

ODONATES FROM A FEW WADIS IN THE EL AOUNET REGION, NORTH OF TEBESSA (EXTREME EAST OF ALGERIA)

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Abstract. The odonatological fauna study was carried out at the Mellegue Oued and some of its tributaries during the period January - May of 2018. Seven families were identified, distributed over 13 genera and 18 species. The specific richness is greater and the population of Odonata is more balanced in the stations at Mesloulou than in the stations at El Aouinet. Coenagrionidae and Libellulidae are the most abundant and frequent families at the two sites. Coenagrionidae are the most diverse in El Aouinet and Libellulidae in Mesloulou. *Ischnura graellsii* is the most abundant species in El Aouinet, while *Orthetrum chrysostigma* and *Trithemis annulata* are abundant in Mesloulou.

Keywords: Odonata, inventory, abundance, frequency, El Aouinet.

Rezumat. Odonatele din câteva văi seci din regiunea El Aouinet, la nord de Tebessa (estul extrem al Algeriei). Studiul privind fauna odonatologică a fost realizat în zona uedului Mellegue și a câtorva afluenți ai acestuia în perioada ianuarie-mai 2018. Au fost identificate șapte familii, care acoperă 13 genuri și 18 specii. Bogăția specifică este superioară, iar populația de odonate este mai echilibrată în stațiile din Mesloulou decât în stațiile din El Aouinet. Cele mai abundente și mai frecvent întâlnite familii în cele două locații sunt Coenagrionidae și Libellulidae. Coenagrionidae prezintă cea mai mare diversificare în El Aouinet, iar Libellulidae în Mesloulou. *Ischnura graellsii* este specia cea mai abundentă în El Aouinet, în timp ce *Orthetrum chrysostigma* și *Trithemis annulata* sunt abundente în Mesloulou.

Cuvinte cheie: odonate, inventariere, abundență, frecvență, El Aouinet.

INTRODUCTION

The fauna of the Odonates has been known for a long time, it is very studied in Europe and in the world. The odonates occupy very varied environments. From brackish basins to mountain lakes, there are hardly any aquatic environments that cannot be colonized by odonates (MASSELOT & NEL, 2003). They have ecological requirements which make them an ideal group to be used as tools for the evaluation and conservation of aquatic environments (DOMMANGET, 1989). As predators, they play a significant role in the regulation of part of the fauna of these biotopes. As prey, they contribute to the maintenance and development of other animal species (D'AGUILAR & DOMMANGET, 1998). Odonata are generally used as a group of bioindicators of habitat quality, health management and the conservation of ecosystems (CORBET, 1999; SUBRAMANIAN et al., 2008; DOLNY et al., 2011) and the enhancement of the importance of the characteristics of the habitats and microhabitats of the systems of rivers (ROMERO, 1988). Odonates such as *Aeshna juncea* and *Platycnemis pennipes* may be candidate indicators for particular contaminants (VILLALOBOS –JIMENEZ et al., 2016). They are sensitive to stressors in aquatic and terrestrial habitats, the Odonata can provide information on the effects of urbanization on biodiversity (VILLALOBOS–JIMENEZ, 2016). Odonatological diversity can be an interesting tool for assessing the quality of environments (MASSELOT & NEL, 2003) and environmental variety (CAMPOS et al., 2014).

According to BOUDOT (2010), the odonatological fauna of North Africa and the Maghreb in particular (Morocco, Algeria and Tunisia) is relatively well known. BOUDOT et al. (2009) In North Africa, there are 83 species (35 Zygoptera and 48 anisoptera), 61 species in Morocco, 54 species in Tunisia and Algeria. SAMRAOUI & MENAI (1999) produced the first synthesis declaring the presence of 63 different species on the Algerian territory, the studies follow one another since this period, one can count some carried out in different region of Algeria like SAMRAOUI & CORBET (2000a), SAMRAOUI & CORBET (2000b), SAMRAOUI B. (2009), SAMRAOUI & ALFARHAN (2015); BOUCHELOUCHE et al. (2015); KHELIFA et al. (2013); KHELIFA et al. (2015); HAFIANE et al. (2016); YALLES-SATHA & SAMRAOUI (2017); BOUCENNA et al. (2018) and many others.

