https://doi.org/10.35513/21658005.2019.1.4

Zoology and Ecology, 2019, Volumen 29, Issue 1
Print ISSN: 2165-8005
Online ISSN: 2165-8013

DIVERSITY AND ECOLOGICAL DIAGNOSIS OF DRAGONFLIES OF HIGH-MOUNTAIN TEMPORARY PONDS IN THE AKFADOU MASSIF FOREST (ALGERIA)

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Article history
Received: 15 January 2019; accepted 8 April 2019

Keywords:
Dragonflies; Akfadou; diversity; ecology; temporary ponds; Algeria

Abstract. An Odonata study was carried out during six successive months at five high-mountain temporary ponds located in the Akfadou massif forest, northeast Algeria. These wetlands are virtually unexplored; some of these places are unknown to the general public. However, some of them appear to face numerous threats. The results obtained by this study gave us an idea of the odonatological settlement in this area. With 18 species of Odonata, this territory contains about 1/3 of the Algerian Odonata fauna, of which nine species reproduce in this forest massif. These study stations share in common three species, namely: *Ischnura graellsii*, *Anax imperator,* and *Orthetrum cancellatum*. These three species are omnipresent in more than 75% of the surveys and are distributed in a consistent way in various biotopes. The first species (*I. graellsii*) together with *Lestes virens* and *Chalcolestes viridis* dominate in numbers, accounting for more than half of the total numbers recorded. The Shannon-Weaver index and Equitability index applied to odonatological fauna reveal that Agoulmime Ikher (AI) and Agoulmime Tala Guizane (AT) ponds are the best-structured and most stable in terms of stands in this massif.

INTRODUCTION

A significant portion of forest biodiversity depends on small "aquatic ecosystems" associated with woodlands. These forest wetlands, and especially ponds, are the cradle of frogs, toads, salamanders and newts, insects, aquatic plants and also serve as a "pantry" for many species (birds, chiropters, reptiles, etc...) (Marsh and Trenham 2001; Baudran and Blanchard 2008). According to Rosset (2012), ponds are remarkable environments with a high ecological value. They are endowed with a unique biodiversity, which is often richer than can be found in flowing waters or lakes. Ponds are also an exceptional and useful pedagogical support for teaching and research because they offer many research opportunities on very varied subjects. However, most research has focused on permanent water bodies, and temporary ponds have been largely neglected (Williams et al. 2001). Many deficiencies remain in our basic knowledge about the ecology and functioning of these ecosystems. Indeed, the lack of information on the natural values of these temporary ponds and an absence of appropriate management measures will lead to their deterioration or even disappearance in the years to come. Among aquatic insects, dragonflies are often the dominant predator group in aquatic habitats, particularly in fishless systems such as temporary ponds (Cannings, Cannings, and Ramsy 2000). According to some authors, this taxon can also be used as an indicator of the health status of aquatic ecosystems (Perron and Jobin 1998; Corbet 1999; Cannings, Cannings, and Ramsy 2000; Grand and Boudot 2006; Benazzouz et al. 2009; Martín and Maynou 2016). Dragonflies are currently one of the most studied and best-known groups of insects due to their small species numbers and relatively easy determination (Bonnifait, Defos Du Rou, and Soulet 2008). Despite this, knowledge about this taxon remains non-existent in some regions of Algeria, especially in remote and inaccessible mountainous areas. Thus, to our knowledge, in Algeria, the Odonata of high-mountain forests have not been the subject of any study so far.

The study of Algerian Odonata began in the middle of the 19th century under the impetus of Selys-Longchamps (1865, 1866, 1871). However, the first general synthesis of Algerian Odonata fauna was under the aegis of Samraoui and Menai (1999). These authors cited 53 species to which 10 other putatively authentic taxa were added from historical information, which made it possible to bring to 63 the total number species known in Algeria. In recent decades, northern Algeria has received special attention from odonatologists and naturalists, permitting a better knowledge of the biology and distribution of Odonata in this vast territory. However, the majority of published studies on Algerian Odonata fauna are concentrated in the northeast part of the country. Among these studies, we can mention those carried out by Samraoui et al. (1993), Samraoui and Corbet (2000), Benchalel and Samraoui (2012), Khelifa et al. (2011, 2013, 2016), Zebsa, Khelifa, and Kahalerras (2015),

Guebailia et al. (2016), Khelifa and Zebsa (2018), Mellal et al. (2018), and Amari et al. (2019).

