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Future prospects of the genetic integrity of two species of okra (*Abelmoschus esculentus* and *A. caillei*) cultivated in West Africa

S. Hamon[1] & P. Hamon[2]
[1] Laboratoire de Ressources Génétiques et d'Amélioration des Plantes Tropicales, ORSTOM, B.P. 5045, 34032 Montpellier Cedex 1, France; [2] CIRAD/IRAT, B.P. 5035, 34032 Montpellier Cedex 1, France

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Summary

A study of the geographical distribution of two species of okra, *Abelmoschus esculentus* and *A. caillei,* shows that both are cultivated in almost all villages from the Gulf of Guinea to the southern limit of the Sahel. If the cultivars of both species, collected in the same village, are sown simultaneously, as often is the case, study of flowering reveals the possibility of interspecific pollination during about 7 weeks to 2 months. Interspecific hybrids can be obtained artificially, but at experimental stations and in the field very low rates of cross fertilization are observed. In addition, the sterility of the F1 hybrids makes their genetic participation in subsequent generations unlikely. In this study, we show that: 1) although grown for the same purpose, the two species are clearly managed as two separate crops by local growers; 2) the conditions which allow gene flow between both crops exist, and 3) the rate of spontaneous introgressions is low. The genetic integrity of the two species does not, therefore, seem threatened and the relative balance between them is mainly tied to the choice of the growers.

Introduction

Okra is a tropical vegetable, probably of Indian origin (Zeven & Zherkovsky, 1975), grown throughout the intertropical and Mediterranean area. In general, only *Abelmoschus esculentus* is grown (Charrier, 1984). However, Chevalier (1940) reported in Guinea an undescribed cultivated okra from (*A. manihot* var. *caillei Chev. var. nov.)* which has since been elevated to the level of a species (*A. caillei* (A. Chev.) Stev.) by Stevels (1988).

The first study of this new species was carried out in the Côte d'Ivoire by Siemonsma (1982a, b). Having only identified 79 *A. esculentus* out of 314 okra samples collected in the Côte d'Ivoire, this author concluded that an unconventional type (*A. caillei*), i.e. an amphiploid of *A. esculentus* (2n = 130–140) and *A. manihot* (2n = 60–65), is replacing the ordinary okra in the humid parts of West Africa. The consequence of such a process would be a marked loss in genetic diversity of *A. esculentus* cultivated in this region. As artificial interspecific hybrids can be obtained (Hamon & Yapo, 1986), the question arose as to whether an invasion by *A. caillei* threatens the existence and the genetic integrity of *A. esculentus.* Two principal factors may affect the relative proportions of the two species selection, by local growers and the absence of genetic isolation.

We have examined samples of the two cultivated okra species in order to study various aspects of the possibility and actual occurrence of gene flow be-

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tween the two species. We have studied: 1) the geographical distribution of the two species in Togo and Bénin; 2) the possibility of overlap of the flowering periods of the two species; 3) the degree of outcrossing under experimental and local conditions; 4) the fertility of interspecific F1 hybrid plants.

Materials and methods

Cultivated okra collection

ORSTOM and I.B.P.G.R. have collaborated during 10 years to improve the scientific knowledge concerning the *Abelmoschus* genus and to increase the genetic resources of okra available in collection (Hamon & van Sloten, 1989; Hamon et al., 1991). Concerning the increase of accessions two procedures were used: 1) specific collecting missions were carried out, as for example in Togo and Bénin (Hamon & Charrier, 1983) and in Thailand (Hamon et al., 1987); 2) during multicrop collecting missions okra samples were also considered. That was the case in Sudan (Hassan et al., 1983, 1985) and in Zambia (Attere et al., 1983).

1807 accessions, corresponding to the two cultivated species, were available for characterization. The breakdown by country is: Bénin (283), Burkina Faso (176), Cameroon (23), Côte d'Ivoire (332), Egypt (29), Ghana (47), Guinea (192), Mali (19), Niger (31), Nigeria (73), Sudan (129), Togo (379), Zambia (24), Zimbabwe (70).