This study constitutes a contribution to the knowledge of part of the Algerian odonatofauna that shelters the main wadis of the study region. The main purpose of this study is to identify part of the Algerian odonatological fauna in this region where information is weak or even non-existent. Although a large part of Algerian Odonatology is known to date, some habitats remain unexplored, and our study falls within this framework. It paves the way for several future studies on the study of larvae and exuviae in order to confirm the breeding habitats for the listed species.

MATERIAL AND METHODES

Presentation of the study area: The study area is located at north of Tebessa wilaya (Extrem East of Algeria) at the northern edge of the desert, it covers an area of 624 Km². This area, which is characterized by its richness in terms of mineral resources (mines that have been shut down for years), generates pollution favored by the surface flows of Oued Mellegue which promotes the movement of pollutants (BELHAMRA et al., 2016).

The climate is semi-arid, characterized by a dry season (summer) and a rainy season (spring). This study is carried out at the El Aouinet and Masloulia sites and the four stations chosen for sampling are located on Oued Mellegue and its tributaries (Oued Masloulia, Oued Chabro and Oued Meskiana) (Fig. 1; Table 1). The substrate is rocky or silty or sandy with the presence or absence of pebbles with the presence of moss algae on the slabs and the edge vegetation includes the species *Phragmites* sp., *Nerium oleander*, *Phoenix Dactifira*, *Tamarix*. sp, *Juncus* sp., *Polygonum equisetiforme*, *Atriplex halimus*.

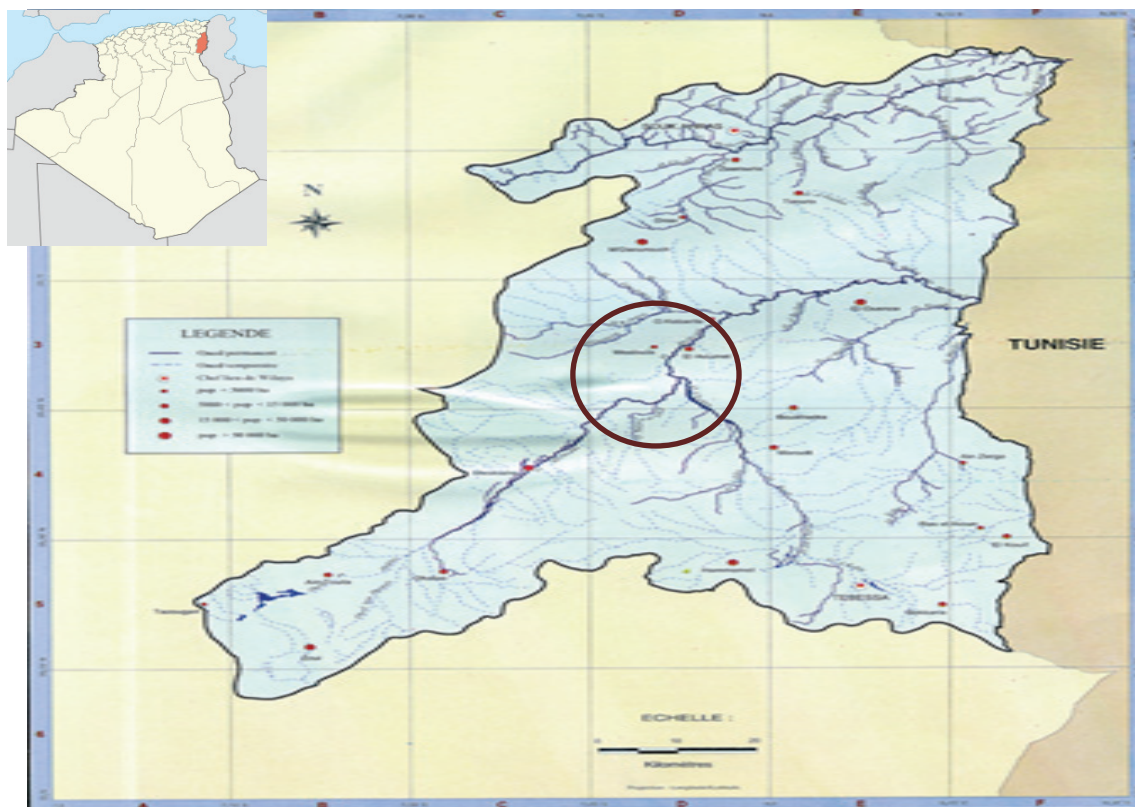


Figure 1. Geographic location of the study area (A.N.R.H., 2011).

