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Floristic Diversity Of Temporary Ponds In The Setif Region (Northeastern Algeria)

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Abstract
The Setif region, known as the High Setifian Plains, is located in the Tell Atlas in northern Algeria. The climate is characterized by cold and temperate winters and hot dry summers; the north is wetter than the south. Administratively, the Setif region consists of 20 districts (daïras) and 60 municipalities. It is distinguished by its richness and diversity of wetlands, among which are ponds.
Following surveys conducted among local populations regarding the presence or absence of ponds, 14 municipalities located in the north were visited between 2017 and 2019. We recorded 102 ponds that were subject to a floristic inventory over two hydrological cycles (spring and summer). The flora consists of 139 species and 87 genera belonging to 35 botanical families, with a dominance of the Poaceae family (19 species). These species are either submerged in wetlands or associated with terrestrial environments. The overall biological spectrum composition shows a dominance of hemicryptophytes, with 70 species (50%). The majority of the recorded species belong to the northern phytochorion group (37%). Ten species are endemic.
The majority of the surveyed ponds are privately owned, and despite their richness, these ponds are subjected to increasing anthropogenic pressures, leading to their transformation or complete disappearance. They are often drained due to drainage or grazing, filled with debris, cultivated, or urbanized. As a result, they are threatened by climate change, particularly drought. In Algeria, as in the rest of the Maghreb, no temporary pond is currently protected. The preservation of this significant and threatened biodiversity requires the urgent implementation of protection measures and the creation of legislative texts to safeguard these habitats.
Keywords: *temporary pond, Setif region, floristic inventory, human impact, conservation.*

1. INTRODUCTION

Ponds are unique environments, neither truly aquatic nor completely terrestrial, where the alternation of dry and flooded phases promotes the establishment of original and diverse plant and animal communities. These ponds occupy more or less closed depressions of varying surface area and depth (Grillas et al., 2004).
They are characterized by highly autonomous hydrological functioning (Bensettiti et al., 2002). These are unique environments found in the five regions with a Mediterranean climate (Grillas et al., 2004): Southern Europe, North Africa, South Africa, North America (California), South America (Chile), and Australia (Bliss & Zedler, 1998; Pyke et al., 2004; Barbour et al., 2005). Considered among the most ecologically valuable habitats in the Mediterranean region, they host plant species that are often rare and threatened, with high heritage value (Medail et al., 1998; Quezel, 1998; Paradis, 2007). By harboring high biological richness, they make a significant contribution to regional biodiversity (Rhazi et al., 2012) and are considered biodiversity hotspots (Medail & Quezel, 1999).
Algeria is home to a wide variety of wetlands, including ponds. These ponds are mainly concentrated in the northern part of the country, particularly in the eastern region. Recent scientific research in terms of flora has mostly focused on large ecosystems such as wadis, lakes, or sebkhas, while very few studies have investigated pond flora. Among the notable works are: Joleaud (1936); Gauthier-Lievre (1937); Chevassut

& Quezel (1956, 1958); Lefranc (1865); Feldman (1946); Morgan (1982); Stevenson et al. (1989); Gehu et al. (1992, 1994); Kaabeche et al. (1994); de Belair (2005); Boulaacheb et al. (2007); Boulaacheb (2009); Boulaacheb et al. (2011); Boulaacheb et al. (2013); Laribi (2016); Allem (2017).

In the Sétif region, only the flora of the temporary ponds of Djebel Megriss, located in the municipalities of Amoucha and Ouricia, has been studied by Boulaacheb et al. (2007); Boulaacheb (2009); Boulaacheb et al. (2011); Boulaacheb et al. (2013). Our study contributes to the knowledge of the flora of ponds in the Setif region. Its main objective is to inventory, assess, and map these ponds for better management and conservation.

2. MATERIALS AND METHODS

2.1 study site

The Wilaya of Setif covers an area of 6,504 km², representing 0.27% of the national territory. It is located in the Northeast of Algeria. It is bordered to the west by the Wilaya of Bordj Bou Arreridj, to the east by Mila, to the north by Bejaia and Jijel, and to the south by M'sila and Batna (ANIREF, 2014). The Wilaya is made up of 60 municipalities (departments) and 20 districts (Daïras) **(Figure 1).**

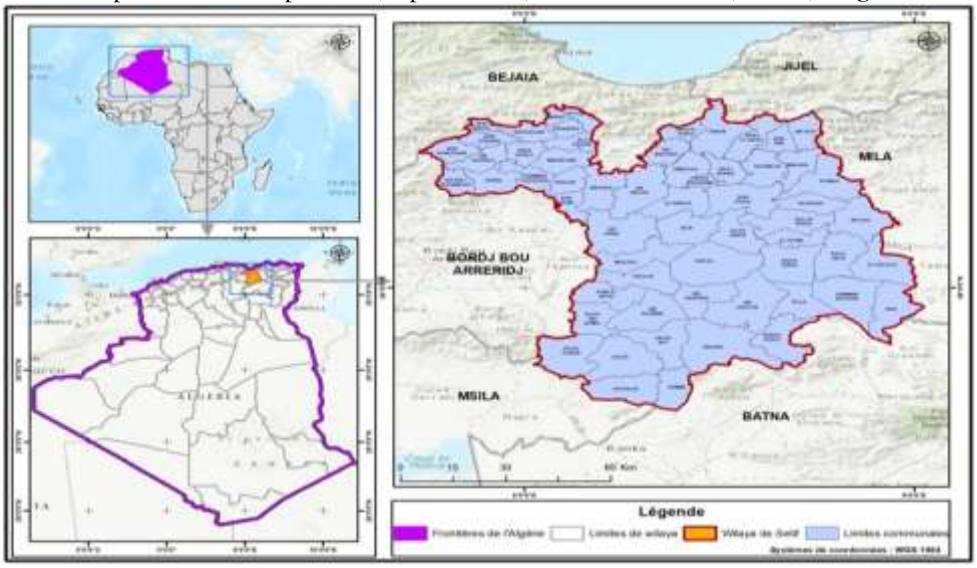

Figure 1: Location and administrative boundaries of Setif region (Slimani Y., 2024).

