COENOLOGICAL SHIFT FOLLOWING FERTILIZATION IN MEDITERRANEAN GRASSLAND

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Abstract - In Rome both meadows of Central-European affinity and Mediterranean dry grasslands are present. We studied a site (Parco Regionale Urbano del Pineto in Rome) with very diverse vegetation, where species belonging to both coenological groups occur. We fertilized a grassland with a combination of phosphorus (P) and nitrogen (N). After fertilization diagnostic species of Helianthemetea guttati (Therophytes) decrease while species of Molinio-Arrhenatheretea (Hemicriptophytes) increase. In a climate as that of Rome, transition between Mediterranean (with summer drought) and Central European (without summer drought), nutrients availability modulates the distribution of vegetation Classes with respectively Mediterranean or Central-Europe affinities.

Key Words - Fertilization, N and P, grassland, Rome, Ellenberg Indicators, life-forms, chorotypes

INTRODUCTION

Fertilization experiments have been routinely carried for decades in Central Europe (Aerts & Chapin, 2000; van der Hoek *et al.*, 2004, Güsewell, 2005).We have large knowledge about competition, nutrient requirements, succession in plant communities. In the Mediterranean studies are instead scarce (Mamolos *et al.*, 2005). The Pineto Park is a representative case study site, because a large amount of historical and recent floristic information are available (Montelucci, 1953-54; De Lillis & Testi, 1989; Bianco *et al.* 2003) and because the biotope, although completely surrounded by intensively urbanized areas, preserves semi natural vegetation and a rich biodiversity. In this study site both meadows of Central-European affinity and Mediterranean dry grasslands are present. We studied the response to fertilization with N and P in an ecotonal site where species belonging to both coenological groups occur.

STUDY AREA

Pineto Park is one of 15 protected areas within the city of Rome (Figure 1). The 247-hectare park is characterized by a remarkable variety of landscapes, including cork oak (*Quercus suber*) forests, species-rich grasslands, ponds, and wetlands; these diverse landscapes provide habitat for 642 plant species, giving to the park the richest plant-species density in Rome (Celesti Grapow *et al.*, 1995).

The park is located within the metropolitan area, approximately two kilometers from the walls of the Vatican. Until about 15 years ago it was used primarily as sheep pasture. Saved from development thanks to the efforts of citizens, it is the last expanse of undeveloped land in a highly urbanized sector of Rome. The park is in fact completely surrounded by heavily built-up areas with few green or open spaces.

In the study area moist meadows and dry grasslands coexist but with a different spatial distribution: the former occur at bottom of the small valleys, Mediterranean dry grasslands on slopes. Their distribution follows the water availability in soil. (Figure 2).

In the last decade a sharp change in management occurred. The end of grazing, which at first glance might be considered a good conservation measure, has coincided with an increase in Ellenberg's N indicator values (Bianco *et al.*, 2003). This is possibly due to the fact that when grazing ceased, so did nitrogen removal by the sheep.

The area has a moderate Mediterranean climate, with a mean annual temperature of around 16°C and a mean annual rainfall of more than 800 mm. The average January temperature is 7.4°C, the average July temperature is 23.9°C, and frosts are very rare. There is a drought period that extends from June to August (Monte Mario meteorological station) (Figure 3).

