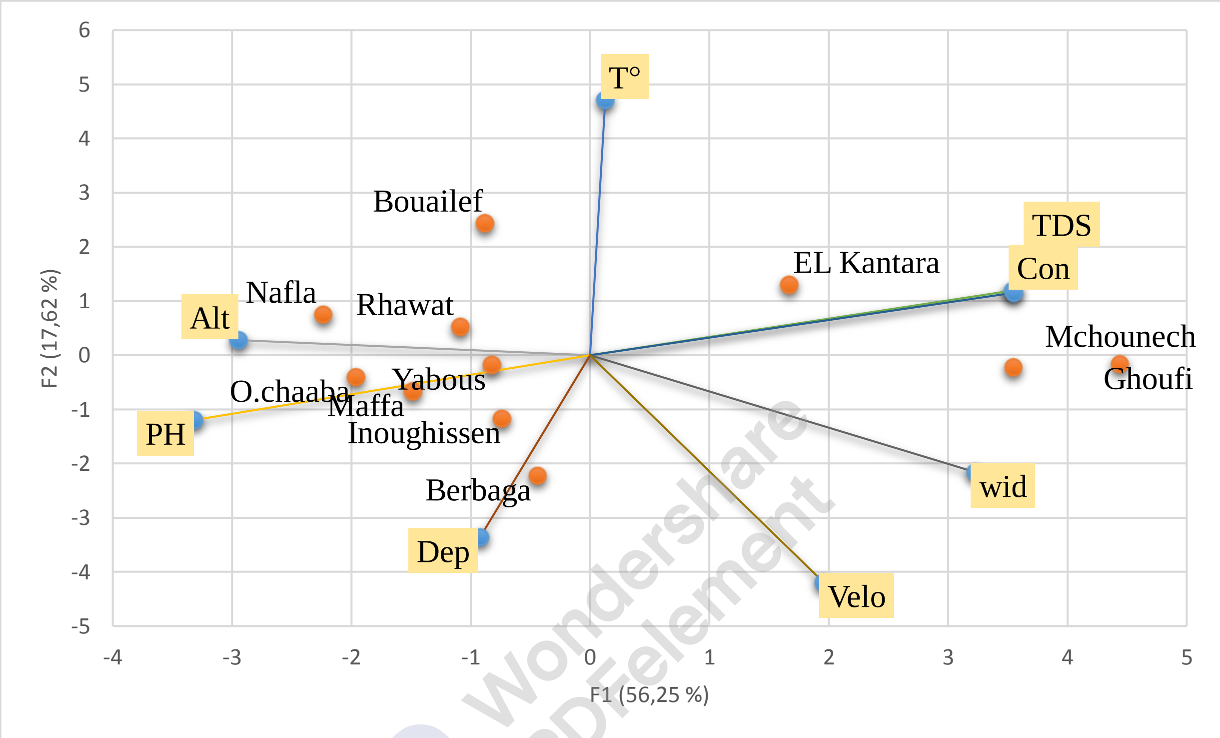


Fig.15: Distribution of environmental parameters on different sites

The PCA, having provided with an objective summary of all the data, a hierarchical ascending classification (CAH), carried out based on the PCA results, clearly visualizes the relationships between all stations according to environmental factors (**Fig.16**).

Through the statement, we see that both Ghoufi and Mchounech differ completely from the rest of the sites, and this is for the group of physicochemical properties that they are distinguished. Basically, they are two sites belonging to the white Valley that passes through the Inoughissen site first. Still, upon crossing the Arris region, nature here dives more in the desert area, so the nature of the young, plants, and atmosphere directly affects the quality of the water.

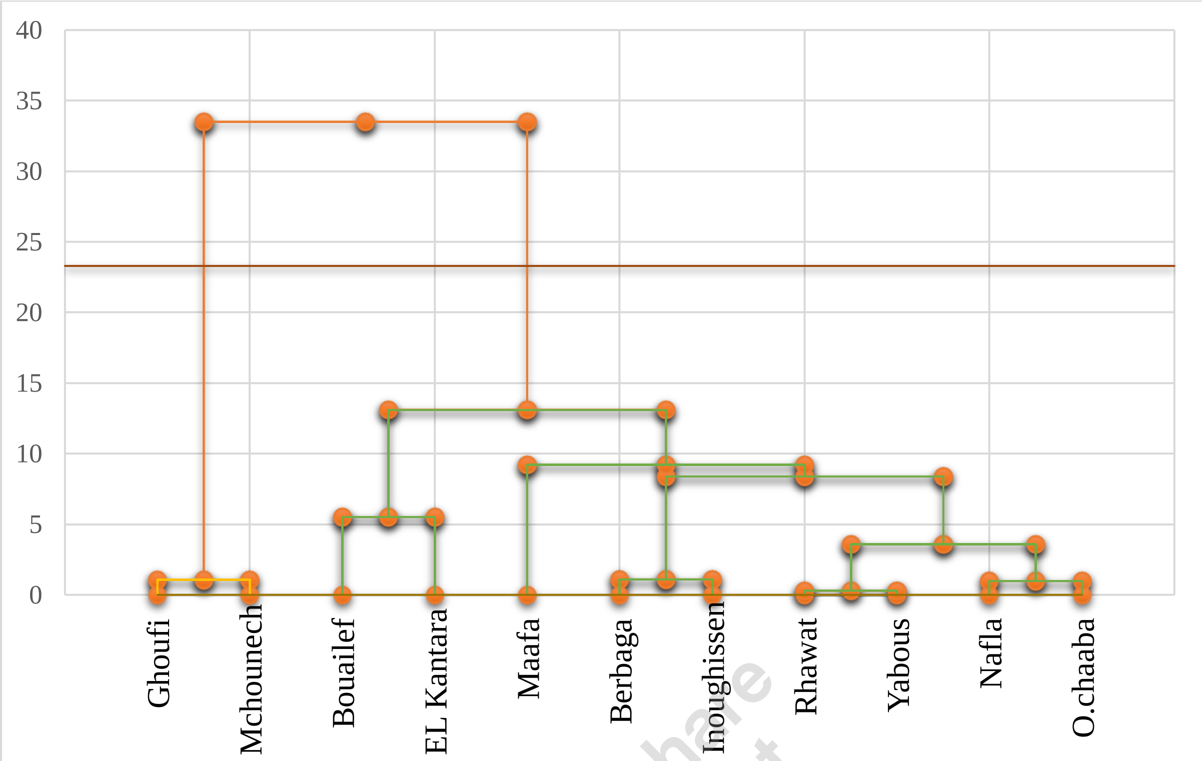


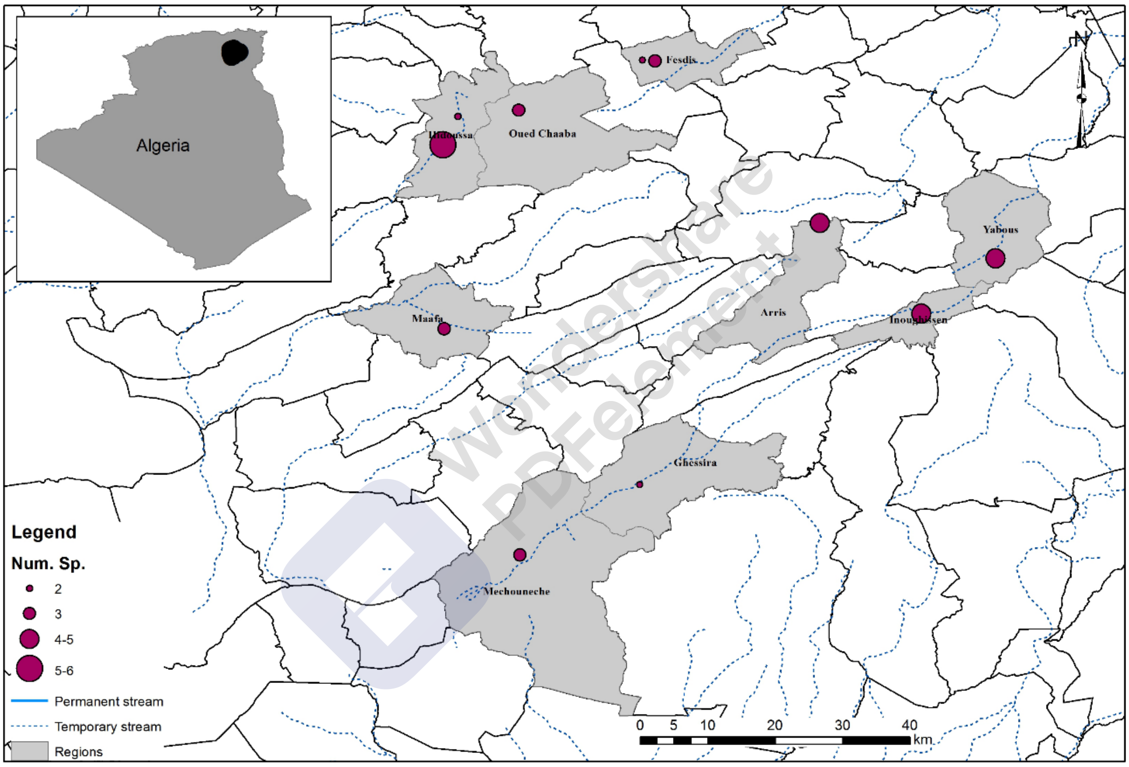
Fig.16: Dendrogram visualizing the relationships between different sites.

The rest of the sites meet with different groups, so we find Bouailef and El Kantara together. This is most likely due to the effect of the water temperature significantly observed in these two sites, which is a basic feature. Berbaga and Inoughissen are also similar in terms of properties.

Both Nafla, Rhawat and O.Chaaba are closely in fact. They are shared the same characterized physicochemical and topographic, Although Yabous are far from these sites, but it has the same characteristics.

II. Study on Trichoptera ordre:

A total of 937 specimens of Trichoptera are identified in this study, belonging to 18 species in 10 families and 14 genera. In Eleven sites from seventin investigated in the Aures area, this Trichoptera species distributed (**Map.2**) at difrenet microhabitats. four Trichoptera species new to the Algerian fauna: *Tinodes dives*, *Hydropsyche modesta*, *Plectrocnemia conspersa*, and *Setodes acutus*. likewise, and because this investigation is practi cally the first work focus on Trichoptera Order, we wanted to add a bibliography search an updated caddisfly inventory of Algeria includes 55 species (**Appendix I**).



Map.2: locations of the Trichoptera species in the studied region

Family Rhyacophilidae

Rhyacophila sp.

