Université Inter-âge, 13/2, 20/2 et 5/3/2012

Les voyages des plantes cultivées

Serge Bahuchet
Muséum national d'Histoire naturelle

Sauf mention contraire, photos de l'auteur

Un marché en Provence…

Europe

Asie

Amérique

Proche Orient

Proche Orient

Europe

Amérique

Un marché à Rio au Brésil…

Amérique

Europe

Eurasie

Plan des conférences

- Aux origines, la domestication
- 1er diffusion : les plantes et l'agriculture
- 2e diffusion : par les terres et par les mers, les routes de commerce
- 3e diffusion : explorations et voyages de découverte
- 4e diffusion : colonisation et acclimatation
- 5e diffusion : aujourd'hui, « la mondialisation »

Plan des conférences

- **Aux origines, la domestication**
- **1er diffusion : les plantes et l'agriculture**
- 2e diffusion : par les terres et par les mers, les routes de commerce
- 3e diffusion : explorations et voyages de découverte
- 4e diffusion : colonisation et acclimatation
- 5e diffusion : aujourd'hui, « la mondialisation »

Aux origines: la domestication

- Les outils
  - Biogéographie
  - Archéologie
  - Génétique
- Les mécanismes de la domestication
- Les centres d'origine

Les outils (1) : la biogéographie

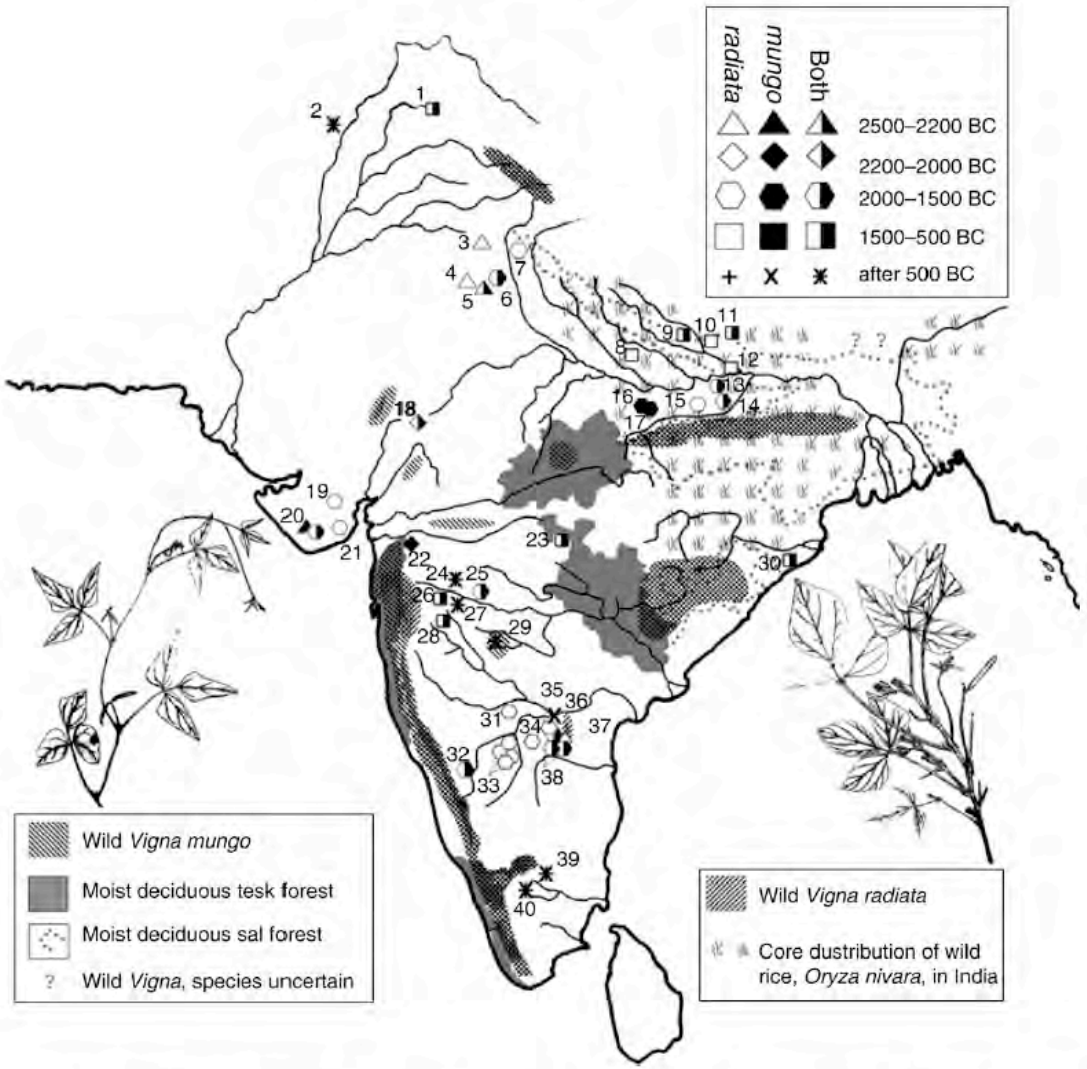


FIG. 11. A map of the wild progenitors of *Vigna radiata* and *V. mungo* in India in relation to the moist deciduous forests and the region with extensive wild rice populations (based on Tomooka *et al.*, 2003; Fuller and Harvey, 2006). Archaeobotanical finds of the *Vigna* pulses are indicated which include secure species-level identifications. Sites are numbered: 1, Semthan; 2, Hund; 3, Balu; 4, Kunal; 5, Burthana Tigrana; 6, Mitithal; 7, Hulas; 8, Hulaskhera; 9, Charda; 10, Imlidh-Kurd; 11, Narhan; 12, Khairadih; 13, Malhar; 14, Senuwar; 15, Tokwa; 16, Mahagara; 17, Koldihwa; 18, Balathal; 19, Babar Kot; 20, Rojdi (two phases); 21, Oriyo Timbo; 22, Kaothe; 23, Tuljapur Garhi; 24, Paithan; 25, Apegaon; 26, Bhokardan; 27, Nevasa; 28, Inamgaon; 29, Terr; 30, Golabai Sassan; 31, Piklihal; 32, Hallur; 33, Tekkalakota, Kurugodu, Sanganakallu and Hiregudda; 34, Hattibelagallu; 35, Sanyasula Cave; 36,

Les outils (2) : l'archéologie

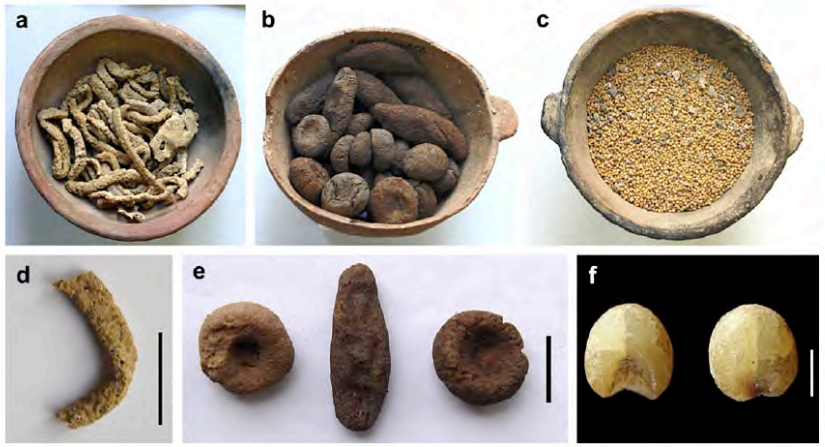


Fig. 3. Materials chosen for archaeobotanical analysis. (a) Noodles in the earthenware bowl from M10:3; (b) Cakes in the earthenware bowl fromIM11:1; (c) Fruits of millet in the earthenware bowl from III M27:8; (d) Noodles chosen for archaeobotanical analysis. Scale bar = 2 cm; (e) Three cakes chosen for archaeobotanical analysis. The long-elliptical one in the middle is named Cake 1 in this paper, the khaki-coloured one on the left is Cake 2, and the brown-coloured one on the right is Cake 3. Scale bar = 2 cm; (f) Photomicrograph of caryopsis of *Panicum miliaceum* from III M27. Scale bar = 1 mm (Photos a–c supplied by Prof. Enguo Lü).

Fig. 43. Desiccated almond fruits from Tutankhamun's tomb, Egypt. These fruits are now placed at the Royal Botanic Gardens, Kew, UK. (Photo: A. McRobb. With kind permission of F. Nigel Hepper, formerly Assistant Keeper of the Herbarium at Kew.)

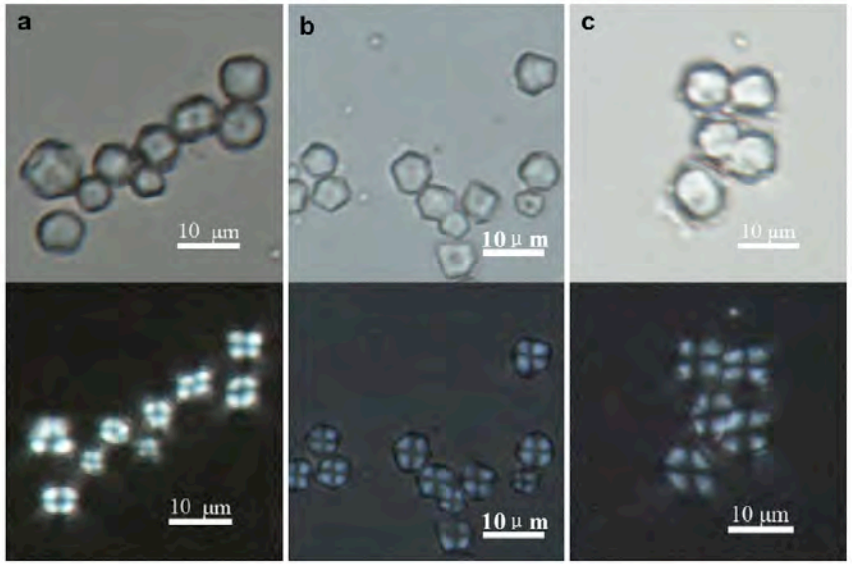


Fig. 4. Starch grains from modern and archaeological common millet (*Panicum miliaceum*). The upper row of photographs showing starch grains under transmitted light; and the lower row showing corresponding ones under polarized light. (a) starch grains from modern common millet; (b) starch grains from archaeological common millet with husk in the Yingpan Tomb; (c) starch grains from archaeological common millet in the Subeixi Cemeteries.

Les mécanismes de la domestication

- Transformation des espèces : le syndrome de domestication
- Conserver des modifications des caractères utiles:
  - augmentation de la taille des « propagules »
  - perte des mécanismes naturels de dispersion
  - et de protection (épines, toxines)
  - changement de rythme de maturation
  - perte de la reproduction sexuelle

Deux types de reproduction des plantes cultivées

- **Reproduction sexuée**
- **Multiplication végétative**

- **Reproduction sexuée** :

  graminées (céréales) - blé, maïs, mil, sorgho, riz...

