THE OCCURENCE OF A HYBRID SWARM INVOLVING *O. LONGISTAMINATA* A. CHEV. ET ROEHR., *ORYZA GLABERRIMA* STEUD. AND *ORYZA SATIVA* LINN. IN JEBBA, NIGERIA.

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ABSTRACT

A hybrid swarm involving O*ryza longistaminata*, *O. glaberrima* and *O. sativa* was discovered at Jebba in Nigeria. A preliminary study in 2000 paved the way for this study which used extensive morphological and anatomical markers to identify and characterise putative hybrids and their advanced generation segregants.
The factors favouring the occurrence of the hybrid swarm were identified as the existence of large population of *O. longistaminata* as natural vegetation in this location, peasant farming based on *O. sativa* in cleared plots inside *O. longistaminata* leading to interphases between cultivated rice (*O. sativa* and *O. glaberrima*) and the wild. The key favourable husbandry practices identified are minimum tillage, harvesting by straw-clipping, saving of hybrid forms on the plot at harvest and ratoons from harvested crop both allowing for introgression, and the timing of the planting of the rice crop which synchronizes with the flowering of *O. longistaminata* about September. Inspite of the upsurge of rice farming in this location, *O. longistaminata* still grows around natural impoundments which the peasant farmers still sustain. The population dynamics of the three rice species arising from the factors identified are discussed. The stability and the future of their hybrid swarm are speculated.

Key words: O*ryza longistaminata*, *O. glaberrima, O. sativa*, Hybrid Swarms, Peasants, Population Dynamics.

INTRODUCTION

The O*ryza longistaminata* population at Jebba (09° 08"N: 04° 50"E, Nigeria) was discovered in 1993 (Faluyi and Nwokeocha, 1993). It consisted of populations of the wild rice occupying wetlands (fadama) around natural impoundments. Aladejana (2000) reported the occurrence of a small population of *Oryza glaberrima* making an interphase with a small population of *O. sativa* in the largest of these populations. In 1993, the fadama in Jebba sustained small pockets of peasant rice holdings which had since developed into larger holdings (Faluyi and Nwokeocha, 1993).

Nwokeocha (1998) reported the occurrence of interphases between cultivated rice and its wild relatives in all the agroecologies of Nigeria. An *O. punctata*-*O. sativa* interphase was found in Sekona (7° 23"N: 4° 12"E, Nigeria). Faluyi and Nwokeocha (1992) reported the occurrence of a tetraploid population of O. punctata in Ipetumodu, Nigeria (7° 30"N: 4° 45"E) which showed genetic uniformity. The model for the population dynamics worked out by Faluyi and Nwokeocha (1992) for the Ipetumodu population of tetraploid *O. punctata* showed that there was an active component of the seed bank from which new generations could be regenerated in case their rootstocks were destroyed through the activities of man. There was evidence that mud preserved the active component of the seed.

Surveys since 1981 have shown that *O. sativa* is cultivated all over the agroecologies of Nigeria and it is the only cultivated rice species, having displaced *O. glaberrima* which are now treated as weeds on *O. sativa* farms or as pockets in the wild. *Oryza barthii* is restricted to the low-lying swamps of the Northern Guinea Savanna; *O. longistaminata* is restricted to the fadama and flood plains of the Middle Belt of Nigeria (largely in the Southern Guinea Savanna Zone) while *O. punctata* which is distributed throughout Nigeria is tetraploid (BBCC) in the Forest/Derived Savanna of Southern Nigeria and diploid (BB) in the Savanna of Northern Nigeria (Nwokeocha, 1992; Faluyi and Nwokeocha, 1993a). In all the agroecologies surveyed, cultivated and wild rices were found growing together to a greater or lesser extent creating wild-cultivated interphases. An *O. punctata*-*O. sativa* interphase has been reported in Sekona; in the Middle Belt, *O. longistaminata* is usually cleared

to grow *O. sativa* giving rise to extensive interphase between the two species throughout the zone beginning from Jebba.