Study stations:

Table 1. Characterization of the sampling stations chosen for carrying out this study.

Study stations	Latitude	Longitude	Altitude	nature of stream	Type of flow
Station 1	35°49'12.5''N	7°51'51.3''E	659 m	Permanent	low current or absent
Station 2	35°52'18.7''N	7°53'26.2''E	627m	Permanent (urban)	Medium
Station 3	35°52'15.8''N	7°49'34.5''E	723m	Temporary	Medium
Station 4	35°52'19.8''N	7°49'31.07''E	715 m	Temporary	Slow

Odonata sampling

Sampling is carried out every 15 days during January-March and then every week until the end of May in the year 2018. The methodology followed is that of the transects on either side along the Wedi on a distance of 700m. Odonata are randomly caught by means of a butterfly net; identification is carried out on the basis of specific keys (JACQUEMIN & BOUDOT, 1999; DIJKSTRA & LEWINGTON, 2007).

Data analysis

We studied the odonatological settlement in a comparative framework (between the two sites and between the four stations) in terms of presence / absence of species by a similarity analysis which demonstrates the degree of resemblance of two inventories by calculating the Jaccard similarity index

$$J = c / (a + b - c)$$

This ratio can vary from 0 (no similarity) to 1 (total similarity), the relative abundance is expressed in % according to the formula:

$$AR\% = n_i / N * 100$$

Constance is expressed in % according to the formula (DAJOZ, 1985)

$$F\% = Pa / P * 100$$

When species are omnipresent (F = 100%); constants (75 = F = 100); regular (50 = F = 75); accessories (25 = F = 50) and accidental species (F = 25).

The richness of the habitat in Odonates and the distribution of the Odonatological population are calculated according to the following formulas:

Shannon-Weaver Diversity Index (BLONDEL et al. 1973):

$$H' = -\sum Q_i \log_2 Q_i$$

Equitability: (RAMADE, 1984)

$$E = H'/H' \text{ max.}$$

$$H' \text{ max.} = \log_2 S$$

Statistics: the influence of altitude on the distribution of species is demonstrated by the Principal Component Analysis method (PCA), biplot type.

RESULTS

This contribution has enabled us to list the Odonatological species at the two study sites north of Tebessa in Algeria during the period January-May of the year 2018; the inventory allowed us to identify 18 species divided into 4 families of the sub-order Zygoptera and 3 families of the sub-order Anisoptera. The maximum specific richness is noted in the families *Coenagrionidae* and *Libellulidae* with 6 species each one (Table 2).

Table 2. Inventory of odonatological fauna identified in the study region.

Order	ODONATA	
S/Order	Families	Genres & Species
Zygoptera	Coenagrionidae	<i>Coenagrion scitulum</i> (Rambur, 1842)
		<i>Coenagrion puella</i> (Linnaeus, 1758)
		<i>Ischnura graellsii</i> (Rambur, 1842)
		<i>Ischnura</i> sp.
		<i>Enallagma</i> sp.
		<i>Erythromma lindenii</i> (Selys, 1840)
	Calopterygidae	<i>Calopteryx haemorrhoidalis</i> (Vander Linden, 1825)
	Lestidae	<i>Sympecma fusca</i> (Vander Linden, 1820)
		<i>Chalcolestes viridis</i> (Vander Linden, 1825)
	Platycnemididae	<i>Platycnemis subdilata</i> Selys, 1849
Anisoptera	Aeshnidae	<i>Anax imperator</i> (Leach, 1815).
	Libellulidae	<i>Crocothemis erythraea</i> (Brullé, 1832).
		<i>Orthetrum nitidinerve</i> (Selys, 1841)
		<i>Orthetrum trinacria</i> (Selys, 1841)
		<i>Orthetrum chrysostigma</i> (Burmeister, 1839)
		<i>Trithemis annulata</i> (Palisot de Beauvois, 1807).
		<i>Trithemis kirby</i> Selys, 1891
	Gomphidae	<i>Gomphus</i> esp. Indet.

