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THE ANDEAN PHYTOGENETIC AND ZOOGENETIC RESOURCES

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THE ANDEAN PHYTOGENETIC AND ZOOGENETIC RESOURCES

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THE ANDEAN PHYTOGENETIC AND ZOOGENETIC RESOURCES

"A country is a given technological capacity over its geography and it is only through accepting and being aware of such geography that we will make every effort to produce the food that such geography may offer us. This is the only means to break the vicious circle of imports which diminishes the wealth of our peasants and limits urban industry to insuficient markets".

Mr. Alan García Pérez
President of the Republic of Perú

The Andean mountains cross from North to South of the South American continent and embrace tropical and subtropical latitudes having altitudes which range from sea level to over 4,000 m. The area located above 2,000 m occupies more than 2'000,000 hectares belonging to seven different countries.

Within the framework of the above conditions, settlers who arrived 10,000 years ago used this broad range of flora to select species such as : grains, tubers, roots and nourishing cormos, spice and healing plants, and fibers for their clothing.

The ample range of pasture in the highlands, allowed for the domestication of wild ruminants, as the New World camelids (llama and alpaca), whose meat, skin and fibers, were used. Likewise, old chronicles do mention the domestication of a type of hen and bird such as the "huallata" or South American goose.

I. THE ANDES AS CENTER OF ORIGIN OF CROP AND ANIMAL SPECIES

Vavilov (1935) refers to the Andean region of Ecuador, Perú and Bolivia, as one of the eight centers of origin of crop plants in the world. This region was the center of the Pre-Incan civilizations and gave birth to the Incan Empire in the XI century. In spite of the fact that this zone is not significantly large, when compared to South America as a whole, it is of utmost importance for endemic crop plants and animal resources.

Yacovleff and Herrera (1943) reviewed and analyzed the information compiled by Spanish chronicle authors since their arrival to the Andes, on plants demosticated by natives of the pre-Spanish culture. Mention is made of 159 species being used, even though some of them are found in semi-wild state.

Table No. 1 shows the main domesticated crop species which could have potential use in other regions of the world.

The domestication of wild animal species in the Andes was focused on animals which could provide both their skin and fiber and be used as a means of transportation for food and other materials. The South American camelids include two domestic species and two wild species adapted to the different conditions of the pastures of the Andes.

TABLE 1

MAIN ANDEAN NATIVE FOOD SPECIES ABOVE 2,000 M *

COMMON NAME	SCIENTIFIC NAME	BOTANICAL FAMILY
GRAINS		
Quinoa	Chenopodium quinoa	Quenopodiaceae
Kañiwa	Chenopodium pallidicaule	Quenopodiaceae
Kiwicha	Amaranthus caudatus	Amarantaceae
Tarwi	Lupinus mutabilis	Leguminosae
TUBERS		
Oca	Oxalis tuberosa	Oxalidaceae
Olluco	Ullucus tuberosus	Baselaceae
Mashua	Tropaeolum tuberosum	Tropaeolaceae
ROOTS		
Maca	Lepidium meyenii	Cruciferae
Jimaca, Ajipa	Pachurrhizus ahipa	Leguminosae
Arracacha	Arracacia xanthorrhiza	Umbeliferae
Yacon "Jiquima"	Polymnia sonchifolia	Compositae
COMMON FRUITS		
Nuez del Perú	Juglans peruyiana	Juglandaceae
Chirimoya	Annona cherimola	Anonaceae
Pacae, "guamos"	Inga feuillei	Leguminosae
Huagra-manzana	Crataegus stipulosa	Rosaceae
Capulí	Prunus serotina	Rosaceae
Mora de Castilla	Rubus glaucus	Rosaceae
OTHER FRUITS		
Ciruela del Fraile	Bunchosia armeniaca	Malpigiaceae
Tumbo, curuba	Passiflora mollisima	Pasifloraceae
Tintin	Passiflora pinnatistipula	Pasifloraceae
Lucuma	Lucuma bifera	Sapotaceae
Capulí, "uchuba"	Physalis peruviana	Solanaceae
Sacha tomate	Cyphomandra betacea	Solanaceae

*Maize and potato are not mentioned due to their worldwide distribution.

TABLE 2

MAIN ANDEAN ANIMAL SPECIES

SPECIES	SCIENTIFIC NAME	PRESENT STATUS
MAMMALS		
Llama	Lama glama	Domesticated
Alpaca	Lama glama pacos	Domesticated
Vicuña	Lama glama vicugna	Wild
Huanaco	Lama glama guanicol	Wild
CERVIDAE		
Deer	Hippocamelus antisensis	Wild
CARNIVORS		
Fox	Dusicyon sp	Wild
Puma	Felis concolor	Wild
POULTRY		
Condor	Vulture gryphus	Wild
Wallata	Choephaga melanoptera	Wild
Pariwana	Phoenicoparus andinas	Wild
Partridge	Nothoprocta sp	Wild
RODENTS		
Cuy	Cavia parcellus	Domesticated
Vizcacha	Lagidium peruanum	Wild
Chinchilla	Chinchilla laniger	Domesticated

II. THE ANDEAN MOUNTAINS AND THEIR GENETIC DIVERSITY

CROPS

The presence of numerous skin wild species and ancestres of domesticated plants are an indicator of the diversity that may be expected from the Andes. Those crops which have a high priority in the Andean Region due to their greater proliferation, appropriate nutritional value and efficient reproduction system, are listed in Table 3.

TABLE 3

MAIN ANDEAN NATIVE CROPS IN PERU

	Crop Area in ha	Altitude masl
GRAINS		
Quinoa [1]	15,000	0-3,900
Kaniwa	5,000	3,900-4,100
Amaranthus	500	0-3,000
Lupinus	3,000	1,500-3,800
TUBERS		
Oca	18,000	3,000-4,000
Olluco	16,000	2,000-3,900
Mashua	6,000	2,800-4,000
ROOTS		
Yacón	300	0-3,000
Arracacha	400	0-3,000

1 It is estimated that there are 40,000 ha of quinoa in Bolivia and 2,000 ha in Ecuador.

GRAINS

Quinoa (Chenopodium quinoa) is generally found in the Andean highlands from 3,500 to 4,000 m of altitude. However, it has been established also that it grows from sea level to near the snow caps.