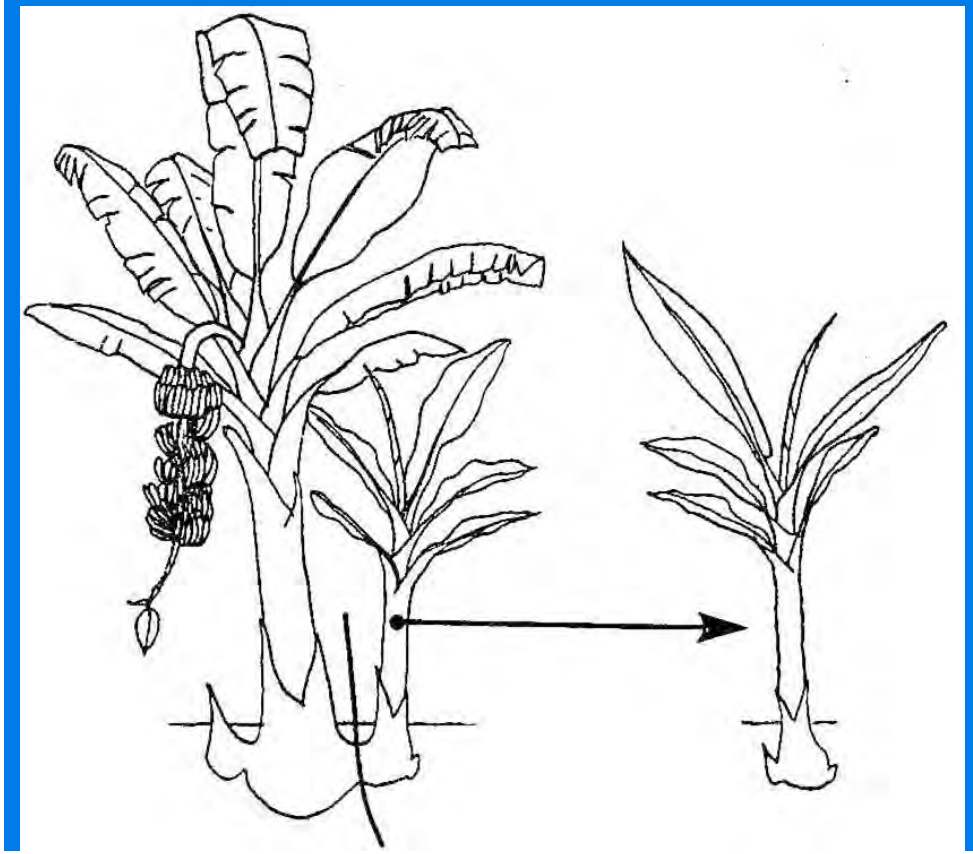
  —> **croisement** de deux patrimoines génétiques, mâle et femelle =

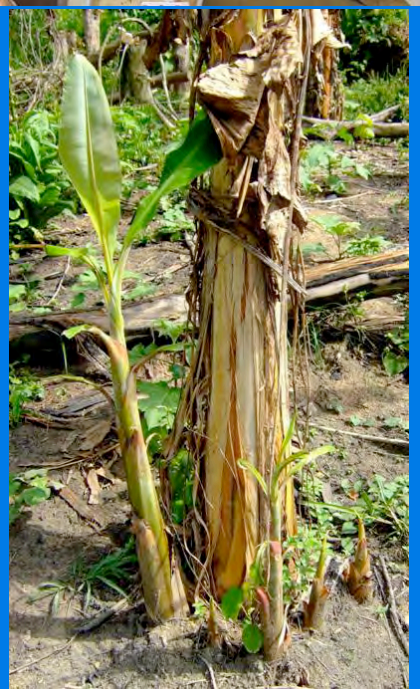
  un nouvel individu

- **Multiplication végétative** :

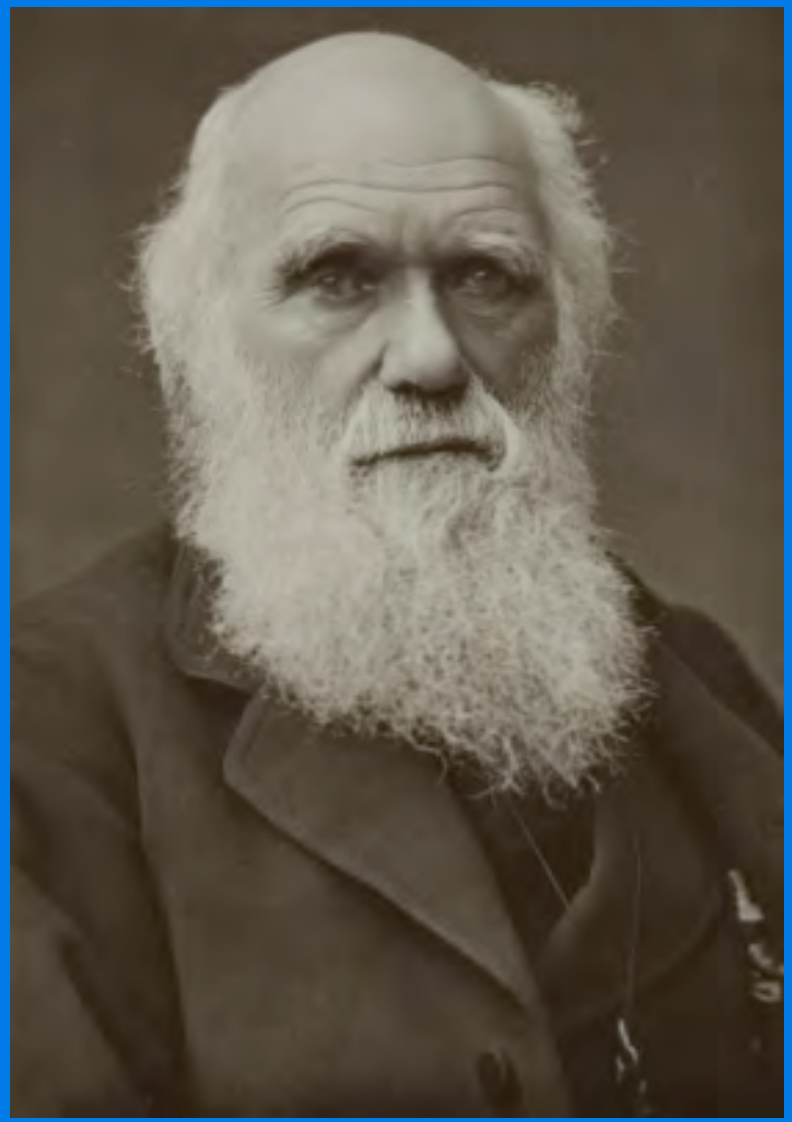
  plantes à bouture (tubercules, féculents...) - manioc, pomme de terre, igname, bananier...

  —> **clonage = le même individu** est répliqué

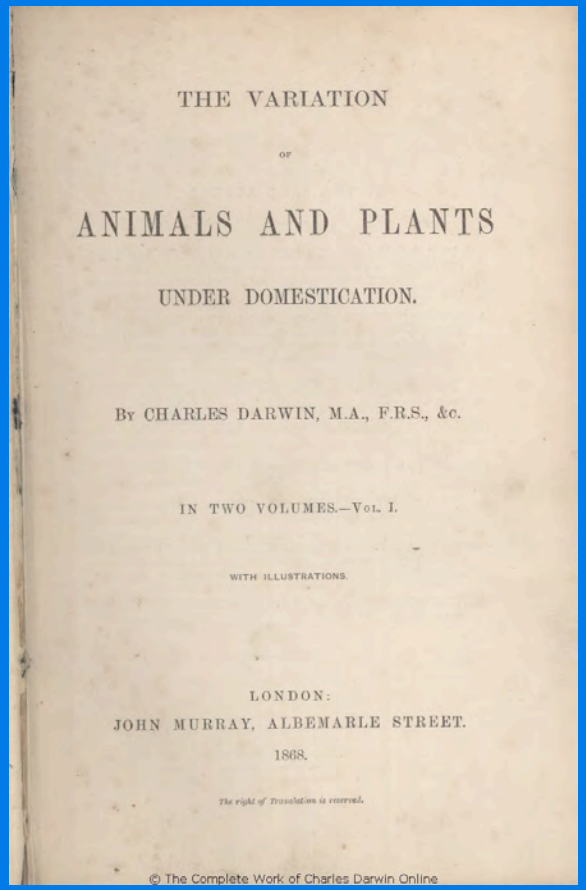




La recherche de l'histoire des plantes cultivées



Charles Darwin (1809-1882)



THE VARIATION

OF

ANIMALS AND PLANTS

UNDER DOMESTICATION.

By CHARLES DARWIN, M.A., F.R.S., &c.

IN TWO VOLUMES.—Vol. I.

WITH ILLUSTRATIONS.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1868.

La variation des animaux et des plantes à l'état de domestication
1868

ORIGINE

DES

PLANTES CULTIVÉES

PAR

ALPH. DE CANDOLLE

Associé étranger de l'Académie des sciences de l'Institut de France,
Membre étranger des sociétés royales de Londres, Edimbourg et Dublin,
des Académies de Saint-Pétersbourg, Stockholm, Berlin, Munich,
Bruxelles, Copenhague, Amsterdam, Rome, Turin,
Madrid, Boston, etc.

PARIS

LIBRAIRIE GERMER BAILLIÈRE ET Cie

108, BOULEVARD SAINT-GERMAIN, 108

—

1883

Alphonse de Candolle (1806-1893)

Nikolai Vavilov
(1887-1943)

