Considerations on Distribution of Cultivated Rice in Africa

Tadao C. KATAYAMA
(Faculty of Agriculture, Kagoshima University, JAPAN)

Introduction

The present author has been carrring out a research project on the origin and differentiation of cultivated rice in the world for the past 20 years. For observing and collecting the cultivated and wild rice species, several scientific tours in Asian countries had been done by many researchers, including the present author [7, 8, 10]. Those reports and experimental results had contributed not only to the theoretical studies but also to the breeding programmes of the cultivated rice.

Theoretically, following the studies carried out in Asian regions further studies in African areas come to loom up as a necessary condition for the realization of these purposes. Accordingly, as a part of the project, a scientific survey team was organized by the present author.

During the periods from October to November in 1984, from August to November in 1985, and from May to August in 1988, the writer and others travelled through 8 countries of Africa, *i.e.*, Madagascar, Tanzania, Kenya, Nigeria, Ivory Coast, Liberia, Senegal and Gambia, before and after the preliminary and arranging studies in France and England, for the collection of the wild and cultivated rice species under the project, entitled "Studies on the Distribution and Ecotypic Differentiation of Wild and Cultivated Rice Species in Africa," supported by a Grant from the Ministry of Education, Science and Culture of the Japanese Government. Making use of these opportunities, the cultivated rice distributed and under cultivation in African countries were studied.

The author is most grateful to the Government Officials in the African countries concerned. Thanks are also due to the scientists in the respective countries.

Documentary records on cultivated rice in Africa

On the distribution of the cultivated rice species in Africa, some reports have already been published.

The origin, evolution, cultivation, dispersal and diversification of the two cultivated

rice species (*Oryza sativa* L. and *O. glaberrima* STEUD.) have evoked wide ranged interests not only among the agronomical and biological scientists but also among geographers, and other social scientists. Because of the gaps on deficiencies in evidences outside the botanical disciplines, as well as on account of the state of flux still facing the biosystematics of over the 20 taxa in the genus *Oryza*, hitherto publications to fix a data on this broad subject, have been largely discipline-oriented and have failed to provide a concise and comprehensive view.

Firstly ROSCHEVICZ (1931) postulated that the center of origin of *O. glaberrima*, one of the two cultivated species, was in Africa [21]. After a quarter of the century, PORTÈRES (1956) suggested that the common progenitor of cultivated rice species was of a rhizomatous and floating form [20]. Almost all the botanists have generally treated the two cultivated species, *O. sativa* and *O. glaberrima*, as the distinct geographic entities. By HARLAN (1973), re-examinations have been carried out on the geographic distributions of the wild and the primitive strains of cultivated rices [4]. Judging from the findings on the evolutionary processes of the grasses and of the crop plants [25], it may be most reasonable to visualize the general process as in the following, namely, wild perennial → wild annual → cultivated annual. However, some strains show a perennial behavior under the comfortable condition, in case of *O. sativa*, and in rare chance even in case of *O. glaberrima*.

PORTÈRES (1956) postulated [20] the primary variation center of *O. glaberrima* as Nigerica group, and further the secondary one as Senegambica group, and the third one as Humilis group. According to his theory, the primary center of *O. glaberrima* was found to be about 1,500 BC. The secondary center is estimated to be 500 years younger than the primary one. Judging from the history of the domestication and the extent of varietal diversities within the species, it appears plausible that the differentiation-date of *O. sativa* in Asia is far earlier than the date of *O. glaberrima* in West Africa.

The geographical dissemination of one the cultivated species, *O. sativa,* in the Asia has been discussed by a lot of workers. On the contrary, that of another cultivated species, *O. glaberrima,* in Africa has rarely been discussed.

In the viewpoint of ecological diversification, *O. glaberrima* in West Africa is the dominant crop growing in the flooded areas of the Niger and Sokoto River basins (Table 1 of the previous paper [11]), where the broadcasting of it has been executed on hoed fields. On the shallowly flooded land, a rain-fed lowland crop is either directly sown by broadcasting or dibbling, or is transplanted [12]. The African cultivars and their annual wild species are less diverse than their Asian relatives [3]. While, PORTÈRES [20] already recognized the two subspecies (*vulgaris* and *humilis*) in *O. glaberrima*. OKA [16] considered that the *barthii-glaberrima* complex might have became differentiated into the two sorts of subspecies, deep water one and upland one.