TABLE 4

QUINOA MAIN GROUPS AND THEIR ECOLOGICAL ADAPTABILITY

GROUP	ALTITUDE	COUNTRY/REGION
- Sea level Quinoa	0- 500	Chile/Central Zone
- Valley's Quinoa	1,000-3,000	Perú, Bolivia, Ecuador, Colombia
- Highland Plains Quinoa	3,500-33,900	Perú, Bolivia
- "Salares" Quinoa	3,700-3,800	Bolivia
- High "Yungas" Quinoa	2,500-3,000	Bolivia/Perú

Gandarillas (1968) describes eighteen races, classified as per their growth habitat, type of inflorescence and shape and edge of leaves.

Quinoa's configuration ranges from branches to one single stem plants and shows amaranth or glomerulous leaf types and smooth to saw-edge leaves.

The height of this plant ranges from 1 m to 3 m. The smallest ecotypes are found in the Highland plains and the higher ecotypes in the inter-Andean valleys located at 3,000 masl.

Given this broad diversity, it is possible to select some varieties which can endure low humidity. Quinoas may be grown in salty pans ("salares") with only 280 mm of rain provided that specific agricultural techniques, which consist of small holes dugged in the ground, are used. Quinoas grown in the valleys may withstand rainfalls over 1,000 mm. Tolerance to fungus diseases, such as mildiu (Peronospora sp), is associated with rainfall and humidity.

The colour of the grain varies from dark (usually associated with a higher protein content, up to 21%) to white. Grains can be amilaceous as well as crystalline ("chullpi") ranging from 12 to 16% protein. Additionally, there is a group of gray skinned quinoas called "ccoito" which produce soft flour.

The adaptability of quinoas to different soils is related to their pH. The "royal quinoas" grown in the "salares" are highly halophyte and can grow in alkaline soils (pH 7.8). The sea level quinoas show good adaptability to neutral pH's.

Kañiwa is possibly the most resistant crop to low temperatures existing in the world. This plant has a special anatomical structure which protects the inflorescence and can withstand temperatures as low as -3°C during flowering.

Its grains show different hues ranging from light brown to black. The grain cover (perisperm) ranges from light gray, yellow, orange or dark red to almost black.

The Andean Amaranthus is identified by way of two species : A. caudatus in the Central Andean mountains in Perú and Bolivia and A. edulis in Southern Bolivia and Northern Argentina, known under names such as "coyo", "achis", "achita", "coimi", and "millmi", which often lead to confusion. A similar specie is A. hibridus known as "hat'ago" eaten in its tender stage as a vegetable. The height of this plant ranges between 1 m and 3 m.

Tarwi or chocho (Lupinus mutabilis) also shows a broad diversity. Three different types may be clearly identified, as indicated in Table 5.

TABLE 5

DIVERSITY OF LUPINUS MUTABILIS

COMMON NAME	AREA	ALTITUDE	GROWTH
Tarwi or tauri	Bolivia, Southern Perú	3,600-3,800	Slightly ramified Semi-early
Chocho	Central and Northern Peru, Ecuador	3,000-	Ramified/late type
Tarwi	Around Lake Titicaca	3,800-3,850	Slightly ramified/ very early (150 days)

Several authors mention the ample variability of Lupinus wild species. McBride (1953) indicates the existence of 82 species, some of which are grown and used as food. Carrillo (1947) has described most of these species, one of which is Lupinus praestabilis grown in altitudes up to 4,200 masl. Tapia (1980) has suggested the kind of germplasm that could be used in a breeding programme for the enhancement of man-grown species, with emphasis on resistance to frost, diseases and pests.

TUBERS

Andean tubers such as Oca (Oxalis tuberosa), Olluco (Ullucus tuberosus) and Mashua or Isaño (Tropaeolum tuberosum) do not vary only in their shape, size and color of tuber, but also in their precocity, tolerance to cold, and oxalic acid content, as in the case of oca, and mucilagous content as in the case of olluco (Table 6).

This broad genetic diversity, a common indicator of the Andean species, should be used advantageously in a cooperative programme among countries having high mountain conditions, in order to obtain improved materials adapted to these environments.

Diseases and pests are to be considered within the framework of a plan for the selection of tolerant ecotypes and should be a logical alternative to the use of chemical products.

TABLE 6

CHARACTERISTICS OF OCA TUBERS [1]

COMMON NAME	ORIGIN	COLOUR	LENGHT OF STYLE
Yurac Oca	Bolivia, Potosí	White	Long
Pallihuaya	Bolivia, Omasuyo	Yellow	Short
Puca Oca	Bolivia, Cochabamba	Red	Short
Keni Pecke Oca	Bolivia, Pillapi	White	Medium
Ibia	Colombia, Zipaquirá	Light Yellow	Medium
Lari Oca	Bolivia, Tunari	Purple	Medium

1 Source : Cárdenas (1958)

Generally speaking, resistance to low temperatures is associated with height of plants. Normally, species growing very close to the ground surface would withstand better lower temperatures.

ROOTS

Yacon is grown from Venezuela to Argentina. It is a perennial root, even though aerial stems are annual. These roots are eaten raw and have a sweetish flavour (Leon, 1964).

Arracacha is a species considered to be the oldest in America (Bukasov, 1930). As it is a short photoperiodic plant, its introduction to places outside the tropics has been impossible. (Montaldo, 1972).

There are white and purple varieties adaptable up to 2,700 m. Plants produce 4-10 cone shaped roots.

ANIMALS

SOUTH AMERICAN CAMELIDS

Out of the four camelids found in the Andean region, two of them, the llama and alpaca are domesticated.

