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AN ETHNOBOTANICAL FIELD STUDY OF PRIMITIVE POTATO VARIETIES IN PERU

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SUMMARY

In field studies carried out at Cuyo-Cuyo, southern Peru, an area of traditional agriculture, the varietal and ploidy richness of two potato fields cultivated by the Quechua Indians was determined. Tetraploid primitive varieties were the most common, representing 95% of all plants sampled, but diploids and triploids were also found. The tuber crops agricultural system on the Incaic terraces was documented, and factors affecting the selection of potato varieties were assessed. Flavour and dry matter content were the most important quality factors indicated by local farmers.

INTRODUCTION

Ethnobotanical field studies of the native South American primitive potato varieties have long been neglected. Yet to understand the evolution of these cultivated potatoes, it is necessary to appreciate the interrelationship of man and his crop. UGENT (1968) described *criolla* potatoes of the Nevado de Toluca, Mexico, and how they could be found in mixtures in the same field. He suggested that the nature of such potato fields, containing varieties with varying degrees of susceptibility, may be the best way of impeding the spread in the field of a fungal pathogen, such as *Phytophthora infestans* DE BARY. Gene exchange between cultivars and wild species could further contribute to disease resistance and the stability of these *criolla* potato fields. However, all the cultivated varieties were tetraploid (2n = 4x = 48) belonging to *Solanum tuberosum* L. ssp. *andigena* (JUZ. et BUK.) HAWKES.

In contrast, South American cultivated potatoes are highly variable, comprising nine species and subspecies (HAWKES, 1963), and ranging in ploidy from diploid (2n = 24) to pentaploid (2n = 60). The most common varieties are tetraploid, *S. tuberosum* ssp. *andigena*, but the diploids, *S. stenotomum* spp. *stenotomum* JUZ. et BUK. and ssp. *goniocalyx* (JUZ. et BUK.) HAWKES and *S. phureja* JUZ. et BUK. are also very widespread in Peru. *S.* × *chaucha* JUZ. et BUK. (2n = 36) is a hybrid between tetraploid and diploid varieties, and has a similar geographical distribution throughout Peru. Another diploid, *S. ajanhuiri* JUZ. et BUK., has a limited distribution in the south of Peru and northern Bolivia, and two frost-resistant species, *S.* × *juzepczukii* BUK. (2n = 36) and *S. curtilobum* JUZ. et BUK. (2n = 60), are cultivated alongside the other species but also at high altitudes where frosts become a limiting factor.

The cultivation of potatoes in Peru has been practiced for many thousands of years

(ENGEL, 1970; TOWLE, 1961), but at present, the greatest diversity of varieties can only be found well away from the main centers of population (OCHOA, 1958, 1964). It is known that the Quechua Indians grow their potatoes in mixtures (HAWKES, 1941), and that all ploidy levels are grown together. The data from collecting expeditions show the frequencies of the various ploidies, but do not indicate genotypic diversity.

It is impossible to observe the early stages of potato domestication, and even at the present time it is difficult to assess the type and degree of selection which is being practiced by man. However, it was felt that a study of potatoes grown under native agricultural conditions might provide an insight into the selection processes of the present-day Quechua Indians.

This paper describes the field studies which were carried out at a place called Cuyo-Cuyo in southern Peru, an area of traditional agriculture. The objectives of this study were to determine the varietal and ploidy richness of potato fields, to document the associated agricultural practices, and to try and assess the impact of man in directing the evolution of cultivated potatoes by means of his selection processes.

THE SITE

The site chosen for study was the village of Cuyo-Cuyo (in the Department of Puno, southern Peru), which lies at the head of the Sandia Gorge (approximately 14°50′S, 69°50′W), at an altitude of about 3300 m. Above the village lies an upland plateau, the *altiplano*, at about 4000 m. Below Cuyo-Cuyo, the Sandia Gorge quickly drops to the coffee and banana plantations on the humid, east-facing slopes of the Andes.

The valley in which Cuyo-Cuyo lies is some 500 m deep, and the sides are covered by an extensive system of Incaic terraces (Fig. 1). The actual date of their construction is unknown, but it is believed that they had been in continuous cultivation for many centuries prior to the Spanish conquest of Peru. The terrace system is largely intact and actively worked. In this respect, the site is probably unique, for in many parts of Peru such terraces have long fallen into disuse and disrepair. After the Spanish conquest, a large proportion of the Indian population was moved from working the land into the mines. The destruction of the social system, with allegiance to the Inca also caused changes in agriculture.