2.2 Methodology

The choice of the study area is mainly due to its topographical heterogeneity, climatic characteristics with the north being wetter than the south and the scarcity of previous studies. The method adopted for this work was carried out in two phases: first, to identify the existence and location of these ponds by consulting the local population; the second phase involved studying their floristic diversity by belts.

2.2.1 Inventory of ponds

Based on the information obtained, we were able to select the municipalities to survey. A descriptive form was created including flora, condition, altitude, area, geographic coordinates, depth, origin, ownership, use, and threats.

2.2.2 Floristic study

The ponds in the study area were monitored seasonally: vegetation was studied over two periods (spring and summer) and across three hydrological cycles from 2017 to 2019. The floristic inventory was conducted by zones. Sometimes, access to the center of certain ponds was difficult or even impossible due to depths exceeding 1 meter.

Species were identified according to the flora of Quezel and Santa (1962–1963); the updated nomenclature for the inventoried species was based on recent works compiled in the synonymic and bibliographic index of the flora of North Africa (Dobignard and Chatelain, 2010–2013) and the African Plant Database website (http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php?langue=fr).

3. RESULTS AND DISCUSSION

3.1 Pond inventory

3.1.1 Typology of ponds in the Setif region

We have identified 102 temporary ponds, classified into three categories based on their surface areas **(Table 1).**

Table 1: Pond Categories According to Their Surface Area

Categories	Surface Areas (m²)
Large ponds	1000-8000
Medium ponds	400-900
Small ponds	20-400

- **Large ponds**

We recorded 12 large ponds, characterized by varying ecological parameters (location, surface area, depth) but sharing similarities such as remaining nearly wet throughout the year, depending on rainfall fluctuations. These ponds range in size from 1,000 to 8,000 m², with depths sometimes reaching up to 2 meters. Among these large ponds are: Oum Lamoudjene Pond, located in the northwest, and Zaatria Pond, located in the northeast of the Ain Abbasa municipality; Dar El Hamra Pond in the eastern part of the Djemila municipality; and Ghedir El-Mrabta Pond in the northeast of the Beni-Aziz municipality **(Figure 2).**

The vascular flora is mainly distributed from the center toward the periphery: *Mentha aquatica* L., *Carex divisa* Huds. *Carex acutiformis* Ehrh, *Juncus conglomeratus* L., *Juncus acutus* L., *Glyceria fluitans* (L.) R.BR, *Alopecurus bulbosus* Gouam., *Ranunculus aquatilis* L., *Alisma plantago-aquatica* L., *Typha angustifolia* L., *Lemna minor* L., *Lathyrus pratensis* L., *Ornithogalum umbellatum* L., *Rumex pulcher* L., *Galium palustre* L., *Eleocharis palustris* (L.) Roem. & Schult., *Ranunculus macrophyllus* Desf., *Capsella bursa-pastoris* L., *Cardamine parviflora* L., *Nasturtium officinale* R. Br., *Cerastium atlanticum* Dur. During the summer period, the water level decreases and the center of the pond become filled with:

Rumex conglomeratus L., *Mentha pulegium* L., *Juncus effusus* L., the case of the Oum Lamouadjene pond, visited on 02/08/2018. The non-vascular flora consists of algae such as Spirogyra sp., Zygnema sp., and Chara sp. These ponds are characterized by a high faunal diversity, including turtles, leeches, frogs, dragonflies, butterflies, grasshoppers, bees, and ducks.

Figure 2: Belt and center of the Dar El-Hamra pond (Djemila Municipality) (Slimani Y., 2018).

- **Medium ponds**

These are the most abundant, with variable sizes (400–900 m²), and appear to be shallow, ranging from 15 centimeters to one meter in depth. They remain filled with water for 5 to 7 months. They host: *Jacobaea gigantea* (Desf.) Pelser, *Juncus inflexus* L., *Oenanthe globulosa L.*, *Rumex conglomeratus* Murray, *Galium palustre* L., *Alisma plantago-aquatica* L., *Eleocharis palustris* (L.) Roem. & Schult., *Callitriche hamulata* Kütz., *Ranunculus ophioglossifolius* Vill, *Callitriche obtusangula* Le Gall, *Sparganium erectum* L., *Carex divisa* Huds.,

Mentha aquatica L., *Ranunculus lateriflorus* DC., *Ranunculus aquatilis* L., *Ranunculus trichophyllus* Chaix., *Nasturtium officinale* R. Br., *Juncus heterophyllus* Desf., *Alopecurus bulbosus* Gouam., *Plantago major* L.
Once the ponds dry up, other plants appear, *Apium graveolens* L., *et Epilobium parviflorum* Schreb., *Isolepis setacea* (L.) R.Br., *Trifolium pratense L.*, *Mentha pulegium* L., *Cynodon dactylon* (L.) Pers.

