The Origin of Flooded Rice Cultivation

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Abstract: Rice cultivation has long been considered to have originated from seeding of annual types of wild rice somewhere in subtropics, tropics or in the Yangtze River basin. That idea, however, contains a fatally weak point, when we consider the tremendous difficulty for primitive human to seed any cereal crop in the warm and humid climate, where weed thrives all year round. Instead of the accepted theory, we have to see a reality that vegetative propagation of edible plants is a dominant form of agriculture in such regions. The possibility is discussed that Job’s tears and rice, two cereal crops unique to the region, might have been developed via vegetative propagation to obtain materials for medicine or herb tea in backyard gardens prior to cereal production. This idea is supported by the fact that rice in temperate regions is still perennial in its growth habit and that such backyard gardens with transplanted taro can still be seen from Yunnan Province of China to Laos. Thanks to detailed survey of wild rice throughout China for 1970-1980, it is now confirmed that a set of clones of wild rice exist in shallow swamps in Jiangxi Province, an area with severe winter cold. In early summer ancient farmers may have divided the sprouting buds and spread them by transplanting into flooded shallow marsh. Such way of propagation might have faster improved less productive rice through a better genetic potential for response to human interference than quick fixation in seed propagation, because vegetative parts are heterogeneous. Obviously, such a primitive manner of rice cultivation did include the essential parts of rice farming, i.e., nursery bed, transplanting in flooded field of shallow marsh like. Transfer from the primitive nursery to true nursery by seed may have later allowed rice cultivation to be extended to northern regions. In thus devised flooded cultivation there were a series of unique advantages, i.e.; continuous cropping of rice in a same plot, no soil erosion, slow decline of soil fertility, availability of minerals, and resulting in high yield per unit area, which have collectively attained the highly productive cereal cultivation in the warm and humid region. Rice cultivation in marsh is also favorable to raise fish culture, both of which constituted a nutritionally balanced base. Development of irrigation technology to construct flooded farms gave strong bases for stable rice-cultivating society, which in the end formulated the rise of ancient kingdoms of Yue and Wu in China in BC 6th-5th centuries. They were direct descendents of those people who had developed the unique rice cultivation from the era of Hemudu culture, which is dated back to 5 000 BC. Their movement to the south is considered to have established rice-cultivating communities in South China and Southeast Asia, while to the north it transferred the rice-based technology to ancient Korea and Japan and had established there a base for a civilized society.

Key words: primitive agriculture; vegetative propagation; perennial habit; sustainable cultivation; rice and fish farming; ancient kingdom; spread of rice cultivation

Domestication of cereal crops in general

Rice cultivation has long been considered to have originated from seeding of annual types of wild rice somewhere in subtropics or tropics. Some authors considered rice might be domesticated as an upland crop in subtropical high land. Other scientists emphasized the implication of annual types which may have differentiated in a climate with alternation of dry and wet season, and considered the possibility that rice was domesticated in such a climate in the vast range from northern part of Southeast Asia to South China. These ideas were basically translated from the widely accepted concept about the origin of cereal crops in Mesopotamia, where primitive human had learned to collect grains from plants, scattered the seed near by their settlement, and gave a basis for primitive farming.

Domestication of cereals in the Mediterranean climate

In the Mediterranean climate, wild cereal plants germinate in early autumn, thrive in humid or rainy season from autumn to winter, and produce a large
amount of seeds after flowering in early summer. The plants have to survive hot dry spells in summer by the form of seed which contains adequate carbohydrates as resource. There, far before farming they had acquired the growth habit to bear a large grain on relatively small grass. This is explanation by Diamond [4] for the reason why annual cereal crops were domesticated in ‘Fertile Crescent’ ranging between Mesopotamia and Nile delta. Thus, in the domestication of cereals in the Mediterranean climate, a sustained selection of productive plants would not have been an indispensable preparatory step, because the plant had been pre-adapted to bear heavy grains. On a basis of experimental harvesting from wild cereals, collecting the grain is supposed to have provided fairly sufficient food for primitive human.