There was no obvious evidence of hybridization between the tetraploid *O. punctata* and the *O. sativa* at Sekona. No hybrid was observed between *O. sativa* and *O. longistaminata* at Bida (09° 05" N: 06° 01"E, Nigeria) where interphases between the two species were observed. In all the surveys, no interphase was found between the wild rices, which can be attributed to the fact that they grow in specified agroecologies across Nigeria. Another member of the A-genome, *O. barthii*, is usually found in the Northern Guinea Savanna. Aladejana (2000) observed that rice farming was more intense in Badeggi leading to regular disturbance of fallow land thus making the establishment of hybrids more difficult inspite of the large interphase of *O. sativa-O. longistaminata* that existed in the location.
This paper reports the occurrence of a hybrid swarm at Jebba, Nigeria. It discusses the conditions that gave rise to this hybrid swarm, the dynamics of the population and the prospects for speciation in the A-genome.

MATERIALS AND METHODS

The fadama site in Jebba was carefully surveyed for intermediate forms of *Oryza* species selected on the bases of plant type, rhizomatous habit, spikelet form, spikelet sterility, pollen stainability, panicle form, presence or absence of awns, awn type, pigmentation of awns, pigmentation patterns, flag leaf form and presence of leaf appendages (ligules, auricle, microhairs, macrohairs *etc*).

Collections were made as seeds and rootstocks from the putative hybrids selected. The seeds harvested from F_1 plants (BC_1F_1 seeds because F_1 plants are sterile) in the wild were raised in progeny rows in the experimental plot at the Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria. Progeny rows were also raised as BC_1F_2 plants from seeds collected from fertile BC_1F_1 plants. These progenies were scored for segregation for marker traits characteristic of *O. sativa*, *O. longistaminata* and *O. glaberrima* (Table 1). Foliar epidermal peels of putative hybrids and samples from their segregants were prepared following the method of Cutler (1978). The epidermides were studied for the forms and distribution patterns of their prickle hairs, microhairs, macrohairs and short cells. These features were used to characterize them as *sativa-*, *glaberrima-*, *longistaminata-* forms or combinations of the forms (Table 2).

RESULTS AND OBSERVATIONS

The fadama at Jebba is a fairly large area of lowland inundated with water in the raining season. In some seasons there were impoundments filled with water up till about early January (Plates 1 and 2). *Oryza sativa* is cultivated throughout the fadama by clearing the native cover which is predominantly *O. longistaminata*, but this species still persists around the natural impoundments, providing interphase with the cultivated rice species. Indeed, wild rice, *O. longistaminata* has become endangered in the last 10 years as a result of more intense cultivation of rice in the fadama but for the persistent populations that perennate around the natural impoundments.
The popular practices in peasant rice agriculture in Jebba are seed sowing in clusters, harvesting by straw-clipping, threshing by beating spikelets out of straw. The farmers have the curious habit of leaving the intermediate plants on their plots at harvesting (Plate 1B) and they do not destroy the populations of *O. longistaminata* around the impoundments which were always observed throughout the period of the surveys carried out in this study.

The interphase between the wild rice and the cultivated rice species is not exactly a frontier. *Oryza longistaminata* constitutes a major weed in the farmers' plot (Plate 2) and it develops into large populations around the impoundments. Three observations are crucial to the understanding of the dynamics of the hybrid swarm in Jebba: 1. Seed dormancy sustained the seeds of the hybrid forms; 2. The period of the dormancy break synchronizes with the onset of the rains when cultivated rice is planted; 3. Cultivated rice, *O. longistaminata* and *O. glaberrima* populations flowered at the same time creating the condition for full exchange of genes.

Our observations over a period of 18 years show that the fortunes of the hybrid swarm at Jebba have declined. By the year 2000, the population of *O. glaberrima* had declined and, by the year 2010, the population of *O longistaminata* had given way to *O sativa* as a result of massive rice farming. The intermediate plant forms that lined the bank of the largest impoundment had also disappeared.

Plate 1: A Collection Site at Jebba

A: As at November, 2007; note the water body at the centre and the small population of *Oryza longistaminata* (arrow) .
B: Putative Hybrid found at the study site in Jebba .
Note the stubs of the tillers after harvesting

Plate 2: A Typical I mpoundment at Jebba in June, 2010

hb1 and hb2 are hybrid forms; 'inter' refers to the intermediate zone that interphases with *Oryza sativa*. The zone is popul ated by *O. longistaminata*