These two animals fulfill different though complementary functions. The llamas are taller and differ in height: adult llamas found in the Bolivian "salares" are 2.20 m tall and those found along the drier high desertic lands ("punas") are 1.60 m tall. Llamas are used as means of transportation of agricultural products (potato, barley and fruits) along the highlands. Their fiber though somewhat thicker, is highly appreciated for its strength and durability. Meat of younger animals is widely accepted and a variety of products is produced with the leather, such as clothing and straps for agricultural and construction products.

The manure of these animals is used for agricultural purposes. For this reason, it is important source of resources for peasants in the high Andean region.

There are three distinctive types: two with a lot of fiber which differ according to their height, and a third group of animals almost hairless.

Alpacas are finer and have a higher quality of fiber. An adult alpaca produces 2,103 kg per year. Alpaca meat is highly appreciated and it has been widely used in the sausage industry.

TABLE 7

CAMELIDS POPULATION IN SOUTH AMERICA, FAO (1971)

COUNTRY	ALPACAS	LLAMAS	TOTAL
Perú	3'290,000	900,000	4'190,000
Bolivia	300,000	2'000,000	2'300,000
Chile	50,000	70,000	120,000
Argentina	Few	Few	-
TOTAL	3'640,000	2'970,000	6'610,000

GUINEA PIG "CUY"

In Perú, at present, there are about 20'000,000 "cuys" born per year (Arroyo, 1986), and the annual consumption is estimated in 1.2 kg per capita. They are bred by families, and there are four different species.

A research study carried out by Calero del Mar (1978) on the variability of these species, shows that their hair varies from white to black, and their body shape is adequate for beef production, except those with a more angular type. The amount of hair is also highly variable.

TABLE 8

COMPARISON OF CONVERSION EFFICIENCY BETWEEN GUINEA PIG AND OTHER SPECIES (ALIAGA, 1979)

SPECIES	WEIGHT/KG	CONSUMPTION PER WEIGHT %	INCREASE/WEIGHT %
Guinea Pig	0.8	31.25	0.9
Bovines	40.0	12.50	0.3
Cattle	500.0	10.0	0.2

TABLE 9

ANNUAL PRODUCTION OF MAIN DOMESTICATED ANDEAN SPECIES

	Meat/kg/unit	Fiber kg	Milk/l/day
Llamas	40 - 60	3 - 4	1 - 3
Alpacas	30 - 50	2 - 5	1 - 2
Guinea Pig	0.3 - 0.8	-	-

III. COLLECTION EXPEDITIONS : THE ANDEAN NATIVE CROPS AND DOMESTIC ANIMAL RESOURCES GERMPLASM BANKS.

Numerous isolated efforts have been deployed in order to collect this material. Probably one of the most relevant expeditions was the one compiled by Dr. Jorge Leon, and Eng. Julio Rea on the early 60's, when the Programa de Cultivos Andinos of IICA was first started. These collections included mainly tubers and roots.

The material was distributed to the universities of Ecuador, Perú, and Bolivia, and a variable percentage of this material is still available. A large portion of the material on oca is kept in Cusco and Huancayo, and the germplasm on arracacha is kept at the Cajamarca University in Perú.

The biggest collection was sent to Dr. Martín Cárdenas of Cochabamba University in Bolivia. Upon the establishment of accessions, important evaluations were made, and publications were produced (Cárdenas, 1958).

During the late 60's and early 70's several expeditions were made by the Peruvian regional universities giving special importance to Andean grains.

In Puno, most efforts were devoted to Quinoa and Kañiwa, while in Cusco and Huancayo, Lupinus was the main priority.

As of 1975, a coordinating action for the organization and compilation of the collections existing in Bolivia and Perú, was initiated under the Program Andes Altos of IICA, based in Bolivia. Support was also provided to similar actions undertaken in Colombia and Ecuador.

This program was further supported, founded and guided by FAO's International Committee on Phytogenetic Resources (CIRF).

Apart from the support received for several expeditions between 1976-1980, the following facilities were constructed and/or endowed :

Bolivia

Belén Experimental Station (E.S). Improvement and endowement of installed facilities.

Patacamaya E.S. Purchase of equipment.

Perú

Camacani E.S. (Puno). Building and equipment.
Kayra E.S. (Cusco). Building and equipment.
E.S. (Ayacucho). Building of facilities.

The setting of this infrastructure facilitated the identification of the material, as well as the selection of improved lines.

The Lupinus project supported by GTZ, was carried out in Perú during eight years, and contributed to the collection of these species. The above mentioned germplasm was distributed between Cusco and Huancayo and the construction of an appropriate building was funded.

Up to the present, CIRF and IDRC have continued supporting the maintenance and evaluation of specific collections in Ecuador, Perú, and Bolivia.

In 1982, the Amaranth collection (227 accessions) was given to Cusco University leading to the establishment of a program for the promotion of this crop.

In 1985, the Instituto Nacional de Investigación y Promoción Agropecuaria del Perú (INIPA), created the Programa Nacional de Cultivos Andinos (National Andean Crops Program) which is now concentrating all efforts on the research of these species.

TABLE 10

INSTITUTIONS RESPONSIBLE FOR GERMPLASM

CROP	INSTITUTION
Quinoa-Kañiwa	- CIPA XXI-PUNO, c/o Ing. Valeriano Huanco Apartado 388 Puno, Perú
	- UNA, c/o Ing. Roberto Valdivia (Universidad Nacional del Altiplano) Apartado 271 Puno, Perú
Lupinus	- Universidad del Cusco, c/o Ing. Oscar Blanco Apartado 1006 Cusco, Perú
	- CIPA XVI-JUNIN, c/o Ing. Oscar Garay Calle Real 509 El Tambo, Huancayo, Perú
Andean Tubers and Kiwicha	- Universidad del Cusco, c/o Ings. Hernán Cortéz/Luis Sumar Apartado 1006 Cusco, Perú
	- Universidad de Ayacucho c/o Ing. Julio Valladolid Apartado 243 Ayacucho, Perú
Andean Crops/General	- Programa Nacional de Cultivos Andinos c/o Dr. Mario Tapia Apartado 110097 Telex 25194 NC Lima 11, Perú