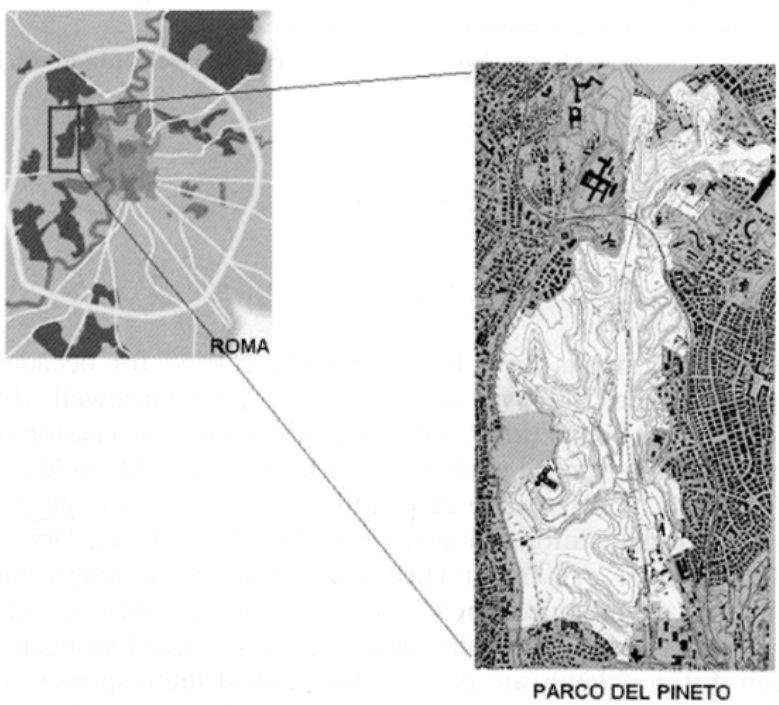

FIGURE 1 - Study site.

FIGURE 2 - A sight of the study site: in the bottom of the valley meadows (*Molinio-Arrhenatheretea*) occur, on the slopes dry grasslands (*Helianthemetea guttati*); plots are located in the ecotone between the two communities.

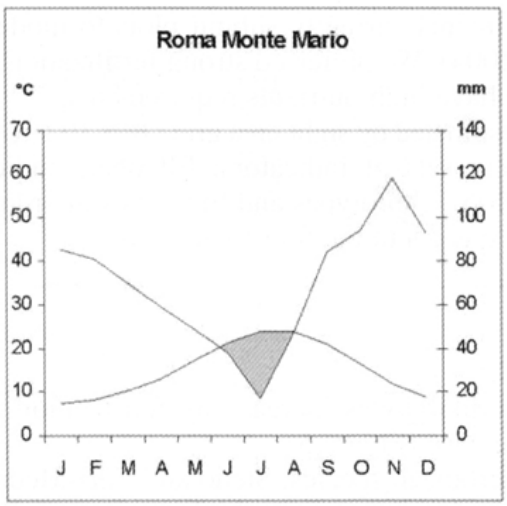

FIGURE 3 - Ombrothermic diagram of the study suite (Rome - M. Mario)

METHODS

We fertilized a plot with a combination of phosphorus (P) and nitrogen (N) (Figure 4).

The plot has been divided in 20 squares of 1 m^2: 5 squares have been fertilized with nitrogen (urea, 200g/m^2), 5 squares with phosphorous (orthophosphate, 150g/m^2), 5 with a combination of both elements, and the last 5 were left as control plots. Fertilization was carried in early spring.