Spatial distribution of the Odonatological population

The distribution of population in the two sites showed the richness of the site Mesloula where seven families and 15 species are listed as only five families and 11 species are present at El Aouinet. The family Coenagrionidae is the most diverse in El Aouinet, on the other hand in Mesloula, it is the family Libellulidae which is the most diverse (Table 3). All families are accidental in El Aouinet except Coenagrionidae and Libellulidae, and in Mesloula Coenagrionidae, Platycnemididae and Libellulidae are regular, while the rest of the families are either incidental or accidental (Table 3).

Table 3. Richness R, frequency of occurrence (F%), status (S) and relative abundance (RA%) of the Odonate families identified in the study stations (r: regular, a: accessory, acc: accidental).

Sites Families	El Aouinet				Mesloula			
	R	F%	S	RA%	R	F%	S	RA%
Coenagrionidae	4	61,42	r	79,69	4	66,66	r	45,5
Calopterygidae	1	0	0,1	0	1	16,66	a	0,97
Lestidae	2	7,14	a	15,8	1	16,66	a	0,33
Platycnemididae	0	0	-	0	1	16,66	a	10
Aeshnidae	1	7,14	a	1,63	1	23	acc	2,44
Libellulidae	3	50,28	r	2,88	6	63	r	40,7
Gomphidae	0	0	-	0	1	16,66	a	0,22
Total	11	-	-	100	15	-	-	100

Coenagrionidae is largely dominant in El Aouinet (79.69%) of the total population, in Mesloula this family represents 45.5% followed by Libellulidae 40.7%. The other families are very poorly represented in the study sites (Fig. 2).

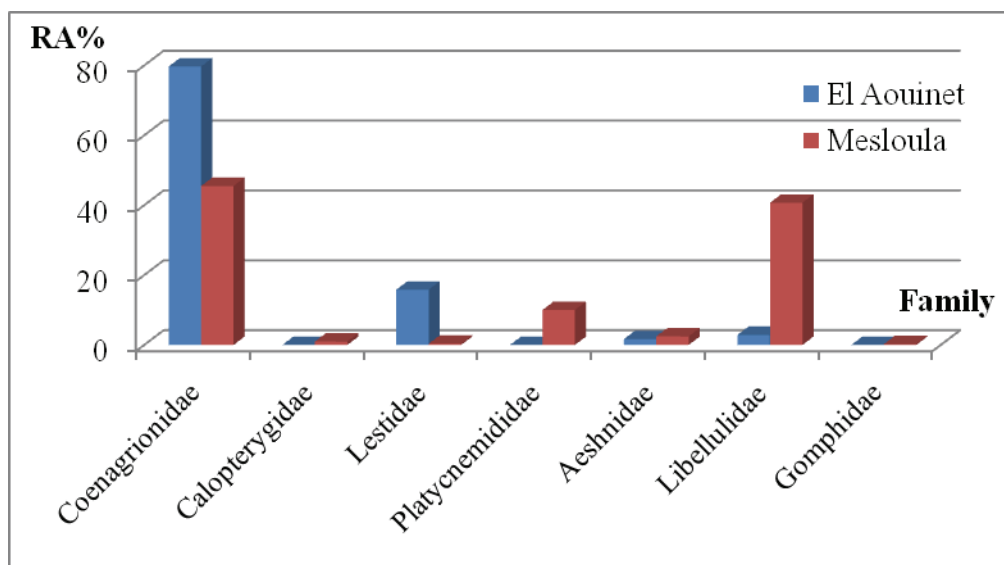


Figure 2. Relative abundance (RA%) of Odonate families in study sites.

Two species are mainly abundant in El Aouinet: *Ischnura graellsii* (54.26%) and *Orthetrum nitidinerve* (27.69%) the other species are poorly found in this site; on the contrary, several species share the site of Mesloulia, i.e. *Orthetrum Chrysostigma* (19.42%) followed by *Trithemis annulata* (17.69%), *Ischnura graellsii* (14.67%), *Platycnemis subdilata* (13.66) and *Erythromma lindenii* (12.80), the rest of the species are not abundant (Table 3); in terms of frequency of appearance in the sites the species *Ischnura graellsii*, and *Orthetrum nitidinerve* have regularly appeared in El Aouinet as well as the species *Ischnura graellsii*, *Platycnemis subdilata*, *trithemis annulata*, *Orthetrum chrysostigma* in Mesloulia. The other species are either accidental or rare (Table 4).