Les centres d’origine de Vavilov

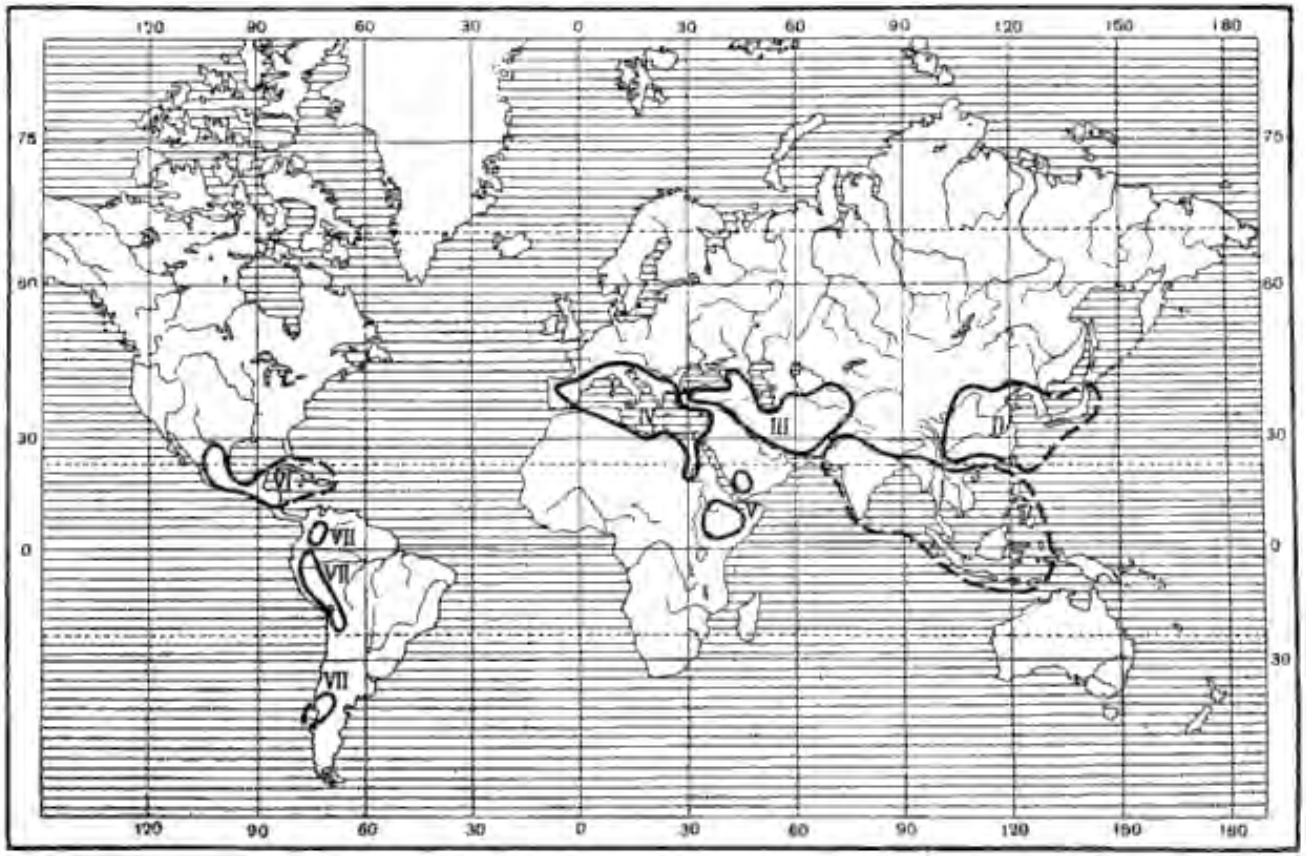
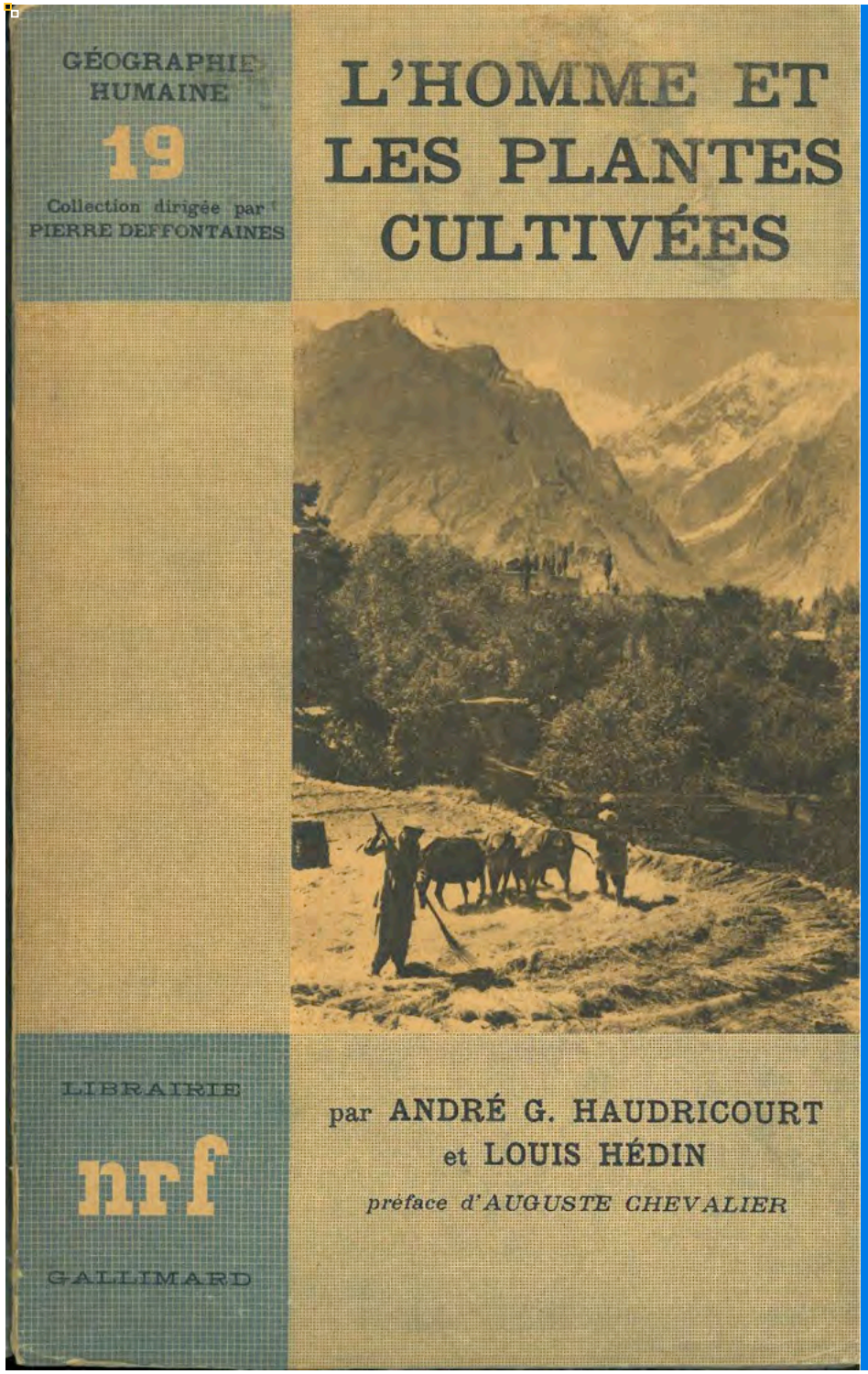
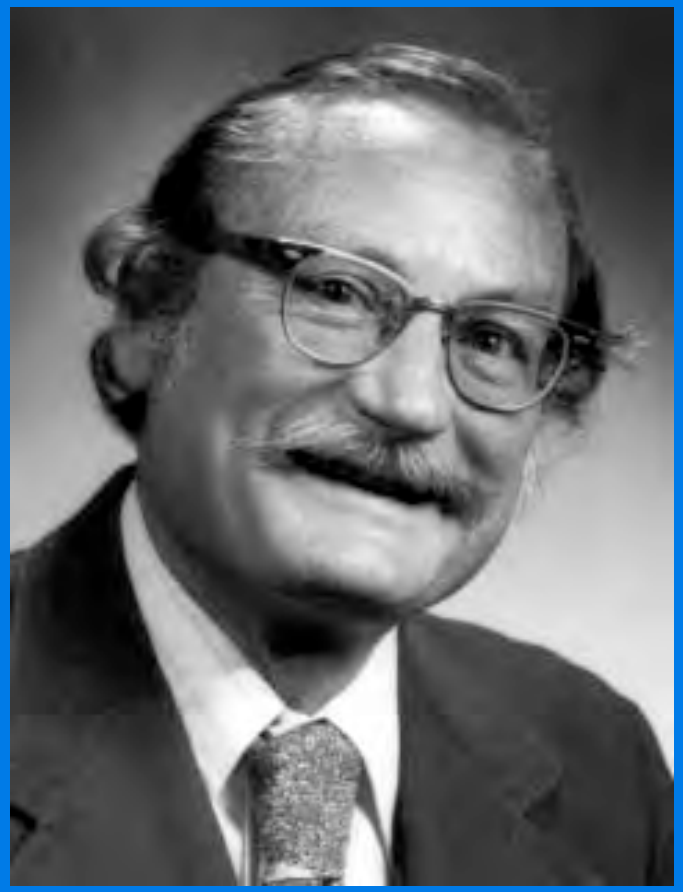


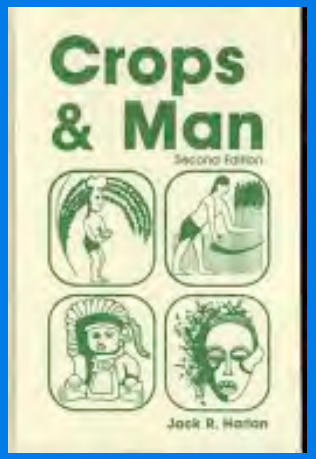
Fig. 1. Center of origin of cultivated plants. I. The tropical south-Asiatic center; II. the east-Asiatic center; III. the southwestern-Asiatic center; IV. the Mediterranean center; V. the Abyssinian center; VI. the Central American center; and VII. The Andean (South American) center.



André-G. Haudricourt (1911-1996)



Jack Harlan
(1917-1998)



1975

TECHNIQUES VIVANTES

C.I.L.F.

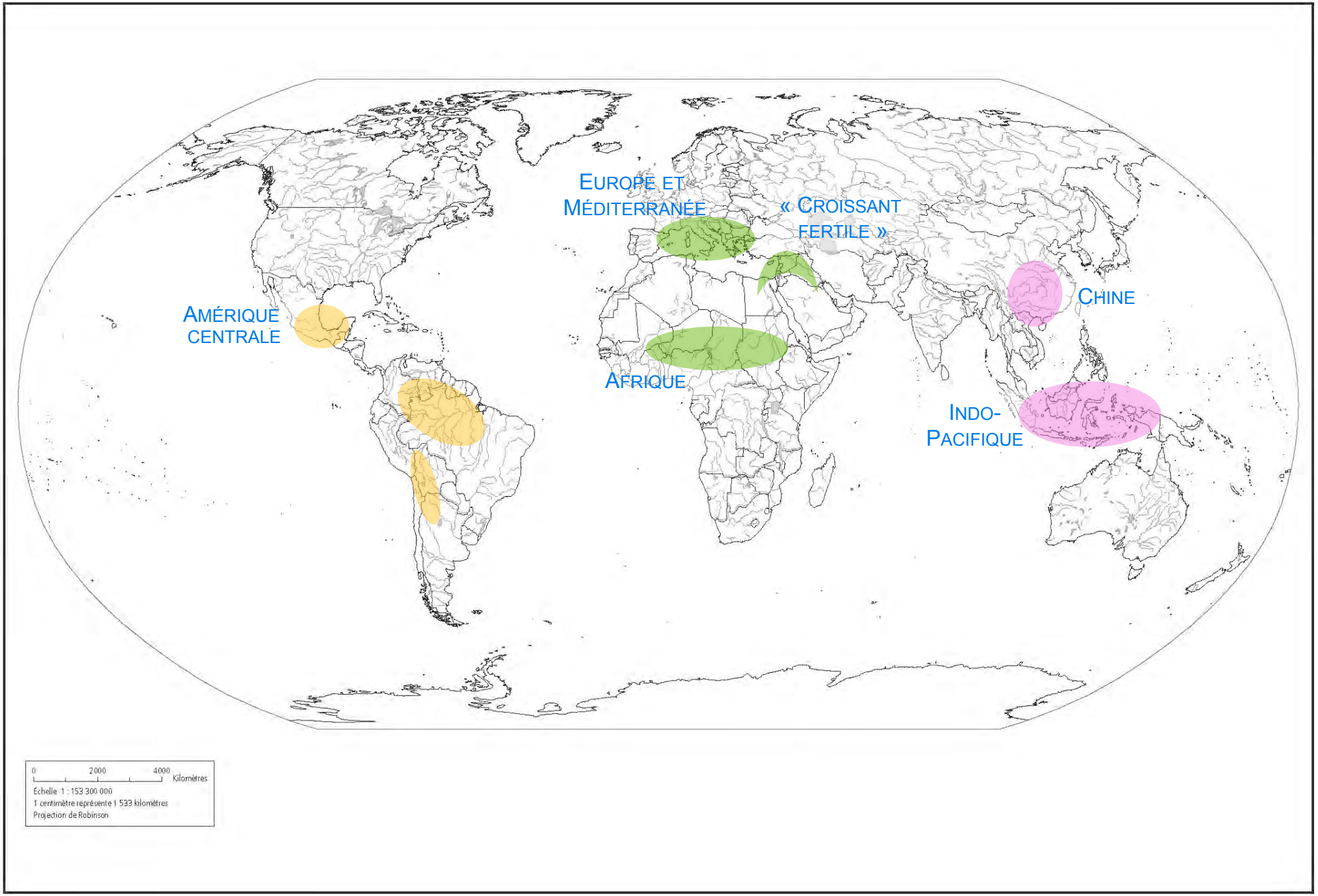
J.R. HARLAN

LES PLANTES CULTIVÉES ET L'HOMME

AGENCE DE COOPERATION CULTURELLE ET TECHNIQUE
CONSEIL INTERNATIONAL DE LA LANGUE FRANÇAISE
PRESSES UNIVERSITAIRES DE FRANCE
1987