Geographical distribution of the species and cultivars

Species and cultivar identifications were made by investigating progenies. For species, identification was based on morphological characters as defined in the determination grid of Stevels (1988, 1990). For cultivars, two accessions of the same species, collected in the same village, are considered as different cultivars when progenies are homogenous and differ from each other, on morphological and (or) agronomical characters, according to the okra descriptor list (Charrier, 1984). Thus, numbers of cultivars per species and village were counted and the mean number per climatic region was estimated.

Due to the different collecting procedure, it is only possible to have a general overview of the species distribution if we consider the 1807 accessions reported earlier. Data of the collecting mission in Togo and Bénin (Hamon & Charrier, 1983), with a large number of accessions collected mainly in villages, is able to give a more precise information. From a total of 718 accessions collected in these 2 countries, 19 were samples of *A. moschatus* a species cultivated in the south for animism practices, 37 failed to germinate and 87 were characterized by an unsufficient set of seedlings so only 575 were usable for the study of the geographical distribution of the cultivars.

Possibility of simultaneous flowering

The flowering period was established on a representative sample of 1,083 cultivars which originated from different ecogeographical zones of West and Central Africa: 660 samples of *A. esculentus* and 423 of *A. caillei.* During a characterisation trial performed between September and February at the ORSTOM station at Adiopodoumé (southern Côte d'Ivoire – wet tropical climate with two rainy seasons), the 50% flowering day of opening of the first flower was noted on a set of 20 plants per cultivar. During this period all varieties, except those coming from countries situated near the equator (Cameroon), flower without any problem. Control varieties were in our local conditions: ORS 776 (*A. esculentus* – Orig. Mali, 35–40 days), Clemson Spineless (*A. esculentus* – Orig. France Tézier, 60–65 days), ORS 520 (*A. caillei* – Orig. Côte d'Ivoire, 85–90 days).

An okra plant may flower for one to two months, producing one flower on the main stem every two or three days. Flowering continues until the plant stops growth. Young unripe pods, suitable for consumption, are harvested 2 or 3 days after flowering. The duration of flowering is given by the time lapse between the day of the first flowering and the day of the appearance of the first symptoms of apical senescence. In this study, ten cultivars per species representative of the diversity of flowering behaviour were selected (Table 1). For each we have harvested, two times a week, all the pods produced. The relative production per week is calculated as follows: number of pods harvested for a given week/ total number of pods harvested from the first to the last week of flowering.

Degree of outcrossing

For calculating the degree of outcrossing we count the number of hybrids identified in the progeny, when a plant (mother plant) of a given cultivar is isolated in a field where is grown another cultivar (pollen donor). Two tests were performed. In one the pollen donor is the cultivar ORS 520 (*A. caillei*) for which interspecific hybrids plants with *A. esculentus* are easy to identify. In the other, the pollen donor is the cultivar ORS 803 (*A. esculentus*) which have a red stem. In controlled progenies, this red colour is dominant over all green stems. Considering that a flower of a green variety, used as mother plant, only has the possibility to be self-fertilized or cross-fertilized by pollen grains from ORS 803, plants generated from cross-fertilization will be red and plants coming from self-fertilization will be green.

In each test, the following arrangement was used: in the unit plot (12 × 15 m) plants distance was 0.5 m × 0.5 m (720 plants). Eighteen mother plants of *A. esculentus* were uniformly distributed. Any pod formed before all plants had produced at least one flower were removed. Insect pollination was allowed to proceed unhindered for one month, and was then stopped by cutting off all young buds likely to produce flowers subsequently. After pod ripening, cross-fertilization was calculated on the basis of the number of hybrid plants after sowing of seeds collected only from the mother plants. In this way, 13,734 seedlings were observed.

During characterisation of the samples collected in Africa, we noted in 1807 samples the presence of natural interspecific hybrids in the sowings (30 plants per accession). This allowed estimation of the degree of outcrossing under local conditions.