Table1: Morphological Markers

Character	Oryza Type	Putative Accessions
Rhizomatous culm	*O. longistaminata*	-
Long ligules, 2-cleft (>2.0 cm)	*O. longistaminata*	-
2-cleft ligules with medium length(1 - 2 cm)	*O. sativa*	PUT2, PUT3, PUT5, PUT6, PUT7, PUT8, PUT9
Truncate ligules (<1.0 cm)	*O. glaberrima*	PUT4
Straight and open panicles	*O. longistaminata*	JEBBA TOL X TOS
Compact and drooping panicles	*O. sativa*	-
Compact panicle with several secondary branches	*O. sativa*	PUT3, PUT4, PUT6, PUT7, PUT8, PUT9
Compact panicle with none or very scanty secondary branches	*O. glaberrima*	JEBBA TOL X TOS, PUT2, PUT5
Lanceolate flag leaf, pubescent	*O. longistaminata*	PUT4, PUT5, PUT 6, PUT7, PUT8,
Lanceolate flag leaf, glabrous	*O. glaberrima*	-
Linear flag leaf, pubescent	*O. sativa*	PUT2, PUT3, PUT9

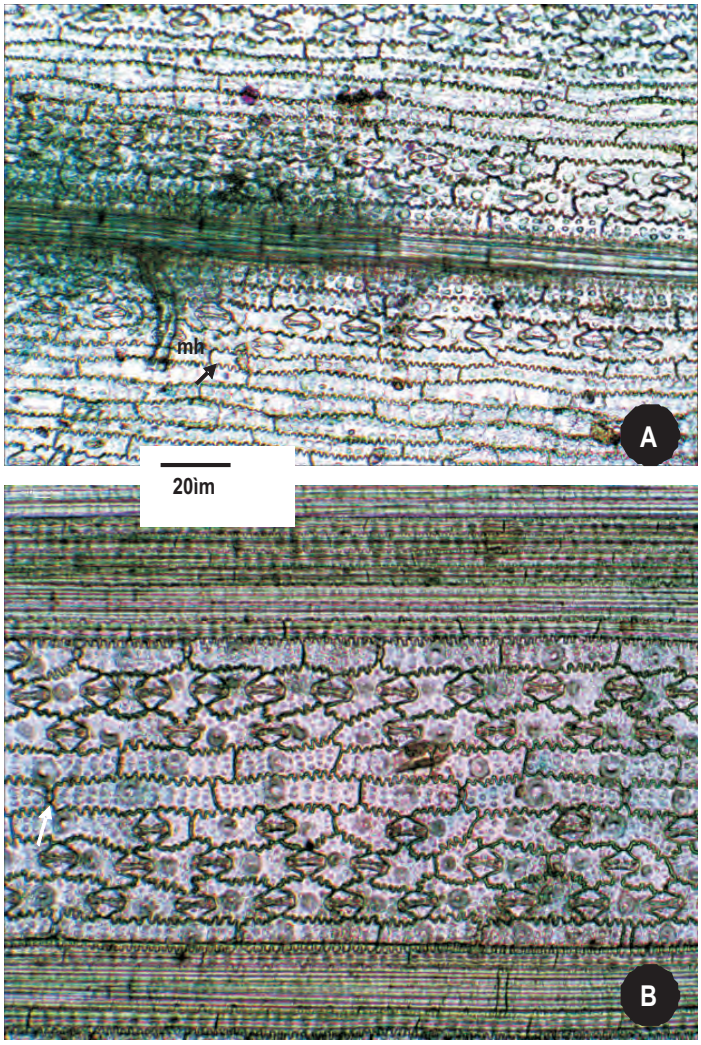

Plate 3: Foliar anatomical features of Putative 5: Adaxial (A) showing macrohair (mh) on the costal zone, short cell (arrow) and absence of prickle hair; Abaxial (B) showing microhair basal cell (arrow) and absence of prickle hair.