Les « Non centres » de Harlan

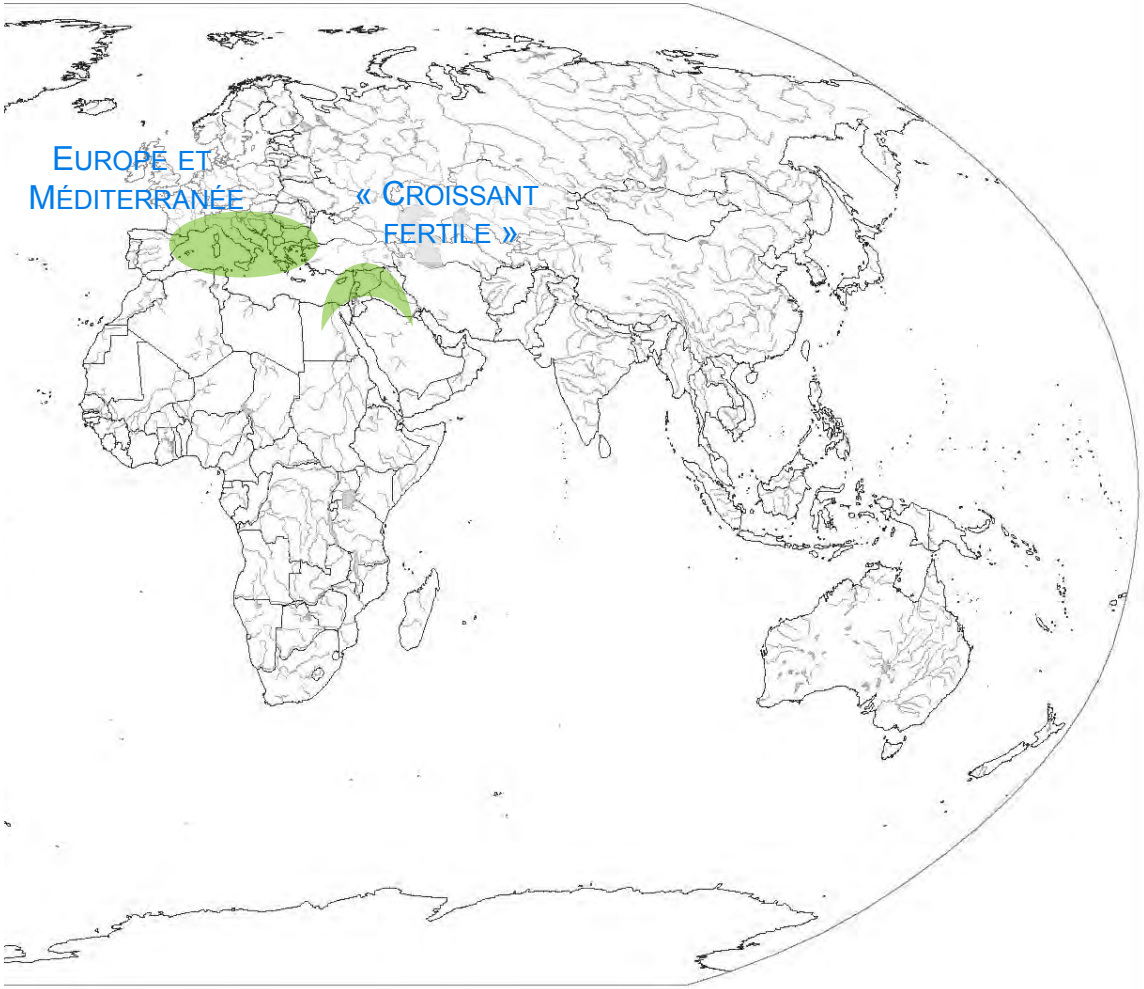
Zones d'origines des plantes cultivées



Proche Orient & Europe

- céréales: blé, avoine, orge, seigle
- fruitiers: figuier, olivier
- légumes: pois, lentilles, pois chiche, oignon, ail, poireau, laitue, navet, radis, persil
- techniques: opium
- boisson: vigne
- fleurs: tulipe

Europe: chou, lin



Les blés

Blé tendre *Triticum aestivum*

Blé poulard *T. turgidum*

Blé dur *T. durum*

Engrain *T. monococcum*

X

Égilope *Aegylops spp.*

Amidonnier *T. dicoccum*

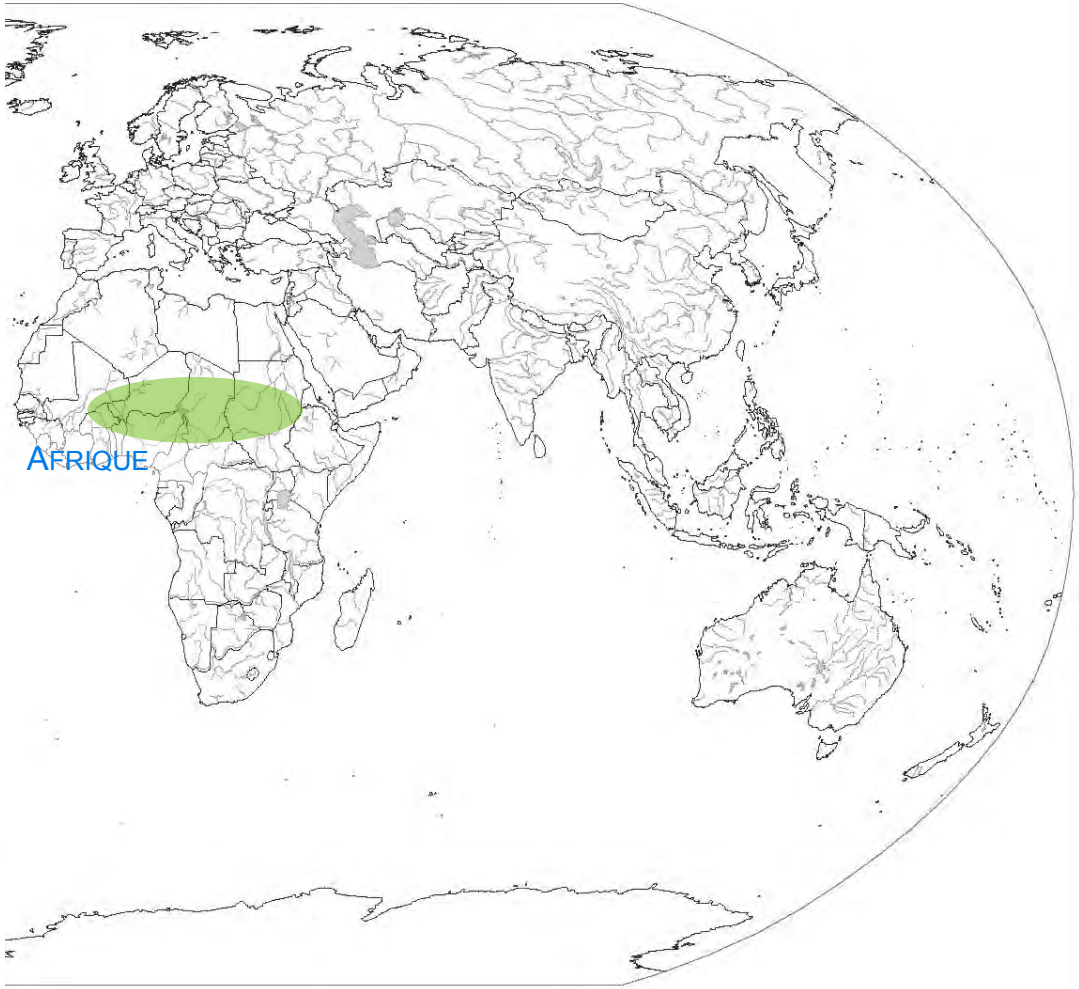
X

Blé tendre *T. aestivum*

La Vigne *Vitis vinifera*

Afrique

- Céréales: sorgho, mil, éleusine
- Féculents: ignames
- Légumes: pois de terre, melon, pastèque, haricot-à-œil, ricin, sésame
- Arbres: palmier à huile, figuier, café



Sorgho *Sorghum bicolor*

Plusieurs races :

- *Durra*
- *Caudatum*
- *Guinea*
- *Caffra*

12

FIG. 12. Distribution of the major cultivated races or sorghum in Africa: Caffra ○; Caudatum ◑; Durra ◒; Guinea ●. Each dot represents one or more collections.

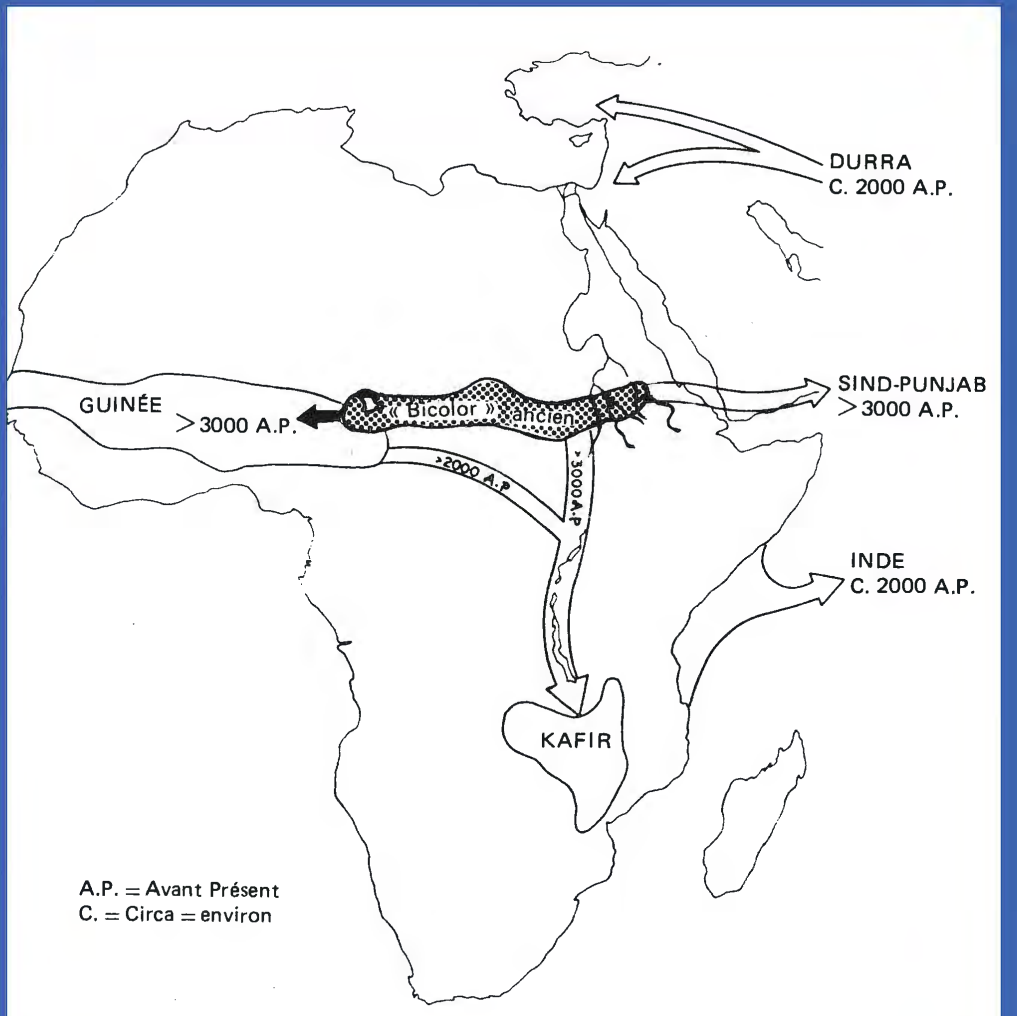


Figure 7 — Déplacements anciens du sorgho. La domestication initiale a eu lieu dans la zone ombrée. (D'après Harlan et Stemler, 1976).

