

# TAXONOMIC STUDIES OF THE GENUS *ORYZA*

TUGUO TATEOKA

*Kihara Institute for Biological Research and the National Institute of Genetics, Japan*

## INTRODUCTION

Since the early part of the century, the taxonomy of the genus *Oryza* has been intensively studied (PRODOEHL, 1922; ROSCHEVICZ, 1931; CHEVALIER, 1932; CHATTERJEE, 1948; SAMPATH, 1962; etc.). ROSCHEVICZ (1931) published a comprehensive study of 19 species which provided a basis for later taxonomic studies in the genus. Following ROSCHEVICZ, CHATTERJEE (1948) listed 23 species. Recently, SAMPATH (1962) presented a revised list, enumerating 23 species of *Oryza*.

Despite these contributions, the taxonomy of *Oryza* species still involves many problems. As the genus *Oryza* is distributed throughout the tropics, and the specimens are scattered in many herbaria of different countries, it is difficult to study exhaustively specimens of all known species. Further, the flora of unexplored areas in tropical countries is only partly known. Expeditions to certain tropical countries would likely discover new varieties of known species and also new species of this genus.

Because of these difficulties, we presently may draw only tentative conclusions. Because of the confusion in nomenclature, however, it is essential to attempt a revision of *Oryza* species on the basis of available evidence. A standardization of species names would greatly assist workers in this genus. Some species of *Oryza* occur as complexes. These often invite different opinions as to species delimitation. It is desirable to clarify the morphological distinctions among closely related species.

In 1961, I visited various herbaria in the United States and Europe and examined many specimens, covering almost all the reported type-specimens. I also discussed nomenclature problems with experts associated with these herbaria. The results are given in a paper to be published in the Botanical Magazine, Tokyo. Now, certain important points will be selected from this paper, with particular reference to the species closely related to cultivated rice.

### *Oryza sativa* COMPLEX

Taking wild species only into consideration, this species-complex is widely distributed throughout the tropics. In the taxonomic literature, the Asiatic forms are generally listed as *fatua* or *rufipogon*, and the American ones are called *perennis*. The African forms are called *barthii* by most taxonomic workers, although CHEVALIER (1932) and CHATTERJEE (1948) applied *perennis* to both the African and American plants. It is

generally assumed that these taxa differ in the lengths of spikelet and awn, in the presence or absence of rhizomes, and in the perennial *vs.* annual habit.

The results of investigations of spikelet and awn lengths in the samples obtained from the three continents are shown in Table 1.

TABLE 1  
SPIKELET AND AWN LENGTHS OF WILD PLANTS IN THE *Oryza sativa* COMPLEX  
(figures below the class-range indicate the number of samples observed)

Spikelet length (mm)	6.75 —	7.25 —	7.75 —	8.25 —	8.75 —	9.25 —	9.75 —	10.25 —	10.75 —	11.25
Asiatic samples	5	20	27	17	6	2	1	0	0	
American samples	2	1	5	6	15	11	7	2	1	
African samples	1	18	31	32	26	13	4	1	1	

  

Awn length (cm)	2 —	3 —	4 —	5 —	6 —	7 —	8 —	9 —	10 —	11 —	12 —	13 —	14 —	15 —	16
Asiatic samples	0	25		5	12	14	18	7	5	4	2	0	0	0	
American samples	0	13		2	2	3	2	5	7	6	8	5	3	1	
African samples	5	19	24	28	29	18	4	5	0	0	0	0	0	0	

The Asiatic, American, and African samples did not differ markedly in spikelet length. But, the Asiatic samples had a smaller mean spikelet length than the American. The African samples had shorter awns than the American. Roughly, the Asiatic samples appeared to be intermediate between the American and the African samples in awn length. Nevertheless, the data in Table 1 indicate that the Asiatic, American, and African samples cannot be clearly distinguished by these characteristics.

Rhizomes usually are lacking in the Asiatic and the American forms. The lower internodes of their culms, usually immersed in water, are elongated and geniculate, and the nodes produce rootlets. Such geniculate or stoloniferous culms are not identical to true rhizomes which usually develop underground. But at least some of the Asiatic and American forms seem to produce rhizomes when they grow in swamps which are not constantly immersed in water. I have observed a plant growing at the fringe of Lake Apo, Musuan, Mindanao, the Philippines, having rhizomes about 6 cm. long. On the other hand, the African forms usually have well-developed rhizomes. The presence of an extensive system of creeping and branched rhizomes in the African plants was reported by PORTÈRES (1949), CHIPPINDALL (1955), and others. It also was confirmed by experimental cultivation of many strains at the National Institute of Genetics, Japan.

