# The Ethnobotany of Rice in Island Southeast Asia

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THE GENUS *ORYZA*, to which the rich cultigens *O. sativa* L. and *O. glaberrima* Steud. belong, has great antiquity. Its Gondwanaland origin and interspecific differentiation before the supercontinent fractured and drifted apart are indicated by the pantropical distribution of the wild species of the genus in a nondisjunct manner across Africa, Asia, Oceania, and Latin America. The geographic distribution of the wild species with known genomes (chromosomal complements) provides a fascinating picture of a widely dispersed semiaquatic grass which differentiated early among the angiosperms (Chang 1976*a*, 1976*b*, 1984, 1985*a*).

The progenitor of the Asian cultigen (*O. sativa*) had its origin on the South Asia plate, which now includes the Indian subcontinent, the northern slopes of the Himalaya range inside China, Mainland Southeast Asia, and some of the major islands in Southeast Asia. The cultigen evolved during the Neothermal period (about 15,000–10,000 B.P.) through early-maturing annual forms along the foothills on both flanks of the Himalaya range. The pathway in its evolution is perennial wild (*O. rufipogon* Griff.) → annual wild (*O. nivara* Sharma *et* Shastry) → annual cultivated. Hybridization among the three species gave rise to the annual weedy race *O. sativa* f. *spontanea*, which became increasingly infused with *sativa* genes. Biosystematic studies of the cultigen and its immediate wild relatives are handicapped by the paucity of typical specimens of the two species because of the natural hybridization among all four forms (Chang 1976*a*, 1976*b*, 1983).

Wild species of *Oryza* have been reported from every one of the major islands in Southeast Asia and from Taiwan and Hainan islands. They are much more abundant, however, in Mainland Southeast Asia. Samples of *O. rufipogon* and *O. nivara* have been collected from East and West Malaysia, Indonesia, Papua New Guinea, Taiwan, and Hainan islands; samples of *O. rufipogon* from the Philippines and Taiwan. Other wild species present in this region are *granulata, longiglumis, meyeriana, minuta, officinalis,* and *schlechteri* (Chang 1975, 1985*a*).

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The route of dispersal to Island Southeast Asia is little known, partly because interpretations of the plate tectonics of the Indonesian islands and the Malaysian peninsula are still in flux (Ridd 1971; Hallam 1973; Audley-Charles 1983; Ollier and Chappell 1985). Moreover, archaeological findings containing rice remains in South and Southeast Asia are insufficient to provide a coherent picture of the past biogeographic aspects of this staple crop.

This paper aims to discuss and to relate various ethnobotanical facets of rice in Island Southeast Asia on the basis of multidisciplinary analysis and synthesis of available information.

## VARIETAL DIVERSIFICATION AND CULTURAL ADVANCES IN ASIAN RICES

Within *O. sativa*, the primary ecogeographic race is *indica*, which is the predominant type grown commercially in South Asia, Mainland Southeast Asia, the Malaysian peninsula, the major islands of Southeast Asia, and the southern and central provinces of China. *Indica* cultivars in Indonesia were called *tjereh*, and more recently, *cere* varieties. A younger *javanica* race, known as the *bulu* (long awned) and *gundil* (awnless) varieties in Indonesia, was probably more important than the *indica* race in the Philippines and Taiwan until the past three to four centuries. Another race, the temperate zone *sinica* (formerly known as *japonica*), is found only in east China, Korea, Japan, and the USSR. A small number of *sinica* varieties were introduced into Island Southeast Asia rather recently but had little significance in the region. Table 1 compares the plant and grain characteristics of the three ecogeographic races (Chang 1976*b*; Lu and Chang 1980).