Mil à chandelle
Pennisetum glaucum

Fonio
Digitaria exilis

Les ignames *Dioscorea spp.*

D. rotundata-cayennensis

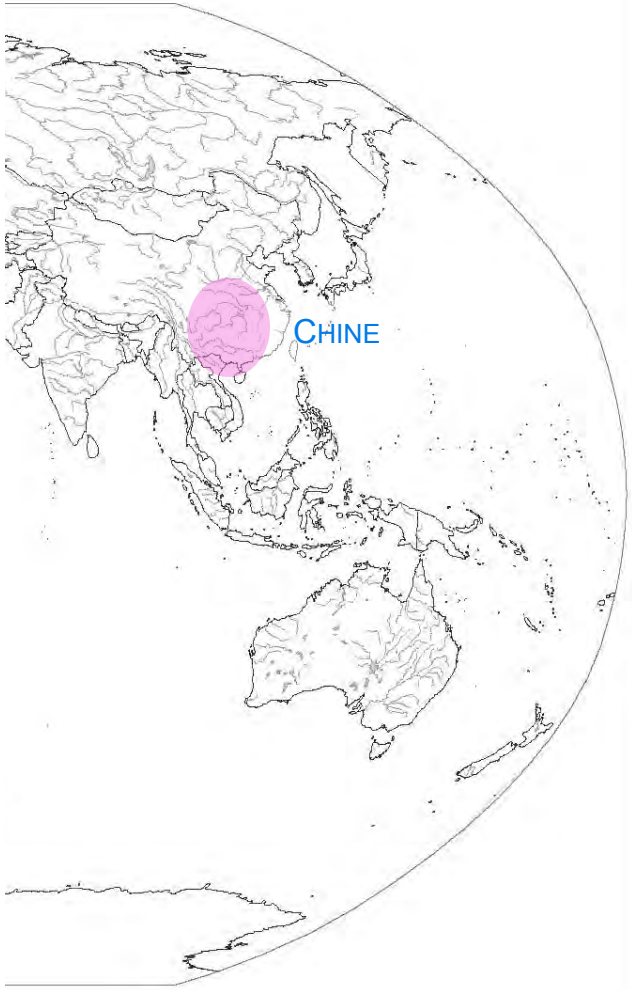
Cl. C.M. Hladik

Melon *Cucumis melo* et Pastèque *Citrullus lanatus*

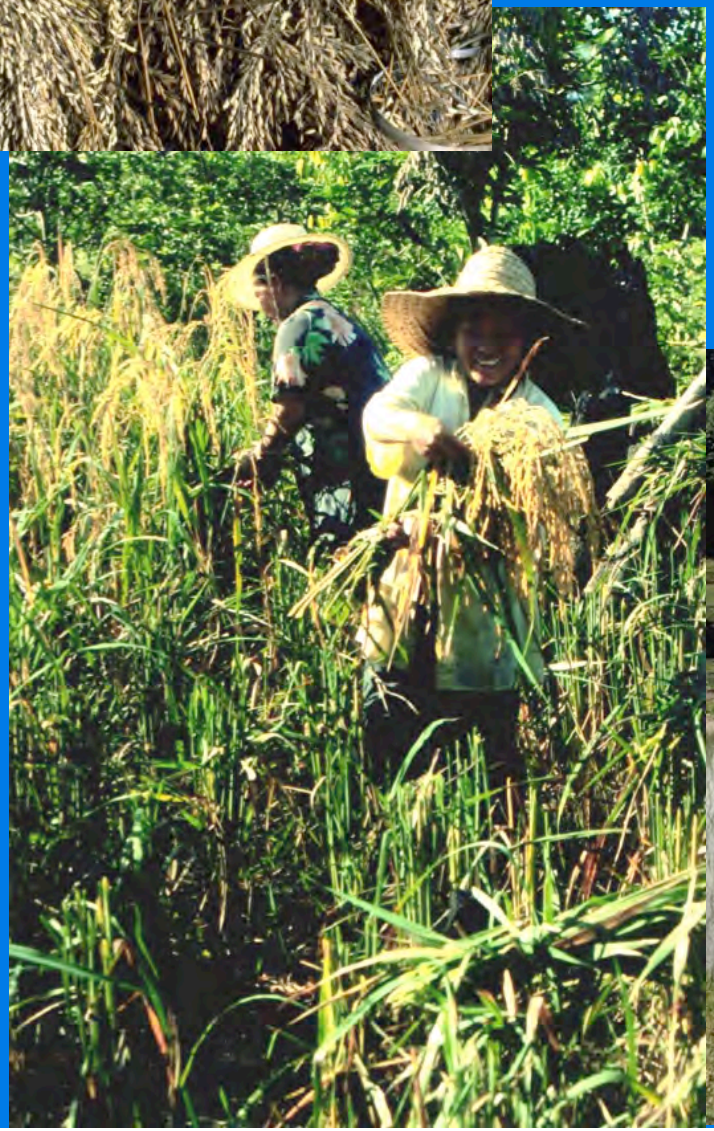
Palmier à huile
Elaeis guineense

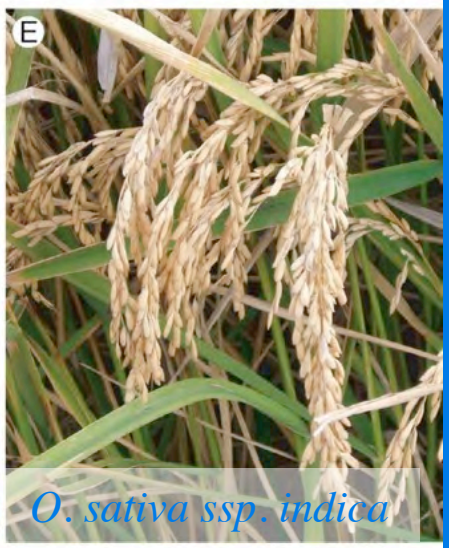
Asie

- Céréales: riz, millets
- Légumes : soja, concombre, aubergine, navet, radis, choux chinois, céleri, ciboule, moutarde, haricot mung
- Fruitiers: pomme, poire, agrumes, noix, pêcher, mûrier
- Boisson: thé



Riz
Oryza sativa





Riz cultivés

O. sativa ssp. japonica

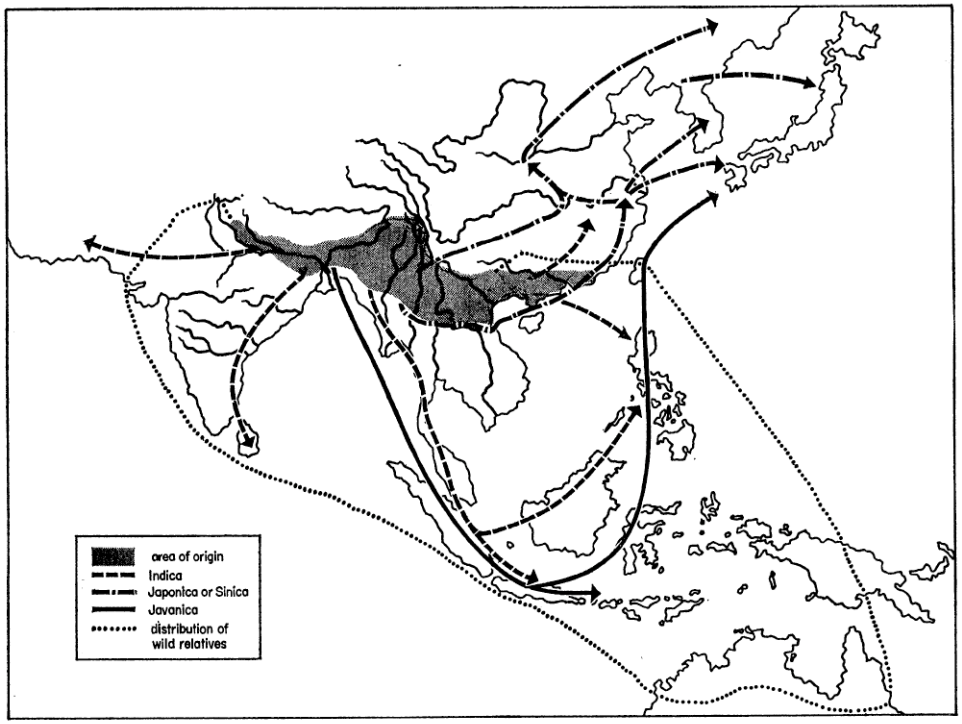


FIGURE 2. Distribution of wild relatives and spread of geographic races of *O. sativa* in Asia and Oceania (adapted from Chang 1976).