Table 4. Relative abundance (AR%), Occurrence (F%) and status (S) of the odonate species identified in the study sites during the study period (r: regular, a: accessory, acc: accidental).

Genres & Species	Sites	El Aouinet			Mesloulia		
		RA%	F%	S	RA%	F%	S
<i>Coenagrion scitulum</i> (Rambur, 1842)		0,48	0,2	a	0	0	-
<i>Coenagrion puella</i> (Linnaeus, 0)		0	0	-	0,14	0,1	a
<i>Ischnura graellsii</i> (Rambur, 1842)		54,26	0,9	r	14,67	0,8	r
<i>Ischnura</i> sp.		0,32	0,1	a	0	0	-
<i>Enallagma</i> sp.		0	0	-	0,71	0,3	a
<i>Erythromma lindenii</i> (Selys, 1840)		1,69	0,1	-	12,80	0,4	acc
<i>Calopteryx haemorrhoidalis</i> (Vander Linden, 1825)		0,88	0	-	1,72	0,3	a
<i>Sympecma fusca</i> (Vander Linden, 1820)		8,29	0,3	a	0	0	-
<i>Chalcolestes viridis</i> (Vander Linden, 1825)		3,62	0	-	2,73	0,4	acc
<i>Platycnemis subdilata</i> Selys, 1849		0	0	-	13,66	0,7	r
<i>Anax imperator</i> (Leach, 1815).		1,69	0,3	acc	1,57	0,3	a
<i>Crocothemis erythraea</i> (Brullé, 1832).		1,04	0,4	acc	2,44	0,4	acc
<i>Trithemis annulata</i> (Palisot de Beauvois, 1807)		0,16	0,2	a	17,69	0,5	r
<i>Trithemis kirby</i> Selys, 1891		0	0	-	8,92	0,4	acc
<i>Orthetrum nitidinerve</i> (Selys, 1841)		27,69	0,5	r	0,86	0,2	a
<i>Orthetrum trinacria</i> (Selys, 1841)		0	0	-	2,58	0,4	acc
<i>Orthetrum chrysostigma</i> (Burmeister, 1839)		0	0	-	19,42	0,6	r
<i>Gomphus</i> esp. Ind.		0	0	-	0,14	0,1	a

Similarity and spatial distribution of the Odonatological population

The similarity between the Odonate populations of the two sites $S = 0.36$ which demonstrates the presence of a small number of common species. Between the study stations, the similarity is different since the greatest similarity is noted between stations 1 and station 2 and between stations 3 and station 4 with 0.81 and 0.85 respectively. The rest of the values are low, demonstrating the presence of a low similarity between the study stations (Table 5).

Table 5. The similarity matrix of study stations.

Stations	Station1	Station2	Station3	Station4
Station1	1	0,81	0,46	0,36
Station2		1	0,42	0,41
Station3			1	0,85
Station4				1

The distribution of Odonate species varies from one station to another, *Ischnura graellsii* largely dominate the other species in station 2, less in station 3 and in station 1, however *Orthetrum nitidinode* is more abundant in station 1 and *Orthetrum nitidinode* in station 4. *Ischnura graellsii* is relatively abundant in all stations (Fig. 3).