The cultivation methods of rice are influenced by a range of topographical, hydrological, edaphic, and cultural variables. Such variations cut across varietal types. The cultural

TABLE 1. ECOGEOGRAPHIC RACES OF *ORYZA SATIVA*: COMPARISON OF THEIR MORPHOLOGIC AND PHYSIOLOGIC CHARACTERISTICS

| *INDICA* | *SINICA* (OR *JAPONICA*) | *JAVANICA* |
|---|---|---|
| Broad to narrow, light green leaves | Narrow, dark green leaves | Broad, stiff, light green leaves |
| Long to short, slender, somewhat flat grains | Short roundish grains | Long, broad, thick grains |
| Profuse tillering | Medium tellering | Low tillering |
| Tall to intermediate plant stature | Short to intermediate plant stature | Tall plant stature |
| Mostly awnless | Awnless to long awned | Long awned or awnless |
| Thin and short hairs on lemma and palea | Dense and long hairs on lemma and palea | Long hairs on lemma and palea |
| Easy shattering | Low shattering | Low shattering |
| Soft plant tissues | Hard plant tissues | Hard plate tissues |
| Varying sensitivity to photoperiod | None to low sensitivity to photoperiod | Low sensitivity to photoperiod |
| 23–31% amylose | 10–24% amylose | 20–25% amylose |
| Variable gelatinization temperatures (low or intermediate) | Low gelatinization temperature | Low gelatinization temperature |

regimes progressed in the sequence of rainfed lowland (wetland), rainfed upland (dryland), deepwater, irrigated, and tidal swamps. Another factor in rice culture is the method of planting in wetland fields: broadcasting in unbunded field, dibbling or row seeding in unbunded/bunded field, and transplanting in puddled and bunded field. Another variable is the permanency of cultivation site and water control: rainfed field under shifting cultivation, rainfed unbunded permanent field, and irrigated and bunded (or terraced) permanent field (Chang 1976*a*, 1983, 1985).

## INTERRELATIONSHIPS AMONG ECOGEOGRAPHIC RACES AND ECOTYPES

The tropical *indica* race is generally recognized as the prototype of the other ecogeographic races. *Indica* rices also have the greatest diversity. Rainfed upland rices were usually considered an ecotype of the *indica* race. However, their tall plant stature, low number of thick-culmed tillers, long and well-exserted panicles, and large and bold grains are morphologically similar to those of *javanica* rices, which are grown primarily in irrigated culture. Recent studies at IRRI have shown that the upland rices and the *javanica* varieties are genetically close to each other, differing mainly in the root system. The two ecotypes also bear rather close affinity to the *aus* varieties (summer rices) of east India and Bangladesh (Chu 1982; Pan and Chang 1983). Earlier Japanese workers have postulated that the *aus* rices may represent a form intermediate between the *indica* and the *sinica* races (Morinaga and Kuriyama 1955, 1958; Morinaga 1968). The *aus* varieties are marked by their early maturity, resistance to drought, a well-developed root system, and rather bold grains (Chang, Loresto, and Tagumpay 1974; Peiris 1983). The *aus* rices could be the progenitor of the *javanica* varieties and the upland rices.

Our recent findings support the dispersal pattern of the three ecogeographic races in Asia as shown in Figure 1 (Chang 1976*a*, 1976*b*). The dispersal of the *javanica* race followed a sea route, and it is also grown in Madagascar.

The *javanica* race is of special interest to this region. It was the predominant race on the island of Bali and (to a lesser extent) on Java and Sulawesi until a decade ago, when the outbreak of brown planthoppers led to its replacement by the hopper-resistant semidwarf varieties. The second largest concentration of the *javanica* race is found in northern Luzon, especially the central Cordillera region. The aboriginal tribes in the mountainous areas of Taiwan also grew *javanica* rice until two decades ago. In all cases, the cultural regime belongs to the wetland type: irrigated wetland in Indonesia and Ifugao; rainfed wetland in Taiwan. The *javanica* rices could also have been introduced into Japan, but no mention of typical *javanica* rice has been found in the Japanese literature.