**Unique background for the rise of agriculture in Southeast Asia**

While some leading scientists, who were preoccupied by the idea that domestication of cereals was initiated by seeding annual types, considered domestication of rice by means of seeding, Sauer [5] was among another group of scientists who recognized the importance of vegetative propagation as a step for primitive agriculture in Southeast Asia, where even today major crops such as sugar cane and banana are propagated via vegetative parts. Sauer indicated the unique position of Southeast Asia, stating ‘No other area is equally well situated or equally well furnished for the rise of a fishing-farming culture’, and ‘this is the world’s major center of planting techniques and of amelioration of plants by vegetative reproduction’. He agreed to the premise that man learned to plant before he grew crops by seeding, and called our attention to planting and plant selection, by stating that ‘the creative curiosity of man in the monsoon lands has operated strongly with asexual plant reproduction, in which, a piece of a plant is set into the ground to make a new plant’. He cited a variety of asexual propagation, i.e., by an offset or sprout from the parent, by dividing a root stock, by a stem cutting, or by a piece of underground stem or root stock. Thus, an individual plant is divided and multiplied indefinitely. Here we may call this type of farming by a term, vegeculture. Another pioneer in the science of primitive agriculture, Werth [6] indicated some unique features of agriculture in Southeast Asia, one of which is a strong tradition of tuber crop cultivation with a set of simple tools of which hoe is a symbol. The other characteristic feature is the use of wide range of edible plants or vegetable plants ranging from wild to cultivated ones. Today, we see many kinds of wild plants or weeds for sale as vegetables in markets in the region. He considered that cereal crops were not originated in the agriculture of this region but introduced from the agriculture in which cultivation by plow was dominant.

**Presumable way for domestication of two cereals originated in Southeast Asia**

In discussing the origin of primitive agriculture, we must consider the tremendous difficulty for primitive human to raise the idea of cultivation that might take place of hunting and collecting wild edible plants. With a sharp insight into this point, Sauer came to the idea that propagation with parts of plants may have preceded to seeding and harvesting of seed from cereal crops. In the humid tropics or subtropics, where the dominant agriculture was characterized by vegeculture, two cereal crops were unique to the region, Job’s tears and rice. In which way were they domesticated, by seeding or by propagating vegetative part? We may better look into this topic.

**Domestication of Job’s tears**

Job’s tears, which was domesticated in the region of Southeast Asia, is one of only two cereal species originated in the region. The utilization of Job’s tears (*Coix lacryma-jobi*) is suggestive of a primitive way of utilizing the plant prior to its use as a food crop. Its edible type (*Coix ma-yuen* Roman) is usually utilized like tea by decocting the grain and sipping it. Domestication of Job’s tears was not likely initiated by seeding it for food, because the grain is covered by a very hard glossy layer like glassy shell, although the hard shelled ones are reported to be used as food in rare cases [7]. The hard grain is still widely used for making necklace and bracelet in villages in highland of Southeast Asia. Also, roots, stems and leaves of the plants are used for medicine in Thailand, Laos and Vietnam. The wild type must have been widely
distributed by women for making accessories in ancient time. There, they may have divided the stocks for propagation in a tiny garden nearby their housing, because the wild type is perennial and suitable for propagation via stock. In somewhere in the wide range of distribution, they happened to find a mutant which lacked the hard shell. The mutant had only a thin layer and contained perhaps more starch than the wild type which needs to allocate much of carbohydrate to make up the hard covering structure. A single mutation may have converted the wild type into the edible Job’s tears with soft-skinned grain, because the hard shell type and thin skin type are proved to segregate at the rate of 3:1 in an F2 generation test after hybridizing the two types [8]. The result implies that the wild type is controlled by a single dominant gene.

**Initial domestication of rice**

Asian wild rice is basically perennial and has very small panicles, and cannot be adapted to seeding in thriving weed in a warm and humid land. If one observes any wild rice in a shallow swamp, it is a perennial plant producing very short panicles with a few grains while vigorously thriving with creeping branches. Almost all of synthesized carbohydrate is allocated to vegetative parts, creeping long stems, leaves for growth and to basal stocks for re-growth in next season. Therefore, even if a man attempted to seed the grain to a small land, he may not have obtained an adequate amount of grain, or obtained too small an amount to feed his family. More precisely speaking, women might have taken care of a small garden near their housing while raising their children in a primitive society. Apparently, such busy women may not be so stupid to spend her energy for obtaining only few grains after long sustained works for weeding and protecting the plant against bird and beast.