After SIMPSON [26], both the *"O. sativa complex"* in tropical Asia and the *"O. glaberrima complex"* in West Africa came to be considered as the evolutionary species that are still undergoing incessant and dynamic changes through the hybridization-

differentiation cycles.

O. sativa, introduced into West Africa in the 15th century, has been rapidly spreading itself in the rain-fed lowlands having made *O. glaberrima* grow formerly. In the irrigated areas and in the mangrove swamps, only *O. sativa* is in growth [17]. However, rice-cultivation in East Africa and Madagascar [2] was postulated to have been occasioned earlier than in the age mentioned above.

IRAT (Instiut de Recherches Agronomique Tropicales et des Cultures Vivrieres) and ORSTOM (Office de la Recherches Scientifique et Technique Outre-Mer) held a meeting on African Rice Species in 1977 with the attendance of 19 participants. In a publication from this meeting [5], the following items were briefly discussed; genetic diversity of *O. glaberrima* and *O. breviligulata* as shown from the direct observation, enzyme variability of the *sativa complex* of *Oryza* in Africa, the ancestor(s) of the cultivated rice and their evolution, morphological varieties and agronomic potentials of *O. glaberrima* and wild species, genetic variations of *O. glaberrima,* including their survey and evolution.

Recently, indigenous rice-collections in African countries were done by several scientists [6, 11, 13, 14, 15, 18, 19, 24, 28, 29]. It is important to ascertain the location where genetic diversity exists in the place where rich variations have been occasioned well in spite of such obstacles as endemic diseases [9], in Asian as well as in African countries.

Northeastern part of India has been looked upon as one of the differentiation centers of *O. sativa*, owing to the several genetical and cytogenetical investigations [8]. Some strains of *O. sativa* are found in the whole rice cultivating areas of Africa [11]. However, it is not easy to identify a route of migration from Asian areas and to clarify the diversification of the species in Africa. Rice culture has been introduced into Madagascar from Asia [27]. There are two currents, the Malay current and the Indian current [28]. Recently, rice and rice cultivation have been reported in Madagascar [1] and all over the Africa [12]. In the latter, it was noticed that the differentiation of rice varieties, *O. sativa* and *O. glaberrima* showed a complex status; selection of species and strains made by the farmers should be seen to be in flexible status, in accordance with several environmental conditions and practical techniques, and social status, and problems were found at several angles.

Taking these items into account, it came to be quite important to ascertain the varietal differentiations and phylogenetical relationships of the cultivated rice in the Asian areas. It was also requested to confirm the evolutional relationships between *O. sativa* and *O. glaberrima* and between the cultivated and the wild species belonging to the genus *Oryza*.

Some records obtained during the tours

The localities concerned in these tours in African countries were mentioned in the previous paper [11]. In the paper, locality name, variety name and some remarks were mentioned. Geographical situation was briefly illustrated in Fig. 1. In this figure, countries concerned and Accession No. of the cultivated rice are given. The strains collected in GAMBIA are included in the group of SENEGAL. *Italic* and roman letters in the figure show the strains collected in the first (1984) and the second (1985), and the third (1988) tours, respectively.

Most of the seed samples collected were divided into two parts, one of which was deposited in the scientific organizations in the respective countries, and another one was carried back to Japan . These plant- and grain-characters are being put under analyses at these institutes, and Kagoshima University and Kyushu University, Japan.

The number of strains collected was 406 in the total. They were constituted by 325 strains of *O. sativa* L. and 81 strains of *O. glaberrima* STEUD. On both of the species, the following remarks might preliminary and briefly be mentioned here.

Oryza sativa L. (325 strains)

Populations of the species were found in abundance at the fields of the whole countries concerned, *i.e.*, 42 strains (1985) and 99 strains (1988) in Madagascar, 105 strains (1988) in Tanzania, 32 strains (1985) in Kenya, 5 strains (1984) and 17 strains (1985) in Nigeria, 1 strain (1984) in Ivory Coast, 11 strains (1985) in Liberia, 13 strains (1985) in Senegal, and strains in many other fields were observed but not collected in these tours. They have almost erect growth in lowland, shallow water, deep water, upland conditions, and sometimes in the waste land and riverbed under cultivation-status. They were sometimes adjacent to fields of *O. glaberrima* and wild rice species, being separated by an embankment or not.