Among the tropical races and ecotypes, the dryland rices are the most biologically advanced ecotypes, as manifested by their low photoperiod sensitivity, poor ratooning ability, deep and thick roots, tolerance to cool night temperatures, long panicles, loss of grain dormancy, large and heavy grains, nonshattering habit of the grains, and high frequency of glabrous (hairless) leaves. The *bulu* and *gundil* varieties under the *javanica* race also have more advanced features than the *indica* varieties grown under wetland culture in the same area. Similar to the dryland rices, the *javanica* rices are adapted to harvesting and storage by the panicles, which are long and very well exserted. The relatively recent evolution of the *javanica* race, which includes the dryland rices (Chang 1976*a*, 1976*b*), does not support the earlier thesis that dryland rice culture by the dibbling method of seeding preceded wetland culture (Hamada 1949; Sauer 1952; Solheim 1967).

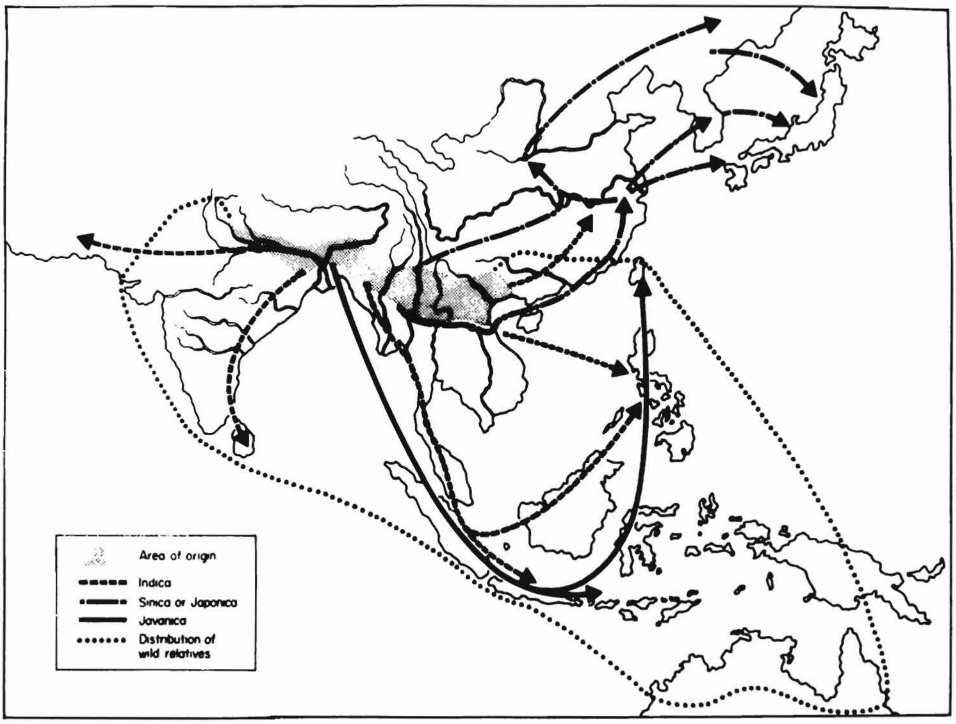


Fig. 1. Distribution of wild relatives and spread of ecogeographic races of *O. sativa* in Asia and Oceania (adapted from Chang 1976*a*).

## ANTIQUITY OF RICE CULTIVATION

Much remains to be learned about the beginning of rice cultivation in Island Southeast Asia. In view of the rather low frequency of wild rice populations in uninhabited areas (Fig. 2), rice probably only supplemented the root crops for the early food gatherers. Yam, taro, and sago were suggested by Burkill (1951) as the main crops in the cropping complex. However, the yams were probably not domesticated much earlier than 2000 B.C. (Alexander and Coursey 1969).

Rice cultivation probably flourished as the Deutero-Malays expanded during the last two millennia B.C. (Spencer and Hale 1961; Chaffee et al. 1969). Rice culture in Indonesia (mainly Borneo and Sumatra) may precede that in Malaysia and the Philippines (Ryan 1967; Chaffee et al. 1969). Chinese influence brought in by traders and settlers can be seen in the spiketooth harrow that has been extensively used in Malaysia and the Philippines and, to a lesser extent, in Indonesia for puddling the wet soil prior to transplanting (Chang 1976*a*).