Perennial *vs.* annual habit has been adopted at times as a characteristic discriminating among the taxa of this species-complex found in Asia. However, it now seems unadvisable to use this characteristic to distinguish the species of this complex. They inhabit swampy areas in wet tropics, and their life span, or the development of new

shoots, must be considerably affected by the conditions of the habitat. It is well known that *Oryza sativa* is not strictly an annual and lives longer than one year, if the environment is favorable. Although both the so-called '*spontanea*' type and the '*perennis*' type are found in Asia, they may hardly be separated at the species level. This view agrees with the opinions of BACKER (1946), BOR (1960), and others.

The nomenclature of the Asiatic forms has been confused. The name *Oryza fatua* was adopted by some authors, but this is a *nomen nudum* (naked name). The name *perennis*, which has been widely used in recent cytogenetic or genetic literature, also cannot be adopted. BOR (1960) and I agree that the correct specific name for the Asiatic plants is *Oryza rufipogon* Griff. Before going further, I should discuss details of the problems regarding the application of the name *perennis*.

*Oryza perennis* Moench (Meth., p. 197, 1794) was described from a plant cultivated in the botanical garden at Marburg, Germany. In his original description, Moench stated that the plant grows in "in frigidario" (at moderately cool countries), and commented that Tab. 296 in TOURNEFORT's (1719) "Institutiones" resembles *Oryza perennis* except for awn traits. The plant appearing in Tab. 296 has broadly oblong spikelets and is unlike the tropical plants to which the name *perennis* has been applied by CHEVALIER (1932), HITCHCOCK (1936), CHATTERJEE (1948), and others. In fact, it resembles a form of *Oryza sativa*. ROSCHEVICZ (1931) regarded *perennis* a synonym of *sativa*. This view seems to be correct, but no evidence can be obtained from the description.

In 1878, BALANSA AND POITRASSON published an amended description for *Oryza perennis*. Their description, however, clearly shows that the plant they saw was a form of *Oryza alta*: "Ligule courte, arrondie, ciliée-velue, au bord, brune - Epillets lineaires oblongs, longs de 8 à 9 mm." It seems rather doubtful that their *O. perennis* is identical with that of MOENCH. PARODI (1933) interpreted *O. perennis* according to BALANSA's description, so the plants called *O. perennis* by PARODI are the same as those generally known now as *O. latifolia* (a close relative of *O. alta*). CHEVALIER (1932) also interpreted *O. perennis* according to BALANSA's description, but curiously adopted it as the correct name with priority for the tropical African and American wild rice with long and glabrous ligules.

Unfortunately, specimens of MOENCH's herbarium, including the type of *Oryza perennis*, have been missing for a long time (according to a personal communication from the curator of the botanical garden at Marburg), and it seems most probable that none of recent taxonomists have examined the type of *perennis*. In my opinion, *perennis* should be treated as a name of uncertain application, and should be abandoned,

So far as the present examinations have confirmed, the American forms of the *sativa* complex cannot be clearly distinguished morphologically from the Asiatic *rufipogon*. Nevertheless, the spikelets of the American plants are generally longer than those of the Asiatic plants (*cf.* Table 1); their awns are usually more erect and stronger than those of the Asiatic plants. Scientists at the National Institute of Genetics, Japan, especially Dr. H. I. OKA and his associates, are studying the differences in morphology and in some other characteristics. The results of this work, when completed, may influence

the taxonomy of this complex group. From our present knowledge, we wish to keep the Asiatic and American forms in one species. Thus, the species *Oryza rufipogon* covers the American forms.

As mentioned earlier, the African plants are distinguished from *O. rufipogon* by the presence of well-developed rhizomes. The awns of the African plants are usually shorter and more flexuous than those of *rufipogon*. These differences support the view that the African plants may be separated from *rufipogon* at the species level. The African plants have been listed as *barthii* A. Chev. in most of the literature, and it seems that the application of this name is correct. From our present knowledge, we wish to treat the African plants as an independent species under this name. Recently, SAMPATH (1962) also adopted a similar treatment.

Literature and specimens indicate that *Oryza rufipogon*, which lacks well-developed rhizomes, is not distributed in Africa. But it should be noted that a few collections from Africa did not produce rhizomes when cultivated at Misima, Japan (in a greenhouse or in an artificial short-day chamber). It is possible that the same plants produce rhizomes in their natural habitat. Further expeditions to tropical Africa will indicate whether plants lacking rhizomes exist in Africa.