Data on forest dragonflies of high-mountain wetlands from North Africa appear to be lacking. It is for this reason that this study was conducted in the Afkadou forest massif area (northeast Algeria). This study was carried out in the Akfadou massif forest (northeast of Algeria) in order to assess the diversity of odonatofauna. This diversity was studied using two ecological indexes (Shannon-Weaver index and Equitability index).

MATERIALS AND METHODS

*S*tudy area

The Akfadou massif forest (Figure 1), situated approximately 160 km east of Algiers, 20 km from the Mediterranean Sea and 70 km west of Bejaïa, administratively belongs to Bejaïa and Tizi Ouzou departments. It represents one of the largest caducifoliate forest complexes in Algeria. This massif extends over an area approximately of 11,000 ha. It is divided into two parts: western and eastern Akfadou, depending, respectively, on the departments of Tizi Ouzou (4600 ha) and Bejaïa (6400 ha) (Messaoudene, Laribi, and Derridj 2007).

Generally, the relief is quite rugged (slopes of 15% to 45%), especially in its south-eastern part, the altitude of Akfadou varies from 800 m to 1646 m (Messaoudene 1989). From a bioclimatic aspect, the Akfadou massif forest is part of the humid temperate and fresh per-humid zone. (Laribi, Derridj, and Acherar 2008). The climatic conditions are very challenging with abundant snow in cold seasons and important precipitation varying from 1200 mm to 2000 mm per year, which places it among the wettest areas of North Africa (Messaoudene 1989).

According to the Bejaïa Forestry Directorate, this forest has been classified as a Regional Natural Park (PNR). This approach aims to preserve and valorise this territory, endowed with an exceptional natural heritage. It is important to mention that this forest massif was classified as a National Park during the French colonization in 1924 (*El Watan*, 28 September 2013, p. 6–7). However, the Algerian legislator did not consider it useful to adopt this classification in the 1980s and 1990s when Algerian National Parks were created.

Study stations overview

In view of the large area of this massif forest, sampling was limited to a study perimeter located in the eastern part of it. Our study stations are high-mountain temporary ponds, whose main characteristics are given in Table 1.

Ponds are the most common aquatic ecosystems in this forest massif. Nested in this forest, some of them are practically surrounded by trees. Apart from the two ponds, Agoulmime Ikher (AI) and Agoulmime Tala Guizane (AT) which are open and very sunny environments, the rest of the ponds, Agoulmime Averkane (AA); Agoulmime Ouroufel (AO) and Agoulmime Walsous (AW), are located inside the oak groves (Figure 2 (c, d, e)). The development of woody vegetation on the banks of these ponds limits the amount of incident light. This