Berbaga: 06.iv.2018, 5 larvae, 1♂, 2♀♀ pupae; 02.x.2018, 2 larvae; 05.xii.2018, 1 larva; 16.i.2019, 4 larvae; 12.ii.2019, 3 larvae; 30.iv.2019, 7 larvae 21.vi.2019, 11 larvae; 06.vii.2019, 1 larva. Inoughissen: 26.vi.2018, 1 larva; 23.xi.2018, 3 larvae; 23.xii.2018, 4 larvae; 6.vi.2019, 10 larvae, 1♀ pupa. Yabous: 02.i.2019, 3 larvae; 21.vi.2019, 3 larvae.

Rhyacophilidae in the begin it combined earlier also Glossosomatidae and Hydrobiosidae and other taxa, is established by **Stephens (1836)** and is a comparatively large family .then the developmental relationships of the family were discussed by **Ross (1956)** and decisively the family was the subject of a large revision by **Schmid (1970)**. The most of the diversity in this family is include in a single genus, Rhyacophila Pictet, the largest genus in Trichoptera, with over 700 species described **(Holzenthal et al., 2007).**

The larvae belong to the *Pararhyacophila* group *sensu* **Döhler (1950)** with tetrafilament (four-branched) abdominal gills and resemble those of the Corsican endemic *Rhyacophila tarda* **Giudicelli 1968**. Furthermore, the head coloration is similar to that of *Rhyacophila munda* **McLachlan 1862**. However, the sword process is long and not as short as in *Rhyacophila munda*. The mature female pupa did not key with any of the known West Palaearctic Rhyacophila species. We speculate that this could be a new species or a hitherto unknown female and larva; however, additional adult material is needed to confirm this species' identity.

Larvae of Rhyachophilidae species living free and predaceous, building pupal chamber from the rocks to continue maturity. In the act of etymology of name Rhyachophilies signal, the larvae accustomed calm, fast-flowing rivers and streams **(Holzenthal et al., 2007).**

This family represent in Algeria by two species *Rhyacophila munda* **McLachlan 1862** and *Rhyacophila urgl* **Malicky & Lounaci 1987**, Both of them spotted in Djurdjura Mountains area (**Lestage, 1925; Gauthier, 1928; Malicky & Lounaci, 1987; Tobias & Tobias,2008; Sekhi et al., 2016**);

In our study larvae of Rhyacophila sp collected from three sites, all of them located in the Mountains region with a higher altitude of 1,400 m a.s.l, and characterized by high currents (0.32±0.48 m/s) and average water temperature(14.27°C), with dissolved oxygen between (3.12±8.57 Mg/l).

Family Glossosomatidae

Agapetus fuscus Vaillant 1954

Maafa: 30.vi.2018, 2♂ adults; 31.xii.2018, 2 larvae.

Described by **Vaillant (1954)** from Oued Boughara, near Arris, (Aures Mountains) at 1200 m.

Agapetus incertulus McLachlan 1884

Rhawat: 06.iv.2018, 28 larvae; 10.v.2018, 50 larvae, 1♂, 5♀♀ pupae; 23.vi.2018, 22 larvae; 26.vii.2018, 52 larvae; 16.x.2018, 2♂♂, 1♀ pupae; 14.i.2019, 1 larva, 1♂ adult; 03.iv.2019, 1♂, 2♀♀ adults; 05.v.2019, 1♂, 1♀ adult. Inoughissen: 30.iii.2018, 6 larvae, 11 pupae; 17.iv.2018, 40 larvae; 28.viii.2018, 18 larvae; 30.ix.2018, 37 larvae; 21.x.2018, 3 larvae, 1♀ pupa; 28.xi.2018, 6 larvae; 23.xii.2018, 1♂ pupa; 16.i.2019, 1♀ adult; 07.iv.2019, 2 larvae; 06.vi.2019, 3 larvae; 22.vii.2019, 3 larvae; 27.viii.2019, 4 larvae.

Quoted by **Sekhi et al(2016)** in Djurdjura Mountains.

Agapetus sp.

Yabous: 03.ii.2018, 1♀ pupa. Berbaga: 12.ii.2018, 6 larvae; 06.iv.2018, 2 larvae; 12.v.2018, 18 larvae; 6.vi.2018, 55 larvae; 2♀♀, 1♂ pupae; 01.ix.2018, 30 larvae; 21.x.2018, 22 larvae; 28.xi.2018, 2 larvae; 16.i.2019, 4 larvae; 12.ii.2019, 31 larvae; 06.iii.2019, 23 larvae; 21.vi.2019, 2 larvae; 06.vii.2019, 3 larvae.

Primitively and as a subfamily of Rhyacophilidae **Wallengren (1891)** determined this taxon, **Ross (1956)** Glossosomatidae was formally fixed as family. Three subfamilies are officially approved. The Agapetinae has three genera, Agapetus Curtis (over 200 species from all biogeographical regions, except the Neotropical), Catagapetus McLachlan (2 western Palearctic species), and Electragapetus Ulmer; Glossosomatinae has 2 genera, Glossosoma Curtis (120+ species) and Anagapetus Ross; Protoptilinae **(Holzenthal et al., 2007).**

In full of Algeria this family appear by three species (**Appendix I**), they were all monitored in both Djurdjura Mountains and Aures Mountains, and even North-Eastern Algeria (**Samraoui, pers. comm.**).

Agapetus fuscus collected on Maafa site, it was one of the points of Oued Abdi Stream, and it is located southeast of the city of Batna. This site describes by small- to medium-sized in semi-mountainous area 932 m a.s.l., with the Somewhat slow flow (velocity=0.24 m/s) and

warm water temperature (17.82 °C), The watercourse located to the agricultural lands in the region; this explains why the nitrate level increased slightly (17.72, despite the average rate of dissolved oxygen in the water (6.85Mg/l).

Agapetus incertulus (**Fig.17.1**) was collected from two streams with altitude 1400-1800 m a.s.l., with from medium-sized stream (1.33±3.16m) with high currents (0.26 ±0.39 m/s) and moderate-water temperatures (13.33±15.70°C).

The other larvae *Agapetus* genus recollected from tow different sites at heights towering over 1400 m a.s.l. with other caddisflies inhabiting the same habitats *Tinodes dives*, *Rhyacophila sp*, *Plectrocnemia conspersa*.

Fig 17.1: larval head and thorax, dorsal (*Agapetus incertulus)*

Family Hydroptilidae

Allotrichia sp., **first record of the genus for the Aures region.**

Rhawat: 10.v.2018, 1 larva.

The genus is known from Algeria (**Morton, 1896**) and has also been recorded in the Chelif River in northcentral Algeria (*Allotrichia pallicornis*: **Arab *et al*.,2004**), in the Grande Kabylie streams at localities varying from 190 to 1170 m a.s.l. (**Sekhi *et al*., 2016**), and in Oued Sebaou at localities between 200 and 1200 m a.s.l. (**Raab & Yacine, 2018**). Because many immature stages of Palearctic hydroptilid species remain undescribed, and possibly new species may be present in the North Africa region, information on species for this genus is difficult to obtain without adult material.

Agraylea sp., **first record of the genus for the Aures region.**

Inoughissen: 28.viii.2019, 1 larva.

Also known from the Chelif River in northcentral Algeria (**Arab *et al*. 2004**). This genus has not been previously recorded elsewhere in North Africa. Due to the lack of larval descriptions, species for this genus are difficult to identify without adult material.

Hydroptila vectis Curtis 1834, **first record for the Aures region.**

Bouailef: 15.v.2018, 1 larva; 22.x.2018, 1 immature pupa, 1♂ adult; 29.xi.2018, 3 larvae; 13.xii.2018, 2 larvae; 26.vi.2019, 1 immature pupa; 08.viii.2019, 3 larvae. Rhawat: 10.v.2018, 23 larvae; 16.x.2018, 1 larva.

Hydroptila vectis (**Fig.17.2**) was first recorded from Algeria by **Morton (1896)**. *Hydroptila vectis* has also been recorded from several streams of the Grande Kabylie by **Sekhi *et al*. (2016)** at altitudes between 190 and 1170 m a.s.l., and from streams of the Oued Sebaou region between 1170 and 1200 ma.s.l. (**Raab & Yacine, 2018**).

Hydroptilidae Established by **Stephens (1836)**, Although this family is distinguished as smallest in the order in terms of body size, but it is the largest in species diversity, with about 2,000 described species in the wild word; The family is divided into 2 subfamilies:

Hydroptilinae **Stephens (1836)** and Ptilocolepinae **Martynov (1913)**; the diversity of Haydroptilidae larvae is highly diverse, habitat, and feeding behavior, albeit most construct cases of silk or sand, some construct flat, fixed shelters, while others remain free-living until pupation. A lot of genera stay unknown in the larval stage **(Holzenthal et al., 2007).**

Fig17.2: Larvae of *Hydroptila vectis*

In Algeria this family represent by 11 species (**Appendix I**). *Agraylea sp.* was presently collected near to 1700 height, at a stream with medium width (3.16 m). While most important factors noticed, was a moderate temperature of water (13.33°C), and significant rise in both scales: Nitrate (72Mg/l), Nitrite (0.2Mg/l), Ammonium (0.51Mg/l). Moreover, owing to the virtue of fact that the region is pastoral and agricultural the value of dissolved oxygen in the water is relatively low (3.12 Mg/l) despite the height on town.

Allotrichia sp. collected from Rhaouat, medium-permanent stream (width: 1.33m, depth: 0.09m), in agric-mountainous area, with low current velocity (0.26 m/s) and temperate water temperature (15.70°C) with the conductivity medium (444.64 Us/cm).

Family Polycentropodidae

Plectrocnemia conspersa (Curtis 1834), **first record for Algeria.**

Berbaga: 28.xi.2018, 1 larva; 25.v. 2019, 1 larva. Yabous: 29.ii.2020, 2 larvae.

Polycentropodidae created by **Ulmer in 1903** and comprises 775 described species in 15 genera (**Johanson et al., 2012; Chamorro & Holzenthal, 2011; Morse, 2016**), this family pose In the West Palearctic (WP) region by Polycentropus (34 species), Cyrnus (8 spp.), Holocentropus (5 spp.), Neureclipsis (1 sp.) and Plectrocnemia (24 spp.) (**Karaouzas & Waringer, 2017**).

In Algeria the family present by three other species of Polycentropus genus(**Appendix I**). While, Plectrocnemia is a widespread species found in the Mediterranean area but the only one other species of the genus has been reported from North Africa, *Plectrocnemia laetabilis* **McLachlan 1880**, which was recorded from Morocco (**Hajji *et al*., 2013**).

P. conspersa **(Fig17.3)** Larvae were collected from two sites in the region, from medium-sized stream (1.54±3.18m) with high currents (0.32±0.48 m/s) and moderate-water temperatures (13.80±14.27°C), with height dissolved oxygen (>8 Mg/l). Altitudinal distribution ambit from 1,400 m a.s.l.