CHEVALIER (1932) described *Oryza perennis* subsp. *madagascariensis* (= *O. madagascariensis*) from the specimen, Perrier de la Bathie No. 11239. In his original description, he described the ligules as short. This type specimen, preserved in the National Museum of Natural History in Paris, has a culm base and upper parts of several culms with four panicles and a few leaves. The ligules of these leaves are shorter than one cm. The same plant might have had longer ligules on the lower leaves, because the lower leaves of this species-complex generally have longer ligules. I examined a number of specimens of *O. madagascariensis* in Paris, but I could not find any morphological difference between *barthii* and *madagascariensis*. For this reason, I consider *Oryza madagascariensis* a synonym of *Oryza barthii*.

Thus, two species are recognized among the wild-growing plants of this *Oryza* species-complex: *rufipogon* and *barthii*. But, it should be emphasized that this conclusion is tentative and subject to further studies. Various problems related to the taxonomy of this species-complex remain unsolved. To my knowledge, no one has tried to determine whether the Australian forms of *O. rufipogon* are closer to the Asiatic or to the American forms. Also, the nomenclature of intraspecific taxa covered by *O. rufipogon* requires careful study.

#### *Oryza glaberrima* COMPLEX

ROSCHEVICZ (1931) and CHATTERJEE (1948) recognized three species in this species complex: *glaberrima*, *stapfii*, and *breviligulata*. *Oryza stapfii* is superficially intermediate between *glaberrima* and *breviligulata*. CHEVALIER (1932, 1937), PORTÈRES (1956), and others discussed the taxonomy of these species. Opinions regarding the taxonomic treatment of *stapfii* are split three ways: (1) that the plant named *Oryza stapfii* may be

a form of the cultivated species, *glaberrima*; (2) that *stapfii* represents a wild species which is separated from *breviligulata* by smaller spikelets (up to 9 mm long vs. 10–11 mm long in *breviligulata*) and shorter sterile lemmas (2–2.5 mm long vs. 3–4 mm long in *breviligulata*); (3) that *stapfii* is united with *breviligulata*.

The writer carefully studied the type specimen of *Oryza stapfii*, preserved in the Kew Herbarium, and found it unidentical to any of the cultivated forms; in fact, the type recalls a dwarf form of *Oryza breviligulata*. This indicates that *Oryza stapfii* should not be united with *Oryza glaberrima*, thus disproving the first opinion.

The writer's observation also failed to support the second view that both *stapfii* and *breviligulata* represent distinct wild species. Table 2 shows the variation in the lengths of spikelets and sterile lemmas found among collections belonging to either *stapfii* or *breviligulata*. The data clearly indicate that the supposed distinctions are practically nil.

TABLE 2  
LENGTHS OF SPIKELETS AND STERILE LEMMAS OF WILD PLANTS  
IN THE *Oryza glaberrima* COMPLEX

Spikelet length (mm)	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6	9.8	10.0	10.2	10.4	10.6			
No. of samples	2	3	1	2	5	7	6	7	7	6	4	5	3				
Length of sterile lem- mas (mm)	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6
No. of samples	2	4	7	9	6	6	11	8	4	0	0	0	0	0	0	0	1

It has also been stated that *Oryza stapfii* has roots at the lower nodes, but that in *Oryza breviligulata* roots appear only at the base. However, this statement is not correct. In the present study, no correlation was found between the rooting condition and the lengths of spikelets and sterile lemmas. Thus, *Oryza stapfii* can reasonably be referred to *breviligulata* as a synonym, as PORTÈRES (1956) suggested. SAMPATH (1962) reached the same conclusion in his classification of this species-complex,

#### TAXONOMY OF THE GENUS *Oryza* IN GENERAL

According to the results of the present work, 22 species are enumerated in the genus *Oryza* (Table 3). The table also compares the writer's classification with that of CHATTERJEE (1948). Further explorations in the tropics might uncover new species and new varieties of known species.

Several points of interest which warrant further study are:

(1) Wild plants closely related to *Oryza sativa*. – As already discussed, various problems remain.