THE STATUS OF POTATO FIELDS

Potato varieties were easily distinguished on the basis of tuber morphology by the farmers at Cuyo-Cuyo. They were also able to recognize some of the varieties in the field on the basis of vegetative characteristics. The help of one of the farmers was enlisted for varietal identification, and tubers of each plant were examined in the field. Two fields were chosen for study. Field 1 had 76 rows, ranging from 1 to 2.5 m in length. Only 10 rows were sampled, but it was felt that these adequately represented the variability of the field. The varietal and ploidy values were corrected to account for the whole field. Field 2 was mapped in its entirety, containing 326 plants in 20 rows.

A total of 25 varieties was found in the two fields. Tubers were collected from each variety, and chromosome counts were made from root-tip preparations to determine the ploidy level.

Fig. 1. Terraces under potato cultivation at Cuyo-Cuyo.

The varietal status of both fields was complex, with 15 and 18 varieties respectively for Field 1 and Field 2 (Tables 1 and 2). There was some interesting variation between the fields with respect to the varieties grown. For example, the variety *Pucca palta* was the most common in Field 1, representing 28% of all plants, whereas in Field 2, only one plant of this variety was present. *Ccolla imilla* was the second-most common variety in Field 2, but no individuals at all were sampled in Field 1. However, *Yana wiriquilla* a tetraploid variety, was the most common variety in Field 2, and the second in Field 1. As can be seen from Fig. 2, the distribution of this variety ('A') throughout Field 2 was widespread, but eight rows were planted to one side which consisted mainly of this variety. In fact, several fields were seen in which only this variety was planted in pure or relatively pure stands.

Tetraploids (*S. tuberosum* spp. *andigena*) were the most common plants in both fields, representing over 95% in each (Table 3). No bitter potatoes of the species *S.* × *juzepczukii* and *S. curtilobum* were found. Because the fields were sampled after flowering, there were insufficient vegetative characteristics to determine the species of the diploid varieties. Both diploids and triploids (*S.* × *chaucha*) were found at low-frequencies, but they did not form a significant proportion of the varieties.

FACTORS AFFECTING THE SELECTION OF VARIETIES

It is difficult to define what constitutes a 'good' variety. In Cuyo-Cuyo a number of farmers were asked to evaluate each variety, and assign a quality rating, i.e. good,

Table 1. Varietal status of Field 1 (field corrected values) and quality rating (farmer preference).

Variety	Number	%	2n	Quality rating
Pucca palta	238	28	48	Intermediate
Yana wiriquilla	162	19	48	Good
Yana papa	85	10	48	Poor
Quissillo	69	8	48	Poor
Patoruntu	69	8	48	Intermediate
Papa asancoya	62	7	48	Intermediate
Bandarilla	38	4	48	Good
Yuracc imilla	31	4	48	Intermediate
Pucca wiriquilla	23	3	48	Good
Yana ccolla	15	2	48	Good
Alcca imilla	15	2	48	Intermediate
Papa rosada imilla	15	2	24	Poor
Papa awasanca	8	1	48	Intermediate
Papa amapola	8	1	48	Intermediate
Imilla bandarilla	8	1	36	Intermediate

intermediate or poor, depending upon personal preference. Each farmer made his choice independently of the others. The farmers indicated that flavour and dry matter content were the most important quality factors. The latter characteristic was considered to be related to 'flouriness', and such varieties were termed *harinosa*. The assessment of flavour is extremely subjective, yet there was remarkable agreement amongst the farmers concerning the varieties which they considered were the best.

The most favoured variety was *Yana turuña*, a diploid, even though it was found at a low frequency in Field 2. Four tetraploids were also included within the group of varieties with the highest qualities. Fifteen varieties were rated intermediate, and the

Table 2. Varietal status of Field 2 and quality rating (farmer preference).