Fig 17.3: larvae of *Plectrocnemia conspersa*

Family Psychomyiidae

Tinodes dives (Pictet 1834), **first record for Algeria.**

Berbaga: 16.iv.2018, 1 larva; 12.v.2018, 5 larvae; 21.x.2018, 1 larva; 16.i.2019, 7 larvae; 12.ii.2019, 8 larvae; 06.iii.2019, 4 larvae; 30.iv.2019, 2 larvae; 6.vi.2019, 1 larva; 06.vii.2019, 4 larvae. Rhawat: 06.iii.2019, 1 larva. Inoughissen: 08.ii.2019, 1 larva. Yabous: 06.vi.2019, 1 larva. Nafla: 24.xii.2018, 1♀ adult.

Psychomyiidae is a relatively mediocre sized family of net making caddisflies; earlier, it included most of the taxa of Annulipalpia other than Philopotamidae and Hydropsychidae. The Family it was established by Walker (1852), largely 8 genera, is known, and Tinodes Curtis is the most diversified one with +200 species (**Holzenthal et al., 2007**).

Larvae of psychomyiidae make nets with shapes elongate like an irregularly silken tube covered with sand or debris and attached to a substrate (rocks, tree limbs). The larvae feed on diatoms and other algae growing in or near the tubes; they also cultivate algae in the tube's silken mesh and graze on the old portions. The tubes are elongated with grows of the larva (**Hasselrot, 1993**).

This Family presented in Algeria by two species *Tinodes agaricus* was sighted on Aures Mountains and Djurdjura Mountains and Atlas of Blida, and *Tinodes dives* where collected on this new study.

T. dives, found out in five locations on this study all of them at altitudinal distribution ranges from 1,300 to 1,700 m a.s.l.; The majority of microhabitats are composed of Silt-mud, gravel, or Cobbles, gravel, and boulders; the proliferation of larvae begins with the development of and diatoms during the Spring period. Reside between rapid and medium flow (0.10±0.48), The width of the watercourse is intermediate between (1.14±3.18); also the rate of dissolved oxygen in the water varies between (3.12±8.57Mg/l).

Family Hydropsychidae

Cheumatopsyche sp., **first record for the genus in the Aures region.**

O. Chaaba: 08.ii.2019, 1 larva.

Previously known from only the Chelif River, northwestern Algeria (**Arab *et al.*, 2004**). The first citation of this genus in North Africa was by Lestage (1925); he reported larvae from Oued Kerma, near Algiers, under the name *Hydropsyche lepida*. This same name is used by Gauthier (1928) who reported larvae from numerous Algerian rivers. *Hydropsychodes atlantis* Navás1930 was described based on a female from Tinmel (Western High Atlas).

Hydropsyche sp.

O. Chaaba: 12.vi.2019, 1 larva ; 03.iv.2019, 1 larva.

The larvae of several species of this genus have been reported in Algeria and North Africa; many of them have not yet been described or are poorly known. Records presented here should be confirmed in combination with mature pupae and/or adults.

Hydropsyche cf. contubernalis McLachlan 1865

Ghoufi: 30.iii.2018, 1 larva. Mchounech: 11.v.2018, 6 larvae.

Mature pupae and adults are needed to confirm the presence of this species at the study sites.

Hydropsyche maroccana Navás 1932, **first record for Aures region.**

Mchouneche: 11.v.2018, 3 larvae. Bouailef: 05.iv.2018, 4 larvae; 07.vii.2018, 1 larva; 18.iii.2019, 14 larvae; 26.vi.209, 17 larvae, 2♀♀ pupae; 17.vii.2019, 22 larvae; 08.viii.2019, 6 larvae.

Hydropsychidae was scheduled by **Curtis (1835)** with about 1,500 described species, it as Cosmopolitan family; the subfamily Hydropsychinae involve 19 genera from all biogeographic regions of the world, including Hydropsyche Pictet (ca. 275 species) and Cheumatopsyche Wallengren (ca. 260 species) (**Holzenthal et al., 2007**).

In Algeria, this family presented by 13 species the most of them sited in the Djurdjura Mountains (**Appendix I**). *H. maroccana* was identified as *H. modusta* at our article, the two species are very similar morphologically in larval state, the correction was made after the publication: Larval Taxonomy and Distribution of Genus Hydropsyche (Trichoptera: Hydropsychidae) in Northwestern Algeria ***Dekkaki et al., 2021*** by an Errutum (**Dambri et al.,2021**).

We collected the larvae and one pupa female from only one stream in this study, Bouailef is located in Belazma national park, this permanent stream characterized by weak water flow (0.25 m/s), and temperature average (27.45°C).

Family Philopotamidae

Wormaldia cf. occipitalis (Pictet 1834)

Yabous: 06.vi.2019, 1 larva.

The only larva collected did not allow identification to species with certainty. The larva resembles that of *W. occipitalis*, but adult material is needed to confirm this species' presence in the area.

Philopotamidae was established by **Stephens (1829)**, from the Three subfamilies knows the subfamily Philopotaminae holding 16 genera, the greatest is Wormaldia McLachlan (130 species) distributed from all biogeographical regions. Larvae feed microorganisms and residues from the net according to a membranous, T-shaped labrum, exceptional character for the family. Fact that larvae of philopotamidae characterized by uniform appearance and construct similar nets, the description species request reliance on the quite divergent genitalia of adult males. (**Holzenthal et al., 2007**).

In Algeria this family, present with two species *Chimarra marginata & Wormaldia algirica* (**Appendix I**); in this study, we collect one larva from one site, and the fact that many species of the genus cannot yet be identified as larvae, including the endemic *Wormaldia algirica*, makes the identification to species very difficult.

It occupies a very fresh medium-sized stream in mountainous area (1443m a.s.l) characterized by height dissolved oxygen 8.34 (Mg/l) with high current velocity (0.32m/s) and cold waters (14.27°C).

Family Limnephilidae

Mesophylax aspersus Rambur 1842, **first record for Aures region, second record for Algeria**.

Berbaga: 30.iv.2019, 1 larva. Kassrou 14.i.2019, 2 larvae; 11.ii.2019, 13 larvae; 18.iii.2019, 4 larvae. Inoughissen: 30.iii.2018, 1♀ pupa. Ghoufi 05.v.2018, 4 larvae; 12.vii.2018, 7 larvae. Maafa: 16.iv.2018, 1 larva; 24.vi.2018, 2 larvae; 31.vii.2018, 10 larvae; 10.i.2019, 5 larvae. Nafla: 28.vii.2018, 19 larvae; 15.i.2019, 11 larvae; 26.ii.2019, 10 larvae; 23.iii.2019, 5 larvae; 07.v.2019, 6 larvae. O.chaaba: 22.v.2019, 1 larva.

It has also been found in the Seybouse River (**Samraoui et al. 2020**) and Ghoufi (**Samraoui, pers. comm**) and from the Hoggar Mountains, southern Algeria, by Malicky (1998) as the subspecies *Mesophylax aspersus hoggarensis* Malicky 1998. The species is widely distributed, in the Palaearctic region and the Mediterranean region.

Limnephilus sp., **second record of the genus in Algeria.**

Kasrou: 14.i.2019, 1 larva. Maafa: 24.xi.2018, 1 larva.

The family established by **Kolenati (1848)**, next **Schmid (1955)** He made changes on classification, with ameliorations by Wiggins and colleagues (**Wiggins, 1973; Vineyard & Wiggins, 1988).** The family is divided into 4 subfamilies: Dicosmoecinae Schmid, with 100 described species; Drusinae Banks, with 8 genera this subfamilies are bounded to the Palearctic region ; Limnephilinae Kolenati (over 60 genera, divided into 4 tribes), this subfamily add the most lentic genera and also build Limnephilus Leach (the most species-diverse genus) (**Holzenthal et al., 2007**); Pseudostenophylacinae, it is a small subfamily combine of 5 genera and about 100 species **(Schmid, 1990).**

Limnephilidae larvae use both plant and mineral materials to make here cases, also the larvae in cool running waters use rock material, whereas those in warmer lentic environemets use plant material **(Wiggins, 1996)**

Most probably, the larva of the species is *Limnephilus barbagaensis* Malicky, **Sekhi & Lounaci 2019**, recently described from the area (about 20–40 km distance from Kasrou locality). Since the immature stages of *L. barbagaensis* species are yet unknown, species' identification is uncertain and both larvae and adult material are necessary for a safe conclusion.

In Algeria, this family appear with eight species (**Appendix I**). *Mesophylax aspersus* was widely distributed species of Palearctic, in this study the larvae collected from seven sites with altitudes ranging from 600 to 1,700 m a.s.l., on both permanent and temporary habits, with a substrate of Cobbles, gravel and boulders or Silt-mud, grave. As all limnephilidae, species *M.aspersus* has one generation developed at winter, almost all larvae are collected from November to March.

Family Goeridae

Silonella aurata (Hagen 1864), **second record for the Aures region**.

Rhawat: 26.vii.2018, 2 larvae; 16.x.2018, 4 larvae; 05.v.2019, 2 larvae.

Firstly represents a sybfamily of Sericostomatidae by **Ulmer (1903)**, then **Flint (1960)** and others investigated it a subfamily of Limnephilidae, but others always classified it as a separate family (**Schmid 1980**). This family is distributed on all continents except South America and Australia. Goeridae is divided into three subfamilies, Goerinae Ulmer (which contains Silonella Fischer and Silo Curtis the most two diversifies genus in western Palearctic), Larcasinae Navás, and Lepaniinae Wiggins.

Like Limnephilidae the Larvae of Goeridae create cases totally of rock fragments; some genera integrate larger rock fragments laterally as a remarkable structure **(Fig 17.4**.). Most larvae of Goeridae living in calm running waters and are feeding on periphyton.

Only *Silonella aurata* was representingwas representing this family in Algeria. *S. aurata* at first termed as *Selis brevipalpis* by **Vaillant (1954),** collected from Oued Talha and at teeny spring " Ain Fadha", on Mount Faraoun (Aures) at 1400 m a.s.l.; it was also recorded at the same altitude from the headwaters of the Oued Sebaou (**Raab & Yacine, 2018**).

In this study, the larvae of this species collected on one site Rhaouat, at 1, 400 m a.s.l altitude, from Silt-mud, gravel substrate, with the relatively medium running of water and moderate temperature.

Fig 17.4: *Silonella aurata* larva and Case

Family Leptoceridae

Setodes acutus Navás 1936, **first record for Algeria.**

Bouailef: 15.v.2018, 19 larvae, 3 pupae; 10.vi.2018, 1 larva; 07.vii.2018, 1♂ adult; 13.i.2019, 2 pupae; 23.iv.2019, 1 larva; 26.vi.2019, 6 larvae; 07.vii.2019, 6 larvae; 08.viii.2019, 5 larvae, 1♀ and 1♂ adults.