In most of the cases, strains used and practicals were fixed to be of a status of ordinary ones. However, newly developed strains and recently advanced practical cultivation-methods were used to some extent.

Oryza glaberrima STEUD. (81 strains)

Populations of the species were found in abundance at the fields of West and East Africa, *i.e.*, 1 strain (1988) in Tanzania, 9 strains (1984) and 15 strains (1985) in Nigeria, 3 strains (1984) in Ivory Coast, 11 strains (1985) in Liberia, 42 strains (1985) in Senegal, and many other populations were observed, but not collected in these tours. They have almost erect growth in lowland, shallow water, upland conditions, and sometimes in waste land. They were sometimes adjacent to fields of *O. sativa* and wild rice species, being separated by an embankment, or otherwise, growing together with *O. sativa* and /or wild rice sympatrically or allopatrically.

In many fields, *O. glaberrima* was in growth in a mixed stand with *O. sativa*. Sometimes the mixed stand appeared to have been resulted from mechanical mixtures during

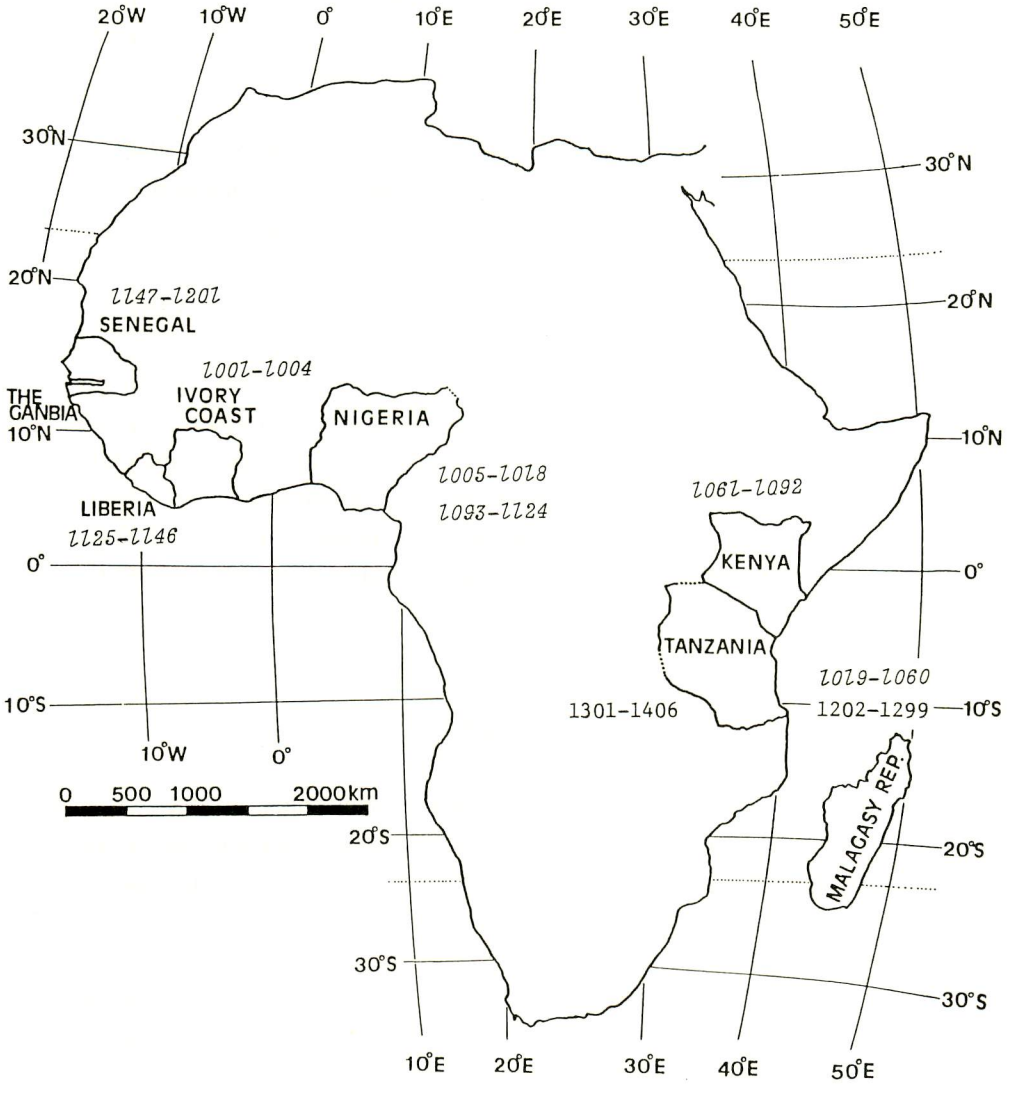

Fig. 1. Map showing the countries where the cultivated rice in Africa were collected and observed. Code numbers used in the figure are corresponding to the accession numbers. *Italic* and roman letters show the strains collected in 1984 and 1985, and 1988, respectively.

harvesting and drying. In some records, a 1:1 mixture appeared to be intentionally provided by the farmer. *O. longistaminata*, a perennial wild rice species, was also frequently found in the fields of *O. glaberrima*. *O. punctata*, another perennial wild rice species, was looked upon as serious weed of cultivated species, too. Sometimes farmers cultivated both of the cultivated species in the same field as an insurance crop.