It is likely that primitive human might have used a small amount of grain of wild rice only for medicine or supplement like tea, propagating it by emerging sprouts in shallow marsh around his housing every early summer. A rich tradition of such ways of plant utilization is still widely found in South China to Indochina peninsula. The habit of sipping tea is perhaps developed in the similar region more for medicine or tasting use rather than for food. The naming for one of wild species of rice, *Oryza officinalis*, suggests that some of rice species had been utilized for medicinal use, because the word ‘officinalis’ implies medicinal use. In fact, Indian scientists reported some kinds of wild rice are today collected for medicinal use.

**Vegetative propagation led wild rice into cultivated one**

In general, selection or improvement of a plant for more productive one must be an indispensable process for the plant to be domesticated, because almost all of wild cereal plants are far from bearing attractive edible parts. When a man attempted to take any of them and put them into domestication, only such a plant may be useful, which could have been converted into more productive one through its responsiveness to a chain of unconscious improvements. It is plausible that only a few plants having an extraordinary responsiveness to human interference might have transformed themselves and were domesticated out of hundreds of wild plants which primitive human might have tried to grow in his garden.

**Genetic potential of propagated plant via clone**

In the course of domestication, variability or responsiveness of plants under care by interested human is perhaps one of the most important factors that lead to the success. Many scientists who supposed that primitive farmers might simply have seeded wild cereals in their farm missed the point of variability. If any seed is self-fertilized within a plant, it inevitably attain genetic fixation so that there won’t be segregation of any variations. The fixation will be attained within the first decade of continuous seeding. Thus, the original poor wild type cannot show any positive response to human care, except a rare case where a useful mutation takes place. But the probability of such mutation is at a rate of 1 to every 100 000 or so.

There is perhaps one exception in which the law of fixation does not present any strong barrier for the initial human attempt. As mentioned before, some
wild cereal plants attained a potentially useful form with big grain to survive dried summer in the form of seed in the Mediterranean climate.

In the area where dry and wet season are clearly alternated in Southeast Asia, there are some wild rice which show annual habit with bigger panicles than others according to some surveys of wild rice in native stands. Such wild rice is considered to be a probable source for primitive rice cultivation\(^{[3,9]}\). But in nearly all of such cases, the possibility for such wild types to have intercrossed with cultivated ones cannot be denied, because there is no barrier for such hybridization in their coexistence of at least several hundred years. It should be noted that no annual type of wild rice was found in the extensive surveys in China, although weedy rice is still not rare, which might have originated from hybrids between wild and cultivated forms in ancient time.

Contrastingly to propagation by seeding which leads to quick fixation, propagating plants via clone can maintain genetic variability, because they are genetically heterozygous. A good example is provided in propagation of an elite fruit tree via grafting. Gardeners must propagate it by cutting buds or shoots of the tree and grafting it on any other stocks, and are able to maintain the elite characters. Any seeded plants from an elite fruit tree cannot produce the parental type, because there is a high frequency of genetic recombination in the formation of progeny seed. As understandable from this case, any clone of plant contains a high level of potential to produce diverse genotypes. This principle is greatly significant for primitive farmers who attempted to propagate a set of clones of wild rice to obtain a handful grain from their tiny farm. They were able to obtain a high level of variation among the progeny, where they happened to find seed-derived plants from the clones mixed themselves in the stand of vegetatively divided stocks. Such a population may have produced a pool of variation for unconscious selection by human interference. In other words, progeny plants from the seed on vegetatively propagated stocks would have provided an adequate level of genetic diversity. Then, the ancient farmer might be able to unconsciously choose early maturing clones or those with lesser degree of seed dormancy and shattering of seed from panicle.