Established by **Leach (1815)**, the family is nearly approach in diversity to the Hydropsychidae. It is not outdone in terms of total richness of the species just Hydroptilidae in the world microcaddisflies. This family is divided into 2 subfamilies, the Leptocerinae Leach of cosmopolitan distribution and Triplectidinae Ulmer distributed specialy in Neotropics and Australasia; The genera Setodes Rambur is particular widespread and diverse on the round of the word, with about 220 species(**Holzenthal et *al*., 2007**).

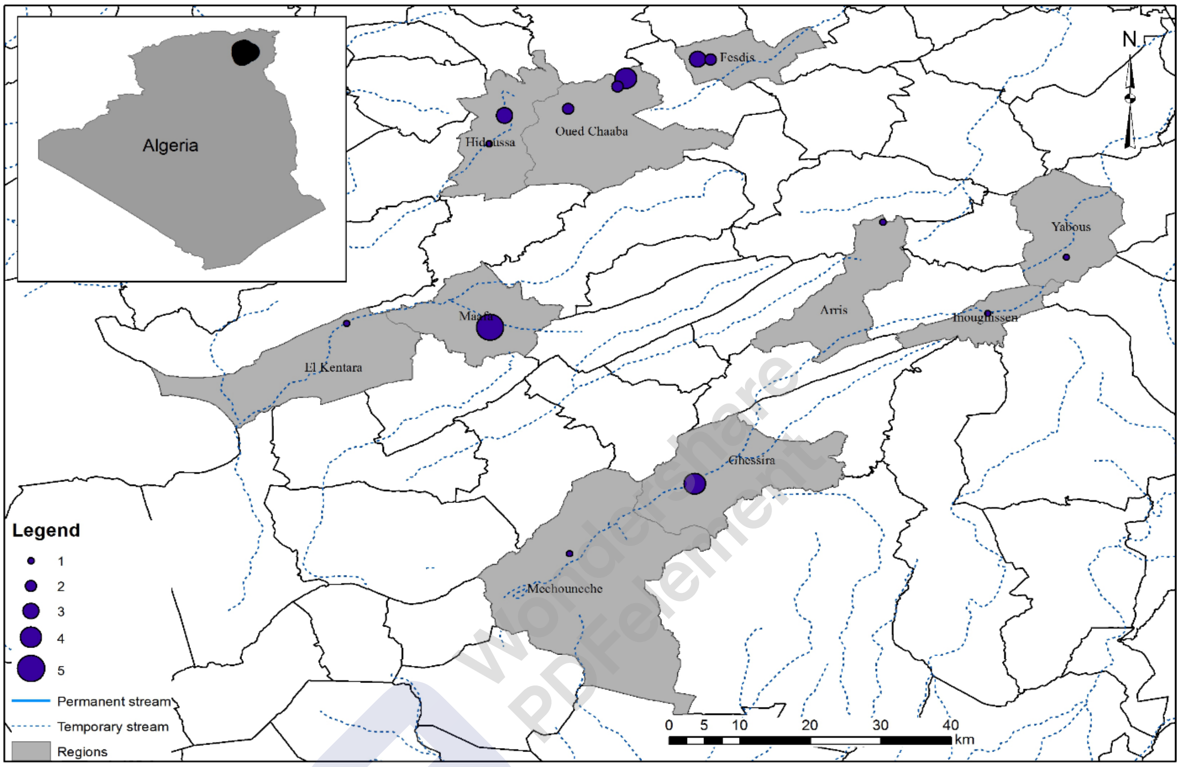
Larvae of the family construct a vast diversity of cases, tubular ones ,can be made it by plant pieces arranged spirally or laid transversely, or sand grains, strongly or only slightly tapered towards the posterior ends;

Leptoceridae Larvae feed as leaf detritus shredders, periphyton scrapers, and predators, they are colonized very large habitats streams to large lowland rivers lakes and even the temporary ones, and some are semi-terrestrial and inhabit the sides of waterfalls. The Adults are characterized by, long slender antennae and narrow forewings (**Holzenthal et *al*., 2007**).

This family present in Algeria by Five species (**Appendix I**).the first recored of *Setodes acutus* was on this study; All the larvae, pupae and adults of this species inhabit at a height 950 m a.s.l., they taken from only one site, a unique one versus the rest. Bouailef it is a medium range permanent stream (1.51 m), located at the PNB, their microhabitats are composed of Silt-mud, gravel with a current of class slow to moderate one(0.25 m/s), and high water temperatures during the whole year (27.45°C). *S. acutus* is sympatric with *Hydropsyche modesta* and *Hydroptila vectis*.

III. Study on Simuliidae family:

Black flies investigated in this work and from 14 sites (**Map.3**) Eight nominal species and species complexes in tow genera were collected and identified in this research, a four of them are new for Aures region



Map.3: locations of the Trichoptera species in the studied region

Simulium (Simulium) ornatum Meigen complex

S. ornatum complex attested her presence in several study in Algeria. In all of Batna and Bouïra Province (**Edwards,1923; Arigue et al.,2016**), also at Biskra Province (**Belazzoug & Tabet-Derraz,1980**), at Djurdjura Mountains (**Lounaci et al.,2000**), and Tlemcen Mountains (**Gagneur & Clergue-Gazeau, 1988; Gagneur & Chaoui Boudghane,1991; Chaoui Boudghane-Bendiouis et al.,2012; Chaoui Boudghane-Bendiouis et al.,2014),** finally in Seybouse Basin **(Cherairia et al.,2014**). One of the two most common taxon in this study to be found in all the sites except that Bouailef and El kantra, these two stations characterized by a high degree of water temperature.

Urosimulium faurei (Bernard, Grenier & Bailly-Choumara)

First recorded in the Aures region,

Previous in Tafna Mountains in the northwestern region (**Gagneur & Clergue-Gazeau, 1988**), either by **Chaoui Boudghane-Bendiouis et al., (2012)** on Western Algeria. From northeastern Algeria, in Seybouse Basin listed by **Cherairia (2015)**. Our data from the Aures region on record from one location caracterized by temporary steame, at 932 m above sea level (asl), with a sand and cobbles substrate, clean water, and low current velocity (0.24 m/s).

Simulium (Eusimulium) velutinum (Santos Abreu) complex

The distributed of the complex in Algeria is know very well. First recorded in Tlemcen Mountains in northwestern Algeria by (**Gagneur & Clergue-Gazeau, 1988, Chaoui Boudghane-Bendiouis et al. 2012**). Then, find In the Eastern region among the Djurdjura Mountains by (**Lounaci et al. 2000a**); Either in Seybouse basin by (**Cherairia et al.,2014**); also, in Guelma and Souk Ahras Provinces (**Adler et al., 2014**); And in the Aures region on Oued El Haï (**Arigue et al., 2016**). Our sampling shows the wide distribution of *S. velutinum* complex in the Aures region over remarkable altitudinal variations from 350 m up to 1700 m (asl).

Simulium (Nevermania) ruficorne Macquart

First record from Aures Mountains.

This species were recorded from Algeria's several location; from saharan region, where founded at habitats characterized by relatively high temperatures water (**cheriaria et adler, 2018**), In each of the Biskra area, Hoggar and Tassili N'Ajjer Mountains; But also, at Tlemcen Mountains and Seybouse Basin. (**Edwards 1923**; **Parrot 1949; Grenier & Clastrier, 1960, Belazzoug & Tabet-Derraz, 1980; Chaoui Boudghane-Bendiouis et al., 2012; Cheriaria et al., 2014; Cheriaria & Adler, 2018**). We found morphoform A based on gill structure for identification, on the Aures Mountains, it collected from two sites at Temperatures range from 17.87-27.45°C.

Simulium (Nevermannia) cryophilum (Rubtsov, 1959) (complex)

First record from Aures Mountains.

S. cryophilum complex is recorded at Eastern and Western Algeria (**Gagneur & Clergue-Gazeau, 1988); also** at Djurdjura Mountains (**Lounaci et al., 2000; Chaoui Boudghane-Bendiouis et al., 2012;**

Haouchine & Lounaci, 2012), and Tlemcen Mountains (**Chaoui Boudghane-Bendiouis, 2016**), It found in this study at three temporary streams.

Simulium (Simulium) variegatum species group

First record from Aure Mountains.

The *S. variegatum* group is well documented in Algeria from Djurdjura Mountains (**Lounaci et al., 2000; Haouchine & Lounaci, 2012**), from Tlemcen Mountains **Clergue-Gazeau et al., 1991**; **Chaoui Boudghane-Bendiouis, 2016**), We collected *S.variegatum* larvae and pupae from two temporary stream with low current velocity 0.24m/S.

Simulium (Wilhelmia) pseudequinum Séguy

Simulium pseudequinum was recorded from Batna, Biskra, Bouira, and Constantine as a first species of Algeria, according to collections of **Edwards (1923)**. After that, in the Western of Algeria listed in Tlemcen Mountains by all of (**Gagneur & Clergue-Gazeau, 1988; Chaoui Boudghane-Bendiouis et al., 2012; Chaoui Boudghane-Bendiouis et al., 2014**) and in Mascara Province by (**Parrot, 1949**); In the Eastern Algeria from Djurdjura Mountains by (**Lounaci et al., 2000; Haouchine & Lounaci, 2012**). Then in Seybouse Basin (**Cherairia et al., 2014**). From Aures region listed in Biskra Provinces (**Belazzoug & Tabet-Derraz, 1980**); Oued El Haï Basin (**Arigue et al., 2016**). We found it in two different settlements, one of them from the saharan environment print by presence of large amount of Water Lenses, "Spirodela polyrhiza and Lemna minor", the second habitat heavy with submerged plants.

S. aureum group

We record 2 larvae and 1 pupae, from one small stream in Kasrou mountain at 1335 m asl. The site was visited only once of time for reasons related to the difficulty of accessing it.

In this study, the strategy of RDA is a canonical correlation analysis in which correlations between the species are and the most important environmental factors can be affect the distribution of Simuliidae species in the region. We have applied this test on the species found in the 11 sites visited regularly, i.e. only *S. aureum* that it does not enter at the data (**Fig.18**)

Both axes of the RDA plot account for nearly 75,55% of the environmental dataset variance; The results (**Fig.18**) showed that depth and Conductivity as physical and chemical conditions predicting simuliid presence species, Simulium ruficorne was associated with Relatively slow water and high temperature. For qualitative variables, S. pseudoequinum and S. orantum were associated with ROC-2, S.ruficone with ELV-2 and ROC-1, and G. the rest of taxa with ELV-1.

