An experimental study of recolonization process in vernal pools following disturbance : preliminary results

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Introduction

Ecosystems are often threatened by various types of disturbances (natural and anthropogenic), which impact the structure and the dynamics of biological communities. A lot of work has long been focused on the importance of disturbance on various ecological processes, such as succession, propagules dispersion, competition, and resilience after disturbance.

Vernal pools are good models for the study of vegetation dynamics after disturbance, because of their high diversity, their contrasted ecological conditions related to topographic gradients (*Grillas et al., 2004*), and their relationships with surrounding mesophilous landscapes through biotic and matter fluxes.

In the Mediterranean region, and notably in Morocco, these temporarily flooded habitats are numerous and harbour a lot of rare and patrimonial species. Their hydrology, which is a key environmental factor, is likely to be affected by the climate change, with important consequences on species and plant communities. The survival of their constitutive species could be related to their ability of propagules dispersion in order to colonize sustainable patches within ponds.

The objectives of the presented work are: (1) to study the structure and the intra-annual dynamics of vegetation, and (2) to study the recolonization process following a disturbance within a vernal pool by taking in account annual and perennial plants.

The studied vernal pool, located in a pastured forested area

Material and methods

The water depth and the vegetation of the studied vernal pool were monitored at 3 dates (February, May, June) in 2006-2007, on quadrats (0,3 x 0,3 m divided into 9 squares 0,1 x 0,1 m) distributed along 2 perpendicular permanent transects crossing the deepest part of the pool. The species abundance on each quadrat was measured as the number of squares occupied. A disturbance experiment was conducted in the same pool comparing 2 treatments ("Disturbed" and "Control") on 18 plots (0.5 x 0.5 m) distributed at 3 locations along the topographic gradient (periphery, intermediate zone and centre) for studying the vegetation recolonization. In the 9 disturbed patches, the soil was removed on 16 cm depth, sterilised in an oven (200°C during 3 days) and replaced at the same plot. On each plot, the vegetation cover of each species was measured during two successive years: 2006-2007 (March, April, May and June) and 2007-2008 (February, March). The species richness and the total cover of vegetation were calculated for each plot. The dynamics of the vegetation was analysed using a correspondence analysis (CA). The effects of the disturbances and of the location along the depth gradient on species richness and on the total vegetation cover were tested using the nonparametric analysis of variance of Kruskal-Wallis.

Results and discussion

1- Vegetation structure and intra-annual vegetation dynamics

The two first axes of the CA (Fig.1) explained respectively 78 and 21% of the original variance. The axis F1 opposes typical pool species (*Isoetes velata, Eleocharis palustris, Callitriche brutia...*), which dominate the deeper and intermediate belts, to terrestrial species (*Cistus monspeliensis, Lolium rigidum, Leontodon saxatilis...*) which occur on margins. The axis F2 opposes the annual plants (*Malva hispanica, Bellis annua...*) to the perennial ones (*Cistus monspeliensis, Mentha pulegium...*). This intra-annual dynamics of vegetation (Fig.1) is characterised by the dominance of aquatic plants and amphibious ones in February. These species regress in May to be replaced by terrestrial therophytes which, in turn, disappear during the dry season (June) when only perennial terrestrial plants persist. This intra-annual vegetation dynamics appears to be mainly controlled by hydrology.

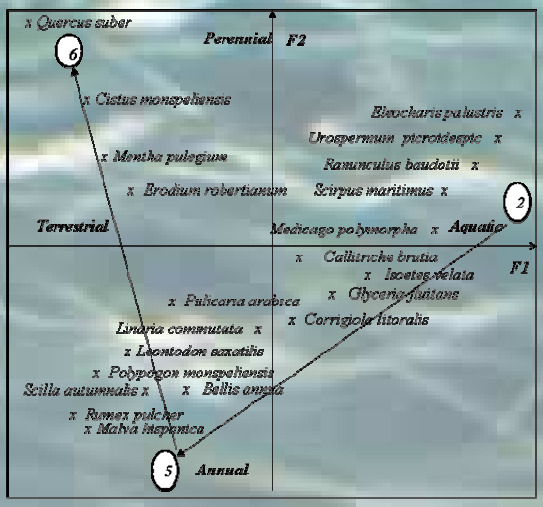

Figure 1: Biplot ½ of the correspondence analysis performed on vegetation data at 3 dates in 2006-2007; the sampling month is indicated by its number in a circle located at the barycentre of the distribution of the quadrats (2,February; 5,May; 6,June).