**Did any annul type play a role for domestication of rice?**

It is noteworthy that a substantial part of cultivated rice, particularly those grown in the temperate region, today still keep the perennial habit of growth. Many scientists, who insisted that domestication of rice would have been started by seeding annual type of wild rice, totally missed the perennial habit of cultivated rice. They see that rice is seeded in spring and harvested in autumn, so that rice may be seen as an annual cereal. But if one sees closely the growth habit of rice grown in the temperate zone, it usually keeps a set of dormant lateral bud in its basal stock and regenerates stems and leaves after upper parts are harvested. The perennial habit inscribed in the cultivated rice explains that clonal propagation had long been essential in the domestication of rice. In this context, the cultivated rice in the temperate zone is closer to wild rice than any annual type of wild rice, and is considered to be direct descent of wild rice, whereas, the genotypes dominant in tropical or subtropical zones are often annual in their growth habit.

**Primitive nursery of rice via clone**

On the basis discussed above, the author believes that ancient farmers may not have started their rice cultivation simply by seeding, instead, in every spring they had divided sprouting clones from perennial stocks of the semi-wild type. Thanks to detailed survey of wild rice throughout the Chinese continent in 1970-1980\(^{[10]}\), it is now clearly confirmed that a set of clones of wild rice exist in shallow swamps in Jiangxi Province at the north latitude of 35°, where the minimum temperature in winter goes down below -5°C (Fig. 1). During winter the rice plants survive the cold by basal stocks with dormant buds which sprout in early spring. Thus, ancient farmers might have divided the sprouting buds and spread them by transplanting them into flooded shallow marsh. Obviously, we see that such a primitive manner of rice cultivation did include the essential parts of rice farming, i.e., nursery bed, transplanting and flooded field of shallow marsh like.
How has a cereal crop been incorporated into the rise of agriculture in the humid climate?

Background of the primitive agriculture

For understanding the background of primitive rice cultivation, it is important to see that the propagation of plant via vegetative parts is prevalent form of cultivation in humid tropics and subtropics. That way of cultivation has been extended to humid temperate zones in south to mid China, together with taro, lotus, bamboo and so on. One can imagine how it is difficult to plow a land and to make seeding in rainy days or in mid of Monsoon season from spring to autumn in Southeast Asia and South China. Propagation of root crops like taro, lotus, sugar cane and banana can better be practiced in rainy or cloudy days. Mostly, divided parts of edible plant are inserted into shallow marsh, which sometimes are very small near or within housing area even today and must have been so in the day of primitive agriculture. As Sauer stated, plants of different kinds, growth habits, and uses were assembled in the same cultivated patches, not in fields but in simple gardens. We are still able to see such small marsh like gardens in villages in the mid of the Mekong River basin (Fig. 2). There are also many kinds of cultivated crops, semi-wild plants and wild plants in the region, to which Sauer called attention. Among those vegetatively selected native plants are taro (*Colocasia esculenta*), Chinese water chestnut (*Eleocharis tuberosa*), yam (*Discorea batatas*), devil’s tongue or elephant tongue (*Amorphophallus* spp.), edible arrow head (*Sagittaria trifolia* var. *edulis*), turmeric (*Curcuma domestica*), ginger (*Zingiber* spp.) and so on.

From the point of nutritional balance, fish culture in the marsh land must have preceded any cultivation of plants in ancient human life in the humid regions and constituted an essential part of the entire nutrition for human life. Thus, from the time of primitive rice cultivation, rice and fish culture shared the same environmental conditions. As documented in the history of ancient China, development of irrigation system and accompanying fish culture have provided a unique basis for civilization in warm and moist areas.

Advance from clone propagation to seeding

It was a miracle that the wild rice responded to human handling and converted itself into a productive cereal crop. That is a conceivable origin of flooded and terraced rice cultivation which at last realized a unique cereal production with a very high level of yield and ecological stability. The profound advantages of flooded rice cultivation have been understood by recent progress in agricultural sciences, as it is to be discussed in the next section.