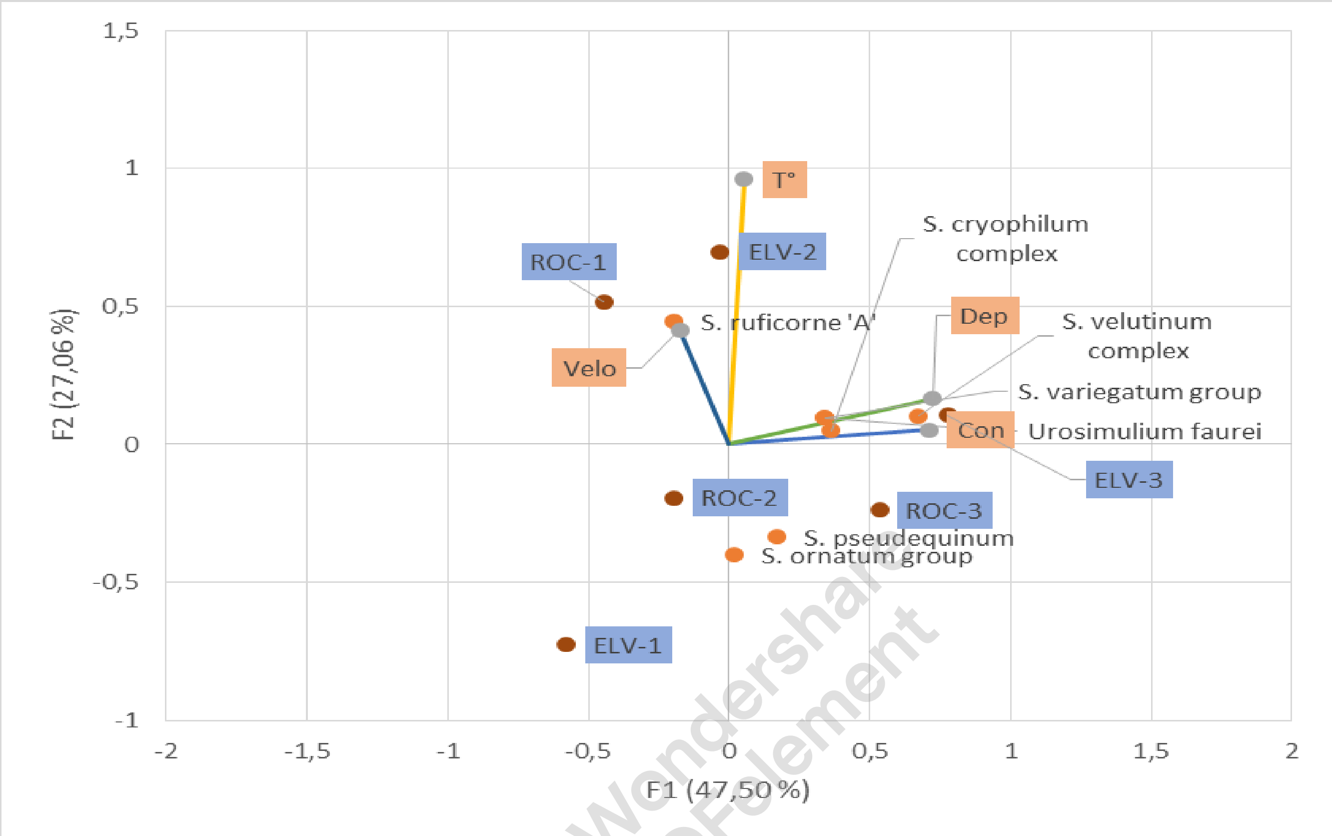


Fig.18: RDA of the effects of the physical and chemical variables on the species of Simuliidae

Figure.19 presents the results of the spatial distribution of the Simuliidae species specified using factorial correspondence analysis (CFA) carried out on the stations x species matrix (14 stations x 08 taxa). The first two axes accumulate 58%. These percentages are explained by the diversity of interdependent factors governing the distribution of species. Considering that this study's objectives were essential to differentiate the coherent species in terms of their ecology.

S. ruficorne sign-on Bouailef and El Kantara stations are hot streams, resulting from them, of high thermal amplitude, which makes them ecologically coherent. *S. pseudequinum* enlist at Ghoufi and Nafla the two sites characterized by the abundance of aqua vegetation. *S.variegatum* and *Urosimulium faurei* sign up on Ravin bleu and Maafa sites, characterized by a slow velocity and Shallow.

S.cryophilum present in three temporary streams, Kasrou, Maafa, and Ghoufi; Regarding *S.ornatum* and *S.velutinum* they are present at all the sites, Almost all places with their differences.

As for *S.aureum* funded at Ravien bleu site associate with both of *S.variegatum* and *Urosimulium faurei*.

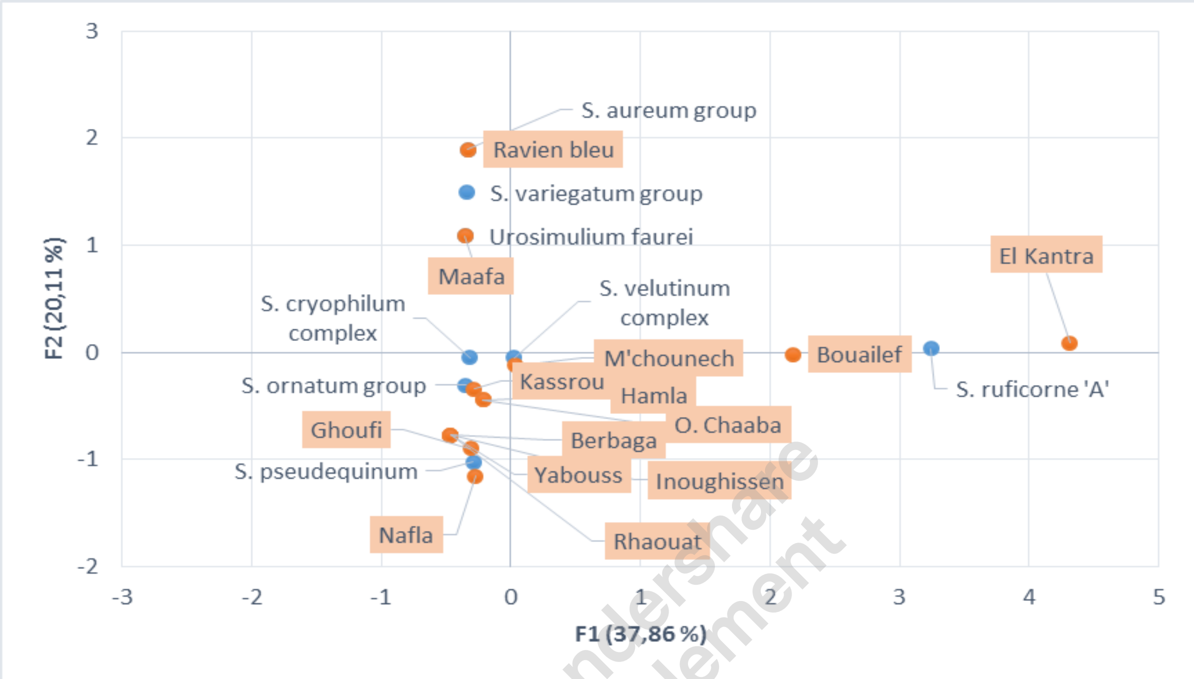
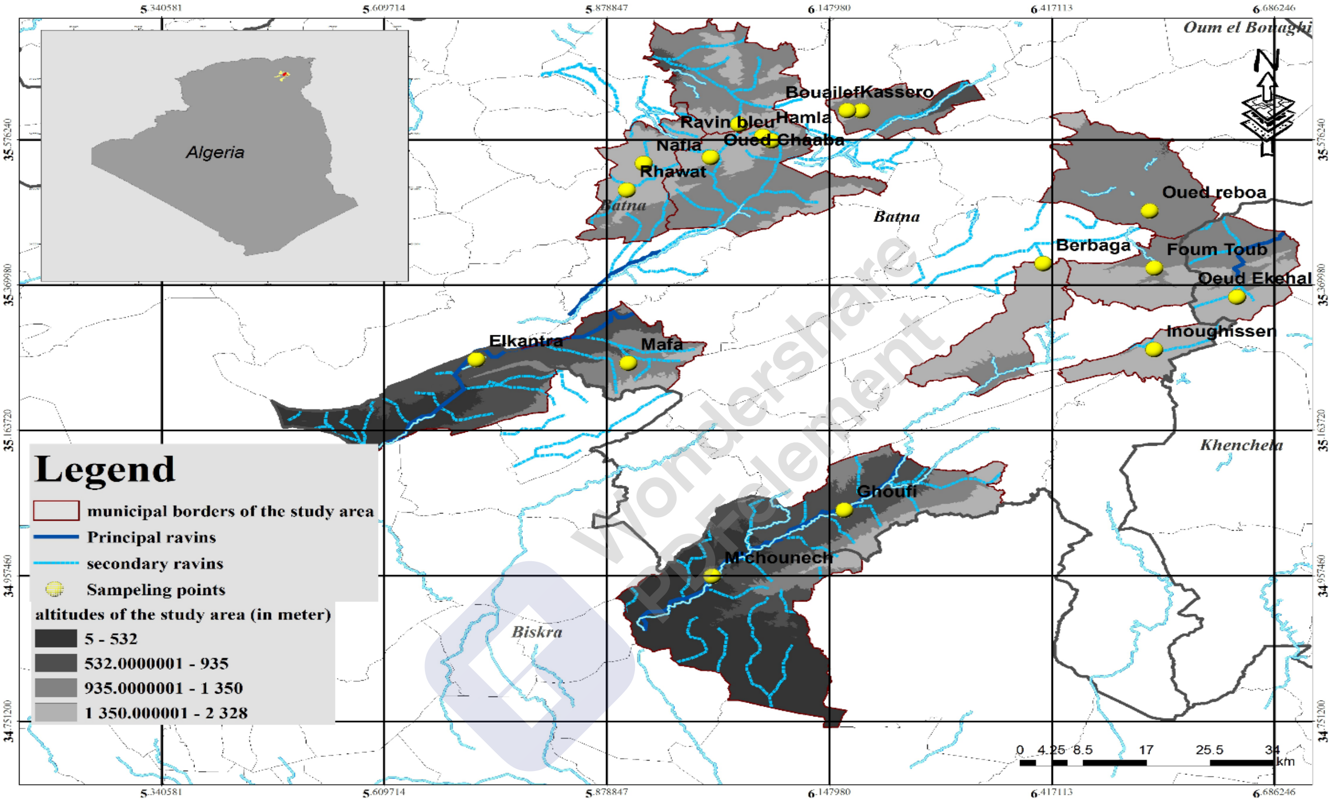


Fig.19: Distribution of the eight Simuliidae taxa at 14 sites.

IV. Study on Chironomidae family:

Forty-eight species of Chironomidae identifies in this study distributed over the sixteen sites investigated (**Maps.4**), belong to 28 Genus, 7 Tribe, and four subfamilies. Because Chironomidae is among one of the benthic invertebrates that can live in extreme conditions, many of them were found in this study in sites considered very poor in invertebrates community such as the El kantara sites. Indeed, there is no study of this Family of Diptera order in the Aures region. This checklist (**Tabl.9**) is considered the first checklist of Chironomidae of the Aures region.