Variety	Number	%	2n	Quality rating
Yana wiriquilla	132	40	48	Good
Ccolla imilla	61	19	48	Poor
Alcca imilla	44	14	48	Intermediate
Patoruntu	22	7	48	Intermediate
Yuracc imilla	18	6	48	Intermediate
Papa amapola	8	2	48	Intermediate
Yana papa	7	2	48	Poor
Pucca turuña	7	2	48	Intermediate
Yuracc lomo	5	2	48	Intermediate
Papa rosada imilla	5	2	48	Poor
Papa pichuya	4	1	48	Poor
Yana imilla	4	1	36	Intermediate
Yana turuña	4	1	24	Good
Pucca palta	1	<1	48	Intermediate
Imilla wancosollu	1	<1	48	Intermediate
Yuracc turuña	1	<1	24	Intermediate
Morada imilla	1	<1	36	Intermediate
Imilla wiriquilla	1	<1	48	Intermediate

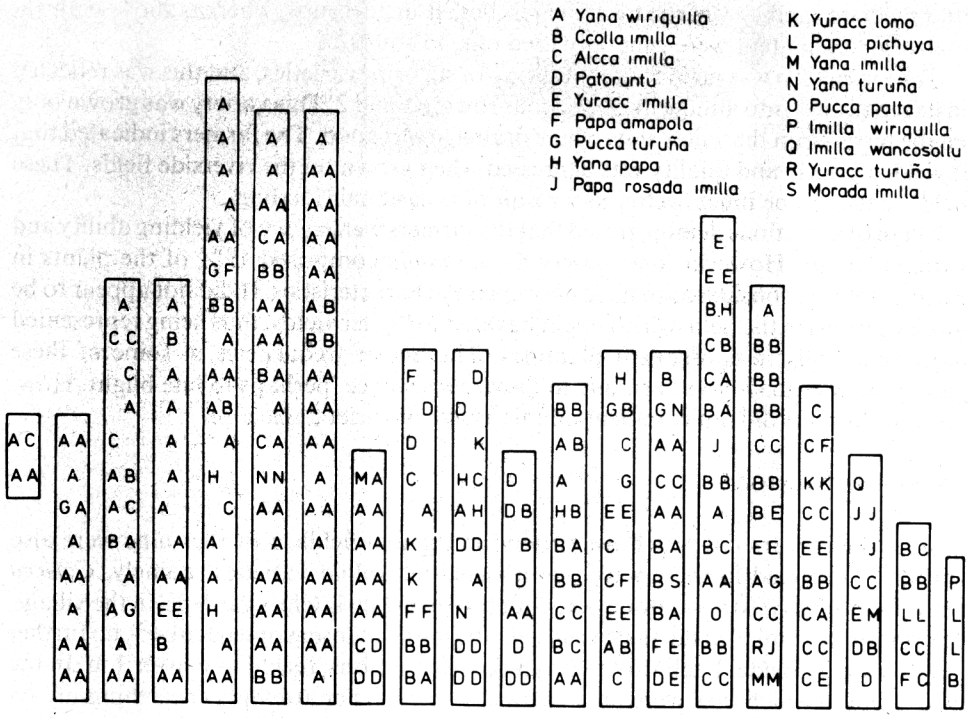

Fig. 2. Varietal status of Field 2.

remaining five varieties were rated poor with respect to the others (Tables 1 and 2). The poor quality varieties were termed *aguanosa*, which suggested a higher water content than the other varieties. The usage of the different potatoes in cooking varied. The best varieties were invariably eaten either boiled or in the form of mashed potato (*puré*). The

Table 3. Ploidy and genotype frequencies in two fields at Cuyo-Cuyo.

	Ploidy	Individuals		Genotypes	
		number	%	number	%
Field 1*	2x	15	2	1	7
	3x	8	1	1	7
	4x	823	97	13	86
	Total	846		15	
Field 2	2x	10	3	3	17
	3x	5	2	2	11
	4x	311	95	13	72
	Total	326		18	

*Field corrected frequencies.

intermediate quality varieties were eaten boiled or in soups, whereas those with the higher water content were generally used only in soups.

Yana wiriquilla was included in the group of superior varieties, and this was reflected in its separation into almost homogeneous rows in Field 2. This variety was grown only on the terraces on the valley side, where drainage was good. The farmers indicated that it yielded poorly and quality was depressed when grown on the riverside fields. These fields tended to be much wetter as a result of occasional flooding.

These observations demonstrated that the farmers were aware of yielding ability and varietal vigour. However, one variety *Ccolla imilla* comprised 19% of the plants in Field 2, yet was considered to have poor quality characteristics. It did not appear to be more vigorous in the field, which might have led to higher yields, thus being represented more frequently in subsequent plantings. The higher frequencies of some of these 'poor' varieties may have been due to disease resistance, perhaps to late blight. However, the farmers did not comment on this aspect of varietal selection.