Transfer from the primitive nursery to true nursery in which seeding is practiced may have included some intermediate steps. The concept of seeding was not essential for primitive rice cultivation as explained by its origin from dividing sprouting stocks to propagating it in tiny fields. A bunch of panicles instead of seed seem to have been used for starting nursery before seeding became routine.
manner. This assumption is supported by a common practice of placing a set of panicles on a nursery bed in the Mountain Province in the Philippines. In the region panicles are harvested from matured plants and stored until processing for cocking. Ancient farmers might have seen emerging seedling from panicles in field. It is an easier practice for the farmers to place panicle on nursery bed instead of seeding on it, because they don’t need to remove seed from panicles.

Apparently, the transfer from panicle placing to seeding is a breakthrough, by doing so rice cultivation became possible in such a region where no stand of wild rice existed. Rice cultivation with the seeding on nursery beds was extended to northern regions and perhaps much improved through the introduction of cattle-drawn plowing which could have been earlier developed in the Yellow River basin in China.

Advantages of flooded rice cultivation

Unexpected advantage of rice cultivation in flooded field

To a first glance, rice cultivation in flooded field may seem to be a primitive way of agriculture, as farmers cannot easily move in flooded field or marsh, pulling his feet out from mud at every step. But the cultivation in flooded field turned out to be a miraculous success in terms of a series of agronomic advantages, once adequate water for flooding field is secured. Such advantages are particularly interesting in the sense that no primitive human might have foreseen the development of flooded rice cultivation.

First of all, flooded field by virtue of surrounding levee is free of soil erosion through wind or heavy rain. Not only it is free of erosion but also it is enriched by sedimentation of fertile clay or silt carried by irrigation water. In contrast, if one sees upland farms, strong rain sheds fertile surface soil away so often that farms tend to be deteriorated in every cropping season.

Second, in the process of land preparation prior to transplanting, any plant residue from preceding cropping is incorporated into soil under flooding and decomposed by anaerobic microbes. In this way, germs or fungi carried over via crop residue are perished. Therefore, continuous cropping of rice is possible without any negative effect of preceding cropping. Contrasting, when rice is consecutively cultivated in upland farms, the yield is known to be decreased due to fungal diseases which are carried over from preceding crops and multiplied. It is of a great benefit that rice can be consecutively cultivated in the same farm, because crop rotation is not necessary, while it is essential in upland cultivation. Without any need for shifting, farmers are encouraged to pay elaborated care to their farm by maintaining canals and levees.

Third, soil fertility tend to be kept better by flooding field, because nitrogen compounds contained in residue of plant and small organism in field is slowly decomposed under submergence due to water as barrier for aerial oxygen. Further, some minerals though in small quantity are supplied from irrigation water. In particular, potassium required to grow rice can be supplied by irrigation water in many areas in Southeast Asia.

Fourth, some nutritional elements like phosphorus which are often less available to plant due to its fixation to iron or calcium in upland soil become available in flooded soil. In other words, submergence of soil changes such nutritional element into a water-solved state thus more available to plants. Some long-term tests of fertilizer application clearly showed this merit. Without phosphorus application upland crops would reduce its yield to half of the attainable at an adequate fertilizer level, but rice under flooded cultivation without phosphorus application reduced yield by 20% or less below the maximum (Fig. 3).

The advantages mentioned above have collectively

![Fig. 3. Relative reduction of yield in the trials without fertilizer (0), no nitrogen (-N), no phosphorus (-P) and no potassium(-K) against the level under complete fertilizer application (All) (Okajima, 1976) [11]. The data were summarized from a large number of trials.](image-url)
attained the unique and highly productive cereal industry in the world. Because rice can be consecutively planted in a same farm, farmers are able to obtain a high level of yield in a limited size of farm, by intensively taking care of a small farm.

Here is an impressive statistics which indicates the advantages of flooded farming. In the medieval age in Europe, farmers were able to multiply seed to harvested grain at the rate of 1:5-10 in wheat cropping. Contrastingly, in the eighth century in Japan an official rate of the propagation is 1:50 in rice cultivation.