- **Small ponds**

The study area contains many small ponds of varying surface areas (20–400 m²) and depths ranging from 10 to 20 cm. From a floristic perspective, the presence of the following is noted: *Juncus maritimus* Lamk. , *Juncus inflexus* L., *Equisetum maximum* Lamk, *Apium graveolens* L., *Bolboschoenus maritimus* L., *Mentha rotundifolia* L., *Cynosurus polybracteatus* Poiret, *Bromus hordaceus* L., *Solenopsis laurentia* (L.) C.Presl, *Callitriche palustris* L., *Eryngium pusillum* L., *Alopecurus pratensis* L., *Trifolium pratense* L., *Trifolium repens* L., *Polycarpon tetraphyllum* (L.) L., *Plantago lagopus* L., *Dactylorhiza maculata* (L.) Soó, *Dactylorhiza elata* (Poir.) Soó. Most of these ponds dry up in summer, where aquatic vegetation is replaced by transitional vegetation such as: *Polypogon monspeliensis* (L.) Desf. *Verbena officinalis* L., *Ammoides pussila* (Brot) Briestr, *Delphinium mauritanicum* Coss., *Scabiosa columbaria* L., *Centaurea parviflora* Desf., *Poa trivialis* L., *Epilobium parviflorum* Schreb.

3.2 Location of the ponds

All the ponds are located in the northern part of the Setif region. This concentration in the north is mainly due to the climate of the area, which is wetter than in the south. The map showing the location of the ponds was created based on geographic coordinates recorded in the field using GPS and processed with ArcGIS software (**Figure 3**).

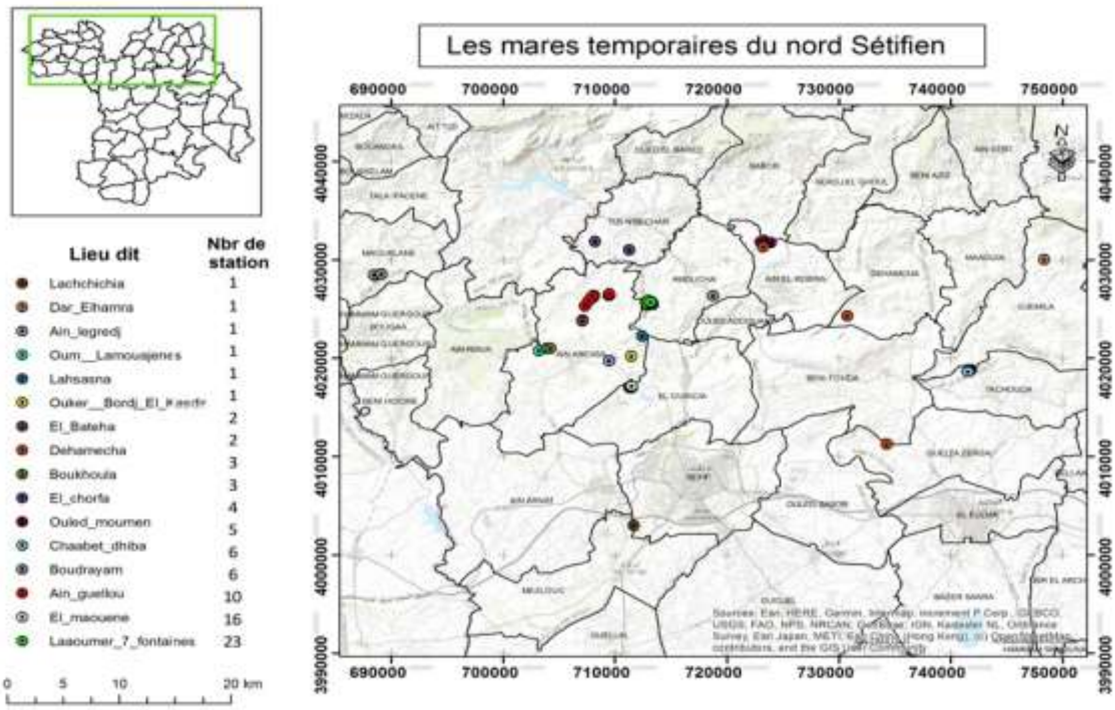

Figure 3: Map of pond locations in the Setif region (Created by Zerroug K., 2024)

4. Floristic Inventory

4.1 Species richness

Out of the 102 ponds inventoried, we recorded 139 species belonging to 35 botanical families. Poaceae represent 13.76% of the total flora, followed by Ranunculaceae at 9.42%, and Apiaceae at 8.69%. Juncaceae, Asteraceae, and Fabaceae each account for 8%. Cyperaceae represent 6.52%, Lamiaceae 4.34%, and Callitrichaceae 3.62%. Caryophyllaceae, Brassicaceae, and Plantaginaceae each make up 2.89%. Polygonaceae account for 2.17%. Five families with two species each represent 1.44% per family, while those with only one species (17 families) each account for 0.72%.

4.2 Floristic Diversity

The studied flora is dominated by dicotyledonous angiosperms, which form the largest systematic group with 90 species belonging to 24 families and 57 genera. Monocotyledons include 49 species distributed across 11 families and 30 genera **(Table 2).**

The surveys conducted allowed the observation of one species of Characeae: *Chara* sp., and *Juncus inflexus*. These are considered bioindicators of the quality of stagnant waters, as they decline rapidly in cases of eutrophication (Lambert et al., 2011). Other bioindicator species of mesotrophic habitats were also recorded, such as: *Alisma plantago-aquatica*, *Eleocharis palustris*, *Galium palustre*, *Carex divisa*, and *Oenanthe fistulosa* (Scoof-Van Pelt, 1973 and De Foucault, 1988). The presence of *Equisetum* indicates clayey and moist substrates, while *Sparganium erectum* indicates well-mineralized and neutrophilous waters (ponds of Ain Elkebira and Djebel Megriss). *Nasturtium officinale* is an indicator species of oligotrophic, poorly mineralized waters on siliceous, acidic substrates and develops in deep waters. *Ranunculus aquatilis* is a hydrophyte of calm waters (Boulaacheb, 2009).

