RESEARCH GUIDE
GUIA DE INVESTIGACION
GUIDE DE RECHERCHE

CIP

CIP Research Guide 27

THE TAXONOMY OF WILD POTATO SPECIES AND THEIR USE IN BREEDING

1992

Peter Schmiediche

INTERNATIONAL POTATO CENTER (CIP)
CENTRO INTERNACIONAL DE LA PAPA (CIP)
CENTRE INTERNATIONAL DE LA POMME DE TERRE (CIP)

CIP Research Guide 27

THE TAXONOMY OF WILD POTATO SPECIES AND THEIR USE IN BREEDING

1992

Peter Schmiediche

ERRATA

CRG 27: The Taxonomy of Wild Potato Species and their Use in Breeding. P. Schmiediche

On page 5:

1st. Paragraph, 11th line, should say:
... At CIP, most scientists follow the system of Hawkes, but in the ...

2nd. Paragraph, 4th line, should say:
... found, but is an escape from a nearby experimental station, and it has established ...

On page 7:

3rd. Paragraph, 4th line, should say:
... have according to theory, it was highly fertile in ...

CIP
Apartado 5969
Lima, Peru

Location:
Av. La Universidad s/n
La Molina, Lima

Fax 351570
Tel. 366920
Telex 25672 PE

CIP Research Guides (CRGs)

Describe technologies that have been developed and used by CIP and National Programs in order to promote the research and the exchange of information among scientists. They are regularly updated according to the scientific advance.

Peter Schmiediche. 1992. The taxonomy of wild potato species and their use in breeding. CIP Research Guide 27. International Potato Center, Lima, Peru. 7 pp.

THE TAXONOMY OF WILD POTATO SPECIES AND THEIR USE IN BREEDING

Knowledge about wild potato species was scarce until the second decade of this century. A large number of wild species had been collected previously, particularly in the 19th century. However, a comprehensive taxonomic classification did not exist until the German taxonomist Bitter reviewed and classified the whole of the *Solanaceae* family just before World War I.

Bitter belonged to a taxonomic school whose adherents would be called "splitters" nowadays. As the word indicates, these taxonomists would create great numbers of species, subspecies, varieties, races and so on based on minute morphological differences in each of the specimens (mostly herbarium specimens) they were describing. At that time neither genetics nor the influence of the environment on the morphology of a given taxon were sufficiently understood, and there was therefore justification for the approach of the "splitter".

The eminent Russian geneticist Vavilov was the first scientist to recognize the value of wild species for breeding, and he organized or influenced the organization of various, now famous, plant collecting expeditions throughout the world. From 1925 to 1933 various Russian expeditions (under the leadership of the famous Russian potato taxonomists Juzepczuk and Bukasov) went to Mexico and South America to collect wild and cultivated potatoes. Bukasov and Juzepczuk discovered a large number of new wild species and demonstrated to science that there was not only

one cultivated potato species namely *Solanum tuberosum* L., but many more completely unknown outside South America.

Bukasov and Juzepczuk continued to follow the line of Bitter and described an enormous number of new species, subspecies and races. Apart from following classic taxonomic principles based on morphology, they also carried out cytological investigations and discovered that the tuber-bearing *Solanums*, cultivated as well as wild, existed as polyploid series.

That is to say, they found out that the basic number of chromosomes of the tuber-bearing *Solanums* is 12. In other words, the smallest reproductive cells of most species in this group, the pollen or eggs, contain one set of 12 single chromosomes. Such a set has conventionally been donated as X. A plant that has resulted from the union of an egg, (carrying one set of chromosomes) has two sets of chromosomes and is hence called diploid. Each gamete (egg or pollen) is normally described as having 'n' chromosomes, so a diploid plant has 2n=2x=24 chromosomes or two sets that have originated from two gametes each containing 12 chromosomes.

Apart from diploids (cultivated and wild) Juzepczuk and Bukasov also found triploids (2n=3x=36), tetraploids (2n=4x=48), pentaploids (2n=5x=60) and hexaploids (2n=6x=72). Octaploids (2n=8x=96) have been produced artificially.

We shall not discuss at this stage how the formation of these polyploid series came about, but try to illustrate the enormous variability of the genepool that Bukasov and Juzepczuk discovered and described.

Before we do that, however, let us consider some other taxonomic schools who use an approach different from that of the "splitter". They may conveniently be called "lumpers" because they tend to lump many entities into one species. Their approach is not entirely unjustified, because they use a biological species concept that considers any biological unit that can be crossed with another one giving fertile offspring as belonging to the same species. This approach is, on the other hand, problematic as it differentiates too little between quite distinct groups of plants.