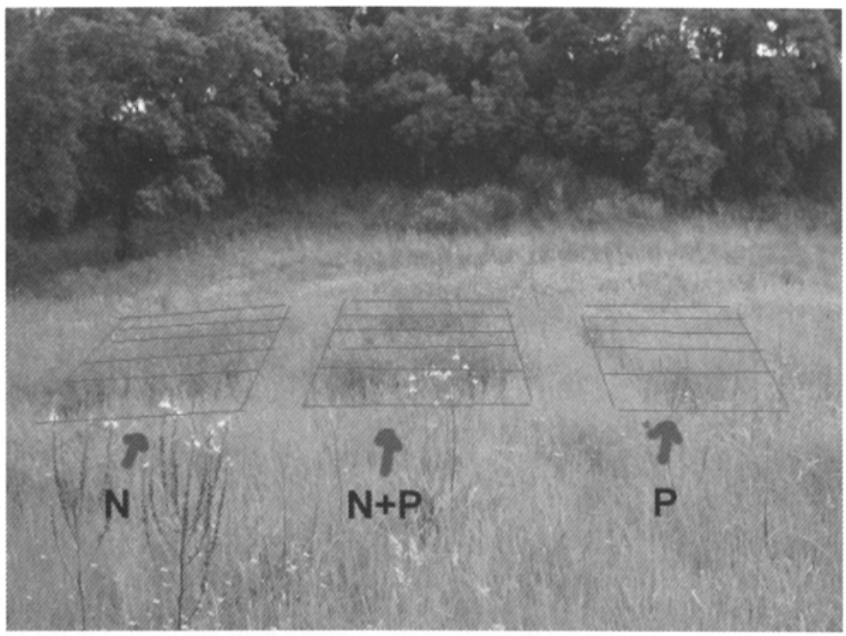

FIGURE 4 - The fertilization plots; the grid used for cover is shown in grey.

Fertilization experiments currently submit plots to moderate fertilization input (van der Hoek *et al.*, 2004). We preferred strong fertilization rates because this vegetation is supposed to have high nutrients requirements.

In May cover was estimated by sight on a grid (10 x 10 cm) located on each square.

We applied different sets of indicators: Ellenberg indicators (Pignatti *et al.*, 2005, Fanelli *et al.*, 2006), chorotypes and life forms in order to study the response of different groups of species to the four treatments.

RESULTS

Life forms: Hemycriptophytes increase by fertilization (both N, P and N+P), while Therophytes decrease (Figure 5).

Chorotypes: Mediterranean species, Steno and Euri-Mediterranean, decrease by fertilization, especially with nitrogen; the highest percentages occur in the unfertilized plots; large distribution species show the opposite pattern (Figure 6).

The species number decreases after fertilization (Figure 7).

Ellenberg indicators: the highest N value has been recorded in the plots fertilized with the combination of N and P, whereas the lowest value in the unfertilized plots (Figure 8), F values follow the same pattern (Figure 9).

Different species present different response to treatments (Figure 10): Species diagnostic of *Molinio-Arrhenatheretea* and *Agropyretalia repentis* increase with N fertilization, less with N+P fertilization and P fertilization.

Species diagnostic of *Helianthemetea guttati* Br.-Bl. 1931 emend. Rivas-Martinez 1977 decrease with fertilization and show highest values in control plots.

Ruderal annuals diagnostic of *Brometalia rubenti-tectorum* and *Stellarietea mediae* show the strongest response with N+P fertilization.

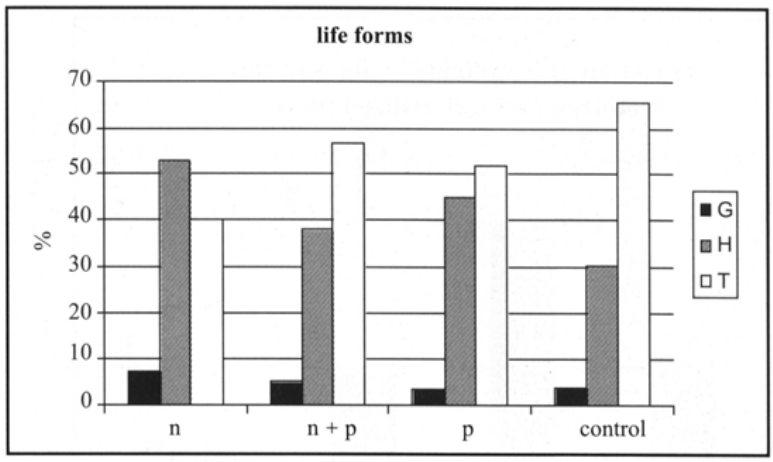

FIGURE 5 - Life forms percentages after the 4 treatments.