The inventory led to the discovery, for the first time, of the species *Elatine alsinastrum* and *Isoetes longissima*, previously reported by Quezel and Santa (1962) in Numidia.

According to the Red List of Vascular Flora of Metropolitan France (2019), out of 421 species classified as threatened or near-threatened, four near-threatened species were identified in our studied ponds: *Cardamine parviflora* L., *Dactylorhiza elata* (Poir.) Soó., *Oenanthe globulosa* L., and *Trifolium retusum* L., all showing declining population trends. Among the threatened species, *Eryngium pusillum* L. is classified as endangered, and *Ranunculus lateriflorus* DC is listed as vulnerable.

According to the Red List of Vascular Flora of Brittany, *Elatine alsinastrum* L. is classified as critically endangered. *Ranunculus arvensis* L. and *Carex acutiformis* Ehrh. are considered endangered species, while *Butomus umbellatus* L., *Calendula arvensis* L., and *Ranunculus ophioglossifolius* Vill. are classified as near-threatened.

Table 2: List of recorded species

Family	Species	Life-from	Chorology
Apiaceae	*OEnanthe fistulosa* L.	*Hemicryptophyte*	*Euras*
	Oenanthe gIobulosa L.	*Hemicryptophyte*	*Eur. Med.*
	Oenanthe virgata Poir	*Geophyte*	*End NA*
	Eryngium pusillum L. .	*Hemicryptophyte*	*Eur. Med.*
	Eryngium campestre L.	*Hemicryptophyte*	
	Selinopsis foetida coss. & Durieu ex Batt	*Hemicryptophyte*	*End*
	Apium graveolens L.	*Hemicryptophyte*	*N. Trop.*
	Scandix pecten-Veneris L.	*Therophyte*	*Eur. Med*
	Daucus Carota L.	*Geophyte*	*Med.*
	Ammoides Pussila (Brot)Briestr	*Therophyte*	*Med.*
	Thapsia garganica L/.	*Hemicryptophyte*	*Med.*
	Helosciadium nodiflorum L.	*Hemicryptophyte*	*Euras.*
Asteraceae	*Calendula arvensis (vaill.) L.*	*Therophyte*	*Sub- med.*
	Leontodon tuberosus L.	*Hemicryptophyte*	*Med*
	Hyoseris radiata L.	*Hemicryptophyte*	*Eur.- Med*
	Dittrichia viscosa (L.) Greuter	*Hemicryptophyte*	*Circummed.*
	Reichardia picroides (L.) Roth	*Hemicryptophyte*	*Med.*
	Chrysanthemum myconis L.	*Therophyte*	*Med.*
	Helmenthia echioides (L)Gaertn	*Hemicryptophyte*	*Eur med.*
	Anthemis arvensis L.	*Therophyte*	*Med.*
	Centaurea parviflora Desf.	*Hemicryptophyte*	*End Alg. Tun.*
	Jacobaea gigantea (Desf.) Pelser	*Therophyte*	*End N.A*

	Centaurea amara L.	*Hemicryptophyte*	*End. Alg-Tun*
Alismataceae	*Alisma plantago-aquatica* L.	*Hemicryptophyte*	*Circumbor*
Asparagaceae	*Ornithogalum umbellatum* L.	*Geophyte*	*Atl. Med.*
Brassicaceae	*Nasturtium officinale* R. Br.	*Hemicryptophyte*	*Cosm.*
	Cardamine parviflora L.	*Therophyte*	*Circumbor.*
	Sinapis arvensis L.	*Therophyte*	*Paleo-Temp.*
	Capsella bursa-pastoris L.	*Therophyte*	*Med.*
Boragenaceae	*Myostis arvensis* (L.)Hill	*Therophyte*	*Circumbor*
Butomaceae	*Butomus umballatus* L.	*Geophyte*	*Euras*
Cyperaceae	*Carex distans* L.	*Hemicryptophyte*	*Paleo-temp.*
	Eleocharis palustris (L.) Roem. & Schult.	*Geophyte*	*Subcosm.*
	Carex leporina L.	*Hemicryptophyte*	*Circumbor.*
	Isolepis setacea (L.) R.Br	*Therophyte*	*Paleo-temp.subtrop.*
	Carex divisa Huds.	*Hemicryptophyte*	*Atl.-Med.*
	Carex acutiformis Ehrh	*Hemicryptophyte*	*Euras.*
	Carex pendula Hudson.	*Hemicryptophyte*	*Euras*
	Bolboschoenus maritimus L.	*Geophyte*	*Cosm.*
	Scripoides Holoschoenus	*Hemicryptophyte*	*Paleo-temp*
Caryophyllaceae	*Polycarpon tetraphyllum* (L.)L.	*Hemicryptophyte*	*A. N.-Sicile*
	Cerastium atlanticum Dur.	*Therophyte*	*End-N.A.*
	Silene gallica L.	*Therophyte*	*Paléo-Temp.*
	Silene laeta (Ait) A.B.	*Therophyte*	*W. Med.*
Callitrachaceae	*Callitriche Stagnalis* Scop.	*Therophyte*	*Euras*
	Callitriche obtusangula Le Gall	*Hemicryptophyte*	*Eur.*
	Callitriche palustris L.	*Hemicryptophyte*	*Med*
	Callitriche hamulata Kütz.	*Hemicryptophyte*	*W. Eur.*
	Callitriche brutia Petagna	*Hemicryptophyte*	*Med*
Campanulaceae	*Solenopsis laurentia* (L.) C.Presl	*Therophyte*	*Med.*
Crassulaceae	*Sedum caeruleum L.*	*Therophyte*	*Cent.Méd*
Dipsacaceae	*Scabiosa Columbaria* L.	*Hemicryptophyte*	*Eur. As.*
Elatinaceae	*Elatine alsinastrum* L.	*Hemicryptophyte*	*Euras*
Équisétaceae	*Equisetum maximum* Lamk	*Geophyte*	*Circumbor. Temp.*
Fabaceae	*Lotus corniculatus* L.	*Hemicryptophyte*	*Eur-Asie*
	Trifolium tomentosum L.	*Therophyte*	*Med*
	Trifolium hybridum L.	*Hemicryptophyte*	*Europ*
	Vicia sativa L.	*Therophyte*	*Eur-Med.*
	Trifolium fragiferum L.	*Hemicryptophyte*	*Euras-Med*
	Trifolium retusum L.	*Therophyte*	*Eur.*
	Trifolium strictum L.	*Therophyte*	*Med-Atl*
	Lathyrus pratensis L.	*Hemicryptophyte*	*Med.-Euras.*
	Trifolium pratense L.	*Hemicryptophyte*	*Euras*
	Trifolium repens L.	*Hemicryptophyte*	*Circumbor.*
	Melilotus sicula (Turra) Jackson	*Therophyte*	*Med.*
Gentianaceae	*Centaurium pulchellum* (SW.) Druce	*Therophyte*	*Paleotemp.*