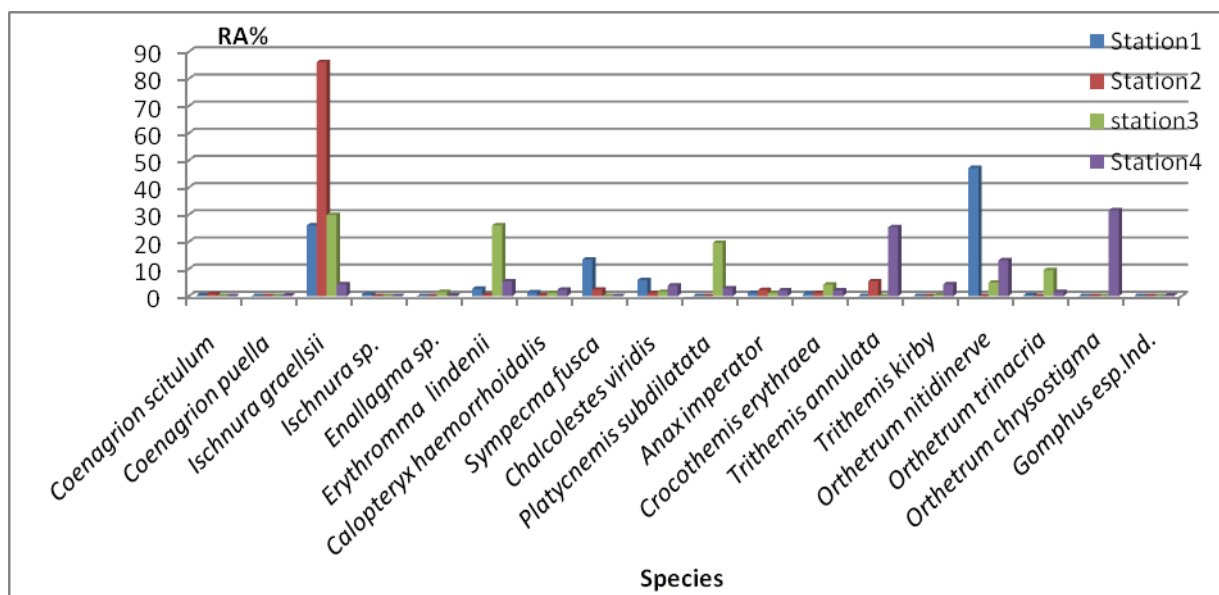


Figure 3. Spatial distribution of the Odonate species listed in the study stations.

The temporal distribution of Odonate staff in study stations

The numbers of the Odonatological population have a different temporal distribution in the study stations. The peak in abundance is observed in stations 3 and 4 during the month of April and the numbers increase overall in the month of March; in stations 1 and 2 the numbers are higher in May (Fig. 4).

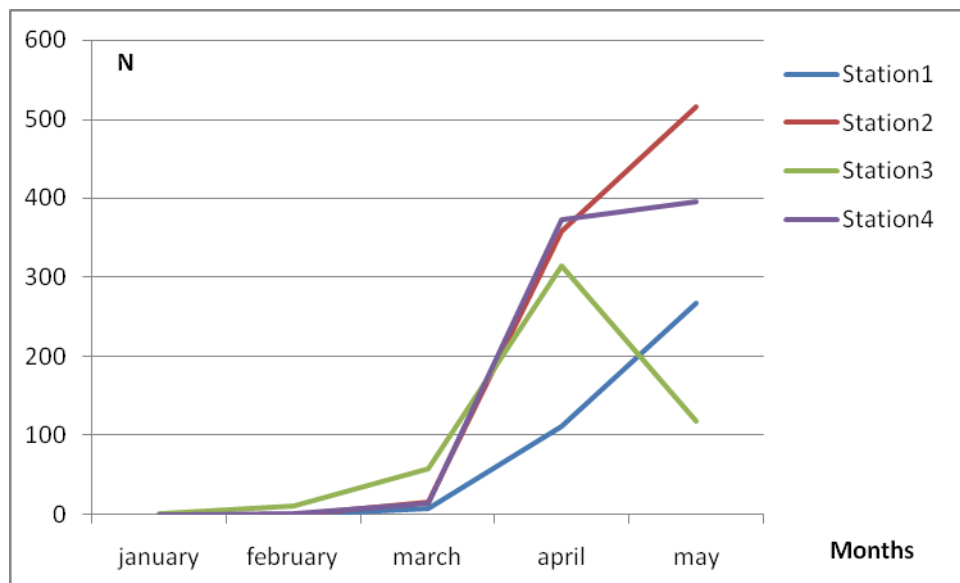


Figure 4. Evolution of the numbers of Odonates identified in the study stations.

Spatial diversity of the Odonata population

The diversity of the Odonatological population differs from one station to another depending on the specific richness and the numbers. Shannon Weaver index values range from 0.93 bits to 2.91 bits. The highest value is found in station 4 followed by station 3 (Table 6). With the exception of station 2 where the equipartition index is low, the equipartition of species is balanced in the other stations with a maximum value observed in station 3 then station 4 (Table 6).

Table 6. Shannon Weaver diversity index in the study stations.