TABLE 11

INSTITUTIONS RESPONSIBLE FOR THE ANDEAN ANIMAL GERMPLASM

ANIMAL	INSTITUTION
Camelids	- IVITA, Universidad Nacional Mayor de San Marcos Apartado 4270 Lima, Perú
	- INIPA, c/o Ing. Julio Sumar Apartado 110097 Lima 11, Perú
Guinea Pigs	- INIPA, c/o Ing. Marco Saldivar Apartado 110097 Lima 11, Perú

TABLE 12

NUMBER OF ACCESSIONS (COLLECTIONS) PER CROP IN EACH GERMPLASM BANK (1985) IN PERU

	PUNO	CUSCO	HUANCAYO	AYACUCHO	CAJAMARCA
Quinoa	1500 (E)	198	48	425	425
Kañiwa	330	-	14	47	-
Kiwicha	-	570	32	109	17
Tarwi	228 (E)	1200 (E)	1500(E)	325	126
Bitter Potato	68	130	42	257	-
Oca	120	610	168	122	30
Olluco	40	13	118	61	18
Isaño, Mashua	65	14	47	107	-

(E) Include material from other Andean countries.

IV. PRESENT AND POTENTIAL USE OF ANDEAN PHYTOGENETIC AND ZOOGENETIC RESOURCES

Andean crops, other than potatoes and corn, have not been used appropriately. It is a result of the food crisis emerged in this decade which has reached critical levels, (Perú imports more than 90% of the wheat and 30% of the milk consumed), that the value of these species has been recognized. They should be suitably analized, improved and promoted as they may prove to be more advantageous than many imported food products.

The surface area of the main crops mentioned here, occupies at present from 60,000 to 70,000 ha; yields and prices vary according to the year and the prevailing climatic conditions (Table 11).

Andean grains such as Quinoa and Kiwicha have awakened great interest. However, their nutritional role has not been clearly defined as yet despite the fact that peasants have traditionally used them for soups and sweet and salty dishes replacing rice.

The grains of Quinoa and Kiwicha have been processed industrially to produce flour which can be mixed with milk, or used to prepare "tortillas" (flat bread). Pop Quinoa, and Kiwicha are also common.

Although Kañiwa will eventually cover a large area (over 50,000 ha), it requires to be roasted before consumption. Its nutritional value, of a high protein content (15%), has been widely recognized.

Tarwi is also rich in proteins (32-42%). It is a legume considered as the Andean soy bean. If processed to release its alkaloid content, it may be used as a food product similar to beans.

The use of this legume in rotations may substantially increase the production of other crops, as it is estimated to fix between 60 to 80 kg of N/ha.

Roots and tubers are an important source of energy. Their future perspective will improve when industrial processing of the flour gets under way.

One hectare of Oca may produce up to 8 T of dry matter/ha, thus competing favourably with other cereals.

Common agronomic practices for these crops are shown in Tables 12 and 13.

Herds of South American camelids such as llama and alpaca reached more than 20'000,000, approximately three times their present population. They were an important source of proteins for the population of the XVI century when the Spaniards arrived.

The selection of animals used to be done yearly in big rodeos "chaco" which permitted choosing the surplus and adult animals. Meat was dried and salted under the sunlight to preserve it for long periods of time.

The above technique is still practiced and allows meat to be transported to the tropical region. Given the fact that these species graze easily in the Andean pastures, their population could increase notoriously if competition by cattle and sheep is reduced (Primov, 1983).

Alpaca hair is highly appreciated in the world markets and countries such as Bolivia and Perú still retain more than 95% of the world's total production.

Guinea pig raising is the most economical source of proteins, because all residues from the kitchen may be used for their feeding. Some selected guinea pigs have reached 1,5 kg in weight.

Guinea pigs may be cooked in different ways such as broiled or fried. Traditionally, it is served on holidays.

As indicated in the opening statement of this article, it is important to know the geography and the resources available in a given region because it allows for the development of agricultural practices and crops which may suit better the prevalent mountain conditions. These resources may be shared, as in the case of potatoes and corn, with other mountaneous countries of the world.

TABLE 13

DISTRIBUTION OF ANDEAN CROPS, ALTITUDE, AND YIELDS IN THE PERUVIAN HIGHLANDS

		CAJAMARCA LA LIBERTAD	ANCASH	VALLE DE MANTARO	AYACUCHO APURIMAC	CUSCO	PUNO	TOTAL AREA HA
QUINOA	D	**	*	*	**	**	***	16,000
	A	2600-3500	2700-3800	2500-3700	2600-3800	2700-3800	3800-3900	
	Y.	1500	1000	1400	800	1300	600-1500	
KAÑIWA	D	--	--	*	*	**	***	4,000
KIWICHA	D	*	*	*	*	*	--	800
TARWI	0	**	**	*	*	**	**	5,000
	A	2000-3300	2000-3400	2500-3500	2200-3500	2400-3500	3800	
	Y	1000	800	800-2000	900	800-2000	1000-2500	
BITTER POTATO	D	--	--	*	*	**	**	38,000
	A			3800	3800-4000	3800-4000	3900-4000	
	Y			8000	7000	7000	7000	
OCA (2)	D	**	**	**	**	**	**	16,000
	A	3000-3800	3000-3800	3000-3900	3000-			
OLLUCO	D	**	**	**	**	**	*	10,000
	A	3000-3800	3000-3900	3000-3800				
ISAÑO, MASHUA	D	*	*	*	**	*	*	6,000
	A	3000-3800	3000-3500	3000-3900				
	Y				10000			

D = Distribution   A = Altitude in masl   Y = Yield kg/ha (1)

(1) Yields vary due to technological levels, years and variety used.
(2) Andean tubers are normally intercropped or associated with maize, thus yields are not included in all cases.