Isoetaceae	*Isoetes longissima* Bory & Durieu	*Geophyte*	*Med.*
Juncaceae	*Juncus effusus* L.	*Geophyte*	*Paleo-bor.*
	Juncus bufonius L.	*Therophyte*	*Cosm.*
	Juncus articulatus L.	*Hemicryptophyte*	*Circumboréal*
	Juncus compressus Jacq.	*Geophyte*	*Euras*
	Juncus heterophyllus Dufour	*Hemicryptophyte*	*Atl-Med.*
	Juncus bulbosus L.	*Hemicryptophyte*	*Europ.*
	Juncus conglomeratus L.	*Geophyte*	*Paleo-bor.*
	Juncus acutus L.	*Hemicryptophyte*	*Subcosm.*
	Juncus maritimus Lamk.	*Hemicryptophyte*	*Subcosm.*
	Juncus inflexus L.	*Geophyte*	*Paleo-temp.*
	Juncus tenageia L.f.	*Therophyte*	*Atl-Med.*
Lamiaceae	*Mentha rotundifolia* L.	*Hemicryptophyte*	*Atl- Med.*
	Mentha pulegium L.	*Hemicryptophyte*	*Euras.*
	Bellardia latifolia (L)Cuatrec	*Therophyte*	*Med.*
	Mentha aquatica L.	*Geophytes*	*Paleo-temp.*
	Salvia verbenaca (L.) Briq.	*Hemicryptophyte*	*Med. Atl.*
	Ocimum basilicum L.	*Therophyte*	*Subtrop*
Linaceae	*Linum strictum* L.	*Therophyte*	*Med.*
Lemnaceae	*Lemna minor* L.	*Therophyte*	*Subcosm*
Onagraceae	*Epilobium parviflorum* Schreb.	*Hemicryptophyte*	*End*
	Epilobium tetragonum L.	*Hemicryptophyte*	*Med*
Orchidaceae	*Dactylorhiza maculata* (L.) Soó	*Geophyte*	*Euras.*
	Dactylorhiza elata (Poir.) Soó	*Geophyte*	*Med.*
Poaceae	*Bromus hordaceus* L.	*Therophyte*	*Paleotemp.*
	Poa trivialis L.	*Hemicryptophyte*	*Atl. Sah. Macar.Euras*
	Poa annua L.	*Therophyte*	*Cosm*
	Alopecurus pratensis L.	*Hemicryptophyte*	*Med.-Atl.*
	Alopecurus bulbosus Gouam	*Hemicryptophyte*	*Med-Atl*
	Phalaris paradoxa L.	*Therophyte*	*Med.*
	Phalaris coerulescens Desf .	*Geophyte*	*Macar.Med*
	Cynosurus polybracteatus Poiret.	*Therophyte*	*End Algero-Tun.*
	Lolium perenne L.	*Hemicryptophyte*	*Circumbor.*
	Lolium rigidum Gaud.	*Therophyte*	*Paleo-subtrop.*
	Polypogon monspeliensis (L.) Desf.	*Therophyte*	*Paleo-subtrop.*
	Rostraria cristata(L.)Tzvelv	*Therophyte*	*Sub-cosm.*
	Bromus lanceolatus Roth	*Therophyte*	*Paleotemp.*
	Anisantha rubens L.	*Therophyte*	*Paleo-subtrop.*
	Festuca arundinacea (Sch.) Hack	*Geophyte*	*Circumbor*
	Phleum pratense L.	*Hemicryptophyte*	*Circumbor*
	Glyceria fluitans (L.) R.BR	*Hemicryptophyte*	*Subcosm*
	Briza minor L.	*Therophyte*	*subcosm*
	Cynodon dactylon (L.) Pers.	*Geophyte*	*Cosm*
Plantaginaceae	*Plantago major* L.	*Hemicryptophyte*	*Euras.*
	Plantago lagopus L.	*Therophyte*	*Med.*

