4th International Congress on Biodiversity
"Man, Natural Habitats and Euro-Mediterranean
Biodiversity", Malta, 17-19th November 2017

A diversity of phenotypes, beyond species and genes

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According to the Convention on Biological Diversity (United Nations, 1992; art. 2), "Biological diversity" [...] includes diversity within species, between species and of ecosystems." The most popular estimations of biodiversity are based on the number of species, commonly, limited to one or a few taxa such as birds, butterflies or flowering plants, sometimes filtered through algorithms highlighting relational properties such as the reciprocal distance of the involved species within a phylogenetic tree. Eventually, from these measures of diversity based on the number of species, the concept of *disparity* was differentiated, this being an estimate of the taxon's occupancy of a suitably defined morphospace. Despite these articulations and refinements of the original idea of biological diversity, all these concepts and measures remain essentially confined within a morphological perspective, eventually integrated by taking also genotypic variation into account.

However, phenotypes are not limited to morphology. Additional important dimensions are found in the diversity of life cycles (often the main base of different resilience to natural harshness and human-induced environmental changes), trophic niches (with a diversity of generalist and specialist alternatives, frequently compounded with age- or stage-related differences), or forms of communication (e.g., songs/calls of birds, frogs, grasshoppers, crickets). But the largest forgotten dimension of phenotypic diversity that should be considered in biodiversity assessments and conservation policy is the phenological one, that is, *temporal phenotypes*. These include, for example, the following: in plants, annual vs. biennial vs. perennial life cycle, flowering calendar, leaf senescence and abscission, Raunkiaer's life forms (e.g., phanerophyte, hemicryptophyte, geophyte, therophyte); in animals, number of generations per year, seasonality of key events or activities along the life cycle (e.g., egg hatching, active feeding, mating) and their dependence on season, lunar phase, day/night cycle, tides. Two strong points supporting an effort to focus on the temporal dimension of biological diversity are (i) conceptually, the fact that temporal phenotypes are products of development (jointly controlled by genes and environment) not less than morphological phenotypes are; (ii) in practice, their impact on human activities, from the flight calendar of pollinator insects to the strong visual impact of plant temporal phenotypes translating into seasonal changes in landscape colour.