Maps.4: locations of collection of Chironomidae at Aures region

The total number of species that were detected in this study and their affiliation are detailed in the following table:

Tab.9: check list of Chironomidae of the Aures

Subfamily	Tribe	Genus	Species
Diamesinae			
	Diamesini		
		Diamesa	
			Diamesa (Diamesa) insignipes Kieffer 1908
Tanypodinae			
	Pentaneurini		
		Ablabesmyia	
			Ablabesmyia sp.
		Conchapelopia	
			Conchapelopia pallidula (Meigen, 1818)
			Conchapelopia sp.
		Zavrelimyia	
			Zavrelimyia sp.
			Procladius sp.
	Tanypodini		
		Tanypus	
			Tanypus sp.
Orthocladiinae			
		Cardiocladius	
			Cardiocladius sp.
		Limnophyes	
			Limnophyes sp.
		Thienemanniella	
			Thienemanniella sp.
		Bryophaenocladius	
			Bryophaenocladius sp.
		Heterotrissocladius	
			Heterotrissocladius marcidus (Walker, 1856)
		Chaetocladius	
			Chaetocladius sp.
		Pseudosmittia	
			Pseudosmittia sp.
	Orthocladiini		
		Orthocladius	
			Orthocladius Orthocladius ashei
			Orthocladius O. oblidens (Walker, 1856)
			Orthocladius (Orthocladius) rubicundus (Meigen, 1818)
			Orthocladius (Euorthocladius) rivicola Kieffer, 1911
			Orthocladius Orthocladius excavatus Brundin 1947

		Eukiefferiella	
			Eukiefferiella bedmari Vilchez-Quero & Laville, 1987
			*Eukiefferiella claripennis (*Lundbeck 1898)
			Eukiefferiella minor (Edwards 1929)
			Eukiefferiella lobifera
		Cricotopus	
			Cricotopus (Cricotopus) bicinctus (Meigen, 1818)
			Cricotopus (Isocladius) sylvestris (Fabricius, 1794)
			Cricotopus C. vierriensis Goetghebuer, 1935
			Cricotopus (Paratrichocladius) rufiventris (Meigen, 1830)
		Rheocricotopus	
			Rheocricotopus (Psilocricotopus) atripes (Kieffer, 1913)
			Rheocricotopus (Psilocricotopus) chalybeatus (Edwards, 1929*)*
			Rheocricotopus dispar (Goetghebuer, 1913)
			Rheocricotopus (Psilocricotopus) meridionalis
Chironominae			
	Chironomini		
		Polypedilum	
			Polypedilum (Tripodura) scalaenum (Schrank, 1803)
			Polypedilum (Polypedilum) nubeculosum (Meigen, 1804)
			*Polypedilum (Polypedilum) albicorne (*Meigen, 1838)
			Polypedilum (U.) convictum (Walker, 1856)
			Polypedilum (Tripodura) acifer
		Cryptochironomus	
			Cryptochironomus sp.
		Demicryptochironomus	
			Demicryptochironomus sp.
		Saetheria	
			Saetheria sp.
		Endochironomus	
			Endochironomus sp.
		Chironomus	
			Chironomus riparius Meigen 1804
			Chironomus thummi gr
	Tanytarsini		

Paratanytarsus	
	Paratanytarsus sp.
Cladotanytarsus	
	Cladotanytarsus sp.
Virgatanytarsus	
	Virgatanytarsus sp.
Micropsectra	
	Micropsectra atrofasciata (Kieffer, 1911)
Tanytarsus	
	Tanytarsus palettaris
	Tanytarsus sp.

Subfamily: Tanypodinae

Conchapelopia pallidula (**Meigen, 1818**): This species collected from Bouailef and O.Chaaba sites.

Conchapelopia sp.: Collected from Bouailef and Ghoufi sations.

Zavrelimyia sp.: Collected in both Hamla, Foum Toub, Ghoufi, Rhawat, and Kasrou, and also Maafa.

Tanypus sp.: Larvae of this species were found only at El Kantara site.

Procladius sp.: Larvae collected from Maafa and Nafla sites.

Ablabesmyia sp.: Larvae collected from Bouailef.

Subfamily: Diamesinae

Diamesa (Diamesa) insignipes **Kieffer 1908**: Collected from Inoughissen site.

Subfamily: Orthocladiinae

Cardiocladius sp.: Larvae collected from Nafla .

Orthocladius Euorthocladius ashei: Collected from O.Chaaba.

Orthocladius E. rivicola **Kieffer, 1911:** Collected from Berbaga and Mchounech sites.

Orthocladius O. oblidens (**Walker, 1856**): Collected in both Ghoufi, Mchounech, Bouailef and Nafla.

Orthocladius O.rubicundus (**Meigen, 1818**): Collected from Ghoufi site.

Orthocladius O. excavatus **Brundin 1947:** Collected from Timgad and Nafla, Foum Toub, Bouailef sites.

Eukiefferiella bedmari Vilchez-Quero & Laville, 1987 : Collected from Bouailef and Nafla and O.Chaaaba sites.

Eukiefferiella claripennis (**Lundbeck, 1898**) : Collected from Hamla and Maafa sites.

Eukiefferiella minor (**Edwards 1929**): Collected from Inoughissen site.

Eukiefferiella lobifera: Collected from Hamla site.

Cricotopus (Cricotopus) bicinctus (**Meigen, 1818**) : Collected in both of Maafa, Bouailef, O.Chaaba, Mchounech and El Kantra.

Cricotopus (Isocladius) sylvestris (**Fabricius, 1794**): Collected in Ghoufi, Bouailef and Timgad.

Cricotopus (Cricotopus) vierriensis **Goetghebuer, 1935**: Collected in both of Ghoufi and Mchounech.

Cricotopus (Paratrichocladius) rufiventris (**Meigen, 1830**): Collected in both Rhawat, Bouailef, O.Chaaba and Foum Toub.

Limnophyes sp.: Collected from Bouailef site.

Pseudosmittia sp.: Collected from Foum Toub site.

Rheocricotopus (Psilocricotopus) atripes (**Kieffer, 1913**): Collected from Ghoufi site.

Rheocricotopus (Psilocricotopus) chalybeatus (**Edwards, 1929**): Collected in all of Bouailef, Maafa, Ghoufi, Mchounech and El Kantra sites.

Rheocricotopus dispar (**Goetghebuer, 1913**): Collected at Bouailef site.

Rheocricotopus (Psilocricotopus) meridionalis: Collected from Bouailef site.

Chaetocladius sp.: Collected in bouth of Hamla, Bouailef and O. El Maa sites.

Heterotrissocladius marcidus (**Walker, 1856**): Collected from Berbaga site.

Bryophaenocladius sp.: Collected from Boauilef site.

Thienemanniella sp.: Collected from O.Chaaba site.

Tanytarsus palettaris : Collected from Bouailef site.

Tanytarsus sp.: Collected from Ghoufi and El Kantra sites.

Micropsectra atrofasciata (**Kieffer, 1911**): Collected from Maafa and Mchounech site.

Virgatanytarsus sp.: Collected from Maafa, Bouailef, Mchounech and Ravin Bleu sites.

Cladotanytarsus sp.: Collected from Maafa and Mchounech sites.

Paratanytarsus sp.: Collected from Maafa site.

Chironomus thummi gr: Collected from Ghoufi site.

Chironomus riparius **Meigen 1804** : Collected from Maafa, El Kantra and Timgad sites.

Endochironomus sp.: Collected from Ghoufi site.

Subfamily: Chironominae

Polypedilum (Tripodura) scalaenum (**Schrank, 1803**): Collected from O.Chaaba and Mchounech site.

Polypedilum (Polypedilum) nubeculosum **(Meigen, 1804**): Collected from El Kantra site.

Polypedilum (Polypedilum) albicorne (**Meigen, 1838**): Collected from Mchounech site.

Polypedilum convictum (**Walker, 1856**): Collected from O.Chaaba site.

Polypedilum (Tripodura) acifer: Collected from O.Chaaba site.

Cryptochironomus sp.: Collected from O.Chaaba site.

Demicryptochironomus sp.: Collected from Bouailef site.

Saetheria sp.: Collected from Rhawat site.

Chironomidae are present in all studied rivers, both in high stations and in low altitude stations. The abundance of all the subfamilies in the study region shows that (**Fig.20**):

Diamesinae subfamily whose elements preferably mountain waters present by a single species in the Inoughissen site.

Orthocladiinae subfamily, accounts for 50% of the family's diversity; As well as, Tanypodinaes subfamily with 13%, these two subfamilies colonize the most upstream habitats as well as those of piedmont and low altitude.

The Chironominae subfamily represented 35% of the family and exhibited by two tribes (Chironomini & Tanytarsini) whose representatives are Eurytherms and resistant to pollution frequent the calm waters of the potamal.