	Plantago lanceolata L.	*Hemicryptophyte*	*Euras.*
	Veronica anagallis-aquatica L.	*Hemicryptophyte*	*Circumbo*
Polygonaceae	*Rumex pulcher* L.	*Hemicryptophyte*	*Med*
	Rumex crispus L.	*Hemicryptophyte*	*Cosm*
	Rumex conglomeratus Murray	*Hemicryptophyte*	*Cosm*
Primulaceae	*Lysmachia arvensis* (L)U Manns & Anderb	*Therophyte*	*Sub. cosmop*
Renonculaceae	*Ranunculus arvensis* L.	*Therophyte*	*Paleo-temp.*
	Ranunculus macrophyllus Desf	*Hemicryptophyte*	*W. Med.*
	Adonis aestivalis L.	*Therophyte*	*Euras.*
	Ranunculus flammula L.	*Hemicryptophyte*	*Euras*
	Ranunculus trichophyllus Chaix	*Hemicryptophyte*	*Circumbor.*
	Ranunculus ophioglossifolius Vill	*Therophyte*	*Med.*
	Ranunculus aquatilis L.	*Hemicryptophyte*	*Cosm*
	Delphinium mauritanicum Coss.	*Therophyte*	*End. N.A.*
	Ranunculus muricatus L.	*Therophyte*	*Med*
	Ranunculus lateriflorus DC	*Therophyte*	*Euras*
	Anthericum liliago L.	*Hemicryptophyte*	*Atl-Méd*
	Ranunculus sclerateus L.	*Therophyte*	*Paleotemp*
	Ranunculus hederaceus L.	*Hemicryptophyte*	*Med-Atl*
Rubiaceae	*Sherardia arvensis* L.	*Therophyte*	*Euras.*
	Galium palustre L.	*Hemicryptophyte*	*Euras.*
Resedaceae	*Reseda alba* L.	*Hemicryptophyte*	*Euras.*
Rosaceae	*Potentilla reptans* L.	*Hemicryptophyte*	*Euras.*
Scrofulariaceae	*Scrofularia auriculata* L.	*Hemicryptophyte*	*Eur-Med*
	Scrophularia tenuipes Coss. et Dur.	*Hemicryptophyte*	*End*
Typhaceae	*Typha angustifolia* L.	*Geophyte*	*Sub-circumb.*
	Sparganium erectum L.	*Geophytes*	*Euras.*
Verbenaceae	*Verbena officinalis* L.	*Hemicryptophyte*	*Paleo-temp.*

4.3 Rarity

According to the national report (2014), the number of more or less rare species, based on the analysis of the flora by Quezel and Santa (1962), is estimated at 1,818 (1,185 species, 455 subspecies, and 178 varieties) across the entire national territory. The sub-sector of the Constantine High Plateaus (H2), which includes the Setif region, contains 159 rare species (Quezel and Santa, 1962). Of these 159, we recorded 10 rare species **(Table 3).**

This low number of rare species is probably due to the types of habitats surveyed. According to Pimm et al. (1988) and Gaston (1991), rare species hold significant conservation value, either for their heritage importance or because of their risk of extinction**.**

Table 3: List of rare species

Taxon according to (Dobignard et Chatelain, 2010–2013)	Quezel et Santa, (1962)
Eryngium campestre L.	AR
Cerastium atlanticum Dur.	AR
Trifolium pratense L.	AR

Phalaris paradoxa L.	R
Centaurea parviflora Desf.	AR
Mentha aquatica L.	AR
Ranunculus ophioglossifolius Villars.	R
Ranunculus lateriflorus DC.	R
Eryngium pusillum L.	R
Selinopsis foetida coss. & Durieu ex Batt	R

AR = Relatively rare **R** = Rare

Of the 452 species listed in the 2012 publication of protected plants in Algeria, ten species have been recorded: *Juncus bulbosus* L., *Cardamine parviflora* L., *Sparganium erectum* L., *Isolepis setacea* (L.) R.Br., *Callitriche palustris* L., *Centaurea amara* L., *Epilobium parviflorum* Schreb., *Ranunculus flammula* L., *Scrophularia tenuipes* Coss. & Dur., *Selinopsis foetida* Coss. & Durieu ex Batt.

4.4 Biological spectrum

The composition of the overall biological spectrum shows that hemicryptophytes predominate (70 species), followed by therophytes (49 species). It is worth noting that the El Chorfa ponds (Ain Elkebira municipality), Djebel Sidi Mimoune El Ghdir (Beni Aziz municipality), and Chaabet Diba (Tachouda municipality) alone account for 27 annual species **(Figure 4).**

The composition of the overall biological spectrum shows that hemicryptophytes predominate; according to Barbero et al. (1989), the dominance of hemicryptophytes is linked to rainfall and cold conditions, especially in winter, and can also be explained by the soil's richness in organic matter and moisture. The high proportion of therophytes indicates a strong influence of uncontrolled grazing, which leads to a reduction in community richness (Ranwell 1972; Jensen 1985; Bakker 1989; Sternberg et al. 2000). In general, ponds are characterized by plant communities dominated by annuals, which are adapted to the alternation of dry and wet phases and to significant interannual variations in the height and duration of flooding (Medail et al., 1998; Rhazi et al., 2006). Barbero et al. (1981) describe therophytization as the final stage of ecosystem degradation. Geophytes are also fairly well represented (20 species); as perennials, geophytes are less affected by grazing and are able to withstand it thanks to their underground stems.