Sterility and seed composition of pods

The interspecific hybrid plants are not fully sterile and exhibited low and irregular fruiting. The flowers were regularly sampled, from the start of flowering, for six consecutive weeks. Each week the proportion of pollen grains with abnormal cytoplasm was estimated. For the eight most fructiferous plants, a note was made of the positions on the main stem of the flowers which set. After pod ripening, the total number of seeds and the number of seeds with an embryo were counted.

Table 1. List of okra cultivars used for the test of flowering overlap

Accession number *A. esculentus*	Country of origin	Collector number	Accession number *A. caillei*	Country of origin	Collector number
Clemson spineless	Variety	–	372	C. Ivoire	SIE-E.012
1134	Togo	HCS-223.A	451	C. Ivoire	SIE-F.042
1135	Togo	HCS-223.B	520	C. Ivoire	SIE-F.013
1147	Togo	HCS-230.B	979	Togo	HCS-111
1246	Togo	HCS-279.B	1256	Bénin	HCD-001
1372	Bénin	HAH-105	1378	Bénin	HAH-111
1397	Bénin	HAH-128	1384	Bénin	HAH-117
1462	Bénin	HAH-185	1557	Bénin	HAH-259
2153	Sudan	HSD-134	1572	Guinea	KA-009
2163	Sudan	HSD-186	2415	Guinea	CL-334.A

Results

Geographical distribution of species

The mean numbers of okra cultivars (per species and village per region) collected in Togo and Bénin are given in Table 2. The two species are cultivated throughout this geographical area. In Togo, the mean number of cultivars of *A. esculentus* per village increased from 1.1 in the preforest south (coastal region) to 4.2 in the north (savannah). The number of *A. caillei* cultivars was 2.3 per village in the central regions of Togo (Centre and Plateaux) and 1.1 in the driest area in the north. *A. caillei* is grown less in Bénin, the frequency per village was lower than in Togo, and remained quite constant throughout the country (0.9). The number of *A. esculentus* cultivars followed a progression comparable to that in Togo, and increased from 0.9 in the south (regions of Mono and Ouémé) to 2.9 in the north (region of Atakora). It can therefore be seen that the two species exist sympatrically in Togo and in Bénin.

Possibilities of flowering overlap

The samples of *A. esculentus* from the Sahel (higher than 14° N) or the forest-savannah transition zone (8 to 12° N) produced their first flower between 40 and 50 days after sowing. Those collected from the forested areas (4 to 8° N) flowered some ten days later. The samples of *A. caillei* were from the transition zone or from the forested area. They began to flower 60 to 70 days after sowing. Only a few samples, native from Cameroon where growing conditions are different (shorter days), remained vegetative.

In Table 3 are recorded the flowering periods observed for 10 *A. esculentus* and 10 *A. caillei* cultivars sown simultaneously. Flowering started 6 weeks after sowing and continued until the 25th week. From the 6th to the 10th week, only *A. esculentus* flowered. There was no risk of outcrossing for about 70% of the flowers. After the 18th week, only *A. caillei* flowered and this corresponds to 30% of its flowers. Hence, if the species are sown at the same time, as it is often the case in May-June at the beginning of the rainy season, the overlap of flowering may extend to seven weeks and the conditions for outcrossing are met. During the period of overlap 22% of the total *A. esculentus* flowered simultaneously with 61% of *A. caillei* flowers.