A third school of taxonomy has, as may be predicted from the former two extremes, taken the middle road and recognizes the need to maintain sufficient differentiation (in order to facilitate communication between scientists) which recognizes also the implications of biology, genetics and genecology with regard to the description of a species. On important branch of this school may be called "experimental taxonomy". This approach tries to demonstrate the origin of a given taxon by recreating it from hypothetical progenitors. It also uses biochemical means (such as various forms of chromotography, electrophoresis or other chemical analysis) to trace the origin or evolution of a species. This school is largely connected with the names of J.G. Hawkes (who was originally a "splitter" from England) and C.M. Ochoa from Peru. At CIP, most scientists follow the system of Hawkes, but is the Soviet Union and many Eastern European countries, scientists still follow the system of Bukasov and Juzepczuk based mainly on morphology and, to some extent, cytology. For example, the tetraploid cultivated Andean potato, ancestor of all other tetraploid cultivated potatoes in the world, is called *Solanum andigenum* in the Russian system and *Solanum tuberosum* subspecies *andigena* in the system of Hawkes. The study of these two names alone demonstrates how these systems differ in their approach.

Using the system of Hawkes, we shall now look at the variability of the wild species complex. There are no wild potatoes outside the Americas. In the Himalayan foothills of Himachal Pradesh in India the wild species *Solanum chacoense* is found, but is an escape from a nearby experimental station, and is has established itself well under the conditions of that part of the world.

In the Americas we distinguish between two very distinct genepools of wild potatoes, one is found in North and Central America with its center in Mexico and one is found in South America with its center in the Andes stretching from Venezuela to Chile.

The Mexican genepool has about 20 species which belong to seven so called Series. They are series MORELLIFORMIA (with one species), BULBOCASTANA (two species), PINNATISECTA (seven species), CONICIBACCATA (two species in

Mexico but more in Central and South America), DEMISSA (seven species), LONGIPEDICELLATA (six species) and POLYDENIA (two species).

Of this Mexican genepool *Solanum demissum* (2n=6x=72) has been used widely in breeding for almost 100 years, as it has specific (vertical) resistance to late blight, and it was the first wild species systematically used in Europe and the United States for breeding for resistance to this fungus. Many of the modern European potato varieties carry genes of *S. demissum*; I have counted 191 from 595 officially recognized European varieties, which contain germplasm from *S. demissum*.

The South American wild genepool has been divided into ten series with about 200 species.

These series are:

JUGLANDIFOLIA	PIURANA
ETUBEROSA	ACAULIA
COMMERSONIANA	CUNEOALATA
CIRCAEIFOLIA	MEGISTACROLOBA
CONICIBACCATA	TUBEROSA

Nobody knows as yet how many wild species there really are in South America. In recent years a long list of new species has been described by C. Ochoa and new ones are still being found (also in the Mexican genepool). Years will pass before the exact relationships of many of the new species will be established and knowledge gained as to what useful characteristics they might have for breeding.

However, information is available about the usefulness of some wild species that are being used for breeding. There is, for example, *Solanum acaule* (2n=4x=48) which is highly frost resistant and which has other characteristics which might be useful in breeding. These include X virus resistance and its ability to be crossed with some of the Mexican species (which otherwise are genetically quite different from the South American genepool) and serve as a bridge for the more useful Mexican species. In other words, *S. acaule* may, for instance, be crossed with Mexican *S. bulbocastanum* which is even more resistant to late blight than

S. demissum, and through certain cytological manipulations the hybrids of *S. acaule* and *S. bulbocastanum* may be used for further crosses with South America cultivated potatoes. These latter hybrids will, in turn, exhibit almost as strong a resistance to late blight as the original *S. bulbocastanum*.

The most recent example which illustrates how wild species might be used in future is rather interesting. *S. etuberosum* is a wild potato species from central Chile and southern Argentina. This species belongs to a series (Etuberosa) that has many typical characteristics of wild potatoes; it does not bear tubers and will hardly cross with any other species outside its series. However, this species has been observed to be highly resistant to potato leafroll virus, and therefore, is important to potato breeders. But how can a wild species be utilized when it will not cross with cultivated material and will not even form tubers, the most essential part of the potato as far as man is concerned?

S. etuberosum was, with a great effort, crossed to a Mexican species, *S. pinnatisectum* and yielded completely sterile diploid hybrids. The chromosome number of these hybrids was doubled which produced an allotetraploid which behaved exactly as it should have according to theory it was highly fertiles in crosses with other tetraploid offspring of the same cross and with itself. This cross was achieved by Dr. Hermsen in Wageningen in the Netherlands. At CIP Dr. Rizvi has tested these hybrids, which have half *etuberosum*. Dr. C. Brown and Ing. R. Chavez are now in the process of crossing these EP hybrids, as they are now called at CIP, with other cultivated or non-cultivated tuber-bearing *Solanum* species hoping to find a bridge that will permit the transfer of this resistance to cultivated potato germplasm This is a long and very laborious process which is, however, very exciting and which shows how we might use wild potato species even if only distantly related to cultivated potatoes in future potato breeding.

Processed by the Training Department, CIP, Lima, Peru, March 1992
Copies printed: 600
XX-TR-E-06-O-600