Quel cadre conceptuel pour la recherche participative ? Adaptation locale et adaptation par plasticité, un concept commun pour étudier l'adaptation

Sylvie Pouteau

Which conceptual framework for participatory plant breeding ?
Local adaptation and adaptation by plasticity, a common concept to study adaptation

Sylvie Pouteau, UR Biologie Cellulaire, INRA Versailles

Working paper

"Living Knowledge" Conference / Conférence des "Savoirs vivants"
Paris, Ecoles des Mines, August 30 - September 1, 2007

Session 1.c The interest of participatory plant breeding for European agricultures
Intérêt de la sélection participative pour les agricultures européennes
Organised by Réseau Semences Paysannes - Chair: Guy Kastler

Introduction

I am interested in the impact of genetic and environmental variation of the transition to flowering on the evolution of developmental trajectories and heritable adaptation by plasticity. I currently have a collaboration with Isabelle Goldringer, RSP and Nature & Progrès in the context of a Région Ile de France PICRI project. This project is on selection and management of wheat varieties for organic quality bred (Développement de pratiques paysannes de gestion et sélection des variétés de blé pour du pain bio de qualité en région Ile-de-France).

As a biologist, I am interested in the background values that are embedded in scientific concepts, approaches and interpretations because these concepts, approaches and interpretations in turn influence the way we can address novel issues and moral and/or philosophical concerns. In other words, I am interested in the metaphysics that lay behind any cognitive endeavour.

Agro-ecological purposes implicitly require an epistemological shift that needs to be clarified and justified. This clarification is not merely an aesthetic, philosophical, moral issue: it is a cognitive issue as well. Adequate concepts are needed, it is not sufficient to recycle current or usual concepts. The success of participatory research endeavours may depend on the raising of such adequate concepts.

I will take the example of the so-called "local adaptation". This notion is usually interpreted by scientists as "natural selection of pre-existing variation" (neo-darwinian theory). I don't want to say that this interpretation is not valid. But I want to stress that it is not the same as what is usually meant by local adaptation in the farmers' view. This may be particularly true in the case of animal breeding.

In contrast, plasticity and its adaptive properties can meet the initial idea of local adaptation. However, plasticity is usually ignored and left behind due to the prevailing theory of natural selection. This is an example of a situation where a conceptual shift is needed to address a reality that is common to different communities, e.g. farmers and scientists.

The case of adaptation by plasticity in wheat

In our project on wheat selection, we are attempting to address this reality with the question: can we justify the conceptual shift to plasticity both in terms of epistemological necessity and biological necessity ? To this end, we have chosen an academic approach based on hypothetico-deductive methology (ANOVA-framing of the experimental set-up...) and making use of a reduced reality (control of all experimental factors, plants grown in artificial, uniform settings...).

What kind of conceptual tools can be used to study adaptation by plasticity ? The working hypothesis is that there exist phases during development that are hypersensitive to endogenous and external perturbations: these phases are called "critical phases". During such critical phases, assimilation of new characters can occur in reaction to the environment relying on plasticity: assimilation is thought to be an auto-organisational, "learning" process. In this context, variation is not seen merely as a by-product of mechanistic failures but also as an inherent property of growing systems: because of growth, these systems are continuously out of balance and due to the properties of non linear dynamic processes they can evolve toward different alternative states, also called attractors. In other words, there can exist both pre-existing variation and acquired variation. Both types of variation can be genetic, i.e. in the DNA script, and epigenetic, i.e. in any other component.

In this context, the in-formation is not concentrated in one specific substrate but distributed over all components. Due to this distributiveness, any local change is eventually global and can affect the whole make-up of the system. Because of non linear properties of living systems, "more is different": during growth threshold are attained under which the system may shift in a completely causally unpredictable state (for instance during embryogenesis). Such processes may be involved in epigenetic inheritance of plastic changes.

Effect of environmental variation in growth chambers

I will briefly sketch our preliminary experiments and data. Firstly, we examined the behaviour of 15 bred wheat genotypes obtained at different periods during the history of wheat selection. These genotypes were grown in different environments, in the field and in growth chambers, providing them with different vernalisation and photoperiod inputs. Most genotypes were sensitive to vernalisation and/or photoperiod. This survey allowed to bring new information on the genealogy of phenology characters.

Secondly, we selected one genotype - Concorde - for its lack of vernalisation requirement and rapid growth cycle under long days (only 5.5 months). We compared the progenies of seeds set in different conditions and found significant differences for the subset obtained in very unfavourable conditions: vernalisation and short days. The plants under these conditions did elongate but ear development was prevented (Concorde is photoperiod sensitive). They eventually headed when the photoperiod was extended but the ears were abnormal and retained various vegetative features. The retaining of a memory of conditions encountered in the previous generation may be interpreted as a maternal effect. It may be reset after one generation or leave a lasting (epigenetic) imprint over a number of generations. To test these possibilities, we need to look at the next generations. We also wanted to examine how plant features evolve over several generations when plants are kept under monotonous conditions, e.g. long days and no vernalisation, to see whether degeneracy may occur as another type of epigenetic memory.

We tried to identify critical phases of development by applying external perturbations at different stages during development. We chose 2 types of perturbations: several days in the cold or in the

dark. We observed that the main effects occur during pre-tillering which may coincide with the transition to flowering. Now we need to determine if perturbations imposed at this specific stage may lead to lasting environmental memory.

Perspective

At this stage of the project, I wish to raise two questions:
- is it possible to convince other scientists that an inductive methodology is adequate by using an hypothetico-deductive approach ? Actually is it possible to convince them at all ? This is an institutional issue because it depends on the possibility to get support within the current academic context.
- is it right to address a complex reality in artificial settings ? This is an epistemological issue. But it is also a financial question because these artificial environments cost a lot of money and impose drastic constraints on the experimental work.