Table 2. Breakdown of collected cultivars by country, region and village

Country Region	Number of villages	Total number of cultivars	*A. esculentus* mean per village	*A. caillei* mean per village
TOGO				
Maritime	12	36	1.1	1.8
Plateaux	23	100	1.9	2.4
Centrale	28	120	2.0	2.3
Savanes	14	74	4.2	1.1
BENIN				
Mono-Ouémé	18	29	0.9	0.7
Zou	16	41	1.7	0.9
Borgou	26	91	2.6	0.9
Atakora	22	84	2.9	0.9
Total	159	575		

Degree of outcrossing under experimental and local growing conditions

Under experimental growing conditions, when *A. esculentus* (ORS 803) was the pollen donor, 19 intraspecific hybrids were identified among 7,709 plants examined. The mean number of cross-fertilization was 2.5 hybrids per thousand seedlings. When *A. caillei* (ORS 520) was the pollen donor, five interspecific hybrids were identified among 6,025 plants examined. The mean frequency of cross-fertilization was 0.8 per thousand seedlings. Under these conditions, highly favourable for outcrossing, the mean frequency was low, about two per thousand in intraspecific crosses and less than 1 in interspecific crosses.

For samples harvested under local growing conditions, during the characterisation of 1,807 samples collected, mainly in West and East Africa, systematic note was made of the presence of interspecific hybrids in the progenies (30 plants per progeny), i.e. 54,210 plants. In 18 progenies (Table 4) from Bénin, Burkina Faso, Guinea, Togo, Sudan, a total of fifty-one natural hybrids were identified, i.e. a frequency of one per thousand. They were found, except for the sudanian accessions in countries where the 2 species were collected. The frequency of pods fertilizated by interspecific pollen is about 1%. Pollen exchanges therefore occur between the two species under natural conditions, although infrequently, in agreement with the limited exchanges we noted at experimental stations.

Table 3. Flowering overlap period between *A. esculentus* and *A. caillei*

Weeks after sowing	*A. esculentus* Percentage of flowering Partial	Total	*A. caillei* Percentage of flowering Partial	Total
6	5			
7	10	15		
8	20	28		
9	22	48		
10	13	70		
11	5	83	6	
12	4	88	7	13
13	4	92	12	25
14	1	96	11	36
15	2	98	10	46
16	1	99	11	49
17	1	100	11	61
18			10	71
19			10	81
20			9	90
21			5	95
22			1	98
23			1	99
24			0.5	99.5
25			0.5	100

Fertility of interspecific hybrids

In each species, every flower resulted in a single pod, accidents apart. This was not so for the interspecific hybrids, in which numerous abortions were noted. The distribution profile of the pods formed, for all plants that formed at least 22 nodes, is shown in Fig. 1. Between the first and seventh nodes (from the neck), 70% of the plants branched, which automatically excluded flower formation. Beyond the seventh node, on the main stem, the frequency of setting increased regularly towards the apex, but did not exceed 50%. This often led to plants with a particular appearance: a

Table 4. Breakdown of cultivated species and hybrids collected in Africa

Country	Area	*A. esculentus*	*A. caillei*	Hybrid	Total
Bénin	West	213	64	6	283
Burkina Faso	West	144	30	2	176
Cameroon	Central	0	23		23
Côte d'Ivoire	West	88	244		332
Egypt	North	29			29
Ghana	West	24	23		47
Guinea	West	97	94	1	192
Mali	West	19			19
Niger	West	31			31
Nigeria	West	49	24		73
Sudan	East	128		1	129
Togo	West	206	165	8	379
Zambia	South	24			24
Zimbabwe	South	70			70
Total		1122	667	18	1807