The high productivity of rice cultivation has formulated a series of basic traits for agricultural community. Farmers were able to produce an adequate level of food for a family from a relatively small farm which is manageable even with hand tools. In the rice farming there was lesser need for collaboration of organized laborers than in other type of agriculture. This implies farmers tended to care their farm without an apparent enforcement by those at power. More important was an intensive care of a rather limited area for maintenance of levees, irrigation canals, and etc. Contrastingly, collaboration of organized man power was essential to manage a large land or a lot of upland farming in the European medieval agriculture, where a significant increase of yield was attained through extension of farm by exploring forests.

Finally, fishing as an indirect but significant advantage of flooding cultivation should not be missed here, as it also constitutes essential attributes of the entire production system. Fish culture is an essential part of rice and fish system in the sense that they constitute a balanced nutrition. Improvement of irrigation canals and expansion of flooded rice terraces can ensure various fishes for their life route from deep marsh in winter to shallow nursery of flooded field where they spawn egg in spring. Therefore, the effort to secure well irrigated rice farms is raising fishes by providing them with a set of good habitats.

**Development of irrigation technology and stability of society**

Considering the merit of flooding cultivation mentioned above, rice must have been planted in marsh from its primitive age. Primitive types of flooded rice fields cannot be found anywhere today, but we still see a tiny marsh like field where taro is cultivated in backyard garden in villages from Southern Yunnan of China to Laos, as shown in Fig. 2. Perhaps that type would have been the most primitive rice field, although today rice is nowhere put in backyard gardens. It is interesting that a series of such small rice fields were emerged in an archeological excavation in Jiangsu Province, China, which is dated back to 6 000 BC (Fig. 4).

One of the striking findings in archeological research is the discovery of ancient rice farming village at Hemudu site near the capital of ancient kingdom of Yue, Kuaiji in Zhejiang Province, China. The site in a marshy topography along a river covers an area of 40 000 m² with 4-meter thick cultural deposit and 4 superimposed layers. The carbon-14 dating after tree-ring correction is 5 000-7 000 BP. The site was excavated two times in 1973 and 1977. The site is assumed to have been surrounded by dense forests and a vast expanse of lakes and lagoons which provided a good and favorable condition for the growth and production of various animals and plants. In the process of exploiting the inexhaustible natural resources, the Hemudu inhabitants created a primitive village which can be the prototype of those found today in Southern China. Together with the remains of rice grains, there were over 170 bone spades made of the scapula of water buffaloes. The spades are crucial material evidence to prove that rice agriculture at the site entered into spade-tillage agriculture. The discovered remains of wild rice in the cultivated rice layers
provides a strong evidence to support that the middle and lower Yangtze River valley is one of the original sites of domestication of rice.

Following this discovery at Hemudu, some of even earlier rice cultivation sites were discovered in Pengtoushan site, Lixian county, Hunan Province and Xianrendong site, Wannian county, Jiangxi Province in the mid and lower basin, respectively of the Yangtze River, which are dated back to 6 000 BC.

The house of Hemudu inhabitants was a construction with girders to support the floor, on which were sets of columns and beams to support roof and walls. There were a large amount of base board, columns, piles and about 100 building components in which those with tenon and mortise joints are recovered (Fig. 5). This type of architecture is still found in minority people-populated areas in southern China. There were also a set of technologies like weaving textures and use of boat with paddles, which were primitive but served for essential needs of the primitive human.

Development of irrigation technology

Throughout the expansion of primitive rice cultivation by dividing and transplanting of sprouting stocks into small ‘rice fields’, it was essential to keep water over the surface of soil. Thus, from the day of primitive rice cultivation, farmers had to do every effort to keep their farm flooded. Meanwhile farmers may have located a series of tiny fields according to a gradient to flow the water from one farm to another. In some archeological surveys of primitive rice cultivation in Korea, rice fields in a shallow narrow valley were found in the form of terraces arranged with a gradient along a canal to which water was introduced from small streams flowing from hilly forests. The fairly developed system of irrigation was found also everywhere in the site of early rice cultivation in archeological surveys in Japan.