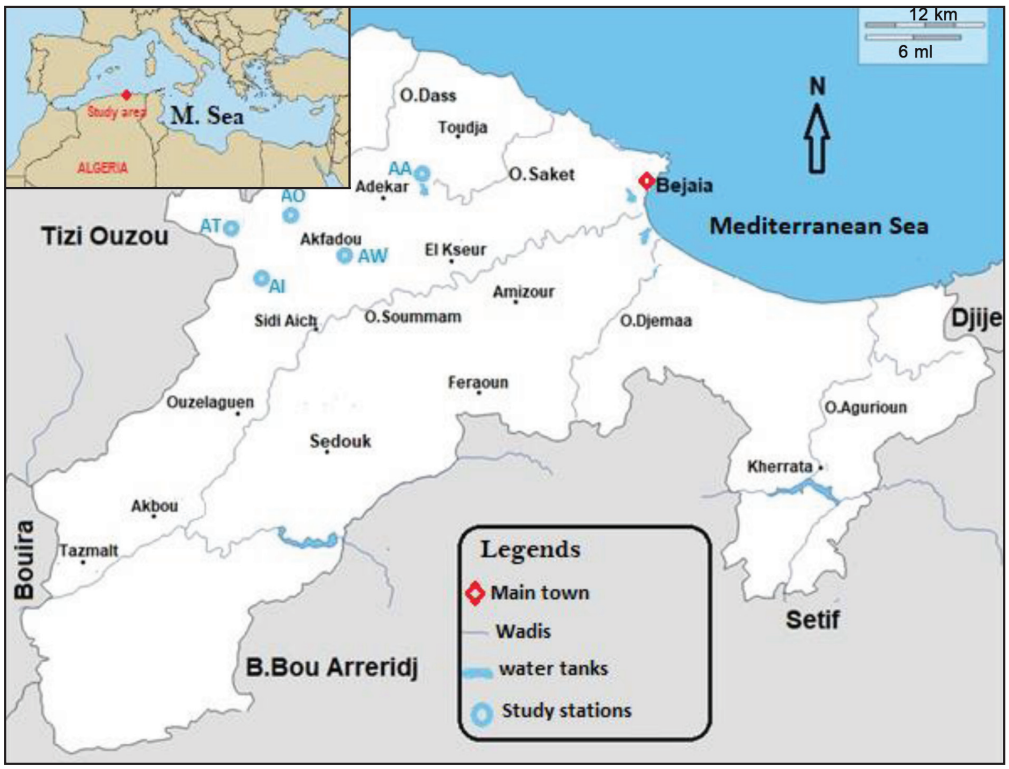


Figure 1. The location of five ponds investigated.

Table 1. Geographic and environmental characteristics of surveyed stations in the Akfadou massif forest.

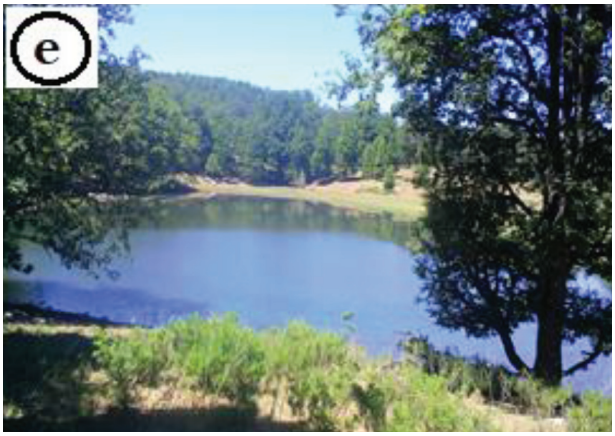
Stations	Code	Locality	Depth	Surface	Altitude	Latitude	Longitude
Agoulmime Walsous	AW	Tifra	0.5 m	2.50 ha	790 m	36°40’02”N	4°39’56”E
Agoulmime Ikher	AI	Tibane	0.8 m	2.80 ha	1065 m	36°37’09”N	4°38’09”E
Agoulmime Ouroufel	AO	Akfadou	0.5 m	1.40 ha	1360 m	36°38’41”N	4°34’42”E
Agoulmime Averkane	AA	Adekar	1.5 m	3.50 ha	1264 m	36°41’47”N	4°36’09”E
Agoulmime Tala Guizane	AT	Chemini	1.2 m	1.20 ha	1572 m	36°37’42”N	4°34’03”E

Agoulmime Ikher (AI)

Agoulmime Tala Guizane (AT)

Agoulmime Ouroufel (AO)

Agoulmime Walsous (AW)



Agoulmime Averkane (AA)

Figure 2. Temporary ponds surveyed within the Akfadou massif forest.

shading can hinder the pond's ecological functioning and reduce its diversity. The (AW) pond is distinguished from other ponds by being invaded by *Schoenoplectus lacustris* progressing towards its centre, greatly reducing the open water sections (Figure 2 (d)). In addition, falling leaves and accumulation of dead wood have led to infilling, thereby reducing the volume of water. This was also observed in the (AO) pond, which dried up in late August.

Odonata sampling

In order to establish an odonatological inventory as complete as possible, it is necessary to resort to sampling larvae, exuviae and imagos. The search for larvae and exuviae allows the observer to obtain valuable information on autochthonous species and also to collect additional data on more discreet species or those difficult to capture (Heidemann and Seidenbusch 2002; Raebel et al. 2010; Lebrasseur 2013). As for this study, for practical reasons the surveys only focused on the recognition of adults (or imagos).

Depending on knowledge state, objectives and means of implementation, Odonata sampling and monitoring are based on different protocol types (Varanguin and Sirugue 2007). To do this, we chose to apply a systematic and regular sampling of the five stations of the Akfadou massif forest. Our investigation consisted of walking around the perimeter of each pond as well as its surroundings (hedges, meadows, trees, etc.) where adults hunt and undertake maturation, as recommended by Grand and Boudot (2006). In all temporary ponds sampled, water was present during the entire sampling season, except for the (AO) temporary pond, which dried up in August. This situation affects Odonata survival in this pond, because we observed only two species (*Lestes virens* and *Sympetrum fonscolombii*) at the end of August and at the beginning of September.