Table 2: Foliar Epidermal Markers

Epidermal Features	Character	Oryza Type	Putative Accessions
Macrohair	Frequent on adaxial, absent on abaxial of costal region	*O. longistaminata*	PUT2, PUT4, PUT5 , PUT6
	Absent on both sides of costal zone	*O. glaberrima*	PUT3, PUT7, PUT8, PUT9
	None to very sp arse on both sides of the costal zone	*O. sativa*	-
	Absent on both sides of intercostal region	*O. glaberrima/ O. longistaminata*	PUT2, PUT3, PUT4, PUT5, PUT6, PUT7, PUT8, PUT9
	None to very sparse on adaxial, none on abaxial of intercostal region	*O. sativa*	-
Short cells	Absent on both sides of the intercostal region	*O. longistaminata*	-
	Frequent to numerous on adaxial, sparse to frequent on abaxial of intercostal region	*O. glaberrima*	PUT2, PUT3, PUT5, PUT7, PUT8, PUT9
	Absent on adaxial, sparse on abaxial of intercostal region	*O. sativa*	-
Pickle hair	Absent on both sides of intercostal region	*O. longistaminata*	PUT5, PUT8
	Frequent on adaxial, absent on abaxial of Intercostal region	*O. glaberrima*	-
	Sparse to numerous on both sides of intercostal zone	*O. sativa*	PUT2, PUT7, PUT9
Microhair	Sparse on both sides of intercostal region.	*O. longistaminata*	PUT5
	Abundant on both sides of intercostal, base cell, sometimes longer than apical cell	*O. glaberrima*	PUT2
	Sparse to numero us on both sides, base cell shorter and thicker than apical cells, sometimes same length	*O. sativa*	PUT3, PUT4, PUT5, PUT6, PUT7, PUT8, PUT9

DISCUSSION

The factors involved in the establishment of the hybrid swarm in Jebba are natural (the fadama, the natural impoundment, the occurrence of the two wild rice species) and anthropogenic (rice farming and its associated practices). At the level of minimal interference by man, the hybrid swarm was initiated and the cultural practices that have been enumerated earlier reinforced the occurrence of the hybrid swarm particularly with the possibility of the advanced generations that arose from introgression and segregation.

Aladejana *et al.* (2007) worked out a model for the population dynamics of the Jebba hybrid swarm. They recognized a primary pool of variability which contains the three parental species, the activity pool which consists of the hybrids (F_1, BC_1F_1, F_2) which inject BC_1F_2, F_2, F_n, BC_nF_1, etc into the secondary pool of variability thus enriching the hybrid swarm. The role of the cultural practices, particularly the minimum tillage, non destruction of most intermediate plants and harvesting by clipping leading to ratoon crops, in intensifying the process of introgression is worthy of note. The role of mud in preserving seeds may also have contributed to the environment of the soil seed bank of advanced generation hybrids in this pool as suggested by Faluyi and Nwokeocha (1992) in their study of a natural population of polyploid *O. punctata* in Ipetumodu, Nigeria.

By 2011, the population of *Oryza glaberrima* reported by Aladejana (2000) had been lost. It is interesting that one of the putative hybrids ($PUT_2BC_1F_2$) had 5 segregants showing truncate ligules typical of *O. glaberrima* while others segregated for long 2-cleft ligules, linear flag leaves, lancoelate flag leaves and pigmentation patterns of node, stigma, apiculus, awn and outer leaf which are mixtures of *O. sativa* and *O. glaberrima* characters. These morphological markers in conjunction with the foliar anatomical characters, provided information on gene flow among the three species involved in the hybrid swarm.

The occurrence of short cells in the epidermides of 6 putative hybrids (Table 2, Plate 4) shows that they are related to *O. glaberrima*. The absence of macrohairs on both sides of the intercostal zones in all the putative hybrids (Table 2 and Plate 3) also shows that the genes of *O. glaberrima* have already been introgressed into the population. The absence of prickle hairs on both leaf surfaces of some of the putative hybrids (Table 2 and Plate 3), suggest some gene introgression from *O. Longistaminata.*

The wild is nature's laboratory. The immense potentials for variability that the Jebba hybrid swarm represented was created by man but the introduction of large-scale farming has virtually distrupted the processes that created the hybrid swarm. With the loss of *O. glaberrima* and the threat to *O. longistaminata,* the dominant species will certainly be *O. sativa* with occasional hybrids and *O. longistaminata* as weeds in the short run.

Man has paid most of his attention to collection and conservation of plant genetic resources. Although *in situ* plant conservation ensures biodiversity in their native habitats with all the attendant advantages, it is probably in the long-term interest of man to pay more particular attention to the locations where nature is known to be actively creating variation as heritage sites which can be studied in the details of their dynamics and appropriate management techniques. This is one of the ecosystem services that the wild should be encouraged to provide for long-term benefits to mankind. There is perhaps no more auspicious time for this than now when man is falling back on nature for renewable resources.

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