Parameters	Station1	Station2	Station3	Station4
Total richness(S)	11	9	11	15
H' (bits)	2,10	0,93	2,60	2,91
H' max (bits)	3,45	3,16	3,45	3,90
E	0,60	0,29	0,75	0,74

The study of the impact of altitude on the distribution of the Odonata population revealed the formation of four groups of species linked to a given altitude such as *Ischnura graellsii* (Ig) at altitude A02, *Trithemis annulata* (Ta), *Orthetrum chrysostigma* (Oc) at altitude A04 (Fig. 5).

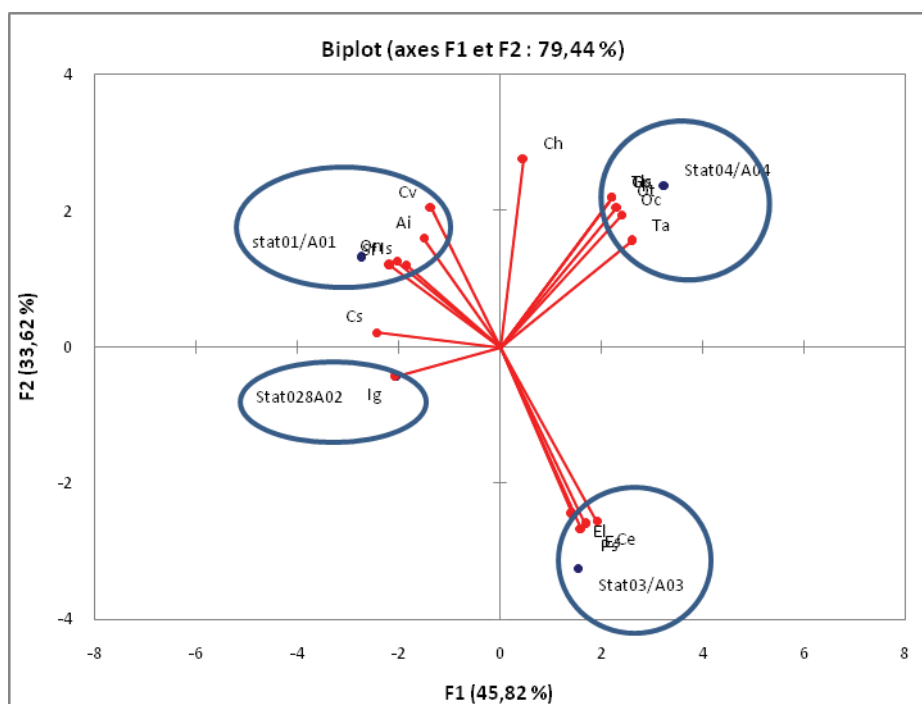


Figure 5. Distribution of the Odonatological population according to the altitudinal gradient.

DISCUSSION

The inventory of the Odonate species found in the various stations chosen for the performance of this study highlighted the presence of 15 species, 10 (ten) species belong to the Zygopteres (Coenagrionidae, Calopterygidae, Lestidae and Platycnemididae) and 8 (nine) species are part of the Anisoptera (Aeschnidae, Libellulidae and Gomphidae).

No species listed in this study is cited by GARCIA et al. (2010) in IUCN Red List Category North Africa. RAZKALLAH & HOUHAMDI (2018) inventoried 17 species of odonates belonging to 7 families and 13 genera in the Seybouse in Guelma. In the region of Bejaia 14 species are listed in 4 wadis by CHELLI & MOULAI (2019), two species of Zygopteres (Calopterygidae and Platycnemididae) and 12 species of Anisoptera (Aeshnidae, libellulidae and Gomphidae).

The overall specific richness is higher in Mesloula, it is richer in *Libellulidae* than the other families, it includes 3 species of *Orthetrum* and 2 species of *Trithemis* including *Trithemis kirbyi* which is one of the most common species in any type of desert water (DUMONT, 2007) and which is in full expansion in Algeria (KHELIFA et al., 2011) and *Coenagrionidae* (closely followed by Libellulidae) is more abundant in this site. In El Aouinet, *Coenagrionidae* is richer and more abundant than other families.