Each station was visited monthly from early April to late September. This is the most favourable period for the observation of, respectively, early and late dragonfly species. The average duration of each visit was about 2 hours in favourable weather between 10:00 am and 5:00 pm, because dragonflies are very sensitive to temperature and weather conditions; they are most active during the hottest hours of the day. If it is cold, rainy or windy, their activity is reduced and they prefer to remain hidden, often placed high in trees or in the middle of tall grass (Grand and Boudot 2006; Lebrasseur 2013).

In each station, visual sampling of adult Odonata was carried out, with two identification practices: visual detection by binoculars and capture-release using an entomological net. All specimens in doubt were kept for careful examination in the laboratory using a binocular loupe and keys provided by D'aguilar and Dommanget (1998) and Dijkstra (2007). The adults observed, as well as their reproductive behaviour (heart shape wheels, tandems, oviposition) were recorded, because they provide useful information on the autochthony of species. Populations of each species were also estimated during each visit.

Data analysis

Odonatofauna abundance and frequency was used to characterize their population structure. Diversity was calculated using the Shannon-Weaver index and the Equitability index. Finally, to better identify the odonatological stand associated with the studied ponds of the Akfadou massif forest, two factor analyses (FA) were performed with the presence of species by station and by month. These analyses were done using XLSTAT-2016.

RESULTS

The results of the current study provided information on the diversity and status of the Odonata communities in Akfadou massif forest temporary ponds during the six months of the study.

The inventory made it possible to establish a preliminary Odonata list associated with these ponds. In the following list (Table 2), the "family" taxa group is presented in systematic order, while the "genus" and "species" groups are presented in alphabetical order.

Eighteen (18) species of Odonata (10 species of Anisoptera and 8 species of Zygoptera) belonging to 11 genera under 4 families were recorded from five temporary ponds of the Akadou massif forest. Four (4) *Sympetrum*, three (3) *Ashena*, two (2) *Anax,* and one (1) *Orthetrum* represent the Anisoptera. On the other hand, Zygoptera are equally divided between Lestidae and Coenagrionidae.

In order to study the odonatofauna structure, the relative abundance of each species was carried out (Figure 3).

In the Akfadou forest massif, 4016 individuals were counted. As shown in Figure 3, the Odonata relative abundance highlights the dominance of three species in terms of the number of individuals; the most abundant was *Ischnura graellsii* with 1133 individuals, followed by *Lestes virens* and *Chalcolestes viridis* with, respectively, 748 and 530 individuals. However, two species have very small populations not exceeding ten individuals; this is about *Sympecma fusca* and *Aeshna isoceles*.

The results obtained were also used to calculate various indices permitting to characterize the composition and structure of odonatological stands (Table 3).

The Shannon-Weaver index, commonly used for intersite comparisons, revealed values which varied from 2.43 to 3.33 (Table 3). The three ponds, Agoulmime

Table 2. List of Odonata species inventoried and their occurrence frequency in the temporary ponds of the Akfadou forest massif.

	Family	Species	Stations				
			Occurrence frequency				
			AA	AI	AO	AT	AW
ZYGOPTERA	Lestidae	*Lestes barbarus* (Fabricius, 1798)	–	R	R	R	R
		Lestes virens (Charpentier, 1825)	R	–	–	R	R
		Chalcolestes viridis (Vander Linden, 1825)	R	R	–	–	R
		Sympecma fusca (Vander Linden, 1820)	R	–	–	–	–
	Coenagrionidae	*Erythromma lindennii* (Selys, 1840)	–	R	–	–	–
		Coenagrion scitulum (Rambur, 1842)	–	–	R	R	–
		Enallagma deserti (Selys, 1871)	R	R	C	R	–
		Ischnura graellsii (Rambur, 1842)*	C	C	C	C	C
ANISOPTERA	Aeshnidae	*Aeshna affinis* (Vander Linden, 1820)	–	R	–	R	R
		Aeshna isoceles (O. F. Müller, 1767)	–	–	–	–	R
		Aeshna mixta Latreille, 1805	–	–	–	–	A
		Anax imperator Leach, 1815*	C	C	C	C	C
		Hemianax ephippiger (Burmeister, 1839)	–	R	–	–	–
	Libellulidae	*Orthertrum cancellatum* (Linnaeus, 1758)*	C	R	R	C	C
		Sympetrum fonscolombii (Selys, 1840)	C	C	C	C	–
		Sympetrum meridionale (Selys, 1841)	–	–	R	–	R
		Sympetrum sanguineum (O. F. Müller, 1764)	R	R	R	–	R
		Sympetrum striolatum (Charpentier, 1840)	–	R	R	C	C
Total		18	09	12	10	10	12

Notes: – Absence of species; *: Common; A: Accessory; C: Constant; R: Regular.