2- Recolonization and intra-pool dispersal

• Treatment effect

The survey of sterilized and control plots during the period study (2006-2008) shows that the total cover of vegetation was significantly lower ($p<0,05$) in the disturbed plots than in the control ones (Figure 2-A). In contrast, the species richness was not significantly different between the 2 treatments ($p>0,05$; Figure 2-B). These results suggest that the recolonization after disturbance can be fast. However, this process could have been affected by the severe drought of 2006-2007, which may have limited the success of species establishment in the control.

• Year effect

Species richness and vegetation cover were not significantly different between years in the control plots. Within the disturbed plots, the total richness and vegetation cover, as well as that of the annuals and perennials species sub-groups, were significantly higher in 2007-2008 than in the previous year ($p<0,05$) (Figure 3 A, B and Table1).

The increase in richness and in vegetation cover probably results from the hydrological conditions, which were wetter during the second year ($p<0,05$).

In 2006-2007, the hydrological conditions were inefficient for plant growth and propagule dispersal. The established species were mostly perennial (*Scirpus maritimus* and *Eleocharis palustris*) and none annual plant was expressed (Table 1).

Conversely, the second study period (2007-2008) was relatively wet and more favourable for the growth of annual species (*Ranunculus peltatus, Glyceria fluitans...*), which established in sterilized plots. These species are not competitive and generally represent pioneer stages in disturbed habitats.

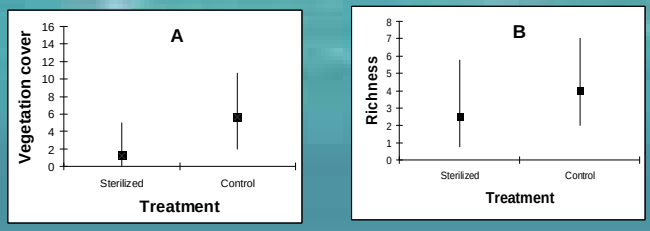

Figure 2: Variation of vegetation cover (A) and species richness (B) in the control and sterilized plots

The first phases of the succession were dominated by pioneer species; their populations are progressively replaced by more competitive communities of plants (*Rees and al, 2001*).

	Test			Quartiles 25% (50%) 75%	
	Chi²	ddl	p	2006-2007	2007-2008
Annual species cover	14,59	1	0,0001	0(0)0	3,76(6,87)25,7
Perennial species cover	7,91	1	0,0049	0(0,12)0,22	0,39(0,85)3,66
Annual species richness	14,78	1	0,0001	0(0)0	1,5(5) 5
Perennial species richness	7,91	1	0,0049	0(1)1,5	1,5(3)3,5

Table 1: Vegetation cover and species richness of annual and perennial plants in sterilized plots -including two period study- with 3 quartiles: the median, and the lower (25%) and upper quartiles (75%).

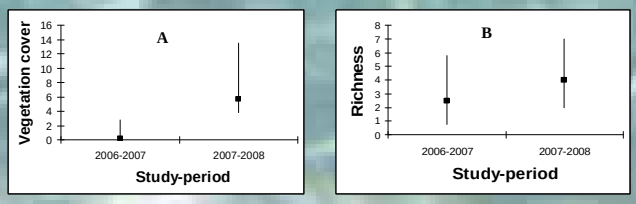

Figure 3: Variation of vegetation cover (A) and richness (B) within the sterilized plots, during the study period (2007-2008)

Conclusion

This study suggests that:

1-In the studied vernal pool, the vegetation was structured as a function of water depth and species succession. The centre and intermediate zones are dominated by aquatic and amphibious plants, whereas the peripheral zone shows a prevalence of terrestrial ones. The intra-annual dynamics of vegetation is variable, and related to hydrology, which induced modification of specific composition at each depth.

2-After a strong disturbance (sterilization at high temperature), the recolonization of parts of a vernal pool is highly possible. However, this process depends on environmental variables, primarily hydrology, that control the ecosystem dynamics.

The vegetation surveys will be maintained in 2008-2009 and the results will be discussed in the perspective of sustainable management and restoration of temporary pools.