The species *Ischnura graellsii* and *Orthetrum nitidinerve* are regular and more abundant than the other species in El Aouinet. On the contrary, five (5) species are abundant (*Erythromma lindenii*, *Ischnura graellsii*, *Platycnemis subdilatata*, *Trithemis annulata* and *Orthetrum chrysostigma*) in Mesloula and the four latter species regularly occur on this site. BOUHALA et al. (2019) have established that the most abundant and most well-spread species are *Ischnura graellsii*, *Platycnemis subdilatata* in Wadi Cherf; on the other hand, in the Ichkeul park in Tunisia, the species *Erythromma lindenii* and *Platycnemis subdilatata* are the most abundant (SELLAMI et al., 2015).

In terms of specific richness, the stations chosen on Oued Mellegue show a similarity between them, like the stations belonging to its tributary (Oued Mesloula). According to KALKMAN et al. (2008) the factors influencing the

distribution of dragonfly diversity can be divided into historical (geological) and ecological factors, the two determining the current diversity of species, while the composition at the family and genus level is mainly determined by the first.

The encountered species show preferences for the relevant habitats, which gives certain specificity to these environments. The species *Orthetrum nitidinode*, *Ischnura graellsii* and *Sympecma fusca* show a preference for site 1 probably due to the presence of ideal conditions for oviposition and the type of supports necessary for the emergence of these species. According to MARTENS (2001) *Sympecma fusca* does not choose between living and dead floating plants to deposit its eggs but it inserts them into the available plant during its oviposition.

Ischnura graellsii is one of the most abundant species in the study environment, largely dominant in station 2 (urban environment) and dominant in station 3 (located in urban environments) followed by *Erythroma lindenii* and *Platycnemis subdilatata* but less important in the other stations. *Ischnura graellsii* is used in Portugal as an indicator of the vulnerability of polluted waters (CAMPOS et al., 2014) with the endemic North African species *Platycnemis subdilatata*, they are pollution tolerant at Wadi Cherf (a tributary of Wadi Seybouse) in the northeast of Algeria according to BOUHALA et al. (2019). This endemic species in North Africa which is very abundant in wetlands and rivers could be a potential indicator of the vulnerability of the environment. (BOUDOT et al., 2009). *Platycnemis subdilatata* which is endemic to North Africa and is widely common in streams and rivers, is the most abundant lotic species in the watershed (KHELIFA, 2017).

Orthetrum chrysostigma and *Trithemis annulata* are abundant in station 4. SAMRAOUI & CORBET (2000a) confirm this information; according to these authors, *Orthetrum chrysostigma* reproduces in temporary wadis (seasonal) and *Orthetrum nitidinode* is abundant in semi-arid regions (such as the region of El Aouinet).

The values of the Shannon Weaver diversity index are close in the three stations except station 2 where they are low and the distribution of the Odonatological population is in equilibrium in the three stations. SAMRAOUI et al. (1998) found that in the Mediterranean region where wetlands can dry out in summer, the species have adapted to the seasonal nature of their habitats. The Odonata fauna is unbalanced in station 2 due to the absolute dominance of the species *Ischnura graellsii*. This species is considered by BENCHALEL et al. (2017), together with other species, as resistant to changes in conditions and urban stresses (VILLALOBOS –JIMENEZ et al., 2016) becoming dominant and widely spread in sites with high contamination. The diversity index obtained by CHELLI & MOULAI (2019) in the Bejaia region is close to the values obtained in the Oued Mesloula stations.

The numbers of Odonates evolve differently over time in the four stations. No species appears in January, very few in February confirming the finding of ROMERO & CORBET (1995) concerning the flight period of most of the Mediterranean species. Flight peaks are reached in April at Oued Mesloula stations and in May or later at El Aouinet stations. According to CORBET (2003), the species at Oued Mesloula occur with a short emergence season while that of El Aouinet has a long asynchronous emergence period. In Oued El Kebir (North East Algeria), the peak of the adult flight period was recorded in July by BENCHALEL et al., (2017). Our results agree with those obtained by SELLAMI et al. (2015) who found that the odonatological settlement in the Ichkeul national park (in Tunisia) reached its maximum in April. The PCA results suggest that the population of Odonates in this region follows a spatial distribution according to an altitudinal gradient (relatively high in the study stations) which probably associated with other factors because species like *Calopteryx haemorrhoidalis*, *Platycnemis subdilata*, *Ischnura graellsii* and *Crocothemis erythraea* have been found at very low elevations (between 47-165 m) in the Bejaia region (CHELLI & MOULAI, 2019).

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