Table 3. The Shannon-Weaver index (H') and Equitability index (E) applied to Odonata of study stations.

Ecological Indices	Study stations				
	Agoulmime Averkane	Agoulmime Ikher	Agoulmime Ouroufel	Agoulmime Tala Guizane	Agoulmime Walsous
Number of individuals	534	432	481	438	2131
Shannon-Weawer index (H')	273	3.33	2.98	3.07	2.43
H' max	3.16	3.58	3.32	3.32	3.58
Equitability (E)	0.86	0.93	0.89	0.92	0.67
Specific richness	9	12	10	10	12
Total richness	18				
Total of individuals	4016				
Total statements	6				

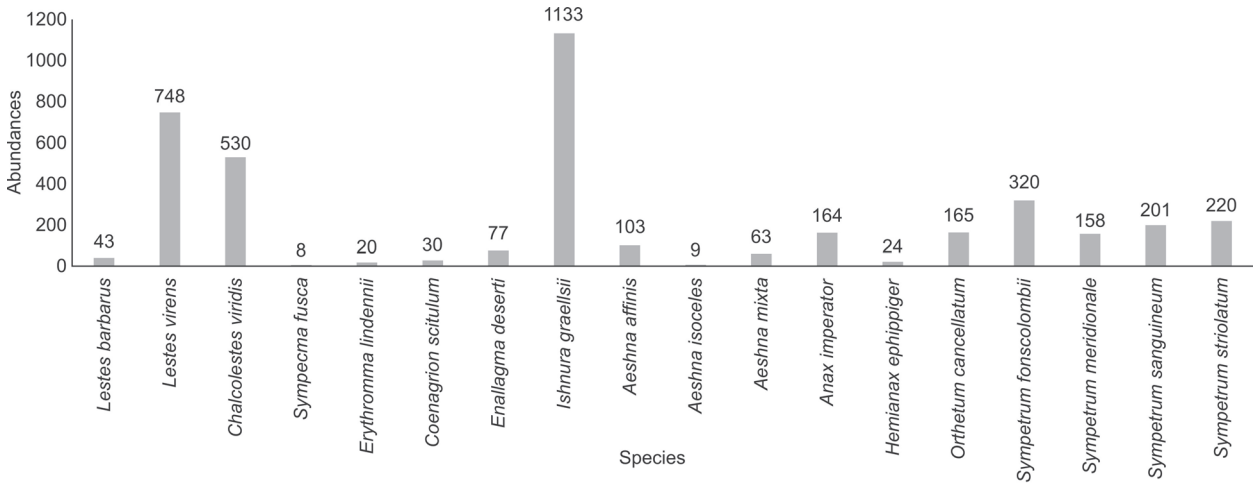


Figure 3. Abundance of species observed in the Akfadou massif forest.

Walsus (AW), Agoulmime Averkane (AV), and Agoulmime Ouroufel (AO) show low values of diversity compared to two other ponds, Agoulmime Ikher (AI) and Agoulmime Tala Guizane (AT).

To highlight the affinity/differences between the sampled temporary ponds, a factor analysis (FA) was applied to a "species" matrix based on presence/absence (Figure 4).

The graphical representation (Figure 4) illustrates the species that were only found at particular sites, such as *Hemianax ephippiger* (He) and *Erythromma lindennii* (El), which only occurred in the (AI) pond. Both Aeshna, *Aeshna isoceles* (Ais) and *A. mixta* (Am) were only noted in the (AW) pond. Finally, the (AA) pond in its turn contained a species not mentioned in other sites, namely the damselfly *Sympecma fusca (*Sfu). Indeed, graphically, these species are located further from the graph centre. The species that are grouped in the centre