Sweeney and McCouch — Rice Domestication

Annals of Botany **100**: 951–957, 2007

« Riz gluant »

Radis daikon
Raphanus sativus

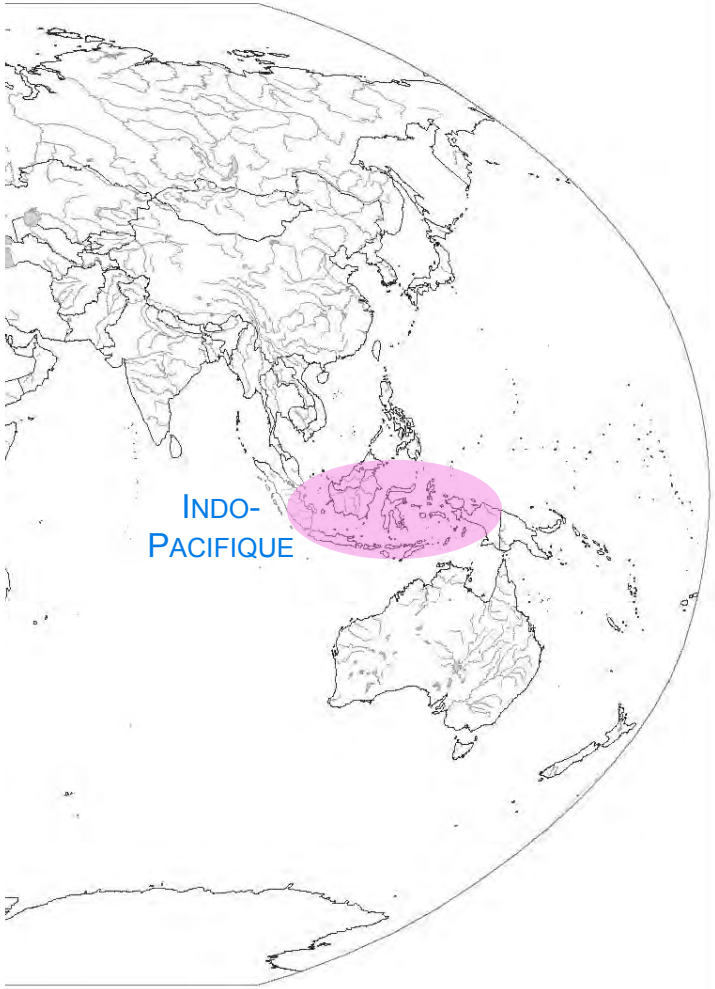
Choux chinois
Brassica chinensis, B. cernua

Haricot mung *Vigna radiata*

Le soja *Glycine max* et ses produits

Indo-Pacifique

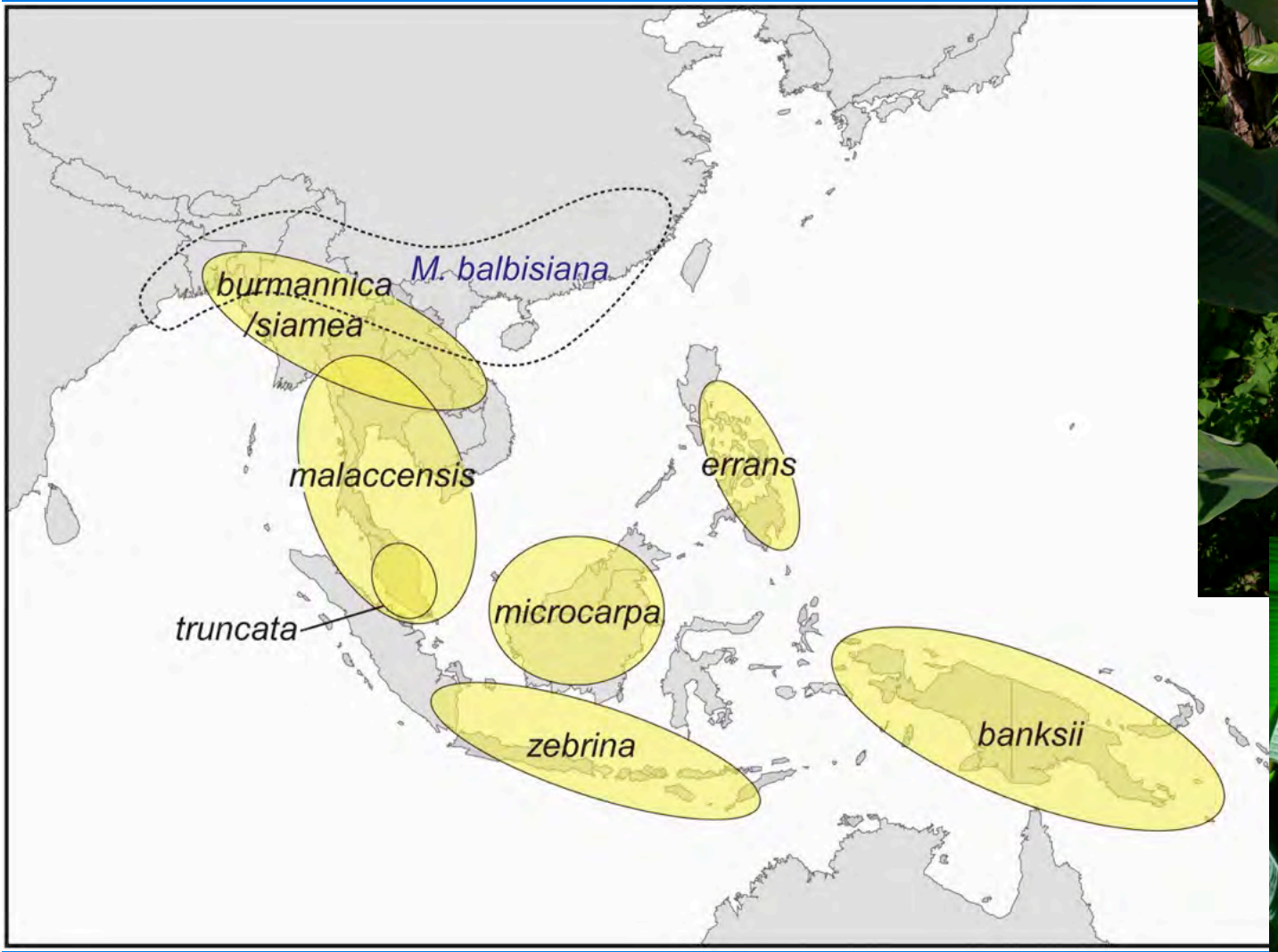
- Féculents: igname, banane, taro, sagou
- Herbacée : canne à sucre
- Fruitiers : arbre à pain, cocotier, manguier,
- Epices : muscadier

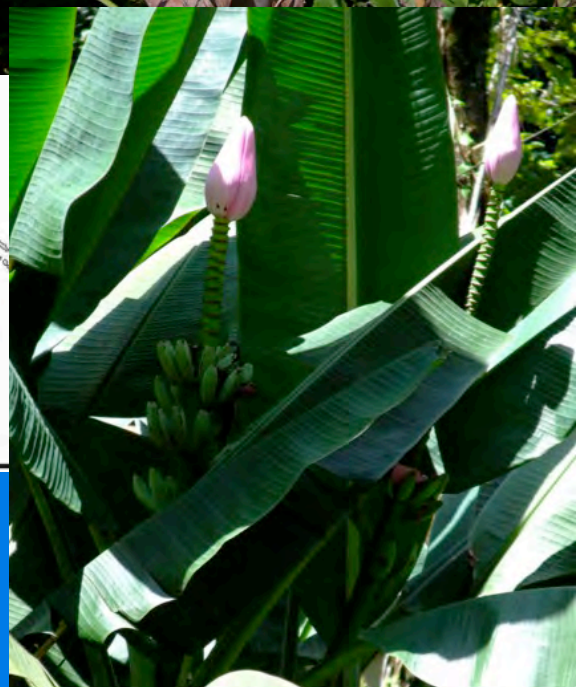


Taro *Colocasia esculenta* (Aracée)

Les bananes *Musa spp.*

Geographical distribution of *M. balbisiana* and subspecies of *M. acuminata*, the wild ancestors of cultivated bananas.



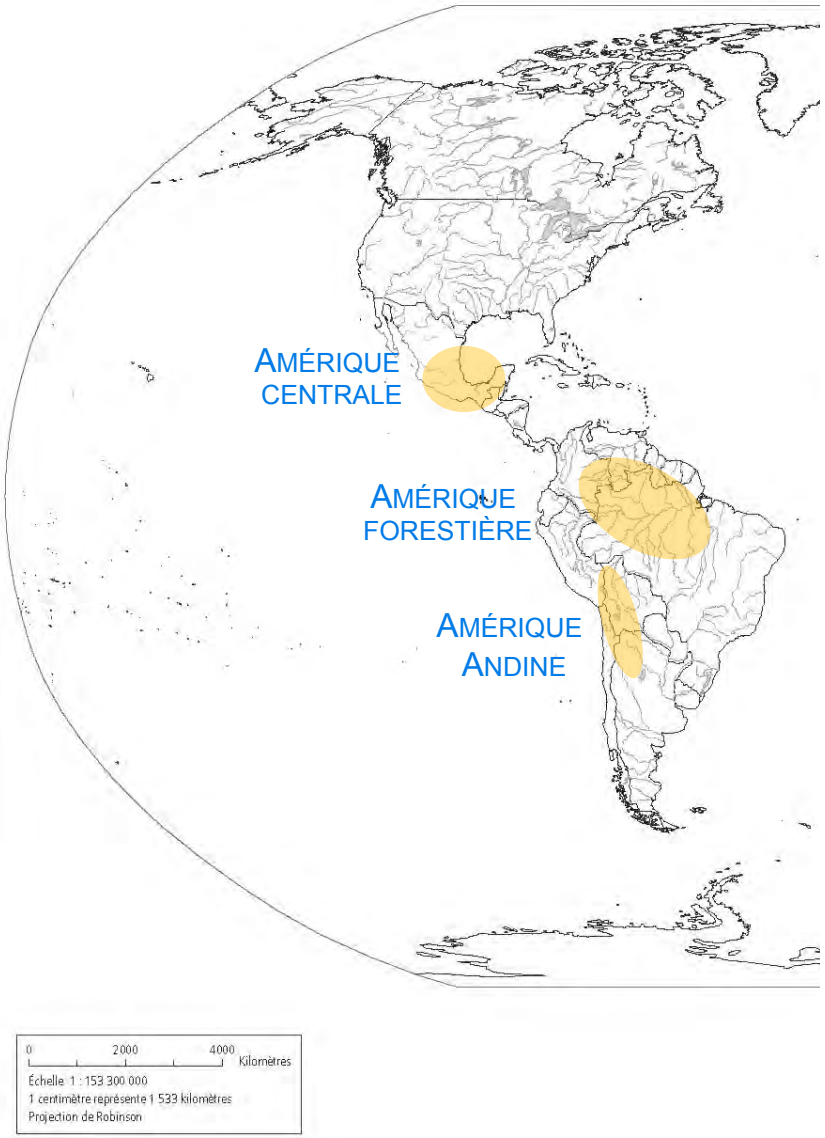


Perrier X et al. PNAS 2011;108:11311-11318

PNAS

Le Jacquier
Artocarpus integrifolia
(Moracée)