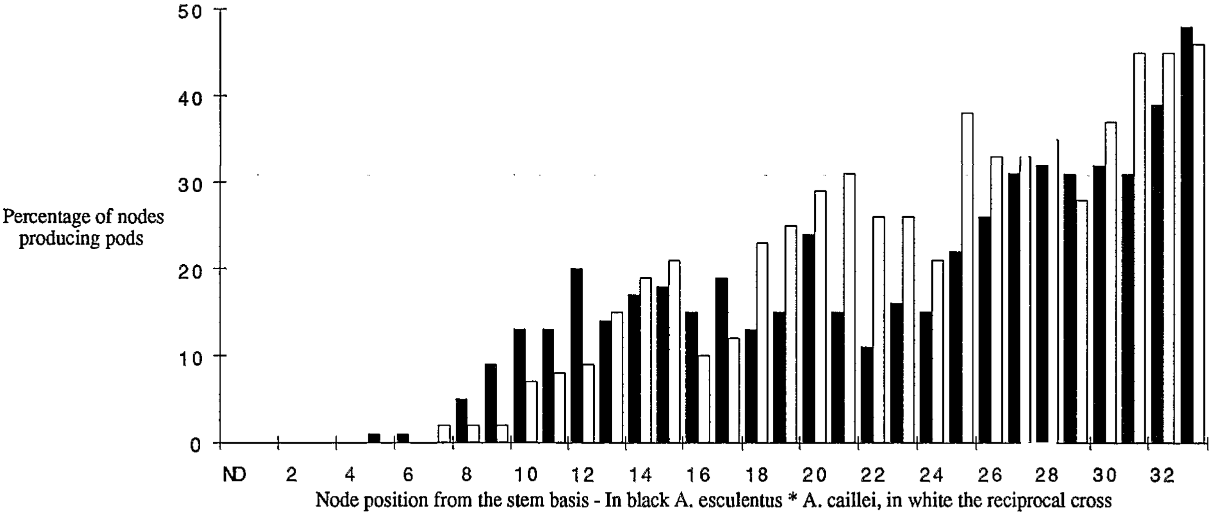

Fig. 1. Pod production of okra interspecific hybrids according to the position of the nodes on the main stem.

principal stem largely devoid of pods (or two or three pods randomly distributed along it), with three to five pods formed near the apex just before the start of the senescence phase. The plant was then in the form of a long stem with a cluster of pods at the top. Little fruiting occurred in the interspecific hybrids, but was sometimes erratic during development and often led to pronounced fruiting at the end of the cycle.

Flowers of hybrid plants were sampled for six consecutive weeks, after the start of flowering. The total number of pollen grains per anther and the proportion of pollen grains with abnormal cytoplasm were noted. Figure 2 shows the number of fully developed pollen grains per anther. A cut-off level is apparent corresponding to a value of 70 stained pollen grains per anther. Above this value there was a positive correlation between the number of stained grains and the total number per anther. Below this value, there was no evident relation between the two variables. The number of fully developed pollen grains varied between 5 and 20%, but did in some exceptional cases reach 60 to 70%, for reasons unknown. As full developed grains were not necessarily viable, male fertility was very low. The pollen sterility of the hybrids was certainly one of the important factors in poor fruit set. In this respect it is difficult to correlate the observed fluctuations and the erratic character of setting, but such an examination would certainly be of interest.

The number of seeds per pod was counted in 135 pods produced under conditions of free pollination, corresponding to the full production of eight F1 plants. Each seed was cut open to verify the presence of an embryo. For a fertile species, the number of seeds per pod ranged between 60 and 150, depending on the cultivar, and rare exceptions apart all grains had embryos. The interspecific hybrids had no more than ten or so seeds per pod, one in ten of which had an embryo. To obtain a general overview of the sterility, we pooled all the seeds harvested on 110 F1 interspecific plants and we only obtained 17 F2 plants. The reproductive potential of the F1 hybrid plants is very limited.

Discussion and conclusions

Unlike other areas of okra cultivation, in West Africa there are two species, *A. esculentus* and *A. caillei.* Our results show that in Togo and Bénin the two species are grown in almost all villages, even if the relative frequency varies from north to south and from one country to another. At the West African level, the analysis of nearly 2,500 accessions indicates that these 2 species are grown sympatrically over about five degrees of latitude from