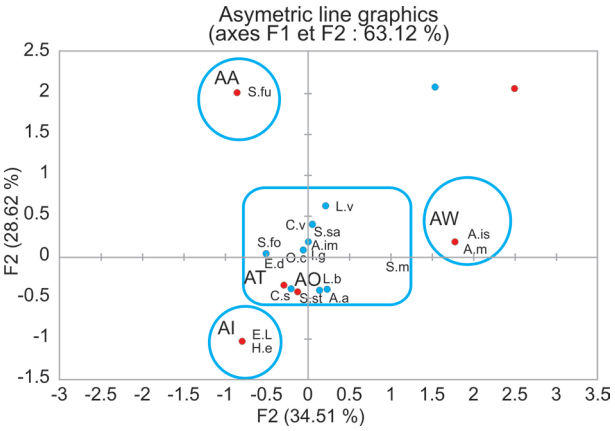


Figure 4. Factorial layout of relationship of Odonata species to site resulting from the factorial analysis. Abbreviations: **Lb**: *Lestes barbarus*; **Lv**: *Lestes virens*; **Cv**: *Chalcolestes viridis*; **Sfu**: *Sympecma fusca*; **El**: *Erythromma lindennii*; **Cs**: *Coenagrion scitulum*; **Ed**: *Enallagma deserti*; **Ig**: *Ischnura graellsii*; **Aa**: *Aeshna affinis*; **Ais**: *Aeshna isoceles*; **Am**: *Aeshna mixta*; **Aim**: *Anax imperator*; **He**: *Hemianax ephippiger*; **Oc**: *Orthetrum cancellatum*; **Sfo**: *Sympetrum fonscolombii*; **Sm**: *Sympetrum meridionale*; **Ssa**: *Sympetrum sanguineum*; **Sst**: *Sympetrum striolatum*.

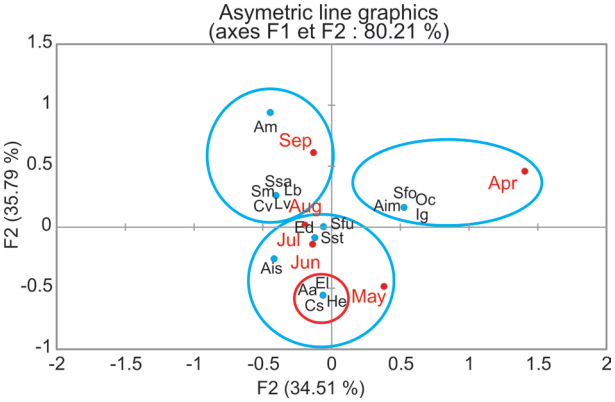


Figure 5. Factorial layout of relationship of Odonata species to month resulting from the factorial analysis.

of the graph (Figure 4) are generally common at various sites, such as: *Anax imperator* (Aim), *Ischnura graellsii* (Ig), and *Orthetrum cancellatum* (Oc), which are often accompanied by a cortege of three *Sympetrums* (*S. fonscolombii* (Sfo), *S. sanguineum* (Ssa), and *S. striolatum* (Sst)) and *Enallagma deserti* (Ed).

To provide insight about odonatological stand structuring in this forest massif, another factorial analysis was also carried out to a "species" matrix based on presence/absence during the six months of the study (Figure 5).

On the graphical representation (Figure 5), we can distinguish three species groups that are more or less well isolated. The early taxa group (period of presence centred on the month of April) is characterized by four species which emerge very early in April, namely: *Anax imperator* (Aim), *Orthetrum cancellatum* (Oc), *Sympetrum fonscolombii* (Sfc), and *Ischnura graellsii* (Ig). To these species, we can possibly add four other species which begin to appear at the beginning of May, this is about *Aeshna affinis* (Aa), *Hemianax ephippiger* (He), *Erythromma lindennii* (El), and *Coenagrion scitulum* (Cs), later accompanied by other species which concentrate in the centre of the graph to form the second mid-season group (period of presence centred on the months of May, June and early July), which are *Enallagma deserti* (Ed), *Sympetrum striolatum* (Sst), and *Aeshna isoceles* (Ais), and finally comes the late taxa group (period of presence centred on the months of August and September), namely *Lestes barbarus* (Lb), *L.virens* (Lv), *Chalcolestes viridis* (Cv), *Sympetrum meridionale* (Sm), *S. sanguineum* (Ssa), and *Aeshna mixta* (Am). It should be noted that this last species was only contacted from the beginning of August (Figure 5).

DISCUSSION

In the absence of similar studies in the Bejaïa region, we have tried as much as possible to compare our results with those obtained at low altitude ponds and various standing waters in north-eastern Algeria and from other countries.

The temporary nature of these environments, their positioning in this massif forest, as well as their physiognomy are strongly limiting factors for dragonflies. Only certain species can survive and be sustained permanently in these ecosystems. According to Alban et al. (2006), the characteristics, biological conditions, geographical location and pond environment determine the Odonata stand, which can range from no species (very closed forest pond) to more than twenty in the best conditions (open pond).