TABLE 3

LIST OF *Oryza* SPECIES COMPARING TATEOKA'S CLASSIFICATION WITH CHATTERJEE'S (1948)

CHATTERJEE (1948)	}	REVISED CLASSIFICATION (TATEOKA)
<i>schlechteri</i> Pilger		<i>schlechteri</i> Pilger
<i>granulata</i> Nees et Arn. ex Watt		
<i>meyeriana</i> (Zoll. et Mor. ex Steud.) Baill.	}	<i>meyeriana</i> (Zoll. et Mor. ex Steud.) Baill.
<i>coarctata</i> Roxb.		<i>coarctata</i> Roxb.
<i>ridleyi</i> Hook. f.		<i>ridleyi</i> Hook. f.
		<i>longiglumis</i> Jansen (described in 1953)
<i>sativa</i> L.		<i>sativa</i> L.
<i>sativa</i> L. var. <i>fatua</i> Prain		
<i>perennis</i> Moench	}	
Asiatic		
American		
African	}	<i>rufipogon</i> Griff.
<i>glaberrima</i> Steud.		<i>barthii</i> A. Chev.
<i>stapfii</i> Roschev.		<i>glaberrima</i> Steud.
	}	
<i>breviligulata</i> A. Chev. et Roehr.		<i>breviligulata</i> A. Chev. et Roehr.
<i>australiensis</i> Domin		<i>australiensis</i> Domin
<i>eichingeri</i> A. Peter		<i>eichingeri</i> A. Peter
<i>punctata</i> Kotschy ex Steud.		<i>punctata</i> Kotschy ex Steud.
<i>minuta</i> J. S. Presl ex C. B. Presl		<i>minuta</i> J. S. Presl ex C. B. Presl
<i>officinalis</i> Wall. ex Watt		<i>officinalis</i> Wall. ex Watt
<i>latifolia</i> Desv.		<i>latifolia</i> Desv.
<i>alta</i> Swallen		<i>alta</i> Swallen
<i>grandiglumis</i> (Doell) Prod.		<i>grandiglumis</i> (Doell) Prod.
<i>brachyantha</i> A. Chev. et Roehr.		<i>brachyantha</i> A. Chev. et Roehr.
		<i>angustifolia</i> C. E. Hubbard (described in 1950)
<i>perrieri</i> A. Camus		<i>perrieri</i> A. Camus
<i>tisseranti</i> A. Chev.		<i>tisseranti</i> A. Chev.
<i>subulata</i> Nees		<i>Rhynchoryza subulata</i> (Nees) Baill. (excluded from <i>Oryza</i> )

(2) *Oryza latifolia*, *alta* and *grandiglumis*, – SAMPATH (1962) recently suggested to lump these three species under the name *Oryza latifolia*. My examinations indicate that the intermediates between *alta* and *latifolia* are not found in the collections from the West Indies, Central America, and the northernmost parts of South America. But, in the collections from the southern and eastern parts of South America, the intermediates between these two species are rather common, and their differences are obscure. A similar relation also was found between *alta* and *grandiglumis*. Considering our limited knowledge, it might be a matter of choice whether the *alta* and the *grandiglumis* types should be treated as species or subspecies (or varieties) of *latifolia*. I have followed the taxonomic treatment which is generally adopted, and have treated these taxa as different species. Sampath's suggestion can be verified by further studies.

(3) *Oryza officinalis* and its close relatives distributed in the Old World. – *Oryza officinalis* and its relatives constitute the most intricate complex in the genus *Oryza*. According to the results of the present work, four species are enumerated: *officinalis*,

*minuta*, *punctata* and *eichingeri*. But further studies may revise this classification. The tetraploid species, *Oryza malampuzhaensis*, reported from Coimbatore, is morphologically close to the diploid species, *officinalis*; I failed to find any clear distinction between them. Dr. H. KIHARA and his associates (unpublished) found that the genomes of *malampuzhaensis* are similar to those of another tetraploid species, *minuta*, distributed in the Philippines, But, *minuta* and *malampuzhaensis* are clearly different morphologically as well as phytogeographically, and *officinalis* may be regarded as an intermediate between the two species insofar as morphological characters and geographical distribution are concerned.

In Africa, two species of this complex, *eichingeri* and *punctata*, are found and both are known to be tetraploids. But among the collections gathered by Dr. K. FURUSATO in his expedition to tropical Africa in 1959, both diploid and tetraploid plants which morphologically fall under *punctata* have been found (TATEOKA AND KATAYAMA, unpublished). The tetraploid forms are close to the type specimens of *Oryza punctata*, which is obviously a tetraploid species. Accordingly, it should be noticed that certain diploid plants distributed in tropical Africa are closely related to *Oryza punctata*. The diploid plants differ morphologically from the Asiatic diploid species, *officinalis*.

If more strains of this species-complex are collected and studied from the morphological, cytogenetical and phytogeographical viewpoints, our knowledge of the taxonomy of this species-complex will be further advanced.