Les Amériques



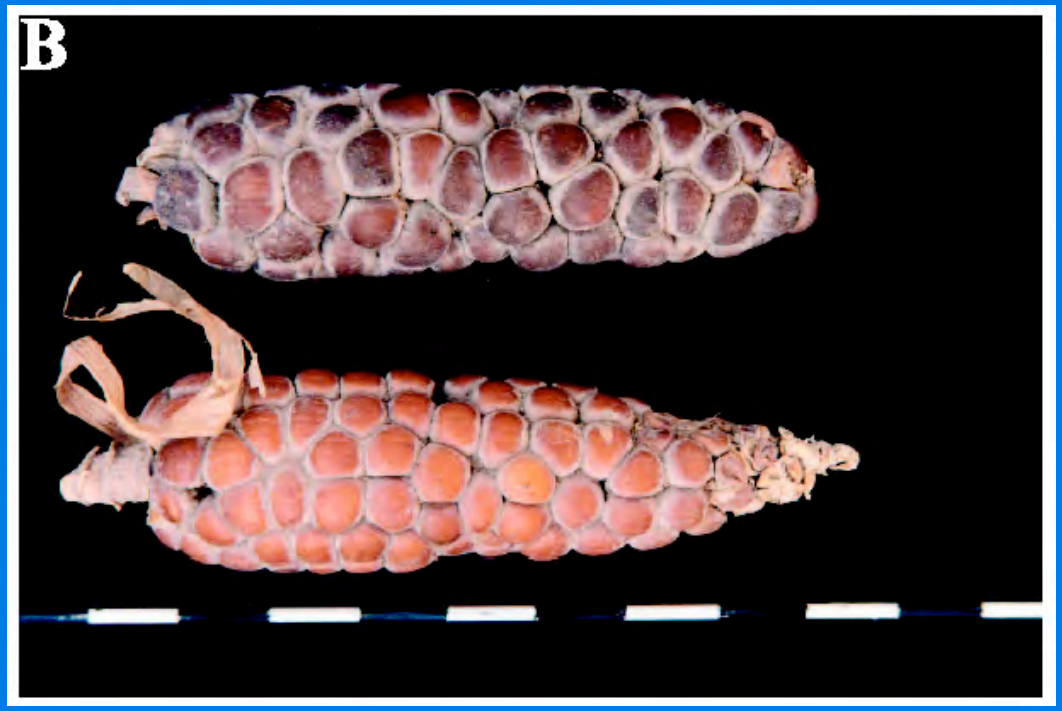
- Céréales: maïs, quinoa
- Féculents: manioc, macabo, pomme de terre, patate douce
- Légumes: tomate, haricot, courge, piments, tournesol, amarante, arachide
- Excitant: tabac
- Epice : vanille
- Arbres: cacao, avocat, papaye, goyave

	Oaxaca 17°	Tehuacán 18°30'	Tamaulipas 23°	Southwest 32°
BEAN	2100	2300	1300	2200
MAIZE	6300	5500	4300	3500
SQUASH	10,000	7,900	6300	3500

Fig. 1. Map of Mexico showing the present-day geographical range of the wild progenitor populations of the domesticated common bean (red) (8) and maize (yellow) (7), as well as the area where wild pepo squash was likely initially brought under domestication, based on archaeological evidence (orange) (14, 15). Also shown are the three areas (Tamaulipas, Tehuacán, Oaxaca) where dry caves have yielded much of the available evidence regarding the early pre-Columbian history of these three major crop plants. The associated chart indicates when domesticated common bean, maize, and pepo squash initially appear in the archaeobotanical sequences of Oaxaca, Tehuacán, and Tamaulipas, which along with the Southwest United States form a south to north transect (note degrees north latitude designations). Expressed in calibrated calendar years ago, the dates of initial appearance of these three major crop plants in these four regions are based on direct AMS radiocarbon age determinations (1, 3, 4, 13–15). The age determination for the initial appearance of pepo squash in Tehuacán is based on an AMS date of 7,100 ± 50 ^{14}C yr B.P. (β123040)—about 7,900 calendar years ago, obtained on seed 201 from Coxcatlán Cave (square 148, level 11, zone XIV).

Smith 2001

Archéologie du Maïs



(B) Preserved maize cobs, 1010 ± 60 years old, from Boquete. The scale bar indicates centimetres. Minas Gerais State, western Brazil.

(Freitas et al. 2003)

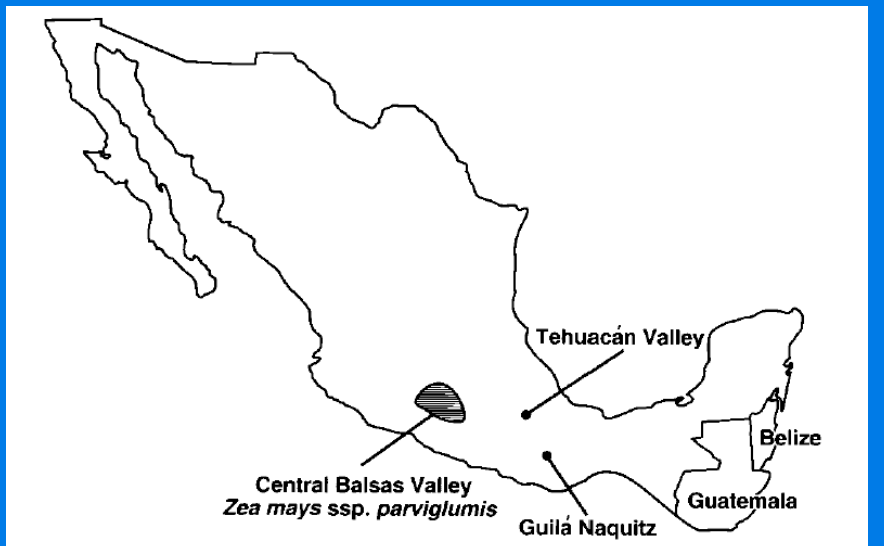


Fig. 1. Map of Mexico showing the location of Guilá Naquitz Cave and the Tehuacán Valley, together with the modern distribution of the populations of *Zea mays* ssp. *parviglumis* from the Central Balsas River Valley, the molecular profiles of which suggest that they are ancestral to maize.

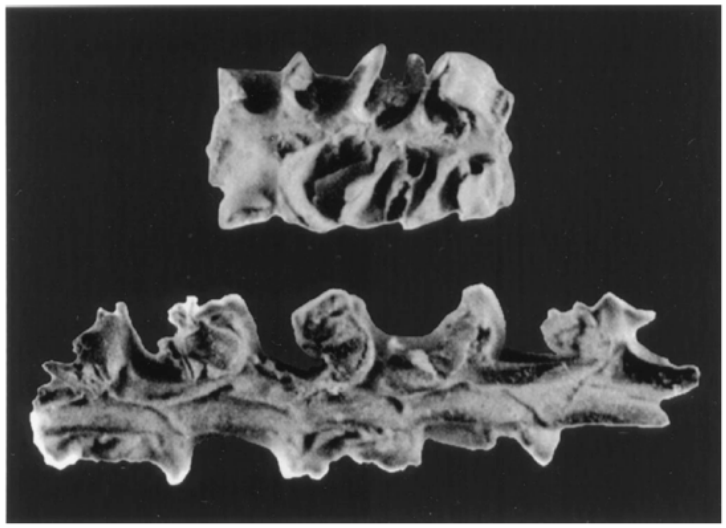
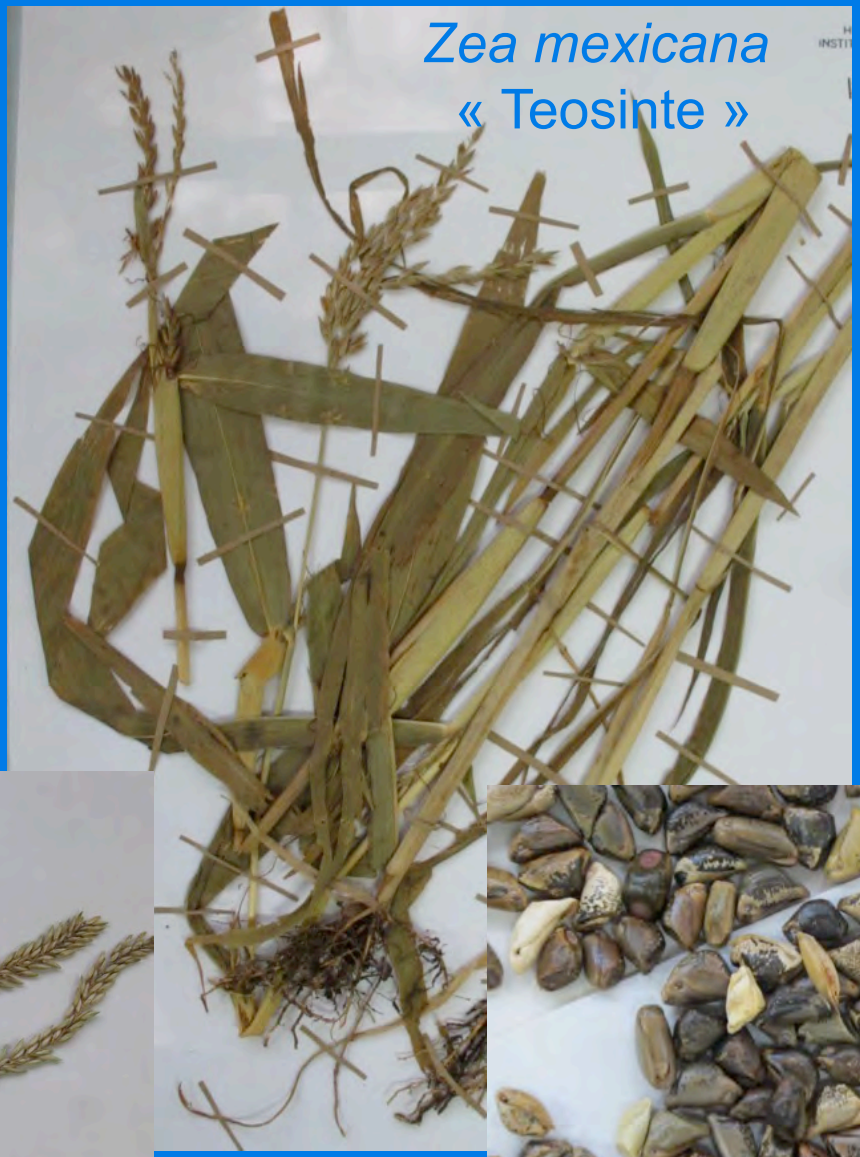


Fig. 2. The two oldest maize cobs in the New World from Guilá Naquitz Cave. The cob at the bottom is from excavation square D10 and is about 2.5 cm long. The cob at the top is from square C9.

(Piperno & Flannery 2001)

Parents sauvages du Maïs

Tripsacum pilosum



Zea mexicana
« Teosinte »

graines

Z. diploperennis

épi

Girolamo Benzoni
(1572)

Modo di fare il pane.


