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Conservation of Mediterranean wetlands: Interest of historical approach

Conservation des zones humides méditerranéennes : intérêt de l'approche historique

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ABSTRACT

The wetlands of North Africa are an endangered and invaluable ecological heritage. Some of these wetlands are now protected by various conservation statutes; which actual impact has not yet been reliably evaluated. This article aims to assess the conservation management (Nature Reserve and Ramsar site) of a protected Tunisian lake, Majen Chitane, by using palaeoecological, historical and modern data, and by comparing it with the unprotected lake Majen Choucha. While located in similar environments, these lakes are today home to very different flora. Baseline conditions reconstructed from literature indicate that both lakes were very similar until the 1950s, and comparable to the current state of Majen Choucha, housing rich oligotrophic plant communities. In the 1960s, at the time that cultivation of the adjacent peatland began, Majen Chitane underwent strong ecological changes as the initial oligotrophic plant, diatom and zooplankton communities were replaced by eutrophication-tolerant ones. Eutrophication led to the local extinction of 40–55% of the hydrophytic and temporary-pool plant species, including those characteristic of the *Isoetion*. Given the damages and despite the recent conservation status of the site, it's unlikely that Majen Chitane will undergo any natural regeneration. Restoring it would start with completely protecting the complex lake-peatland and re-introducing the locally extinct species from Majen Choucha. This work exemplifies the usefulness of connecting palaeoecological, historical and modern data for the conservation of Mediterranean wetlands.

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RÉSUMÉ

Les zones humides d'Afrique du Nord représentent un patrimoine écologique inestimable et menacé. Certaines sont aujourd'hui protégées par divers statuts de conservation, dont l'impact réel n'a pas encore été évalué de manière fiable. Cet article vise à évaluer la gestion conservatoire (Réserve Naturelle et site Ramsar) d'un lac tunisien protégé (Majen Chitane), à travers des données paléoécologiques, historiques et actuelles, par comparaison à un lac non protégé (Majen Choucha). Bien que situés dans des environnements similaires, ces deux lacs hébergent aujourd'hui des flores très différentes. La reconstruction de l'état de

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référence à partir des données de la littérature révèle que les deux sites étaient très similaires avant les années 1950, et comparables à l'état actuel de Majen Choucha : ils hébergeaient notamment de riches communautés végétales oligotrophes. Depuis les années 1960, simultanément à la mise en culture de la tourbière adjacente, Majen Chitane connaît des changements écologiques profonds marqués par le remplacement des communautés oligotrophes initiales de plantes, de diatomées et de zooplancton, par des communautés tolérantes à l'enrichissement du milieu. L'eutrophisation du lac a entraîné l'extinction locale de 40–55 % d'hydrophytes et de plantes caractéristiques des mares temporaires, y compris des espèces de l'*Isoetion*. Compte tenu des dommages subis par Majen Chitane et en dépit des mesures de protection qui ont été prises, sa régénération naturelle ne semble pas réaliste. Sa restauration implique la mise en défens de tout le complexe lac-tourbière et la réintroduction, à partir de Majen Choucha, des espèces localement éteintes. Ce travail met en exergue l'intérêt de l'utilisation intégrée des données paléoécologiques, historiques et actuelles pour la conservation des zones humides méditerranéennes.

1. Introduction

The Mediterranean region includes diversified wetlands [1,2] with high ecological [3,4], economic and social values [5]. Temporary wetlands in particular house a rare and endangered flora, which lend them an especially high conservation value [6–9]. These contribute greatly to regional biodiversities, and both their importance and vulnerability helped to identify several *hotspots* [3,10,11]. Temporary wetlands, abundant mainly on the southern side of the Mediterranean, are rapidly declining [12–16] because of strong human pressure [17–21]. To ensure the durability of these unique and endangered ecosystems, several inventory, assessment and monitoring programs have been implemented on Mediterranean wetlands (e.g. [22–25]), and Maghreb countries have recently developed various wetland-conservation measures and initiatives (National Parks, Nature Reserves and Ramsar sites). However, only a few studies focus on evaluating the impact of these conservation measures. For instance, the MELMARINA project aimed to establish integrated hydrological and ecological monitoring of North African coastal lagoons [26], the CASSARINA project assessed the current state of twelve North African lakes by making biological inventories and reconstructing their recent dynamics [27], and the Ichkeul National Park undergoes a regular monitoring of its marsh and lake habitats [28–33].

In Tunisia, with the exception of Ichkeul National Park, only one semi-permanent lake, Majen Chitane, has been protected since 1993. The lake and adjacent peatland (Dar el Orbi) have been studied repeatedly since the 1950s [27,34–39], but no synthesis of these works has ever been published. The CASSARINA project emphasized the major interest of this site for conservation [27], but the earlier works of Pottier-Alapetite & Labbe [34] and Pottier-Alapetite [35] were not considered. Moreover, Majen Choucha, another Tunisian semi-permanent lake that is relatively similar to Majen Chitane [21,35], is not yet protected. A comparison of these two sites taken with the synthesis of previous studies provides a unique opportunity to make an historical evaluation of the conservation value of both wetlands and the pertinence of the current conservation measures [40].

In recent years, palaeoecological and historical data have been used increasingly for defining baseline conditions of ecosystems, in order to assess the amplitude of their natural variability, their naturalness, their fragility, and the conservation status of rare species [41–44]. The need to connect ecological, palaeoecological and historical data has been highlighted since the 1990s [45–51]. Such interdisciplinary approaches offer theoretical and applied perspectives: they are particularly pertinent for a better comprehension of ecosystem functioning and they can help to refine conservation management policies [45,50–52]. However, they are not often used and are often ignored by scientists and managers [53]. This paper documents local ecological changes of Majen Choucha and Majen Chitane by comparing ancient and recent phytosociological relevés and by using the palaeoecological data available in the literature to: (1) evaluate the changes having affected Majen Chitane and Majen Choucha Lakes, and (2) assess and discuss the current conservation management of Majen Chitane Lake. This work attempts to demonstrate the usefulness and the need of interconnecting palaeoecological, historical and modern data for the conservation of Mediterranean wetlands.

2. Study sites

The terms used for North Africa wetlands vary greatly, depending on regions and countries. The term *daya*, for example, specifically refers to a Moroccan temporary pool [9], whereas in Tunisia, *garâa* (or *garâet*) designates a lowland lake, and *majen* (alternatively *madjen*, *megene*, *majin* or *Majel*), a small mountain lake [54]. Adding to the variety of local terminologies, changes or mistakes about the names of certain sites are not rare in the literature, and may create further confusion. This has been true for the studies carried out on Majen Chitane Lake, which has been named *Lac des Nénuphars* [35,55], *Majen el Orbi* [39], and *Gaâret Sejnane* [38]. This last name is definitely wrong, since Garâa Sejenane is the large alluvial plain close to the city of Sejenane [16] (Fig. 1).

Majen Chitane and Majen Choucha Lakes (Fig. 1; Table 1) are located in the sandstone Oligocene Mogods Hills (northern Tunisia) and are separated by approximately 20 km. This region, with an annual rainfall between 800 to