TABLE 14

AGRONOMIC PRACTICES ON ANDEAN GRAINS

ACTIVITY	KIWICHA	QUINOA	KAÑIWA	TARWI
Planting				
Date	August-October	August-November	September-October	August-October
Method	Rows	Row-Transplanting	Row-Broadcast	Row-/In holes
Seed Treatment	N.N	N.N	N.N	Fungicide
Seeding rate kg/ha	3-6	4-15	3-6	60-80
Planting distance cm	60-80	40-80	40-50	60-80
Fertilization	80-40-0	80-40-0	60-40-0	0-40-0
Hilling Up	At least 1	1-2	N.N.	1
Control				
Diseases	Esclerotinea Alternaria	Peronospora Ascochyta Phoma Pseudomonas		Colletotrichum Uromyces, Chrysocelis
Pests	N.S	Ticona Copitarsia Scrobipalpula Pachyzancla Epicauta Epitrix Myzus Frankliniella Astillus		Agromyza Apion
Birds	N.N	During last 3 months	N.N.	N.N
Harvest Method	Plant cutting	Plant cutting or uproot	Uproot or cut	Plant cutting
Threshing	Manual or mechanical	Manual or mechanical	Manual	Manual
Grain Classification	Wind cleaning or mechanical	Wind cleaning or mechanical	Wind cleaning	By hand

N.S = Non Significant
N.N = Not Needed

TABLE 15

AGRONOMIC PRACTICES - ANDEAN TUBERS

ACTIVITY	OCA	OLLUCO	MASHUA
Seeding rate kg/ha	1200-1400	800-200	1000-1200
Planting distance cm	60-80	60-80	60-80
Fertilization *	120-20-0	60-40-0	100-60-0
Hilling-up (number)	2-3	2-3	2-3
Diseases	N.S	"Fasciación"**	"Fasciación"**
Pests	Copitarsia Bothynus Macrosiphum	Premnotrypex	
Harvest (Vegetative cycle)	220-270	210-245	220-245
Storage (problems)	Rotting Rhizopus	N.S	N.S

* Fertilization is conditioned to the rotational system. In new fields rates are very low, less after fertilized potato and higher after a cereal. The use of manure is common but the rates used are very low.

** Physiological disorder, undefined origin.

N.S. = Non significant

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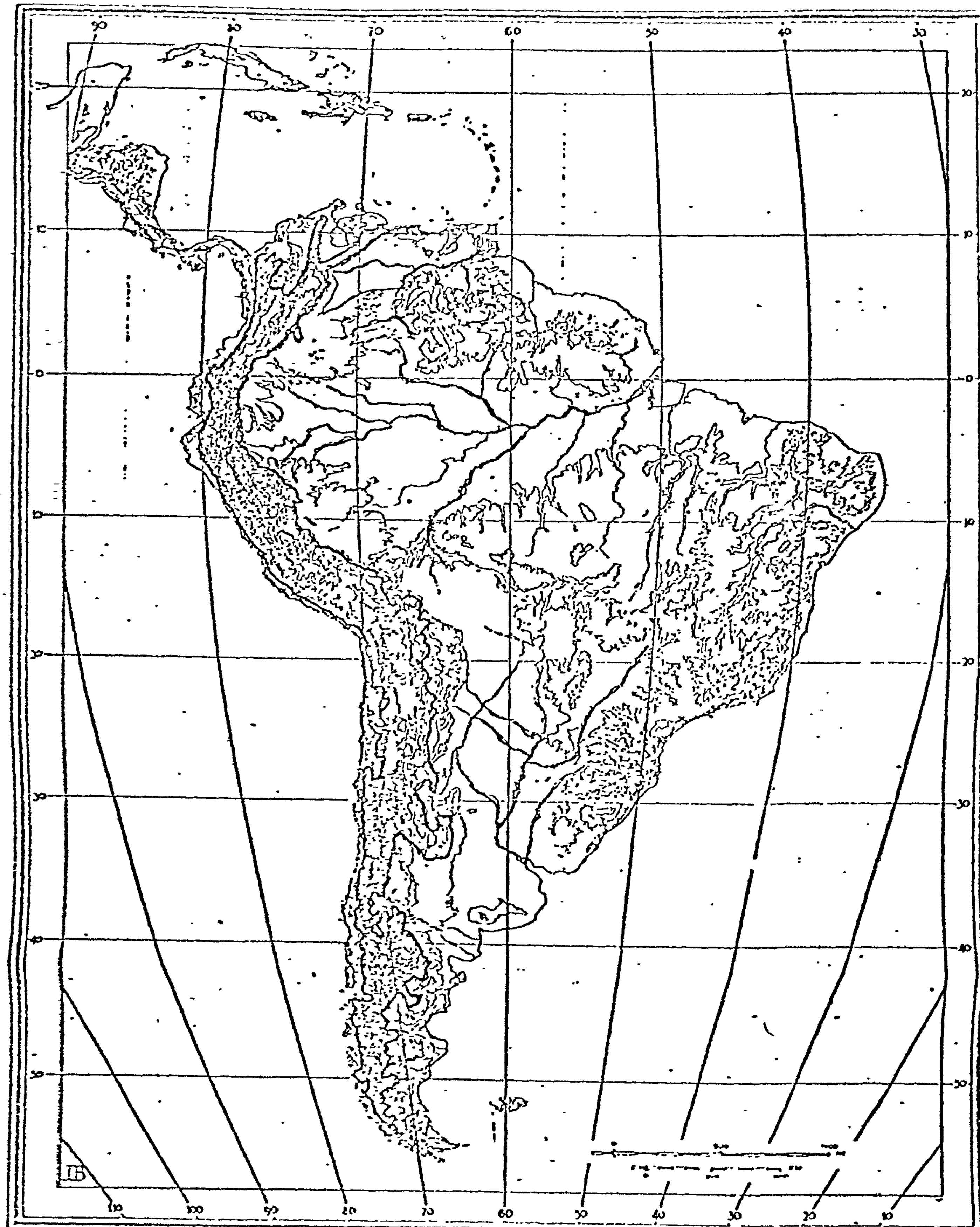