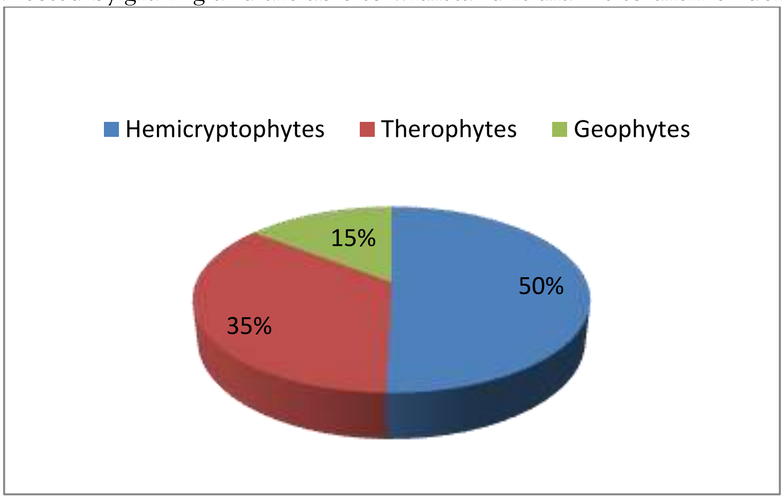

Figure 4: Biological spectrum.

4.5 Chorology

Figure 5 shows the biogeographical distribution of the 139 species into four groups:

➢ **The Mediterranean group:**

Out of the 139 listed species, 26 are Mediterranean. The most represented families are Asteraceae (4 species), Apiaceae and Ranunculaceae (3 species each), and Fabaceae (2 species).

➢ **The Northern group**

This group includes 52 species, representing 37% of the recorded flora. These results are comparable to those of Boulaacheb (2009). Among the 35 families, 24 are well represented in this group, with the most significant being Juncaceae and Ranunculaceae (6 species each), Poaceae (5 species), Cyperaceae and Fabaceae (4 species each), and Apiaceae and Lamiaceae (2 species each).

➢ **Wide distribution:**

This group comprises 47 species, of which 16 are cosmopolitan and subcosmopolitan species. The paleo-subtropical species include 4 species: *Isolepis setacea* (L.) R.Br.; *Anisantha rubens* L.; *Polypogon monspeliensis* (L.) Desf.; *Lolium rigidum* Gaud.

➢ **The endemic group**

According to Yahi et al. (2012), the number of strict Algerian endemic species is 300. The endemics developing in our ponds are relatively few (10 species): including broad North African endemics and strictly Algero-Tunisian endemics.

➢ **North African endemics:** *Cerastium atlanticum*, *Delphinium mauritanicum*, *Jacobaea gigantea*, *Oenanthe virgata*.

➢ **Algero-Tunisian endemics:** *Cynosurus polybracteatus*, *Centaurea parviflora*, *Centaurea amara*.

➢ **Strict endemics:** *Scrophularia tenuipes*, *Epilobium parviflorum*, *Selinopsis foetida*.

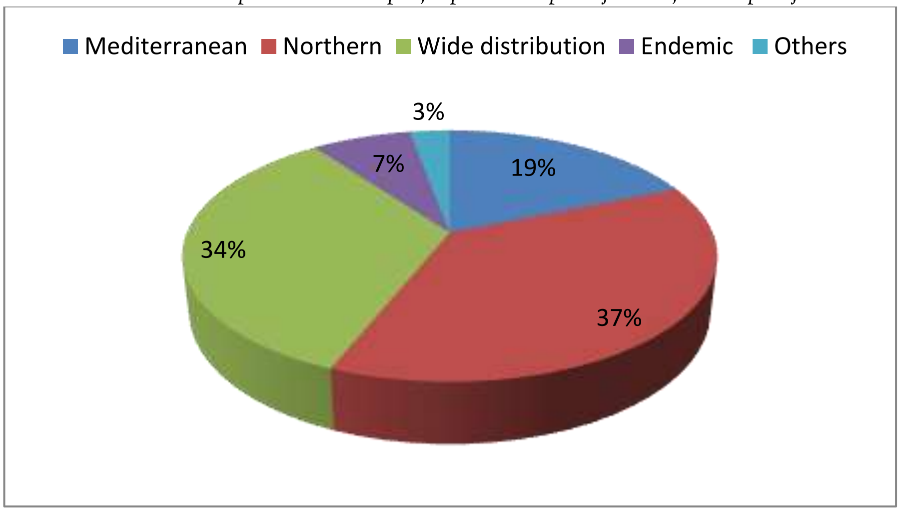

Figure 5: Chorological Spectrum.

5. Measurement of floristic diversity in the studied ponds

The average value of the Shannon index (H': 3.20) for all ponds indicates a high species richness. Among the 102 ponds, the Dar El-Hamra pond (Djemila Municipality) (H': 0.40) and the Zaatria pond (Ain Abbassa Municipality) (H': 0.37) are the most diverse. The Simpson index, which gives greater weight to abundant species, is 0.123, indicating relatively high diversity.