The earliest rice remains found in Southeast Asia to date may belong to carbonized grains and glume fragments from the Ulu Leang cave site in south Sulawesi, Indonesia. The estimated date is about 4000 B.C.[1] (Glover 1977), slightly earlier than the 3500 B.C. or earlier date of Ban Chiang in Thailand (Yen 1982). Rice remains excavated from Ban Na Di (near Ban Chiang) have been dated from about 1400 B.C. (Higham 1984; Higham and Kijngam 1984:30; Chang and Loresto 1984). Glume imprints have been found on

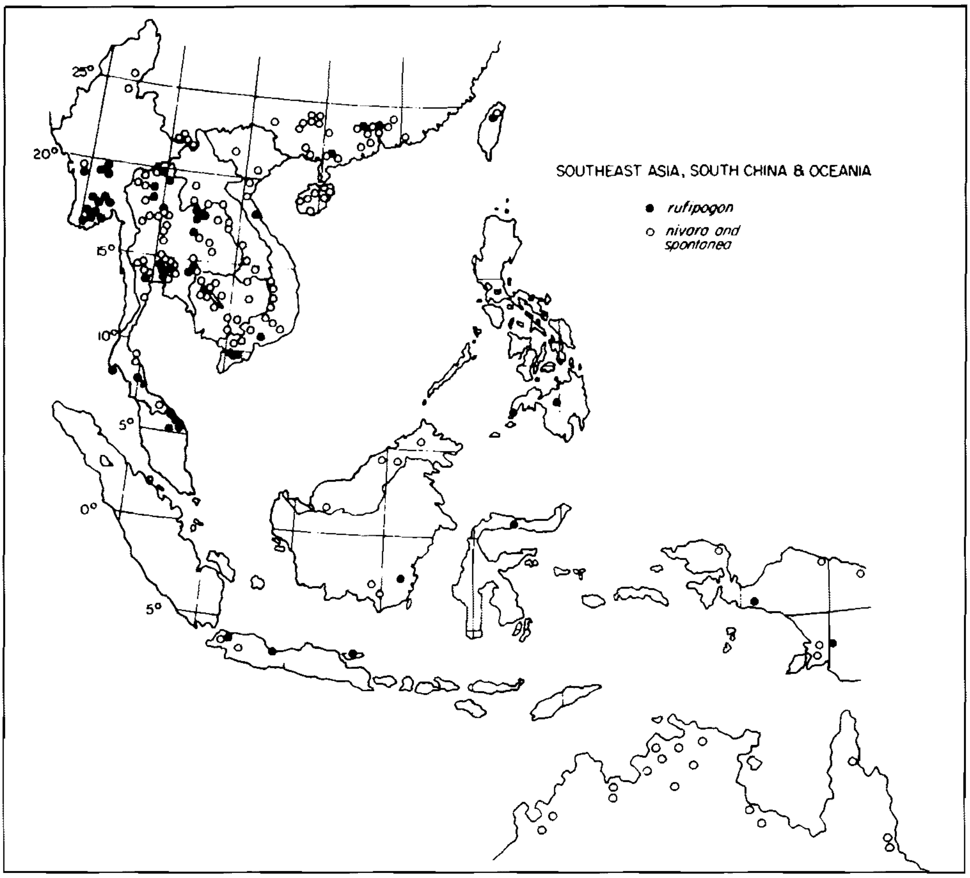


Fig. 2. Geographic distribution of *O. rufipogon*, *O. nivara*, and *spontanea* forms of *O. sativa* in Southeast Asia, Oceania, and China. The Australian form of *nivara* is now named *O. meridionalis* (expanded from Chang 1975).

potsherds excavated at Solana in northern Luzon, Philippines, and a rice husk from this site has recently been accelerator radiocarbon dated to about 3400 B.P. (R. Shutler, Jr., personal communication).