FIG. 1. THE ANDES LOCATION IN SOUTH AMERICA

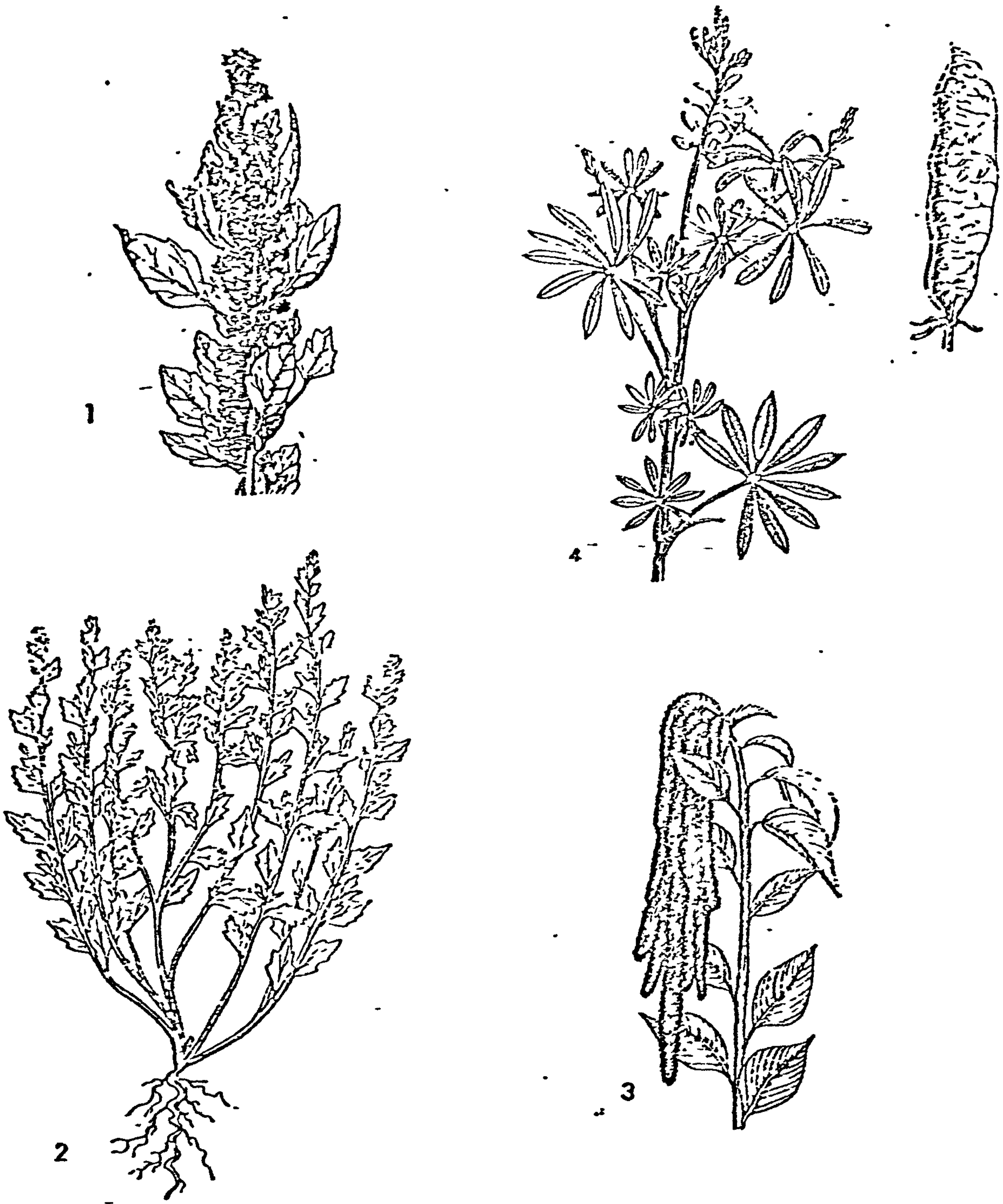

FIG.2 THE ANDEAN GRAINS

1. Quinoa
2. Kañiwa
3. Kiwicha or Amarantus
4. Tarwi or Lupinus