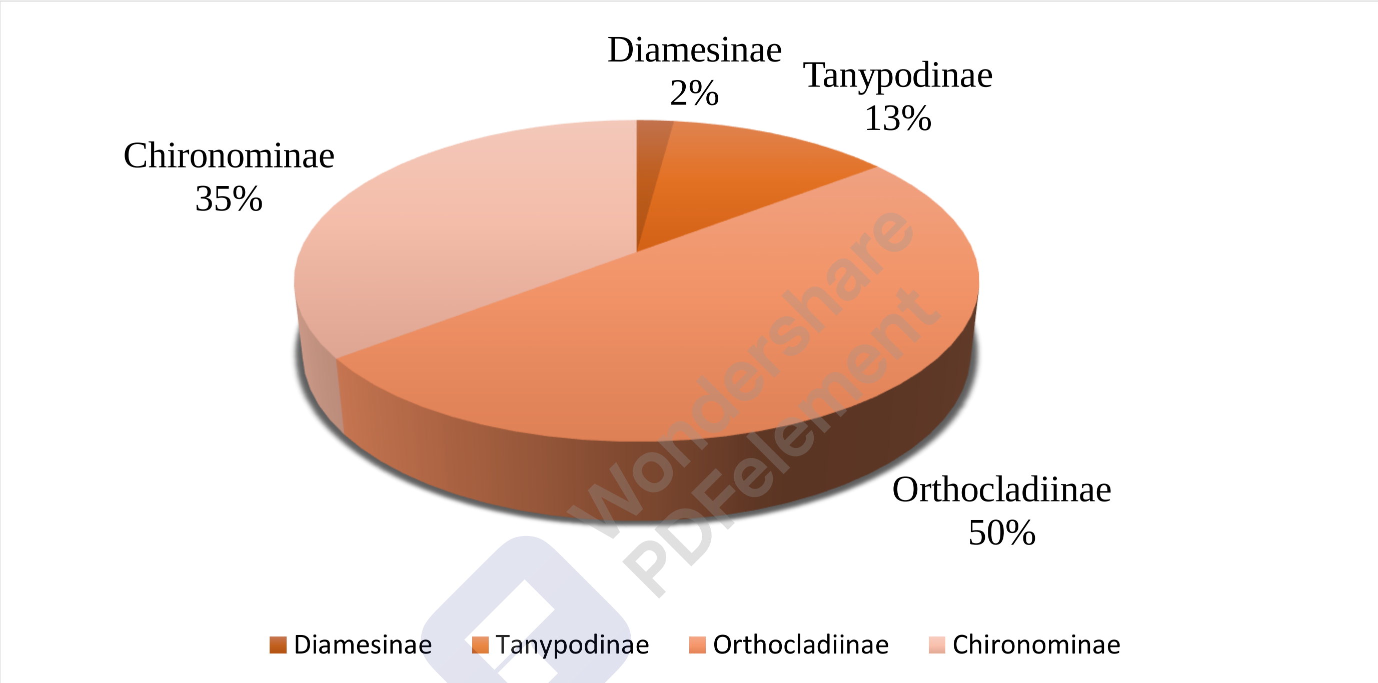


Fig.20: Abundance of subfamilies of Chironomidae in the stations studied

The number of species varies between the sites of the region, as follows in (**Fig.21**). Probably for both Rvian Bleu, Kasrou, Oued El Maa (with 1species, 2species, one species there on the order), this decrease in the number of taxa, explained by the number of sampling affected at these sites. Whereas, despite the lack of sampling in the two sites Timgad and Fum Toub, record a significant number of taxa (4 species and 3 species on order).

The highest number of taxa in Bouailef (18 species) was to intensify sampling operations during August 2019. The breeding of the larvae of the Chironomidae of this site at this period.

In the sites that have been regularly studied, we notice that in Oued Chaaba, Ghoufi, Mchounech, Maafa, and El Kantara, a high diversity of Chironomidae species (10 species, 11 species, 10 species, 10 species, 6 species on order) .

In contrast to Berbaga , Inoughissen and Hamla, Rhawat, and Nafla, it is noticed that there are Diamesinae, Orthocladiinae and Tanypodinaes subfamilies (two species, 2 species, 4 species, 2 species, 5 species there on order). For reference, these sites recorded a high value for dissolved oxygen in the water during the measured laboratory analyzes. (**Appendix II**).

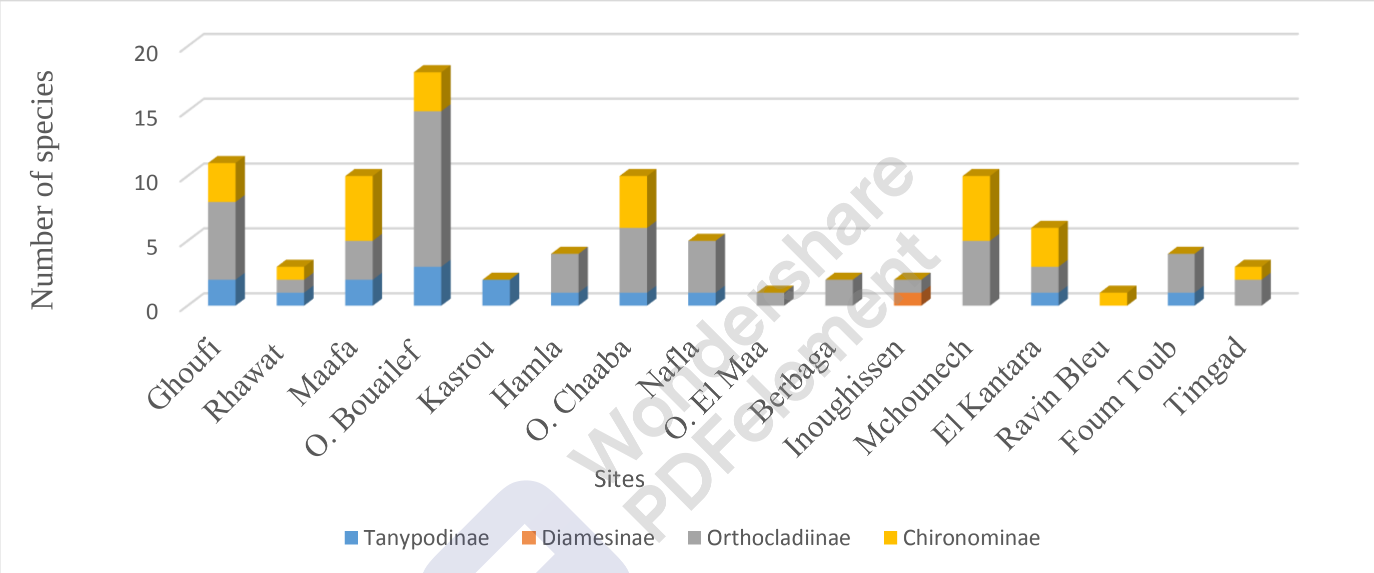


Fig.21: Total number of Chironomidae species within major subfamilies identified at 16 sites

Most species collected in this study are widespread in the Palaearctic area; the relatively high species richness observed can be explained by the high heterogeneity of the microhabitats investigated. Most species are typical of mountain streams, but some Genus are also common in lowland streams (Rheocricotopus, Tanytarsus, Polypedilum, Chironomus).

Many genera of Chironomidae family are considered as only dominant and tolerant to high levels of affected environments by pollution (**Callisto et *al*., 2002**). According to (**Dociel et *al*., 2016**) the Chironomus, Cricotopus, Polypedilum, Rheotanytarsus, and Rheocricotopus are the most common genera found in the habitats were characterized by the affected of human effect or by the high values of substrate Chlorophyll.

Our data showed a specific distribution of some taxa from these genera in both O.Chaaba and Bouailef, Ghoufi (**Fig.22**). However, these regions considered agricultural and pastoral largely. Besides, height measurements of Ammonia, Nitrate, and Nitrite were recorded in the Ghoufi (**appendix II**).

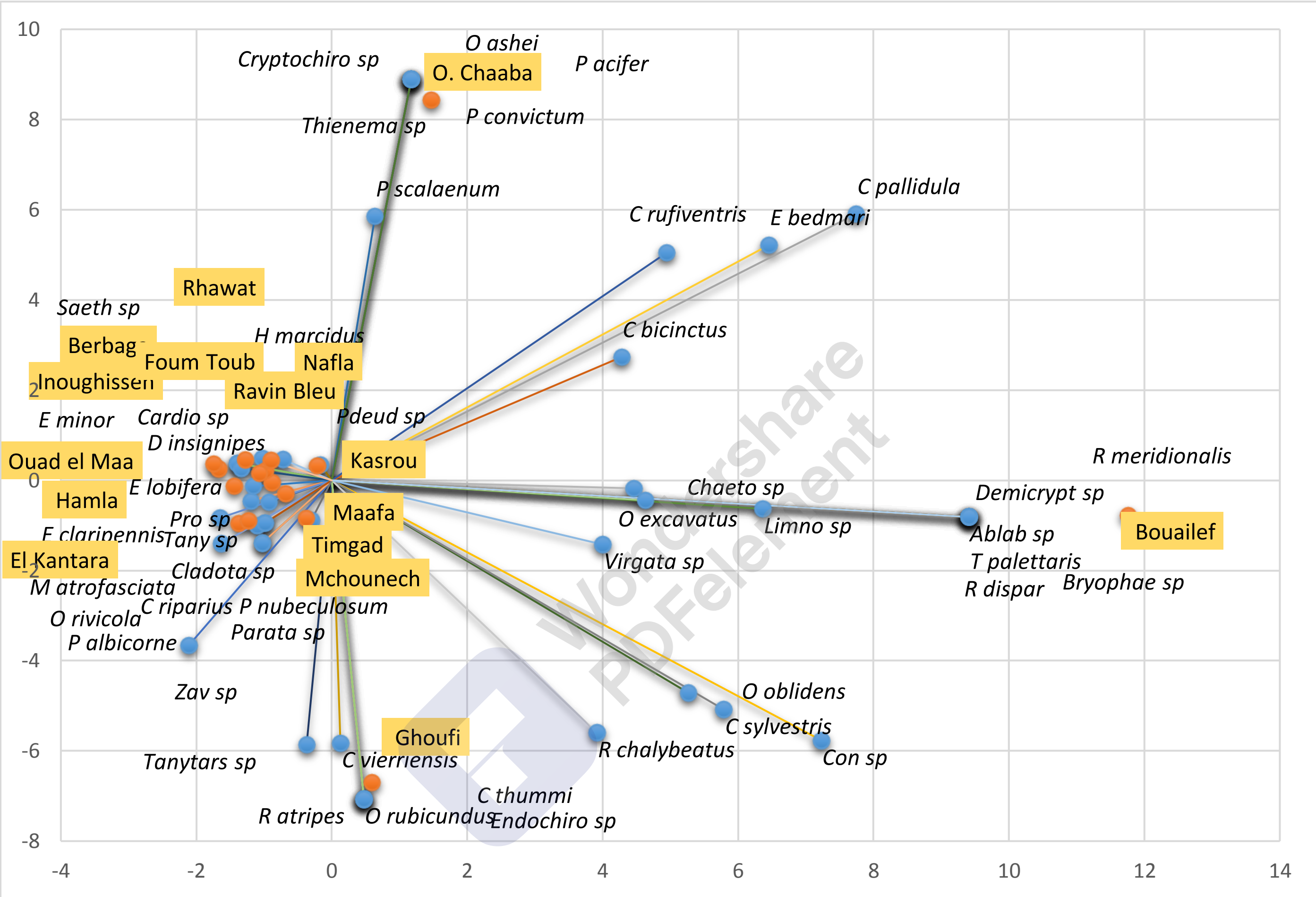


Fig.22: Distribution of Chironomidae species at sampling sites

Conclusion

The Streams in Aures region have a regime characterized by irregular flows and brutal hydrological symptoms. The annual regime is notable by a maximum in winter and spring. The low flow is long, and the summer water deficit determines a temporary flow regime for many streams.

In this work, 10,643 individuals of macrofauna identified divided into 05 Classes, 08 Orders, and 35 Families. They are collected in 17 stations located between 300 and 1800 m altitude.

The most represented groups are the Diptera and the Trichoptera. They have 12 and 10 families. Then come Heteroptera (3 families), Ephemeroptera (3 families), Molluscs (2 families), Oligochaetes (1 family), Crustaceans (1 family).

The benthic population size showed that Ephemeroptera and Diptera are dominant. They represent respectively 42.55% and 29% of the total fauna. They are abundant in all stations and account for 70% of the harvested fauna.