An analysis of the odonatological stand associated with this massif forest shows that Anisopterans are abundant

in most water bodies sampled. This could be due to their high dispersal capacity, like *Gomphus lucasii* who could fly more than 1 km (Zebsa, Khelifa, and Kahalerras 2015), as opposed to Zygopterans which have a limited dispersal capacity (Batzer and Wissinger 1996; Williams 1997; Lawler 2001) and their adaptability to a wide range of habitats (Suhling et al. 2004).

The Odonata group represents a relatively important element in Akfadou massif forest ecosystems compared to those observed in the main lakes of the northeast of Algeria and elsewhere, because with 18 species it represents about 1/3 of Algerian Odonata fauna. In Bejaïa region, Allegrini, Benallaoua, and Benmamar (2006) and Moali and Durand (2015) have inventoried 11 species at Mezaia Lake located downtown. This list has increased to 13 species following various surveys carried out by Rokh (2017). In Lake Bleu, which is one of the most threatened and odonatologically important sites in Algeria, Khelifa et al. (2016) showed the number of species was 19 species. In contrast, Bouguessa (1993) noted 28 species at Oubeira Lake located in El-Tarf department. Jacquemin (1987) recorded 18 species of Odonata in a natural coastal water body located at the Merja of Sidi Bou Ghaba in Morocco, among these species, 11 were noted at Akfadou area, namely: *Lestes barbarus*, *Lestes virens*, *Erythromma lindennii*, *Sympecma fusca*, *Anax imperator*, *Hemianax ephippiger*, *Aeshna mixta*, *Orthetrum cancellatum*, *Sympetrum fonscolombii*, *Sympetrum meridionale,* and *Sympetrum striolatum*. Carchini et al. (2002) reported 16 Odonata species on 21 temporary and permanent ponds in central Italy. This odonatological fauna seems rather similar to ours, except for *Sympecma fusca*, *Enallagma deserti*, *Aeshna isoceles*, *Aeshna mixta,* and *Hemianax ephippiger*, which do not appear in their surveys. In contrast, three species represented by *Erythromma viridulum*, *Orthetrum brunneum,* and *Crocothemis erythraea* have not been reported in Akfadou area. However, the conclusions of Carchini et al. (2002) about Odonata habitats appear to be controversial. These authors suggested that a group of six (6) Odonata (*Coenagrion scitulum*, *Erythromma lindeni*, *Anax imperator*, *Orthetrum cancellatum*, *Sympetrum striolatum,* and *Sympetrum fonscolombii*) are strictly limited to permanent ponds, whereas these species are widely present in Akfadou temporary ponds.

The five ponds surveyed share three species in common: *Ischnura graellsii*, *Anax imperator,* and *Orthetrum cancellatum*. They are also distributed uniformly during the entire sampling period at all of these stations. On the other hand, *Aeshna mixta* is distributed in an accessory way in the (AW) temporary pond where it is only noted. As to other species, some of them have a regular distribution, other ones are sometimes constant and sometimes regular.

Based on various observations and field-notes about reproductive behaviour (heart shape wheels, tandems, oviposition), emergences and the number of individuals, we can certainly confirm that 9 species among this Odonata fauna reproduce in this forest massif. These are: *Lestes virens*, *Chalcolestes viridis*, *Ischnura graellsii*, *Aeshna affinis*, *Anax imperator*, *Orthetrum cancellatum*, *Sympetrum fonscolombii,* and *S. striolatum*.

Of the five ponds surveyed in the Akfadou massif forest, three of them show low values of diversity, namely: Agoulmime Walsus (AW), Agoulmime Averkan (AV), and Agoulmime Ouroufel (AO). These low diversity values recorded in these three ponds can be explained by their physiognomy, their location in this forest, as well as by the anthropogenic impacts that negatively affect the Odonata communities, thus reducing the biodiversity of these aquatic ecosystems. Indeed, the development of woody vegetation on the banks of these ponds limits the supply of light; this shading can hinder the pond's ecological functioning and reduce its diversity. This confirms the findings of Subramanian (2005) who revealed that shade and aquatic vegetation favour Zygoptera more than Anisoptera. According to Merlet and Itrac-Bruneau (2016), the sunshine of the site is crucial to the odonatological stand. That is right, the more open and sunny the environment, the greater the diversity. In addition, the falling leaves and accumulation of dead wood have led to their infilling, thus reducing the volume of water. This was observed in the (AO) pond, which dried up at the end of August, hindering recruitment and persistence of Odonata in this pond. During this period, we observed only two species (*Lestes virens* and *Sympetrum fonscolombii*). In fact, in these kinds of situations, only some so-called pioneer species well adapted to dry periods can survive, such as species of *Lestes* and *Sympetrum* genera, which have a high dispersal capacity and a rapid development cycle (Corbet 1999; Jacquemin and Boudot 1999; Suhling et al. 2004; Merlet and Itrac-Bruneau 2016).