'PERENNIAL POTATOES'

Besides the 25 varieties which were found in the two fields, a further nine were also collected. Included in these were two unusual tetraploid varieties: namely, *Coricca morada* and *Pucca coricca*. Both were found growing in 'kitchen gardens' in the village. They were 'perennial' in the sense that after the initial planting of seed tubers, no further plantings were made. Each variety produced long stolons, reaching to over 1 m. In the mixed plot in which they were seen, there were no rows or attempts at earthing-up. At harvest, sufficient tubers are collected for consumption, and the remainder left to germinate the following year. The dormancy and storage quality of these two varieties would merit further investigation.

DISCUSSION

This study has shown that the potato fields at Cuyo-Cuyo were complex with regard to their varietal status. Although tetraploid varieties were by far the most common, varieties of other ploidy levels were grown, especially if they were associated with a particular quality characteristic which the Quechua Indians deemed important.

The diploids and triploids do not form a significant proportion of the potato varieties at Cuyo-Cuyo, although they are maintained from year to year. The agricultural system, employing a rotation, would appear to be ideally suited for the introduction of new genotypes into the gene pool following the sexual process. In the year following the cultivation of potatoes, another tuber crop, oca, is grown on the same fields, and it is likely that tubers derived from seedlings would be harvested along with the oca tubers. Tubers from seedlings are generally small, and it is likely that they would be retained for planting as 'seed tubers' the following year rather than be eaten. Potatoes were seen growing in oca fields, but whether they were seedlings or volunteers from the previous years cultivation could not be ascertained. It is to be expected that more genotypes would be continually presented to man at the tetraploid level following self-pollination, than at either the diploid or triploid levels, where cross-pollination is necessary. But whatever the reason, there is no doubt that the diploids and triploids,

as well as tetraploids, are in fact maintained by man, and continually used as a food source.

This might help to explain a paradox apparent in the field data (Tables 1 and 2), in that three varieties classed as poor were grown at a higher frequency than some of those which were considered good or intermediate. Also, the two fields represent only a very small sample of the potato fields in the valley. However, the composition of these fields should be considered over a period, and not at one point in time. The cycle of change would involve the incorporation of new 'good' varieties, while old 'poor' varieties are gradually phased out. Vegetative reproduction in potatoes allows man to modify his cultivar population, and if he wishes, to retain both superior and inferior genotypes, which may remain stabilized in the population for a long time.

The selection of different varieties on a quality basis is subtle, but the Indian farmers have a deep, almost instinctive knowledge of their potatoes. What is still perhaps not understood by the outside investigator is the total range of ideas on the part of the Indian farmers as to how they define 'superior'. It would be valuable to carry out a similar study in other areas to compare ploidy status of native potato cultivations, and gain a greater insight into the ways of thought and the types of judgement which the Indian farmers exercise.

Undoubtedly, the Indian farmers practice a type of selection which is related to our own plant breeding work, and there is probably much that we can learn from the potato farmers of the Andes. In this study, only one village was observed. The ploidy status of the potato fields and the agricultural system employed might not be typical of potato cultivation in general, but the data are informative. Confirmative studies in other areas of traditional agriculture are needed.

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REFERENCES

ENGEL, F., 1970. Recolección y cultivo en los Andes Precolombinos. Anales Científicos 8: 122–136.

HAWKES, J. G., 1941. Potato collecting expeditions in Mexico and South America. Imp. Bur. Plant Breed. Genet. pp. 30.

HAWKES, J. G., 1963. A revision of the tuber-bearing Solanums. Second Edit. Scot. Pl. Breed. Rec. 76–181.

OCHOA, C., 1958. Expedición colectora de papas cultivadas a la cuenca del lago Titicaca. I. Determinación sistemática y número cromosómico del material colectado. P.C.E.A. Ministerio de Agricultura, Lima, Perú.

OCHOA, C., 1964. Recuentos cromosómicos y determinación sistemática de papas nativas cultivadas en el sur del Perú. Anales Científicos 2: 1–41.

TOWLE, M. A., 1961. The Ethnobotany of Pre-Columbian Peru. Viking Fund Publications in Anthropology, edit. Sol. Tax. No. 30. Aldine Pub. Co., Chicago.

UGENT, D., 1968. The potato in Mexico: geography and primitive culture. Econ. Bot. 22: 108–23.