Terracing in mountainous areas is a common feature in the region. The Ifugao people of the Philippines and the aboriginal tribes of Taiwan built extensive stone terraces. The Ifugao farmers especially are masters in the art of making terraces. The Ifugao terraces date back to at least the seventeenth century (Conklin 1980), but another date of about 2000 B.C., given by Spencer and Hale (1961), appears too early for the region as the low population pressure then would not have forced the settlers in mountainous areas to build terraces.[2]

It may be mentioned for comparison that in China the earliest remains of *indica* rice at the Ho-mu-tu (Hemudu) site and of both *indica* and *sinica* types at the Luo-jia-jiao site in Zhejiang Province have been dated to about 5000 B.C. (Hsia 1977; Luo-jia-jiao Archaeological Team 1981). Recent excavations in Taiwan have provided two rather early dates for rice: c. 4000 B.P. at Heng-ch'un (Li 1983), and c. 2150–1550 B.C. at the Chih-shan-yen site at Yüan-shan in Taipei City (Wang 1984).

The oldest rice remains in India appear to be from the Koldihwa site in the Belan Valley in Uttar Pradesh. Rice was found both as carbonized kernels and grains embedded in pottery, associated with radiocarbon dates of 8520 ± 210 B.P. (PRL 224) and 6480 ± 185 B.P. (PRL 101) (Sharma et al. 1980:136; Sahara and Sato 1984).

Interisland communication in Indonesia intensified in the third millennium B.C. (Glover 1977). I share a similar view about the much advanced date of early contacts between the Chinese people and their neighbors in prehistoric times (Chang 1983).

## CONTRIBUTIONS OF RICE CULTIVATION TO CULTURAL DEVELOPMENTS AND POPULATION INCREASE

Among the cereals, brown rice provides higher caloric values than wheat, corn, or millet. Average world production from one hectare of rice field can support 5.63 persons per year; the same area of wheat and corn, 3.67 and 5.06 persons respectively. Similarly, rice protein on a per-hectare basis can sustain 2132 persons in a year; wheat 2090, and corn 1921 (Lu and Chang 1980). Milled rice also has high biological value (75%) and can serve as a substitute for milk in weaning babies (Chang 1987*a*). Therefore, it is not surprising that rapid increases in human population followed intensive rice cultivation (Chang 1987*b*). One of the well-recorded instances was the introduction of Champa rices into China during the eleventh century (Ho 1956). Hanks (1972) has provided a rather recent account from Bang Chan, Thailand. Rice cultivation has served as the foundation in the formation of several states in Southeast Asia (Higham 1984). The culture of several Asian countries flourished when rice production provided a strong material basis (Chang 1987*a*).

The ease of cooking milled rice and its good taste may explain the widespread cultivation of upland rice on hilly slopes, in spite of low yields and adverse effects on soil conservation and environmental quality. Among subsistence farmers in humid areas of the world, no other food crop has found a more favored status than rice.

Some of the most complicated rituals and implements found in the region were associated with rice cultivation, especially by the hill tribes (Freeman 1955; Conklin 1957, 1980). Parallel instances may be found in Mainland Southeast Asia (Burling 1965; Huke 1953). Rice cultivation is truly an integral component in the rich cultural heritage of the Asian people.

## NOTES

1. Glover (1985:272) now refers to a date of 1490 ± 210 B.P. (SUA 1080) for this rice sample, so a date of 4000 B.C. for Sulawesi now appears doubtful (ED.).
2. Robert F. Maher has published seven $^{14}C$ dates for sites in Ifugao, five of them well before Spanish contact and one, for what he considered the oldest site in the Bannawol valley, at 2950 ± 250 B.P. (1981 archaeological investigations in the Burnay District of southeastern Ifugao, Philippines. *AP* 24 (2): 223–236). Perhaps it was not population pressure alone which led the Ifugao to settle in the mountains (ED.–WS).

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