Another alarming case that could affect the recruitment of dragonflies is noted at the (AW) pond, which is invaded by *Schoenoplectus lacustris* progressing towards its centre, greatly reducing open water sections. It is important to note that this pond has the highest abundance value (2131 individuals) and the highest specific richness (12); however, it is at its level where the low value of divisibility (2.43) is noted. This high value of abundance is due to a strong proliferation of Lestidae and Coenagrionidae. Indeed, more than 80% of the population is concentrated on three species in this station, namely: *Ischnura graellsii*, *Lestes virens,* and *Chalcolestes viridis*. We are in front of an inequitable distribution of individuals among the different taxa.

This is what equitability explains; a value of 0.67 can be explained by the dominance in numbers of some species over others. In the same way, in a non-homogeneous distribution, the gain in diversity brought about by higher richness is countered by an imbalance in terms of the number of individuals; this is the case in this (AW) pond (Table 3). This pond will soon disappear to the benefit of another ecosystem if no action is taken by the forestry conservation services. The same is true for two other ponds, (AI) and (AT), which are continually subjected to anthropic pressures due in part to the presence of tourists, especially in summer, and on the other part, to overgrazing around these ponds, causing some damage. The banks are trampled by cows forming a mud layer without vegetation. This unfavourable overview could have negative effects on dragonflies' populations. Despite all these disturbances, these two ponds (i.e (AI) and (AT)) seem to have the most stable and most balanced odonatological stands. The equitability value equal to 0.93, which tends towards 1 (Table 3), clearly explains a balanced distribution of individuals between the different taxa at both stations. This reflects well-structured and stable odonatological stands compared to other stations. This is probably due to a very open, sunny and shallow nature of these stations, which allows water to warm up quickly offering ideal conditions for the installation and good development of Odonata, unlike the (AW) temporary pond, which is surrounded by a large wooded belt and almost invaded by *Schoenoplectus lacustris*.

CONCLUSION

With this first study, a report on the dragonflies of Akfadou massif forest temporary ponds was established. Some of them seem to face numerous threats and do not benefit from any protection. Without adequate protection and conservation measures, this region will gradually lose these priceless habitats and their exceptional biodiversity. Well-managed ponds will help both increase the present species populations and attract new mountain species.

The results obtained probably give an adequate overview of the real odonatological fauna of this site at a given period. With a total of 18 species, this territory contains about 1/3 of the Algerian odonatofauna. A cortege of 3 species: *Ischnura graellsii*, *Anax imperator,* and *Orthetrum cancellatum*, seem very tolerant to the various habitats surveyed in the Akfadou massif forest; they are omnipresent in more than 75% of the surveys. The Anisoptera dominate in the number of species, while Zygoptera dominate in the number of individuals, as *Ischnura graellsii*, *Lestes virens,* and *Chalcolestes viridis* which count an abundance of 2411 individuals, representing 60% of the 4016 individuals all species combined. The two temporary ponds, Agoulmime Ikher (AI) and Agoulmime Tala Guizane (AT) are the two biotopes containing the best structured and most stable odonatological settlements in this massif.

The main populations have been identified. However, investigations should last at least two years before a more exhaustive inventory can be claimed. It would also be necessary in the years to come to prospect with other methods such as searching for exuviae along the banks, which will make it possible to confirm the autochthony and the reproduction of species on the site in order to bring new elements on the distribution of these dragonflies in this vast territory.

We hope that this study will highlight the importance of these exceptional environments and that it will also serve as a basis for future studies aimed at implementing a conservation strategy for these habitats so that they can continue to be appreciated in the decades to come. Because tomorrow's legacy depends on today's management.

ACKNOWLEDGEMENT

The writing of this article would not have been possible without the collaboration of several people. The authors would like to thank the group of foresters from Chemini Forestry Department who accompanied us on some field trips, as well as the three botanists, Bekdouche F., Bouadam S., and Abassi H., who listed the plant species of the five ponds studied, without forgetting Amalou D., who was very helpful during this study.

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