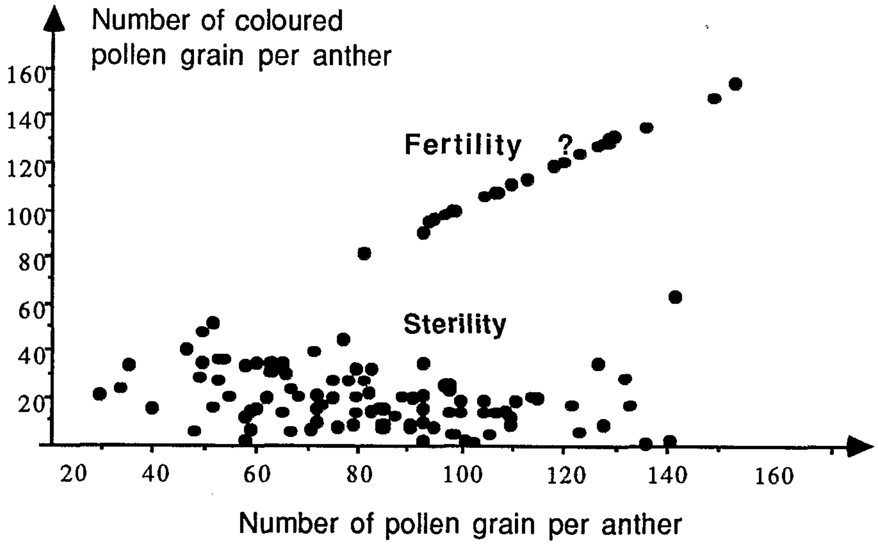

Fig. 2. Relationship between total and coloured pollen grain per anther.

Guinea to Cameroon (Hamon, 1988; Hamon & van Sloten, 1989). The problems of preservation of genetic integrity, and of the risk of loss of crop diversity, therefore arise.

Origin and domestication of A. caillei

A. caillei on the basis of our data and in agreement with Stevels (1988) can be considered as endemic to West and Central Africa. The european herbarium survey does not give contradictory information even if cultivated forms are not well represented (Hamon & Charrier, unpublished). This species presents a large number of morphological similarities with *A. esculentus* but differences are well marked for flower characteristics, plant phenology and architecture. What is the origin of these differences?

Siemonsma (1982b), according to chromosome numbers and the calicule shape, suggested that *A. caillei* could be an amphiploid between *A. esculentus* and *A. manihot.* Martin (1982) is not in agreement with this hypothesis because his experimental interspecific hybrids between *A. esculentus* and *A. manihot* ssp. *manihot* are too different from *A. caillei.* We have made such hybridization with samples coming from the USDA collection (Puerto Rico) and from Thailand (Hamon et al., 1987). Two situations were observed: the obtention of hybrid is nearly impossible with *A. manihot* spp. *manihot* but is very easy with *A. manihot* spp. *tetraphyllus* (Hamon & Yapo, 1986; Hamon, 1988). Hybrids seems to be similar to those obtained by Jambhale & Nerkar (1981) but do not correspond to *A. caillei.*

A. moschatus and *A. manihot* are sympatric in South East Asia and Indonesia (Charrier, 1984). Relictual cultivation of *A. moschatus* in the south part of Togo and Bénin is reported here. This species was certainly introduced by navigators, in the Gulf of Guinea, a few centuries ago. *A. moschatus* has not escaped from cultivation and is only maintained in a very limited number of villages for animism practice and consequently can rapidly disappaer. Despite that *A. manihot* is not found today it is possible that it was introduced simultaneously. Hutchinson & Dalziel (1958), in the flora of West Africa, mention wild forms of *A. manihot* in Sierra Leone. In Guinea, country next to Sierra Leone, accessions of *A. caillei,* collected in the triangle delimited by Faranah, Kissidougou and Mandiana, present prickly hairs on pods and seeds (Hamon et al., 1986), characters which are frequent in *A. manihot.*

The lack of publication on the isoenzymatic polymorphism of okra cultivated species is certainly due to the fact that the polymorphism is very limited. The two cultivated species, high polyploids, are nearly monomorphic and express very similar patterns (Hamon, 1988; Hamon & van Sloten, 1989). Diagnostic electromorphs of *A. manihot* are absent in *A. caillei* but present in F1 artificial interspecific hybrids. So, if *A. caillei* is issued from such hybridization, the actual varieties are the result of a serie of back-crosses on *A. esculentus*. This needs that ancestral forms were more allogamous than actual varieties and that *A. manihot* genotypes were different from what scientists have used for their experimental hybridization. To our knowledge the probability to refound the original type in West Africa seems low.