It is recently said that *O. sativa* are increasing and being cultivated; and *O. glaberrima* are decreasing and not used even in West Africa. It is wrong. *O. glaberima* are easily and simply not changed by *O. sativa* in Africa, owing to several agronomical, economical and social features [12]. It is also said that *O. glaberrima* have been eliminated in East Africa perfectly. It is also wrong. It was collected in Zanzibar in 1988 during the third tour [23]. Moreover, informations concerning *O. glaberrima* in East Africa were frequently gathered during this tour.

Documents of the cultivated rice collected were listed up in Tables 1 of the previous papers [11, 22, 23]. Populations observed but not collected were omitted in the tables. In these tables, collection-number, species name, year, month and date of the collection, abstract of locality and brief information of habitat, were described.

Most of the strains collected were sown in the experimental fields of Kagoshima University and Kyushu University. Many morphological and genetical characters are under analyses.

Abstract

During the three periods, *i.e.*, from October to November in 1984, August to November in 1985, and from May to August in 1988, the writer and others travelled through 8 countries of Africa for collection of the wild and cultivated rice species. The number of strains collected was 406 in the total, *i.e.*, 325 strains of *O. sativa* L. and 81 strains of *O. glaberrima* STEUD.

In the present paper, the following items were reported, *i.e.*, 1) documentary records based on cultivated rice in Africa, 2) distribution, cultivation and habitats of the cultivated species obtained during the three tours.

Basing on the analyses of the date obtained in the field survey, morphological, genetical and ecological characters, geographical, ecotypic and varietal differentiations are going to ascertained in the following papers.

References

1) ABÉ, Y.: Le riz et la riziculture a Madagascar. CNRS, Centre Régional de Publications de Valbonne, 06565 Valbonne Cedex, Paris, pp. 232 (1984)
2) BOURDIEC, F. le: Hommes et paysages du riz a Madagascar; étude de géographie

humaine, Imprimerie de FOIBEN-TAOSARINTANIN' I MADAGASIKARA (1974)