Mexique 2010
ALUHOME

Phaseolus vulgaris

Les courges :
Cucurbita pepo,
C. maxima…

La Tomate

Solanum lycopersicum

Tomate sauvage (Mexique)

Tomatillo (Mexique)
Physalis ixocarpa

Capsicum annuum
Sauvage, Mexique

Les piments

Les piments : un exemple de domestication multiple
Semences de piments à Rio (Brésil)

Pimenta bode amarela (*Capsicum chinense*)

Pimenta dedo de moça (*Capsicum baccatum*)

Pimenta biquinho (*Capsicum chinense*)

Pimenta amarela comprida (*Capsicum annuum*)

Pimenta cumari verdadeira (*Capsicum baccatum*)

Pimenta malagueta (*Capsicum frutescens*)

Pimenta piãozinho (*Capsicum chinense*)

Le Manioc *Manihot esculenta* (Euphorbiacée)

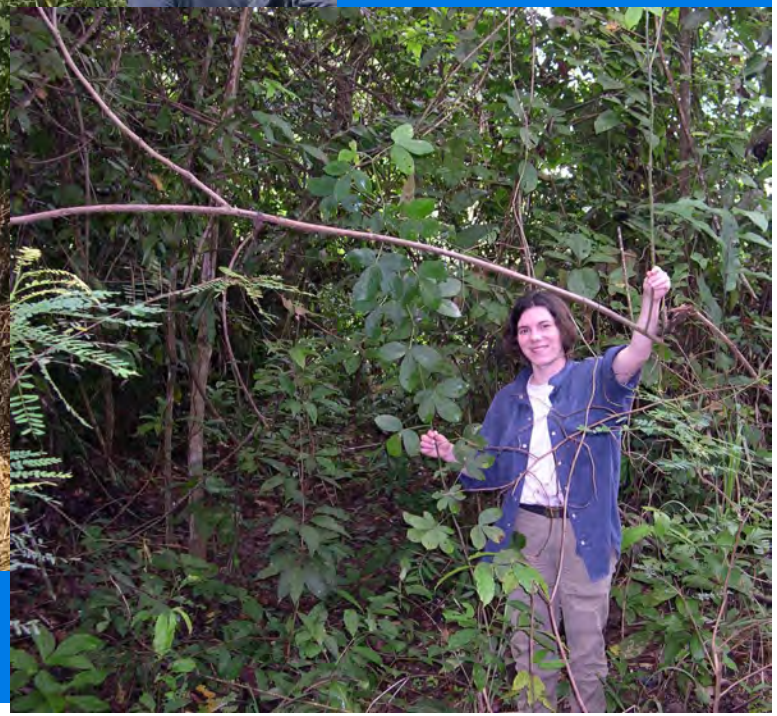

Tapioca
- Origine manioc -
Recette Traditionnelle

Maniocs sauvages au Brésil

Racine tubéreuse

Forme arbustive (savane)

Forme lianescente (forêt)



Cl. D. McKey

Préparations du Manioc en Amazonie

Le Cacao
Theobroma cacao
(Sterculiacée)

Les tubercules des pays andins

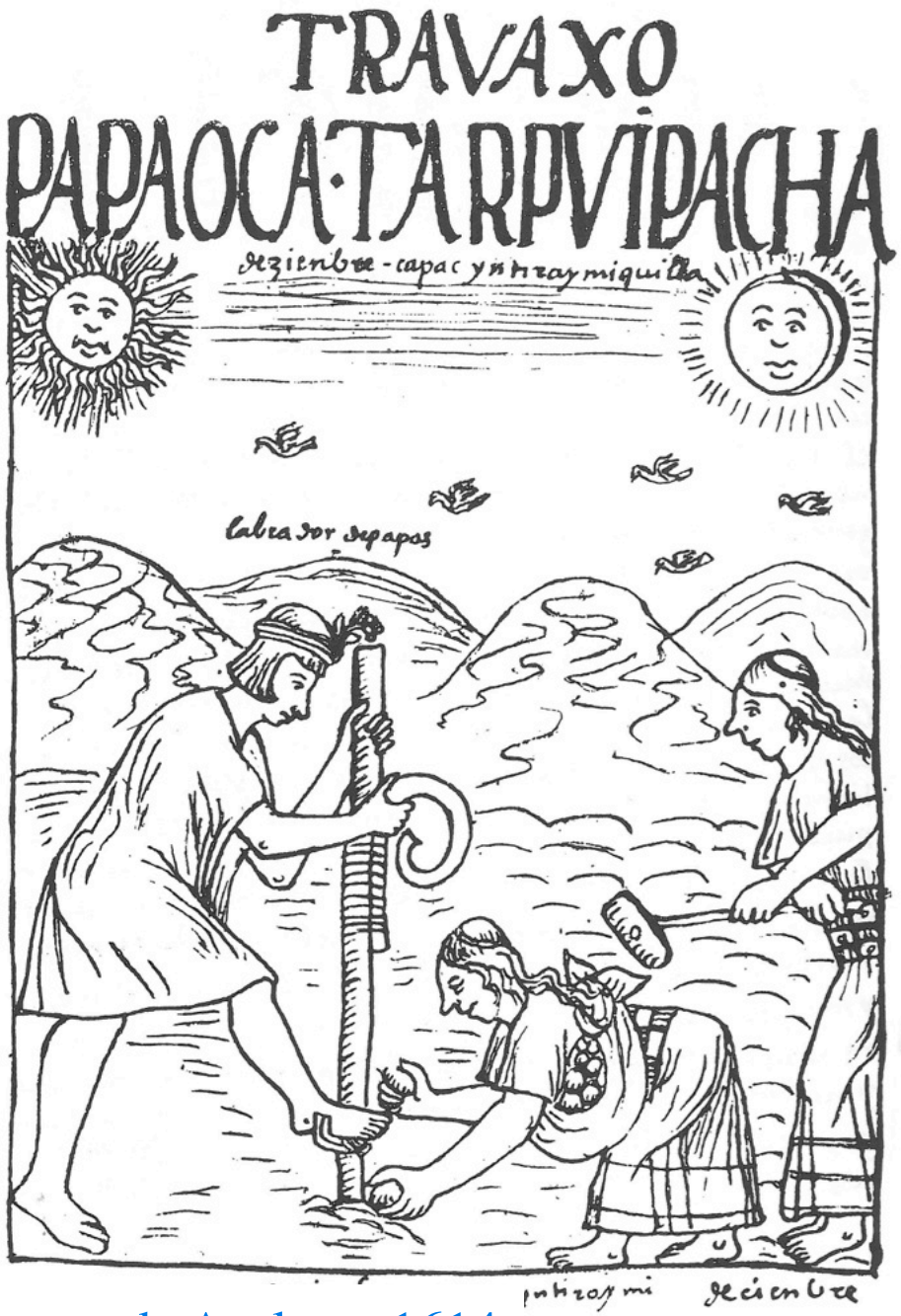
Papas
(*Solanum spp.*)

Ollucos (*Ullucus tuberosus*)

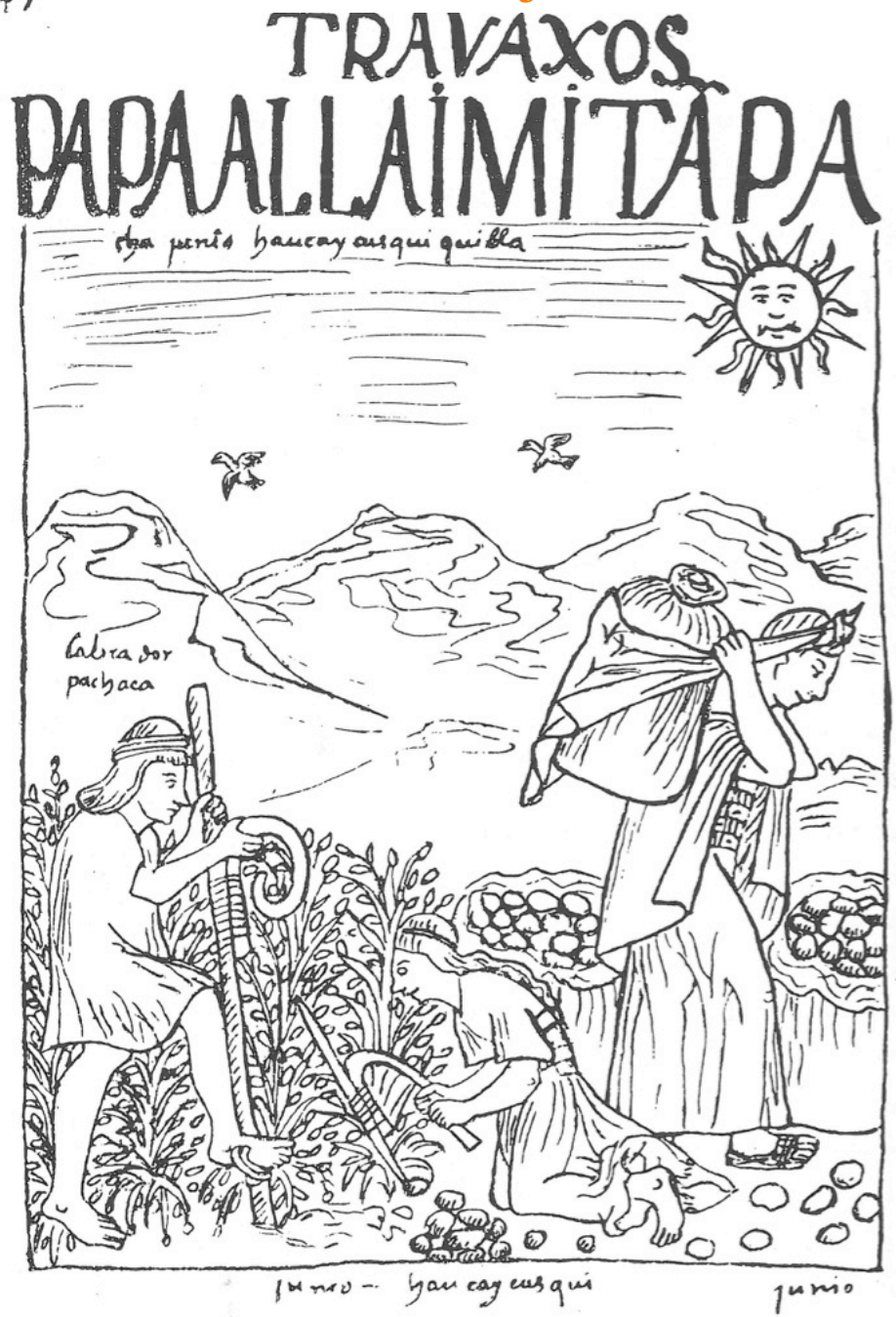
Ocas (*Oxalis tuberosa*)

Mashuas (*Tropaeolum tuberosum*)

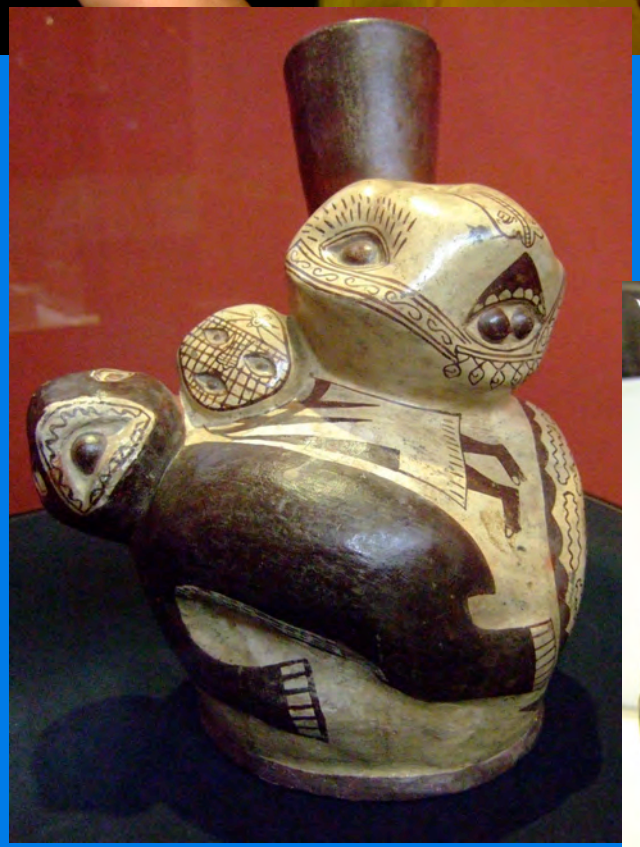
Plantation des *papas*, décembre



La récolte, juin



Poman de Ayala, v. 1614



Moché

Mochica

Chimu

Pérou