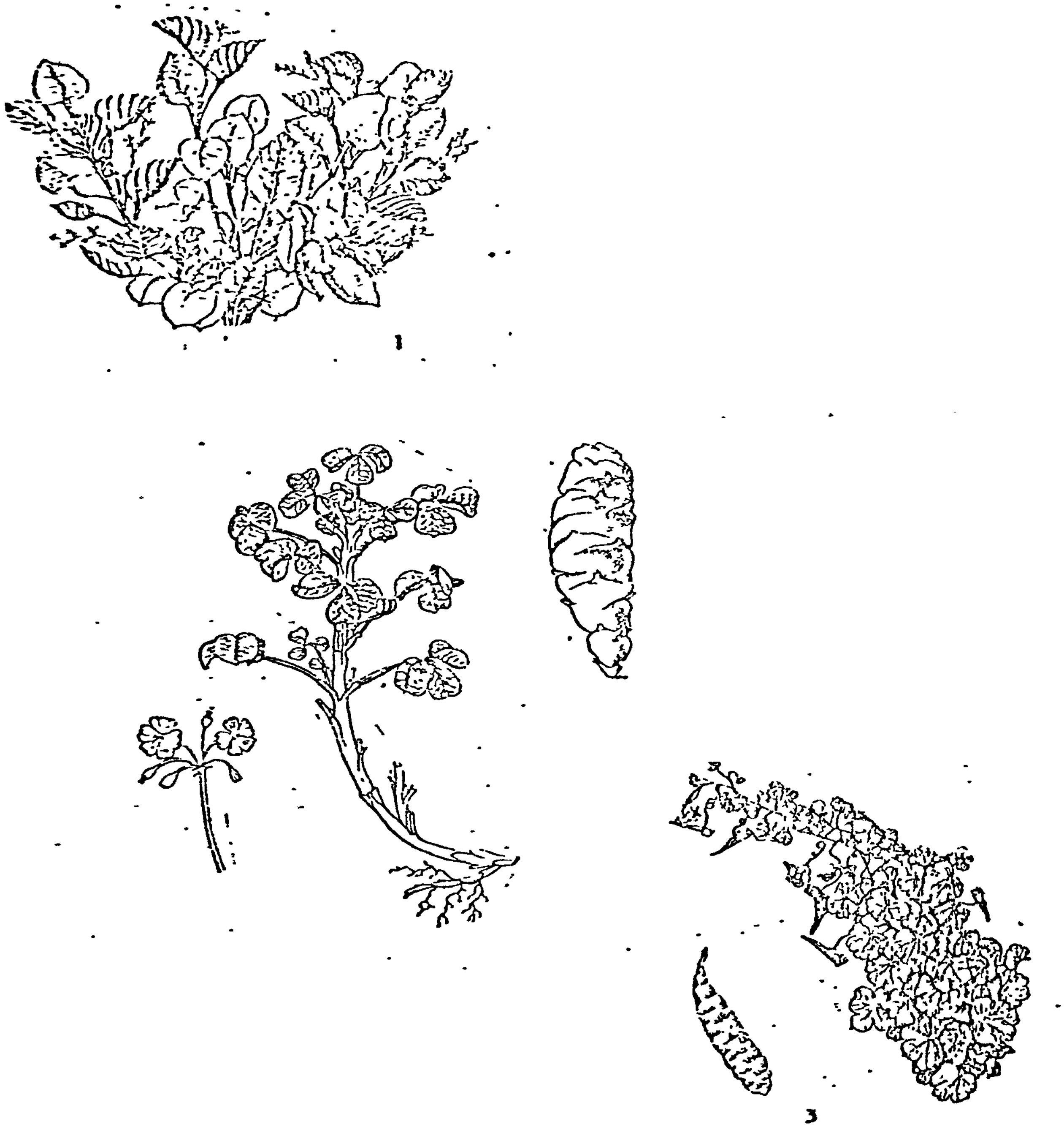

FIG. 3 THE ANDEAN TUBERS

1. Olluco
2. Oca
3. Isaño or mashua

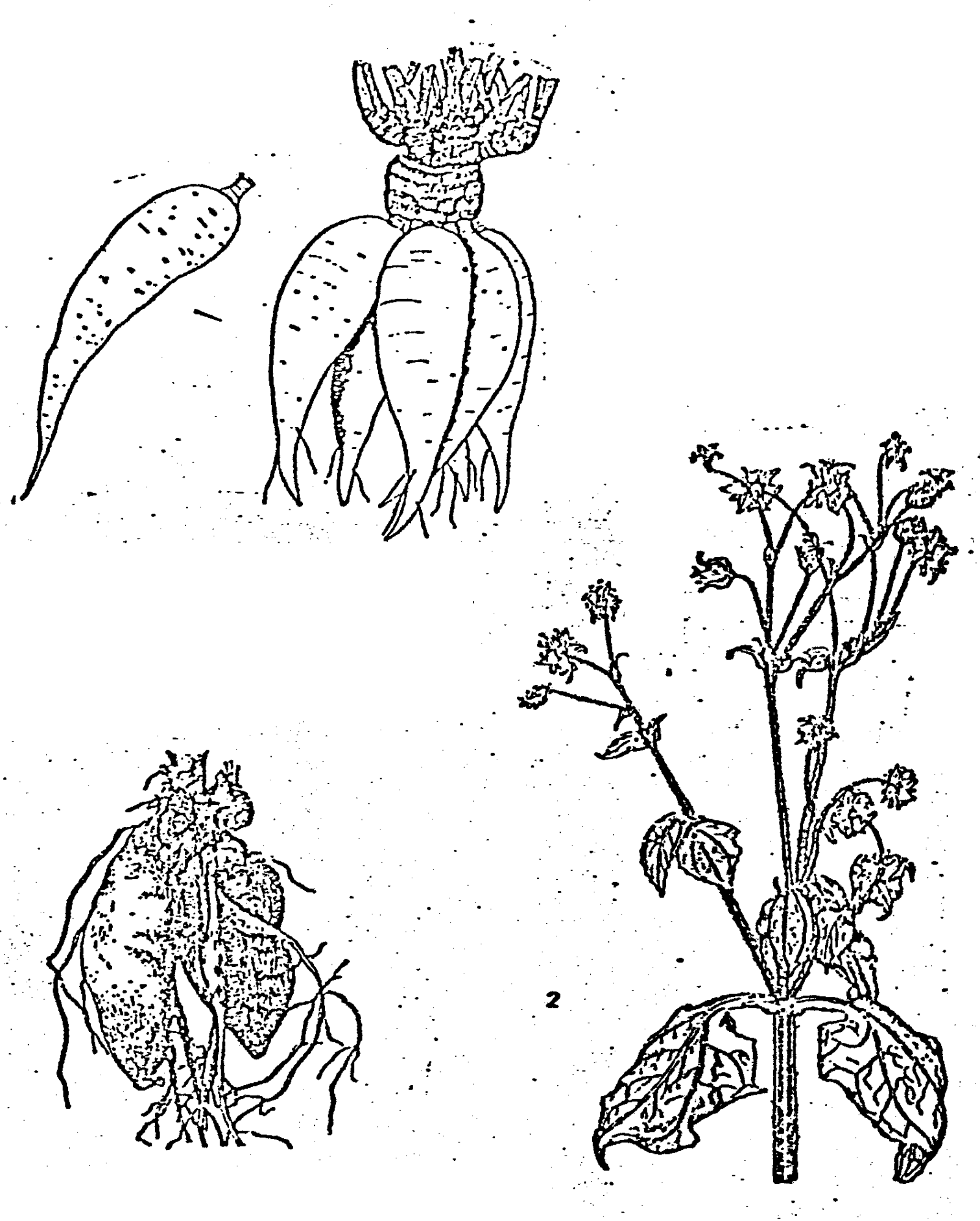

FIG. 4 THE ANDEAN ROOTS

1. Arracacha