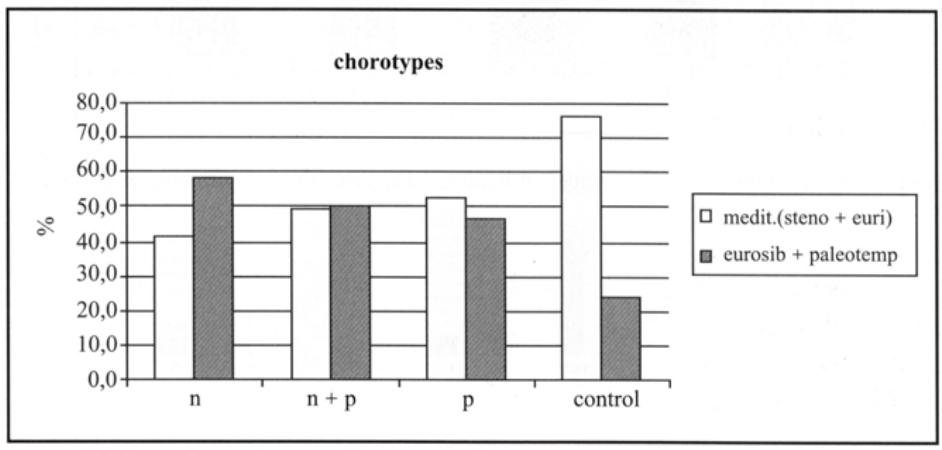

FIGURE 6 - Chorotypes percentages after the 4 treatments.

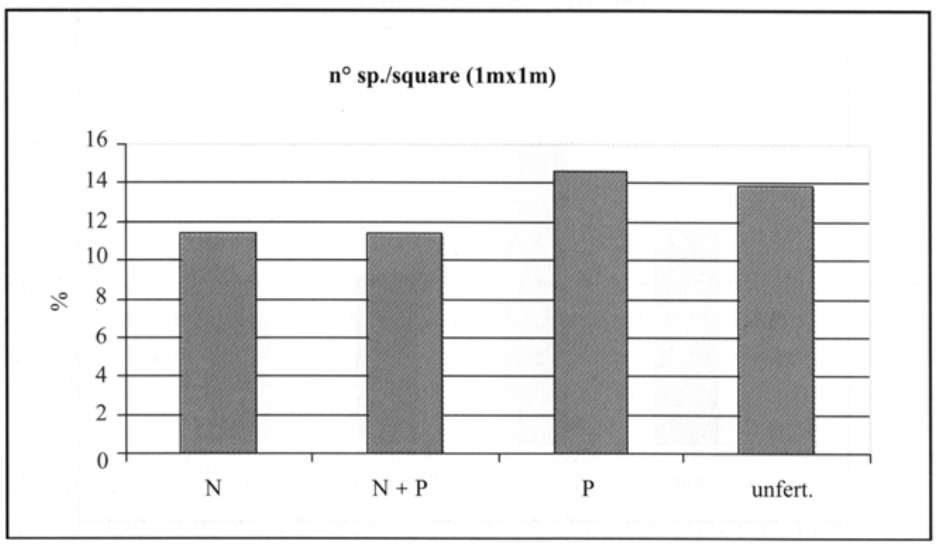

FIGURE 7 - n° species after the 4 treatments.

