The use of reproductive traits to analyze plant community stability

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Plant traits involved in processes pertaining sexual reproduction can represent a viable tool for analyzing the stability of plant communities. Sexual reproduction in angiosperms has three sequential stages: pollination, fertilization and seed maturation. Pollination is the first step in the sexual reproduction of plants, and can be relied on abiotic vectors or on animals. The number of angiosperms pollinated by animals is relevant, for an estimated global average of 85% (1). The majority of animals visit flowers for food, feeding on sugary nectar and/or on the pollen itself, thereby passively picking up pollen and carrying it to another flower. Pollination by animals is an ubiquitous ecological interaction which likely has a marked influence in ecological community dynamics and diversity thereby playing a crucial role in maintaining ecosystems' integrity. Recent research has evidenced several plant traits and structural attributes of pollination interactions that are associated with plant community stability, resistance to secondary extinctions following species loss, and the consequent provision of a vital pollination service (2). To date most studies have evaluated pollination interactions under the assumption that all partners coexist in the same time. However, a temporal analysis may give a misleading picture. In the light of these considerations we examined the stability of dry grassland communities by analyzing temporal changes of some plant reproductive traits as well as of visiting insects – i.e., the degree of generalization of plant species, of pollinator guilds and of the overall pollination network, nectar and pollen production, and pollinator feeding preferences. In fact, in temperate dry grasslands (3), plants and flower visitors are active during periods varying from several days to several weeks, possibly leading to temporal changes in the structure of the pollination network and thus to its resilience.

We monitored contacts between plant species and pollinator guilds every 15 days during the overall flowering season (11 monitoring surveys). For each plant species we measured nectar volume by using microcapillary tubes and counted the pollen grains number on five flowers. For each monitoring survey we built a quantitative plant-pollinator interaction matrix and we calculated the mean value of pollination generalization of plants and pollinator guilds, as well as of the overall network. A high network specialization entails a high dependence of plant diversity to flower visitor diversity (and vice versa), thereby resulting in less resilience to perturbations. Furthermore, for each monitoring we calculated the ratio between the total number of pollen grains and the total volume of nectar, weighted for flowers abundance, and we analyzed the relative abundance of pollinators grouped according to their foraging preferences (i.e., pollen-feeding, nectar-feeding and both pollen and nectar-feeding).

Lowest degrees of generalization of plant species were found during late spring – early summer, when pollinator guilds showed the highest degrees of generalization, while plant species degree of generalization reached the highest values during early spring and late summer, when both generalist and specialist guilds of pollinators were observed, resulting in an asymmetric structure of interactions. While the asymmetric structure was maintained through the flowering season, the degree of generalization of the pollination network was not constant and followed a negative trend. Temporal trend of floral resources highlighted that nectar was associated with plant specialization and pollen with generalization. Thus, nectar availability was higher during late spring – early summer, while pollen prevailed during early spring and late summer. Insects feeding of both pollen and nectar showed a steady trend through the community flowering season, while pollen-feeding and nectar-feeding insects showed two opposite patterns: pollen-feeding insects prevailed during early spring, while nectar-feeding insects during late summer. Although the presence of an asymmetric pattern may enhance the overall ecosystem resilience over time and prevent secondary extinctions, the temporal trend of the pollination network degree of generalization highlighted some critical moments: during late summer the scarcity of nectar may force insect food choice towards nectariferous plant species, thus limiting pollinator sharing and the overall network redundancy and resilience. Plant reproductive traits may represent a powerful tool for detecting interspecific interactions in plant community, enabling, for example, the identification of threatened interactions to which focus conservation efforts.

References
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