Cytogenetic Relationships Between African Annual Diploid Species of Oryza and Cultivated Rice, O. sativa L.1

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Several species of the genus Oryza are indigenous to Tropical West Africa. Part of these African species are annuals with the diploid chromosome number for the genus, 2n = 24, and include both wild and cultivated types. Since these species have the same chromosome number as the principal cultivated species of rice, O. sativa, cytogenetic information concerning their relationship to cultivated rice should be of potential value. One of the 3 African species included in the present study, O. glaberrima Steud., is cultivated while the other 2, O. glaberrima var. stapfii Rosch., and O. breviligulata Chev. and Roehr., are wild.

The results reported in this study represent the second phase of a more extensive project dealing with cytogenetic relationships in Oryza. The first phase of this work was reported recently by Yeh and Henderson (16).

REVIEW OF LITERATURE

Hooker (6) in Index Kewensis credited Steudel with being the first to describe and name the African cultivated rice species O. glaberrima in 1855. Chevalier Roerich (3) named and described the wild species O. breviligulata in 1914, while O. glaberrima var. stapfii was described by Roschevicz (13) in 1931 under the binominal O. stapfii.

In the first modern classification of the genus Oryza, Roschevicz (13) separated these 3 African forms from O. sativa on the basis of length of ligule. The ligule was described as very long, 15–45 mm., in O. sativa but not more than 6 mm. in the 3 African forms. Roschevicz distinguished O. glaberrima from O. sativa further on the basis of awnless or sometimes short awn condition of the spikelet, glabrousness of the lemma and palea, unbranched inflorescence and shorter anthers of the former species. He separated O. breviligulata from O. glaberrima through the presence of long, strongly developed awns, branched inflorescence and pubescence along the keel and ribs of the lemma and palea in the former species. O. glaberrima var. stapfii differed from O. breviligulata in having shorter spikelets, shorter empty glumes and shorter awns.

In a later taxonomic treatment of the genus, Chevalier (2) recognized O. glaberrima and O. breviligulata as valid species but proposed that the O. stapfii of Roschevicz should be considered a botanical variety of O. glaberrima. Chevalier stated further that he had examined the type specimen of O. glaberrima in the Museum of Paris and there was no doubt that it is cultivated by natives in French Guinea and Sudan. In a more recent treatment of Oryza, Chatterjee (1) followed Roschevicz in recognizing O. glaberrima var. stapfii as a separate species. Ramiah and Ghose (12) questioned whether O. glaberrima should be recognized as a distinct species and suggested that this form be considered only a geographical variety of O. sativa.

Morinaga (8) and Morinaga and Kuriyama (9), reporting on studies in hybrids between varieties of O. sativa and O. glaberrima, stated that none of the F1 plants, representing 26 crosses, set seed. However, chromosome behavior was found to be normal during meiosis in these hybrids and it was concluded that O. glaberrima possesses the same genome as O. sativa, which had been designated A in earlier work. Morinaga (8) also reported normal pairing of chromosomes in the hybrid of O. sativa and O. breviligulata and concluded that the latter possesses genome A. Nezu, Katayama and Kihara (10) reported results and conclusions from hybrids of O. sativa with O. glaberrima and O. breviligulata which agree closely with those of Morinaga and Kuriyama. All crosses were completely sterile and only bivalents were found in the 25 to 45 PMC's studied per cross. However, Ramiah and Ghose (12) and Ghose et al. (5) indicated that in India crosses of O. sativa with both O. glaberrima and O. breviligulata were partially sterile.

Chevalier (2) concluded that the cultivated species O. glaberrima was probably derived from O. breviligulata. However, Sampath and Rao (14) offered objections to this conclusion and proposed that O. glaberrima, like O. sativa, arose from a form of O. perennis. Porteres (11) has suggested that O. breviligulata was the primary ancestor of O. glaberrima but that O. perennis also contributed to the origin of this species. Recently, Yeh and Henderson (16) presented cytogenetic evidence that O. sativa was derived by domestication from a wild perennial form native to southeast Asia, which they designated as a separate species, O. balunga, but which had been considered as constituting a botanical variety of O. perennis by other workers.

MATERIALS AND METHODS

The materials consisted of F1 plants representing 7 groups of rice hybrids: between different varieties of O. glaberrima, between O. glaberrima and O. sativa, between O. glaberrima and O. breviligulata, between O. glaberrima and O. glaberrima var. stapfii, between O. glaberrima and O. balunga, between O. breviligulata and O. sativa and between O. glaberrima var. stapfii and O. sativa. Altogether, 19 hybrid combinations were studied involving these 7 groups of crosses. Certain of the parents were included also as controls.

The results included morphological descriptions and crossability of the parental species, chromosome behavior during meiosis in the hybrids and fertility of the hybrids. The material for cytological study was fixed in Newcomer's fixative and was stained with aceto-carmine.

RESULTS

Characteristics of Species in Study

1. O. glaberrima—Three cultivated varieties of this species were included in the study, varieties Legheh and Kebleh from Sierra Leone and the Ekasa variety from French West Africa. These 3 varieties were distinctly annual with glabrous leaves and glumes and very short ligule, only 3–4 mm. compared with 10–24 mm. in varieties of O. sativa. There was only a slight tendency for the spikelets to shatter at maturity. Two varieties had awnless spikelets while the third had short awns. The anthers were much shorter than in O. sativa. In two varieties the seed coat was red but it was colorless in the third. The plants were relatively unproductive in comparison with O. sativa.

2. O. breviligulata—The collection used in the study came from French Sudan. It was a wild annual with hairy leaves and glumes. The ligule was very short. The spikelets were long and slender, with strongly developed awns, and shattered before maturity. Anthers were large and the seed coat was red. The plants were small with very weak straw. Thus, with the exception of short ligule, O. breviligulata differed considerably from O. glaberrima in morphological characteristics.

3. O. glaberrima var. stapfii—The single collection included in the study was introduced from East Africa. It was an annual with short ligule. The leaves and glumes were slightly pubescent. The spikelets had short, rough awns and did not shatter at maturity. The seed coat was

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