3) CHANG, T. T.: The origin, evolution, cultivation, dissemination and diversification of Asian and African rice. Euphytica, **25**: 425-441 (1976)
4) HARLAN, J. R.: Genetic resources of some major field crops in Africa. *In*: O. H. FRANKEL (ed.). Survey of crop genetic resources in their centres of diversity, 45-64, FAO/IBP, Rome (1973)
5) IRAT-ORSTOM: Meeting on African Rice Species. pp. 90 (1977)
6) IRAT-ISRA-ORSTOM: Prospection misson in Casamace (Senegal), December 1978-February 1979. Prospection of African Rice, 1-2 (1980)
7) KATAYAMA, T. C.: Wild *Oryza* species of the Philippines, New Guinea, Borneo and Java. Seiken Zihô, **15**:35-46 (1963)
8) KATAYAMA, T. C.: Distribution and some morphological characters of the wild rice in the central India (III). Mem. Fac. Agr. Kagoshima Univ., **19**:37-53 (1983)
9) KATAYAMA, T. C.: Some aspect on distribution of genus *Oryza*. Proc. 4th Asian Agr. Symposium, 15-31(1985)
10) KATAYAMA, T. C.: Some morphological characters of the cultivated rice grains collected in India (V). Mem. Fac. Agr. Kagoshima Univ., **22**:1-17 (1986)
11) KATAYAMA, T. C.: General remarks on cultivated rice in Africa concerned. Kagoshima Univ. Res. Center S. Pac., Occasional Papers, **10**:91-102 (1987)
12) KATAYAMA, T. C.: Current status of African rice cultivation - mainly, from the technological aspect -. International Cooperation of Agriculture & Forestry, **12**(2):2-12 (1989) (in Japanese)
13) KOCHKO, A. de: Rapport de mission: Prospection des riz traditionnelles et sauvages dans quelques regions des hautes terres de Madagascar. ORSTOM, 1-15 (1984)
14) NG, N. Q.; Plant exploration in Gongola State, Nigeria. IITA, 1-4 (1979)
15) NG, N. Q.: Plant exploration in central Nigeria. IITA, 1-24 (1979)
16) OKA, H. I.: Experimental studies on the origin of cultivated rice. Genetics, **78**:475-486 (1974)
17) OKA, H. I. and W. T. CHANG: Observation of wild and cultivated rice species in Africa (in mimeograph). pp.73 (1964)
18) OKA, H. I., H. MORISHIMA, Y. SANO and T. KOIZUMI: Observation of rice species and accompanying savanna plants on the southern fringe of Sahara Desert (in mimeograph). pp.94 (1978)
19) PEREZ, A. T.: Plant exploration in Liberia (Sep. 24-Oct. 20, 1977). Genetic Resources Unit Exploration, 77. IITA, 27-68 (1977)
20) PORTÈRES, R.: Taxonomie agrobotanique des riz cultives *O. sativa* LINNÈ et *O. glaberrima* STEUDEL. J. Agric. trop. Bot. appl., **3**:341-384, 541-580, 627-700, 821-856 (1956)
21) ROSCHEVICZ, R. J.: A contribution to the knowledge of rice (in Russian with English Summary). Bull. appl. Bot. Genet. Plant Breed., Leningrad, **27**(4):1-133

(1931)
22) SATOH, H., R. XAVIER ROLAND and T. C. KATAYAMA: On distribution and grain morphology of cultivated rice collected in Madagascar, 1988. Kagoshima Univ. Res. Center S. Pac., Occasional Papers, **18**:63-72 (1990)
23) SATOH, H., H. M. CHING'ANG'A, D. ILAILA and T. C. KATAYAMA: On distribution and grain morphology of cultivated rice collected in Tanzania, 1988. Kagoshima Univ. Res. Center S. Pac., Occasional Papers, **18**:73-82 (1990)
24) SECOND, G.: Prospection des espéces africaines de riz au Sénégal et en Gambie (Oct. 1974 – Jan. 1975). Rapport de Mission, ORSTOM, 1-21 (1975)
25) SIMMONDS, N. W.: Evolution of crop plants. Longman, London (1976)
26) SIMPSON, G. G.: Principles of animal taxonomy. Colombia University Press, New York (1961)
27) SOUTHALL, A.: The problem of Malagasy origins. *In*: East Africa and the Orient: Cultural Syntheses in Pre-Colonial Times, edited by H. N. C. CHITTICK and R. I. ROTBERG, 192-215, New York and London : African Publishing Company (1975)
28) TANAKA, K.: Rice and rice culture in Madagascar. *In*: Madagascar: Perspectives from the Malay World, edited by Y. TAKAYA, 25-92, Kyoto: CSEAS, Kyoto Univ., (1988)
29) TAYLOR, A. R. D.: Kenya indigenous rice collection (in mimeograph). pp.9 (1984)