Reproductive barrier and genetic flow

The relationships between the number of pollen grains/number of ovules and the breeding system is defined by Cruden (1977). Cultivated okra species, *A. esculentus* and *A. caillei*, have self compatible flowers. The calculation of their pollen/ovule ratio indicates a breeding system situated between obligate autogamy and facultative autogamy (Hamon & Koecklin, 1991a). In such system, the time at which the allo-pollen is deposited is of great importance. Pollen grains which arrive after midday have only a very little chance of contributing to fertilization (Hamon & Koechlin, 1991b).

The two cultivated species are grown simultaneously. Observations on the phenology of flowering predict serious risks of outcrossing for about two months. However, due to low levels of inter-fertilization, the frequency of hybrids obtained under both experimental and local growing conditions is very low. If outcrossing occurs between the two species, the production of hybrid seeds and F1 hybrid plants is important. They express, for pod and seed production, a high, but not complete, level of sterility. Madhusoodanan & Nazeer (1986) and Fakotun (1987) have observed during the meiosis of identical hybrids, at the early phase of metaphase I, few chromosomes separating, as univalents, and microspores which have very variable sizes. Finally in the field, according to the high sterility and the low intercrossing levels, these plants have an extremely low chance of producing F2 plants by selfing or back-crosses. The participation of such F1 hybrids in the subsequent generation, without human selection, is likely minimal. During different field trips in West Africa, we never have seen a grower making special attention (or selection) to such hybrid.

The risk perceived by Siemonsma (1982b) of an unconventional type replacing *A. esculentus* is therefore explained by a sampling bias. This example demonstrates the importance of the collection of samples in villages and the need of a rapid preliminary evaluation of collected samples. However, if the genetic integrity of the two species is maintained through a marked restriction of interspecific hybridization and pronounced sterility of the hybrids, it may be that there is a risk of disappearance of one of the two species due simply to human preference.

Management of local varieties

In West and Central Africa, okra varieties are traditional and have been empirically selected for pod consumption in ecological conditions which go from tropical rain forest to savannah. On which basis are the growers managing local varieties and how are they taking into account the two cultivated species?

Okra accessions, corresponding to a large pod diversity, were collected in Togo and Bénin (Hamon & Charrier, 1983). These countries are characterized by a mosaic of small ethnic groups (more than 40 in Togo). After translation of the vernacular names, with the help of local conterparts, it was showed that they are composed by a binomic name with a generic name (the name of okra in the local language) and a specific name. This later is given, by decreasing frequencies, according to the following criteria: 1) the length of the cycle or the harvesting period, 2) the pod shape or aspect, 3) miscallenous aspects of the plant (leave color or shape, plant architecture), 4) animism practices, 5) associated crops, culinar particularities, traditionnal or introduced variety (Hamon, 1988).

In this context, how are they taking into account the differences between the two cultivated species? In Table 5 is reported a synthetic view of the vernacular names, most commonly used, and their species correspondance. It appears that *A. caillei,* except for unmentionned rare or minor local types, is mainly considered as the 'dry season okra'. It is far to be the same for *A. esculentus* which is characterized by more identified types with specific names such as antilope horn like (pod length from 25 to 45 cm long), agouti Check like or bachelor's okra (width pod from 3 to 5 cm), 'millet okra' (Mosse Mana in Kabye, cultivated in association with *Pennisetum typhoides*). As a consequence, *A. esculentus* is called 'rainy season okra' only when the variety is standard. Concerning the third cultivated species (*A. moschatus*), varieties found in the south part of Togo and Bénin are very similar and identified by a specific names Sinkon (Fon), Eko-Fétri (Ewe), Egbi (Nago) which means that it is reserved for animism practice.

