INSTITUTUM AGRONOMICUM "DR.PETRU GROZA"CLUJ-NAPOCA (ROMANIA)
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DNA EVOLUTION IN CULTIVATED PLANTS

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Abstract.

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In long cultivated plant species - such as wheat, barley, bean, soya, tomato - during their microevolution from wild to modern cultivated species, the genome size has increased by 200 - 300 %. Presumably the newly acquired DNA of the cultivated species consiste both of noncoding repetitive DNA and of new copies of the polygenes that control the culture-characters. It seems, that in cultivated plants the genetic bases of the gigas-character and of the allometric-growth of the plant organs useful for man, are the amplified polygenes, which control these characters.

Index words: DNA evolution, cultivated plants, polygenes, microevolution.

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Introduction

During the evolution of the Eukaryota, from unicellulars to higher organisms, the quantity of the genetic information stored in their genome, has increased continuously. This increment can be estimated by determining the quantity of the DNA per genome (BRITTEN and KOHNE 1968). According to OHNO et al. (1968) in the evolution of the subphylum Vertebrata, from fishes to mammals in the main line of the evolution, in 300 million years the DNA content of the genome increased by about 500 %. It was assumed, that in this slow evolution, the most important role had the geneduplications, as rare genetic events. Once a gene du-

plicated, the second gene was delivered from the selection pressure and became able to evolve into a qualitatively new gene through subsequent allelic mutations.

A similar macroevolutionary trend in the phylogenesis of plants is difficult to demonstrate. However, in the microevolution of the cultivated plants, a rapid increase of the DNA content per genome can be noticed.

Genome increment in cultivated plants

In older cultivated plant species (such as wheat, barley, bean, soya, tomato) the interphase chromosome volume (ICV) during their microevolution increased by 200 - 300 %, when ICV of the wild ancestor species is taken as 100 % (LAZÁNYI 1983). Since the microevolution of these cultivated plant species did not last more than 10,000 years, the accumulation of new DNA in this case may be considered as extremely rapid, in comparison with the macroevolutionary rate mentioned before.

What may contain the newly acquired DNA of the cultivated plants? Obviously it cannot contain qualitatively new genes, because the length of the microevolution was too short for this. On the other hand, the new alleles arisen from the preexisting genes could not change the quantity of the DNA of the genome.

Presumably, the new DNA contains a good many of non-coding repetitive DNA. But, based on the facts described below, we suppose, that a genetically active part of the new DNA consists of tandem duplications of the polygenes, which determine the quantitative characters of these cultivated plants.

Gigas size and allometric growth in cultivated plants

The cultivated plant species differ from their wild parents in some morphological characters, controlled by the new alleles of a few major genes (SCHWANITZ 1971): e.g. in cereals a tough rachis, instead of a fragile one, naked grains instead of covered ones.

However, we are convinced, that by such allelic mutations only, all characters of the modern cultivated plants could not come into being. It must be considered, in this respect, the gigas size of the cultivated plants, as compared to the wild ancestors, and the allometric growth, i.e. the disproportionate increase of the size of those plant organs which were useful for man (DARWIN 1892, SCHWANITZ 1951).

Hybridological analyses showed that these quantitative characters are controlled not only by some major genes, but also by many groups of polygenes (EAST 1910, McARTHUR and BUTLER 1938, MATHER 1943, SEARS 1954, SUN et al. 1972, etc.).

With these analyses is congruent a model experiment in Arabidopsis (LAZÁNYI 1979), by which it was proved, that induced duplications of the polygenes can change the size of different organs : mutant individuals were obtained with twice as large rosetta leaves, stems and flowers, than the initial form.

The hypothesis

Based on the above-mentioned facts, we assume, that during the microevolution of the cultivated plants a large number of copies of the polygenes had been accumulated in their genome, by artificial selection. Since this selection worked through the phenotype, therefore it favoured the amplification of those polygenes, which controlled the quantitative characters useful for man.

Our second assumption is that the more copies of a polygene are accumulated in a locus, the more developed will be the controlled quantitative character.

It seems likely, that these polygene loci are not oversaturated yet by gene-copies, thus in the near future the induced duplications of polygenes may become an important tool for plant breeders in their endeavour to obtain new cultivars with increased size of the kernels or of other useful plant organs.

Rezumat

LAZÁNYI A., 1987, Evoluţia ADN-ului în plantele cultivate (DNA-evolution in cultivated plants). Not. bot. hort. agrobot., Cluj., XVII, La speciile de plante de mult domesticite ca de ex. la grîu, orz, fasole, soia, roşii etc., mărimea genomului a crescut cu 200-300% în cursul microevoluţiei de la spontan spre cultivat. Se poate presupune că cantitatea de ADN acumulată în cursul acestui proces de microevoluţie constă atît din ADN repetitiv, fără funcţii de codificare, cît şi din copiile unor poligene, care controlează caractere importante pentru cultură. Se pare că în plantele de cultură genele care determină caracterul gigas, respectiv creşterea allometrică a unor organe de importanţă economică pentru om, fac parte din grupa poligenelor, care - prin amplificare - au contribuit la creşterea şi evoluţia cantităţii de ADN în genom.

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RECHERCHES CONCERNANT LA BIOLOGIE ET LA CYTOGENETIQUE DE L'ESPECE COLCHICUM AUTUMNALE L.

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Abstract:
MUNTEAN L., SALONTAI Al., BOTEZ C., CERNEA S., VAIDA FELICIA, CĂREAN V., 1987. Biological and cytogenetical investigations of the species Colchicum autumnale L. Not. bot.hort. agrobot., Cluj., XVII,9-17. . Colchicum autumnale L. derived from seed, develops in the first five years only vegetative organs (tuberbulbs, roots, leafs). In the sixth year the plants develop three leafs in spring and flowering takes place in autumn. The fructification of the plants derived from seed takes place in the seventh year only.
Colchicum autumnale L. has 38 chromosomes, relatively small in size and of high morphological variability that allows for good individualization. There has been reveled a cytogenetic variability in nr.1 pair of chromosomes. This may be a source of genetic variability within the population studied.

Key words: Colchicum autumnale, cultivation, flowering, fructification, heteromorph chromosomes

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La morphologie et la biologie de l'espèce Colchicum autumnale L. developpée de bulbotuber sont déja connues (1, 2, 3, 10). Dans les recherches effectuées à Cluj-Napoca, on a étudié la croissance et le développement de cette espèce issue de graines. On a constaté ainsi que dans la première (5), la deuxième (6), la troisième (7), la quatrième et la cinquième (8) année de végétations ce sont les organes végétatifs qui en résultent (bulbotubers, racines, feuilles).