Analysis of the distribution of harvested fauna revealed their great abundance in high altitude areas. The low-altitude stations record an abundance of between 63 and 379 individuals and less taxonomic richness. These are areas of intermediate disturbance and being ’negative impact of anthropogenic disturbances suffered by these rivers' sectors.

The taxonomic study carried out on the Trichoptera shows that the Aures region characterized by a high taxonomic richness concerning this Order, 18 species identified in this work belonging 10 families, between them 4 new species for the list of Algerian Trichoptera;

Regarding Simuliidae of Aures, most of the sites have not been studied before of this family; this work demonstrated the diversity in the region and the relationship of these species to their environmental conditions. Eight nominal identify, four from them are new for the region.

Respecting Chironomidae, this checklist presents the first list of Aures Chironomidae, the 48 species distributed on all sites investigates are from the practice area, a lot of them are mountainous species. Still, also there are several species of low altitude.

Conclusion

For prospects, it would interest in the future to prospect more depth the various hydrographic networks and start monitoring over several years, with a larger number of stations to establish the biodiversity of macroinvertebrates and the influence of environmental factors on the distribution of fauna in the Aures region.

We propose a depth study of Ecotoxicology and the effect of the various components of fertilizers and pesticides used in the region by farmers and their direct or indirect impact on aquatic invertebrates.

Responsible authorities should consider the sensitive condition that this class of animals suffers from; it should take certain protective measures to preserve aquatic environments from pollution Agaricales and overexploitation of water.

It is also essential to build and maintain in good working order treatment facilities and wastewater treatment plants.

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Table1. Checklist of the currently known Algerian Trichoptera Fauna

Species List	Source	Distribution in Algeria
RHYACOPHILIDAE		
***Rhyacophila munda* McLachlan 1862**	Lestage (1925), Gauthier (1928), Malicky & Lounaci (1987), Tobias & Tobias (2008), Sekhi *et al*. (2016)	Oued de Beni Messous, Bouzareah; Kabylia, Djurdjura Mts.
***Rhyacophila urgl* Malicky & Lounaci 1987**	Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.
GLOSSOSOMATIDAE		
***Agapetus numidicus* Vaillant 1954**	Vaillant (1954)	La Chiffa, Atlas of Blida; Bouzina, Oued Talha, Aures Mts.
***Agapetus fuscus* Vaillant 1954**	Vaillant (1954)	Oued Boughara, Aures Mts.
***Agapetus incertulus* McLachlan 1884**	Vaillant (1954), Sekhi *et al*. (2016)	Aures Mts; Kabylia, Djurdjura Mts.
HYDROPTILIDAE		
***Orthotrichia angustella* (McLachlan 1865)**	Morton (1896)	Constantine
***Ithytrichia clavata* Morton 1905**	Tobias & Tobias (2008)	-
***Oxyethira falcata* Morton 1893**	Lestage (1925), Tobias &Tobias (2008)	El Biar, Bouzareah; Sétif
***Oxyethira unidentata* McLachlan 1884**	Tobias & Tobias (2008)	-
***Hydroptila campanulata* Morton 1896**	Morton (1896); Dakki (1982)	Biskra; Constantine
***Hydroptila serrata* Morton 1898**	Morton (1898)	Annaba (Bône)
***Hydroptila sparsa* Curtis 1834**	Morton (1896), Lestage (1925)	Frais-Vallon, Bouzareah; Fort St. Germain, Biskra.
***Hydroptila vectis* Curtis 1834**	Morton (1896), Tobias & Tobias (2008), Sekhi *et al.* (2016)	Gorges de la Chiffa, Bouarfa, Blida; Kabylia, Djurdjura Mts., Aures Mts.

***Allotrichia pallicornis* (Eaton 1873)**	Morton (1896), Lestage (1925), Hajji *et al.* (2013), Sekhi *et al.* (2016)	Bouzaréa, El-Biar; Kabylia, Djurdjura Mts.
***Stactobia algira* Vaillant 1951**	Vaillant (1951)	Algier, Atlas Mts.
***Stactobia maculata* Vaillant 1951**	Vaillant (1951)	Algier, Atlas Mts.
PHILOPOTAMIDAE		
***Chimarra marginata* (Linnæus 1767)**	Lestage (1925), Hajji *et al.* (2013)	Hammam Debagh
***Wormaldia algirica* Lestage 1925**	Lestage (1925)	Ighzer Tenida, Kabylia.
HYDROPSYCHIDAE		
***Cheumatopsyche atlantis* (Navás1930)**	Lestage (1925), Dakki (1982)	Oued Kerma, Algiers.
***Cheumatopsyche lepida* (Pictet 1834)**	Gauthier (1928), Arab *et al.* (2004)	Chelif River, Northwest Algeria
***Hydropsyche artax* Malicky & Lounaci 1987**	Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.
***Hydropsyche exocellata* Dufour 1841**	Arab *et al.* (2004)	Chelif river, North West Algeria
***Hydropsyche fezana* Navás 1932**	Tobias & Tobias (2008), Sekhi *et al.* (2016)	Kabylia, Djurdjura Mts.
***Hydropsyche iberomaroccana* González & Malicky 1999**	Sekhi *et al.* (2016)	Kabylia, Djurdjura Mts.
***Hydropsyche lobata* McLachlan 1884**	Tobias & Tobias (2008), Arab et al. (2004), Sekhi *et al.* (2016)	Chelif river, North West Algeria; Kabylia, Djurdjura Mts.
***Hydropsyche maroccana* Navás 1936**	Malicky (1983), Malicky & Lounaci (1987), Dakki & Tachet (1987), Arab *et al.* (2004), Dambri et al.(2021)	Chelif River, Northwest Algeria; Kabylia, Djurdjura Mts, Aures Mts.
***Hydropsyche morla* Malicky & Lounaci 1987**	Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.
***Hydropsyche obscura* Navás 1928**	Tobias & Tobias (2008), Sekhi *et al.* (2016)	Kabylia, Djurdjura Mts.

***Hydropsyche punica* Malicky 1981**	Malicky (1983), Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.
***Hydropsyche resmineda* Malicky 1977**	Malicky (1983), Malicky & Lounaci (1987), Dakki &Tachet (1987), Tobias & Tobias (2008), Sekhi *et al.* (2016)	Kabylia, Djurdjura Mts.
POLYCENTROPODIDAE		
***Plectrocnemia conspersa* (Curtis 1834)**	Present paper	Aures Mts., new record for Algeria
***Polycentropus flavomaculatus*(Pictet 1834)**	Lestage (1925), Gauthier (1928), Malicky & Lounaci (1987)	Oued Ighzer temda, Kabylia; Kabylia, Djurdjura Mts.
***Polycentropus kingi* McLachlan 1881**	Tobias & Tobias (2008), Sekhi et al. (2016)	Kabylia, Djurdjura Mts.
***Polycentropus variatus* Navás 1917**	Navás (1917), Lestage (1925)	La Chiffa, Atlas of Blida.
PSYCHOMYIDAE		
***Tinodes algiricus* McLachlan 1880**	Vaillant (1954), Dakki (1982), Tobias & Tobias (2008)	Aures Mts.; Constantine; Kabylia, Djurdjura Mts.; Atlas of Blida, Ghouffi
***Tinodes dives* (Pictet 1834)**	Present paper	Aures Mts., new record for Algeria
ECNOMIDAE		
***Ecnomus relictus* Vaillant 1953b**	Vaillant 1953b	Hoggar Mts.
LIMNEPHILIDAE		
***Enoicylopsis peyerimhoffi* Navás 1917**	Navás 1917	Kabylia, Djurdjura Mts.
***Micropterna testacea* Gmelin 1789**	Sekhi *et al.* (2019)	Oued Hamla, Batna (Aures Mts.)
***Stenophylax crossotus* McLachlan 1884**	Schmid (1957)	Oued Amizour, Amizour
***Stenophylax mucronatus curvidens* Schmid 1957**	Schmid (1957)	Oued Amizour, Amizour

***Stenophylax malatesta* (Schmid 1957)**	Schmid (1957)	Guelt-es-Stel (Central Algeria)
***Mesophylax aspersus* (Rambur 1842)**	Malicky (1998)	Aures Mts. (Khenchela, Batna); Hoggar Mts.; Sahara region (Hassi Babah)
***Limnephilus alaicus* Martynov 1915**	Sekhi *et al.* (2019)	Hassi Babah; Guelt-es-Stel
***Limnephilus barbagaensis* Malicky, Sekhi & Lounaci 2019**	Sekhi *et al.* (2019)	Oued Taga, Ain Barbaga, Aures Mts.
GOERIDAE		
***Silonella aurata* (Hagen 1864)**	Vaillant (1954), Tobias & Tobias (2008), Sekhi *et al.* (2018)	Kabylia, Djurdjura Mts; Oued Talha, Ain Fadha, Mount Faraoun (Aures Mts.)
LEPTOCERIDAE		
***Athripsodes ygramul* Malicky & Lounaci 1987**	Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.
***Mystacides azureus* (Linnaeus 1761)**	Gauthier (1928)	Oued Kerma, Wilaya de Tipaza.
***Triaenodes albicornis*(Ulmer 1905)**	Dakki (1982)	-
***Setodes acutus* Navás 1936**	Present paper	Aures Mts., new record for Algeria
***Oecetis uyulala* Malicky & Lounaci 1987**	Malicky & Lounaci 1987	Wilaya de Béchar; Kabylia, Djurdjura Mts.
BERAEIDAE		
***Beraea auresi* Vaillant 1953a**	Vaillant 1953a	Oued Boughara, Arris, Aures Mts.
UENOIDAE		
***Thremma sardoum africanum* Malicky & Lounaci 1987**	Malicky & Lounaci (1987)	Kabylia, Djurdjura Mts.

Table2: Chemical measurements taken at laboratory

	Oxygene dissous	Nitrate	Nitrite	Ammonium	Carbonates	Bicarbonate	Chlorures
	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l
Bouailef	4.57	0.9	0.03	0.112	0.00	244.00	21.3
Berbaga	8.57	1.33	0.003	0.1	0.00	183.00	21.3
Inoughissen	3.12	72.00	0.2	0.51	0.00	213.5	21.3
Rhaouat	4.00	51.75	0.19	0.541	0.00	183.00	21.3
El Kantra	2.5	87.00	0.5	0.723	0.00	245.6	21.3
Ghoufi	3.10	77.00	0.26	0.562	0.00	238.00	21.3
Mchouneche	3.28	74.98	0.28	0.567	0.00	215.00	21.3
Mafaa	6.85	17.72	0.004	0.09	0.00	183.00	17.75
Nafla	5.14	19.00	0.06	0.027	0.00	183.00	21.3
O.Chabaa	5.71	0.6	0.02	0.12	0.00	244.00	21.3
Hamla	4.16	1.12	0.05	0.034	0.00	235.00	21.3
yabous	8.34	58.03	0.02	0.143	0.00	137.27	35.5