2. Yacón

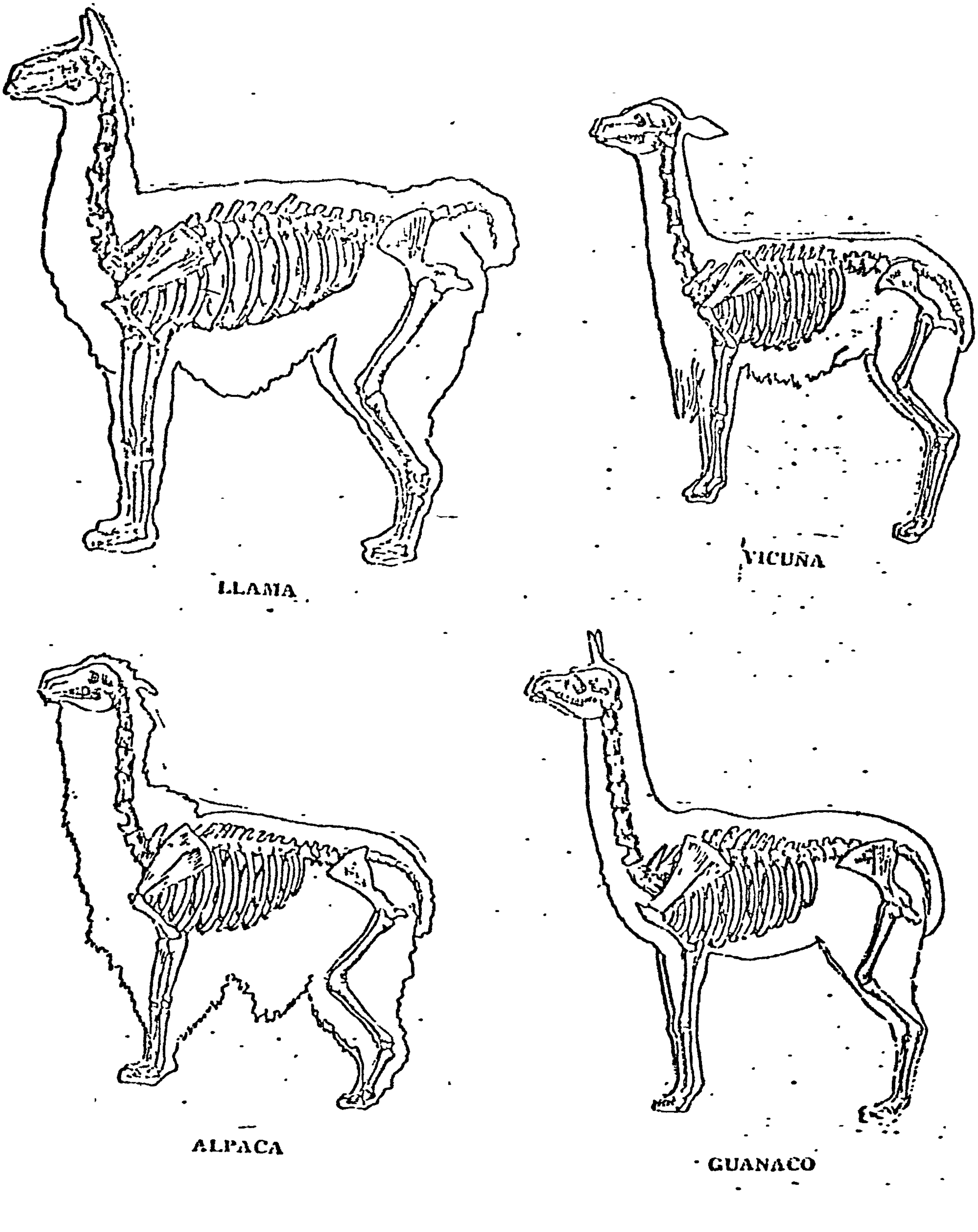

FIG. 5 THE SOUTH AMERICAN CAMELIDS
(Cardozo, 1954)

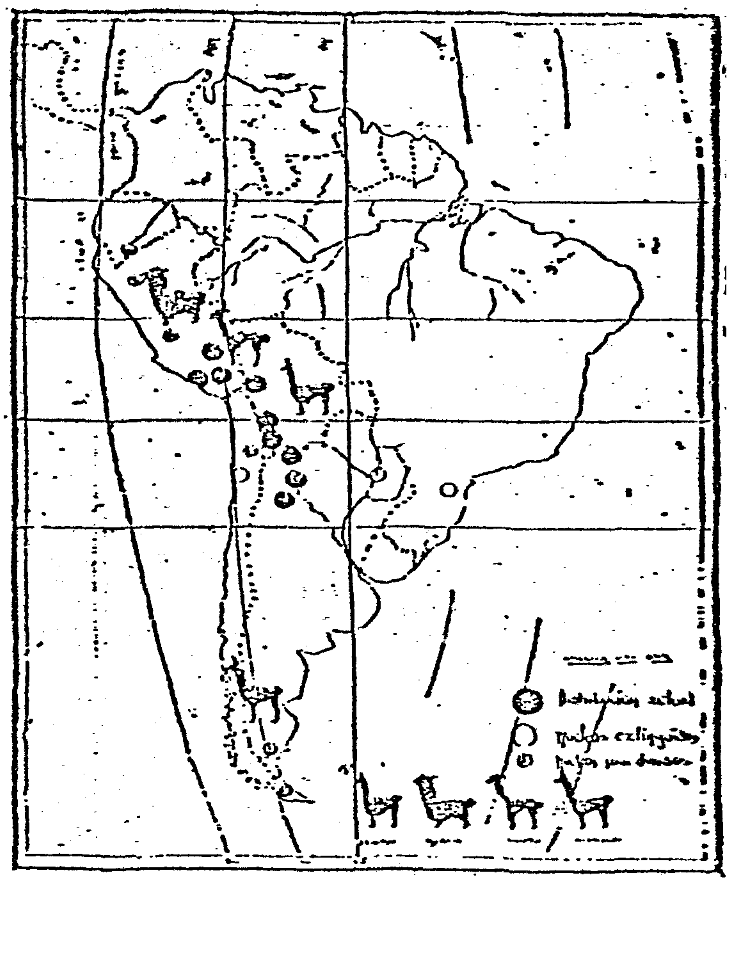

FIG. 6 DISTRIBUTION OF THE CAMELIDS