

This Week's Citation Classic™

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Bradshaw A D. Evolutionary significance of phenotypic plasticity in plants.

Advan. Genet. 13:115-55, 1965.

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The abilities of different components of the phenotype of an organism to be modified by the environment are effectively independent characters, under genetic control. As a result, specific forms of phenotypic plasticity can be selected for or against in relation to particular environmental situations. [The *SCI*® indicates that this paper has been cited in over 160 publications since 1965.]

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"The most important reason that this paper got written was that I was lucky enough to be given a Leverhulme Research Fellowship for 1963-1964, to spend a year with R.W. Allard in the department of agronomy at the University of California, Davis. It was the first time since I had become a university lecturer 13 years previously that I had any real time off. So I had peace and a chance to think, and I was surrounded by a group working on evolutionary processes in plant populations.

"I have always been a rather contrary sort of person and have enjoyed thinking about things that other people pass over. This is really a subtle way of bolstering my ego, because it is easier to be an expert in a field where there are not too many others around. But I had been working on the formation of localised adapted populations in plant species, following in the steps particularly of Turesson, Gregor, Clausen, Keck, and Hiesey. I was very interested in how localised such evolution could be. For my PhD,

I was excited to find differences between populations 100 m apart, and we had just begun to find differences in populations only 5-10 m apart, which was very exciting.

"But in all this work I could not help being struck by the fact that although the genetic differences we found, measured under common environmental conditions, were considerable, the differences that occurred in the field, that we found on collection, were far greater. It seemed that in concentrating on the genetic component of adaptation we were all forgetting about the phenotypic, environmentally induced, component. So at Davis I decided to spend some time seeing what other people had found and to try to make sense of it. I remember finding that I had discovered a gold mine, because so many people, even Darwin, had recognised the possibility, and yet few had worked on it systematically. At the same time, there was lots of evidence that nobody had realised was pertinent. And I had time to read and think.

"It is, I am sure, only a *Citation Classic* because no one had previously tried to make overall sense of the phenomenon. But at the same time, since phenotypic plasticity perhaps accounts for half of all adaptation, some people were likely to be interested. This, to my relief, included the editors of *Advances in Genetics*.

"We did follow-up work on sunflowers,¹ and linseed and flax,² which was very exciting because it showed that phenotypic plasticity really is a character like any other with its own specificity for individual characters and its own genetic control. We even showed that it could have a heritability as high as 50 percent.³ Then I got waylaid by other sorts of evolutionary adaptation and more teaching. Perhaps I felt the point had been made, but how many people, like me, promise they will go back? But at least others have used it as a starting point."

1. Bradshaw A D. Environment and phenotypic plasticity. *Brookhaven Symp. Biol.* 25:75-94, 1973.
2. Khan M A & Bradshaw A D. Adaptation to heterogeneous environments. II. Phenotypic plasticity in response to spacing in *Linum*. *Aust. J. Agr. Res.* 27:519-31, 1976.
3. Khan M A, Antonovics J & Bradshaw A D. Adaptation to heterogeneous environments. III. The inheritance of response to spacing in flax and linseed *Linum usitatissimum*. *Aust. J. Agr. Res.* 27:649-59, 1976.