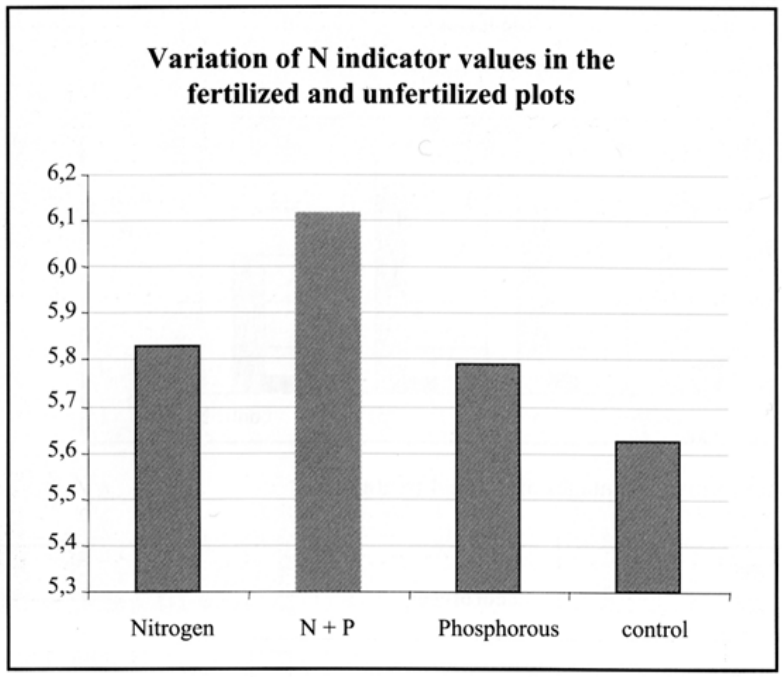

FIGURE 8 - Average Ellenberg's N (nutrients) indicator value after the 3 treatments and control.

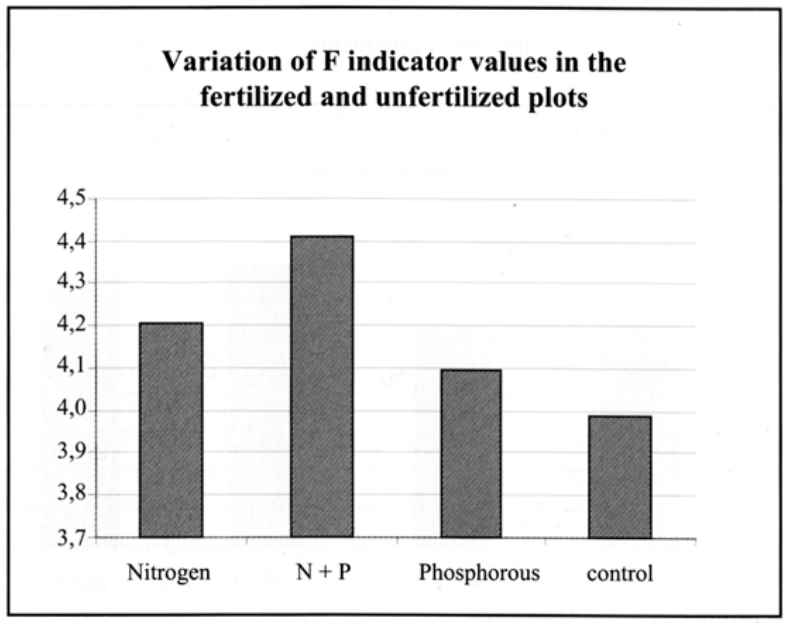

FIGURE 9 - Average Ellenberg's F (dampness) indicator value after the 3 treatments and control.