The management of local varieties is very diversified in West Africa. At present then, it would seem that neither species is threatened by disappearance. Low input agricultural systems makes them vulnerable to outside influences such as the introduction of seeds, fertiliser or new agricultural practices (Astley, 1987). This risk certainly exists in a crop like rice. In West Africa, there is currently a progressive disappearance of *Oryza glaberrima,* a traditional cultivated species, which is being replaced by *O. sativa,* an Asiatic species comprising a large number of selected varieties (Bezancon et al., 1989). This is not due to pronounced introgression since hybrids of the two species are very difficult to obtain (Pham & Bougerol, 1989). In this case, the growers are aware of the superior agronomic performance of *O. sativa.*

Risks with the introduction of improved varieties

As seen earlier, local growers do not cultivate the two species as competitors, but rather as complements like different crops. However, this situation could change radically if one or several, highly productive, cultivars were to be introduced. Improvement and diffusion must, therefore, be well reasoned.

To our knowledge only a few varieties such as Clemson Spineless and Perkins Long pods have been introduced in West Africa. They are well adapted and mainly used for market production during the dry season. Meanwhile these varieties have several drawbacks: 1 – They are very susceptible to Okra Leaf Curl Virus transmitted by the white fly *Bemmissia tabacci.* Between March and June this disease can destroy all the plants and reduces the pod harvest to zero; 2 – These cultivars, compared to landraces, need too much agronomic inputs, insecticide treatments and too frequent har-

Table 5. Examples of Okra vernacular names and species correspondence

Ethnic groups	Region and country	Okra generic name	Okra vernacular names most commonly used			
			Rainy season okra *A. esculentus*	Dry season okra *A. caillei*	Antilope Horn *A. esculentus*	Bachelor's okra *A. esculentus*
Adja, Ewé	Sth. Togo & Bénin	Fétri	Dikabé	Gbodro	Ezizo	Agbonou
Kabye	Ctr. & Nth. Togo	Mana	Yelo-Mana	Logoye-Mana	Gnao-Mana	Kpassa-Bole
Gourma, Moba	Nth. Togo	Mana	Machio	Man-Falé (or Fali)	Kpassa-Coba	
Idacha	Ctr. Bénin	Ila	Ila-Odjo	Ila-Orun	Eou-Egbi	Ideti-Eou
Bariba	Nth. East Bénin	Koupé	Hourou-Koupé	Soun-Koupé	Kpassa-Coba	
Boussa	Nth. East Bénin	Kpé	Ounboun-Kpe	Kpe-Soungna	Kpassa-Coba	Kpé-Outéré
Dendi	Nth. West Bénin	Lafé	Kédi-Lafé	Djéou-Lafé	Guéli-Hili	

vest; 3– Their pods are considered by people living in the country as insufficiently muscillaginous for their purposes; 4 – The producing period, of about 1 month only, is too short compared to landraces, particularly of *A. caillei* but also of some *A. esculentus* which can produce during 6 months.

With plants, like cultivated yams, which have a vegetative multiplication, the problem can be dramatical and can lead to a very strong and rapid genetic erosion. Indeed, traditionally in West Africa, at least two to three species are co-cultivated (Hamon, P. 1988; Hamon & Touré, 1990a, b). The relative importance of the species and cultivars is linked to the restrictions imposed by the grower (sale, best response to climatic risks, storage, possibility of unsupported growth, culinary tastes, ritual ceremonies). Given the method of multiplication, the introduction and massive distribution of one clone may lead within a year to the total and definitive disappearance of yam landraces because farmers cannot store tubers more than one year. The situation is different with okra since in West Africa there is practically no diffusion of selected (or improved) varieties of *A. esculentus* and *A. caillei.* The risk only exists for *A. mochatus* but without alimentary impact.

In conclusion, this study shows that two species can only be sustained in sympatry if two conditions are met: 1 – There must exist a strong reproductive barrier between the two species as is the case; 2 – The growers must prefer to grow both the species. Otherwise, there is a marked risk of loss, which could be rapid.

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