6. Spatial organization of vegetation

The results reveal a structuring of the ponds into three concentric zones:

- A **first belt** consisting of grasslands composed of meso-hygrophilous species such as: *Carex distans, Bromus hordeaceus, Leontodon tuberosus, Capsella bursa-pastoris, Mentha pulegium, Eryngium campestre, Ornithogalum umbellatum, Silene gallica, Cynodon dactylon.*
- A **second belt** dominated by rushes (*Juncus* spp.) accompanied by: *Trifolium pratense, Oenanthe virgata, Oenanthe fistulosa, Carex divisa, Jacobaea gigantea, Trifolium parviflorum, Festuca arundinacea, Galium palustre, Mentha aquatica, Cerastium atlanticum.*
- A **third belt** (with water lasting until mid-July, or at the latest mid-August) colonized by aquatic and/or amphibious species such as: *Ranunculus aquatilis, Alisma plantago-aquatica, Ranunculus ophioglossifolius, Eleocharis palustris, Ranunculus lateriflorus, Glyceria fluitans.*

According to Deil (2005), this structure is linked to the water depth gradient and the duration of submersion. Similar patterns have also been observed in Morocco (Rhazi et al., 2006) and in Sardinia (Bagella et al., 2009b). This zonation appears to be characteristic of Mediterranean temporary ponds, with an outer zone dominated by terrestrial species, an intermediate zone by amphibious species, and a central zone by aquatic species. The high temporary species richness is often explained by the functional nature of these ponds, particularly the alternation of flooded and dry phases, which allows for the coexistence of a heterogeneous assemblage of species (aquatic, amphibious, and terrestrial) (Bouldjedri et al., 2011). During the summer season, most ponds are covered by species such as: *Mentha pulegium, Juncus effusus, Rumex conglomeratus, Delphinium mauritanicum, Phalaris paradoxa, Verbena officinalis, Scabiosa columbaria, Rostraria cristata, Bromus lanceolatus.*

7. Socio-economic survey

These ponds are mainly exploited through anthropogenic activity; a socio-economic survey was conducted during the period 2017–2018 within a study area encompassing fourteen municipalities: Setif, Ain El Kbira, El Hachaïchia, Beni Aziz, Takouka, Tachouda, Ouled Moumen, El Maouane, El Dhamcha, Ain Laghrage, Moaklane, Djemila, Ain Abbassa, and Bougaa. The survey targeted a sample of 70 individuals, arbitrarily selected from within the study area, primarily located near the ponds. Local administrations particularly the forestry districts of Eulma, Beni-Aziz, Ain Abbassa, and Bougaa were also included in the study.

Perceptions of pond usage were more prevalent among men (74%) than women (26%). This reflects the strong connection men have with these habitats, particularly in meeting livestock needs (water, grazing) and for local agricultural practices. This perception is also closely linked to land ownership status. In fact, most users are landowners who view ponds as a freely accessible resource for water, grazing, and the collection of medicinal plants such as *Mentha pulegium* L., *Ocimum basilicum* L., *Dittrichia viscosa* (L.) Greuter, *Trifolium pratense* L., *Rumex pulcher* L., *Verbena officinalis* L., and *Plantago major* L., as well as artisanal plants like *Juncus acutus* L. and *Juncus maritimus* Lam. These are often harvested directly from the ponds and sold locally by the population. Some ponds are also used for traditional therapy by local residents for instance, the pond located in the municipality of Ain Laghrage is known for its leeches, which are sought after for treating certain ailments.

8. Threats and conservation measures.

Concerning the threats and conservation measures, despite their richness, the ponds are subject to increasing anthropogenic pressures, leading either to their transformation or disappearance. The main identified anthropogenic threats include destruction by infilling, drainage for agricultural and urban development purposes, grazing, and alteration of hydrological functioning, pollution, and encroachment by woody species such as *Crataegus azarolus* L., *Olea europaea* L., *Prunus armeniaca* L., *Cupressus sempervirens* L., and *Calicotome spinosa* L., as well as hunting, particularly of ducks. climate change is expected to result in changes in temperature and precipitation patterns, impacting pond hydrology (Brooks, 2009). Increased droughts may lead to more intense summer dry periods, causing ponds to dry up due to evapotranspiration.

This threat assessment can serve as a tool for better management of ponds, especially those hosting endemic, rare, or newly recorded species in the Setif region, such as *Isoetes longissima* Bory & Durieu and *Elatine alsinastrum* L. There is an urgent need to implement a regular monitoring program of plant and animal communities. Moderate grazing is often used as a management tool to maintain floristic diversity in wetlands (Forman & Godron, 1986; Turner, 1989; Burel, 1992; Burel & Baudry, 1999).

These conservation measures must also be accompanied by awareness campaigns targeting local populations, emphasizing the importance of preserving natural habitats, and encouraging their involvement in pond management. Furthermore, it is essential to strengthen political will and introduce greater flexibility into conservation procedures through the establishment of legislative frameworks to ensure legal protection of these natural environments.

CONCLUSION

The study highlighted the richness of the Setif region in temporary ponds, with a total of 102 ponds recorded. The flora comprises 139 species, of which 50% are hemicryptophytes. From a chorological perspective, endemic species account for 10 species (7%), and northern elements are well represented, comprising 37% of the total. It is also worth noting that among the 139 recorded species, 10 are considered rare, and another 10 are listed among the protected and non-cultivated plant species in Algeria. Species previously reported only in Numidia, such as *Elatine alsinastrum* and *Isoetes longissima*, have been newly discovered. These habitats, notable for their unique ecology and biodiversity, represent a significant natural heritage value. The establishment of legislative measures for their conservation is urgently needed.

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