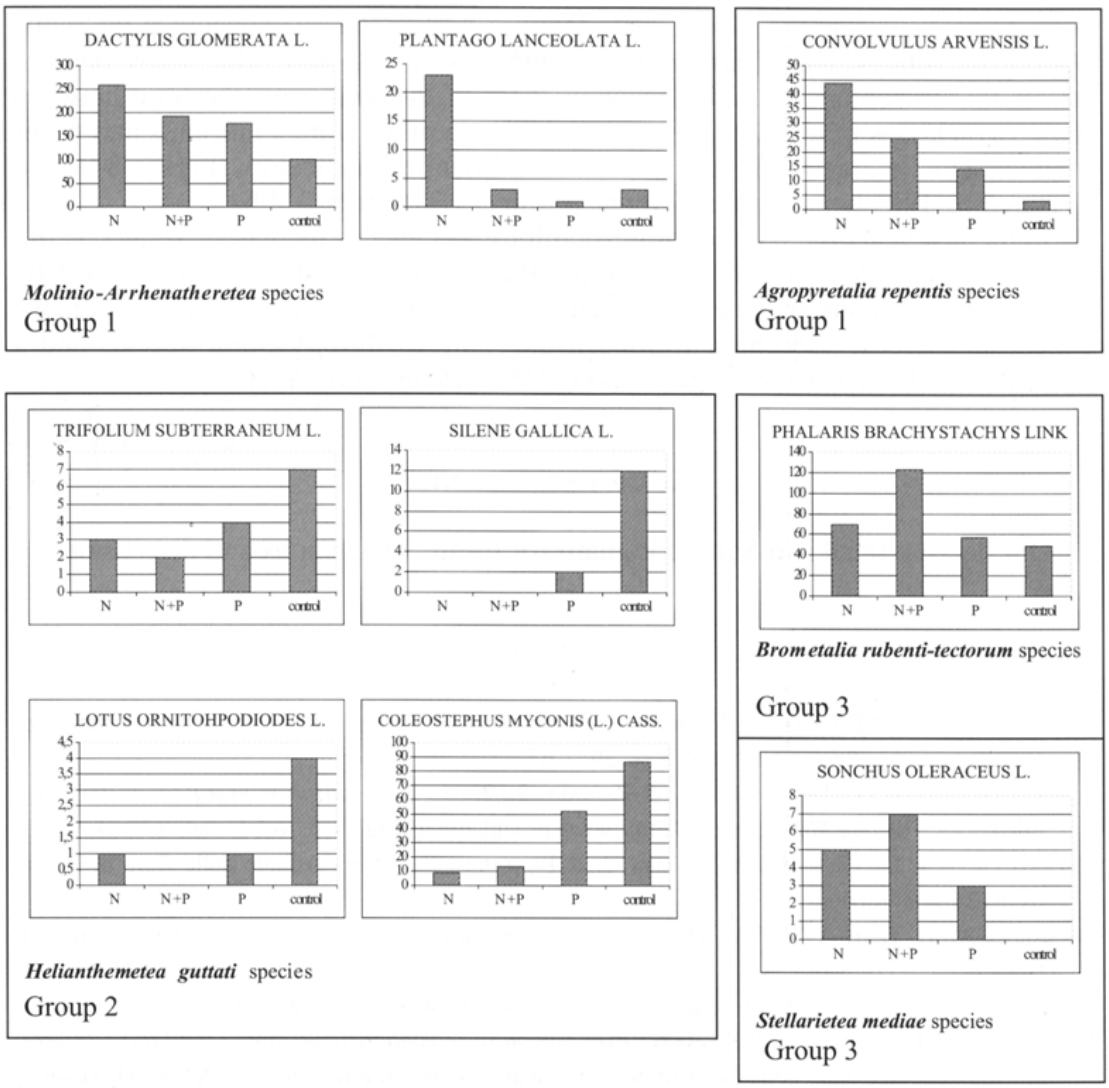

FIGURE 10 - Behaviour of selected species (n. of occurences) in the 3 treatments and control; species are grouped according to phytosociological affinity.

DISCUSSION AND CONCLUSION

Different species show a great diversity of response to fertilization. Coenological groups can summarize this spectrum of responses. In particular Central-European species from group 1 (*Molinio-Arrhenatheretea* and *Agropyretalia repentis*) and Mediterranean ruderal species from group 3 (*Brometalia rubenti-tectorum* and *Stellarietea mediae*) increase with fertilization, whereas Mediterranean species from group 2 (*Helianthemetea guttati* and *Brachypodion phoenicoidis*) decrease with fertilization.

It is well know that species from group 1 are more or less nitrophilous whereas species from group 2 are oligotrophous. Nonetheless in the territory, the natural pat-

terns of distribution of vegetation referred to either classes closely matches water in soils. In particular, in the Pineto Park, *Molinio-Arrhenatheretea* occurs at the moist bottom of valleys and *Helianthemetea guttati* on dry slopes. This study demonstrates that in ecotonal situation, such as those of the study site, the limit between these two classes is set by nutrient availability. In other words, nutrients and water interact. This interaction is nicely shown by Ellenberg indicators (Figure 8-9) and as stated by Ellenberg "nutrients replace water" (Ellenberg, 1996).

In the last years the number of nitrophilous species has increased (Bianco *et al.*, 2003): it's possible that in the near future Pineto Park will show a shift in floristic composition as consequence of this change in nutrients status. In particular, we expect an increase of central European nitrophilous *Agropyretalia* species and a decrease of Mediterranean oligotrophous *Helianthemetea guttati.*

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