Evolutionary Development of plant and Role of environment

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Evolutionary developmental biology (evo-devo) is the study of developmental programs and patterns from an evolutionary perspective. It seeks to understand the various influences shaping the form and nature of life on the planet. Evo-devo arose as a separate branch of science rather recently. An early sign of this occurred in 1999.

Most of the synthesis in evo-devo has been in the field of animal evolution, one reason being the presence of model systems like *Drosophila melanogaster*, *C. elegans*, zebrafish and *Xenopus laevis*. However, since 1980, a wealth of information on plant morphology, coupled with modern molecular techniques has helped shed light on the conserved and unique developmental patterns in the plant kingdom also.

Plant development and plasticity:- As sessile organisms, plants are unable to seek out environmental conditions optimal for their growth and development but instead must complete their life cycles in the environment in which they are growing. However, plants are remarkably plastic, such that a single genotype is able to give rise to a wide range of phenotypes. Developmental plasticity has profound implications for plant evolution and ecology and can make important contributions to improving yield stability in agriculture. In this review, we discuss the genetic control mechanisms that underlie plasticity and their implications for plant evolution, using the control of flowering time in *Arabidopsis* as an example. Furthermore, we consider how rapid improvements in quantitative genetic resources provide opportunities to analyze the molecular mechanisms that regulate developmental plasticity more directly and completely.

This plasticity in development is possible because of the continuous nature of plant development (Palmer et al. 2012). During embryogenesis, the basic body axes of the plant are established, including the main apical–basal axis with the shoot apical meristem (SAM) at one end and the root apical meristem at the other. After germination, this axis is elaborated by the development of root and shoot systems, built through the action of the primary embryonic meristems, as well as the establishment of new secondary meristems, giving rise to lateral roots and shoots and higher-order branches. Each root and shoot can branch to different degrees, elongate to different degrees, and, particularly the shoot, produce a range of different specialized structures of varying types, to various degrees. For example, shoots can produce leaves adapted to shade or bright sunlight and, at some point, switch from making leaves to making floral organs. By integrating environmental information into the regulation of these growth and developmental processes, plant form can be modulated according to the environment in which the plant is growing. In this way, the final morphology of the plant depends on the environment, defining it as plastic.

Evolutionary significant of plasticity

Non-adaptive Plasticity:- As described above, the ability of plants to modulate their development in response to the environment is usually considered to be adaptive, contributing positively to reproductive success. However, before considering the implications for adaptive developmental plasticity, it is important to point out that phenotypic variation between plants grown in different environments may not affect fitness at all, or it may have a negative impact on fitness. Such variation may, for example, reflect variation in a trait as a result of mutation or selection of other traits that are linked (Alpert and Simms 2002), or it may reflect poorly buffered development with negative effects on individual fitness as the inevitable result of stress or resource limitation (Sultan 2000; Steinger et al. 2003; Weiner 2004; Van Kleunen and Fischer 2005).

Adaptive Plasticity

The ability to modulate development according to the environment can clearly be adaptive by maintaining reproductive success in a changing environment. This is true both for a single individual growing in fluctuating environment and for populations growing in heterogeneous environments. These properties mean that phenotypic plasticity has important roles in the evolutionary diversification of plants (Via and Lande 1985; Schlichting 1986; Scheiner 1993) and in the distribution and persistence of plant species, for example, in response to global climate change (Reusch and Wood 2007; Chevin et al. 2010; Nicotra et al. 2010; Palmer et al. 2012). Populations with high plasticity in selectively important traits can rapidly adapt phenotypically to changes in environmental conditions without the need for genetic adaptation (Valladares et al. 2007; Crispo 2008). Similarly, successful invasive species often show higher plasticity than the native species with which they are competing, allowing them to adjust rapidly to their new geographical area (Sultan 2003; Lande 2009).

Environmental causes for plant biodiversity :- One of the most pervasive patterns observed in biodiversity studies is the tendency for species richness to decline towards the poles. One possible explanation is that high levels of environmental energy promote higher species richness nearer the equator. Energy input may set a limit to the number of species that can coexist in an area or alternatively may influence evolutionary rates. Within flowering plants (angiosperms), families exposed to a high energy load tend to be both more species rich and possess faster evolutionary rates, although there is no evidence that one drives the other. Specific environmental effects are likely to vary among lineages, reflecting the interaction between biological traits and environmental conditions in which they are found. One example of this is demonstrated by the high species richness of the iris family (Iridaceae) in the Cape of South Africa, a likely product of biological traits associated with reproductive isolation and the steep ecological and climatic gradients of the region. Within any set of conditions some lineages will tend to be favoured over others; however, the identity of these lineages will fluctuate with a changing environment, explaining the highly labile nature of diversification rates observed among major lineages of flowering plants.

Thank You