Although we are not able to see every developmental steps of irrigation system, some huge monumental constructions of canal and dam systems in South or Southwest frontiers of the Qin Dynasty (ca. 200 BC) prove an accomplished technological achievement in hydrology and civil engineering in China (Fig. 6). It is said today that some of the delicately calculated overflowing dams cannot be improved anymore even by modern scientists. Summarizing the historical development of rice cultivation, it is important to understand that the flooded field for rice is not such a farm as seen in upland farming but a designed construction or a set of facilities to which water is deliberately supplied from surrounding forests or rivers.

Stability of rice farming society

The above mentioned development of flooded rice terraces and accompanied expansion of fish culture formulated a core of agrarian society in humid temperate regions in East Asia. Such characteristics of the society was recognized and depicted by the great historian, Sima Qian (ca.145-ca.86 BC) in China. He traveled through the great empire of Han Dynasty from northern regions in the Yellow River basin to southern frontiers of the empire, and was in a good

Fig. 5. Remains of housing in Hemudu sites (5 000 BC). Houses with tenon and mortise joints on girders which are found there in villages of Thai people today.

Fig. 6. Ancient overflow dam and canal constructed in Guangxi, China in 221 BC.
position to comparatively review economic status of each region. The last part of his enormous work, *Records of the Grand Historian* (Shiji) was allocated to his observation of economic geography, in which he stated that in the southern regions nowhere are people in danger of hungry by planting rice and fishing but at the same time there is no one with infinite wealth. This view implies that in northern regions with the economy of upland farming and developed commercial and industrial activity there were families with infinite wealth together with those at the brink of hunger.

**Linguistic background of the primitive rice-cultivating people and their expansion**

In the east of Eurasia, Sino-Tibetan language family is one of the most predominant one, among which Thai-Chinese subfamily distributes from north to south in the eastern side and Tibetan-Burmese subfamily prevails in the western side from north to south.

Linguistically, the inhabitants in the lower basin of the Yangtze River are considered to have spoken a language different from that spoken in the political and cultural center along the Yellow River basin. Similarity of their language to the present Thai language is shown in respects to several points according to a specialist on ancient Chinese language, A. Toudou[13]. For instance, a noun is followed by an adjective in Thai but the order is reverse in Chinese. However, in ancient Chinese records there were many cases in which an adjective followed a noun, like the case in the present Thai. The use of double consonant in Thai is very popular while it is not so in Chinese. But on the basis of differentiation of a family of words with a common pronunciation into two clearly different pronouncies in Chinese language, a single ancestral pronunciation might have had double consonant from which each of different pronounce was derived. For example, a family of words implying ‘wind’ contains words starting with ‘l’ or ‘p’ which are assumed to have differentiated from a double consonant ‘pl’. There are many examples of similar cases.

Local languages from North to South in the Chinese continent are so differentiated that communication between them is difficult, but a series of variations is detectable among them by linguistic surveys. Therefore, the Sino-Thai language families are considered to be members of a continuum.

Once a group of people, who was differentiated in Thai-Chinese linguistic family, acquired the flooded rice cultivation, they also strengthened their unique position in mid to southern China in the era of dawn of written history. They had extended their unique culture based on rice cultivation and fishing to Southeast Asia. Archeological findings in the ancient rice cultivation at Hemudu site included the remains of wooden high-floored housing, which is today characteristic of villages of Thai speaking peoples from southern borders of China to Laos and North Thai. The skilled lowland rice farmers can be found in the regions of Thai-speaking peoples from South China to Southeast Asia, and further in the highland in Assam, India. This explains also that the ancient people, who developed rice cultivation, may have descended from the Thai-speaking people.

Later the culture on rice cultivation was conveyed to some of those in the family of Tibetan-Burmese language. Burmese and ethnic group of Bai (Pai) in Dali basin of Yunnan Province in China adopted rice cultivation beyond the border with China. But many of minor ethnic groups in the Tibetan-Burmese language family, who are supposed to have migrated from northern highland along the western border of Han empire, have never adopted rice cultivation, having conserved their life style of shifting agriculture or hunting on hilly areas of Southeast Asia. Contrastingly to those in Tibetan-Burmese peoples, those in the family of Malay-Polynesian language have accepted rice cultivation along the coastal, peninsular and insular parts in the Southeast Asia, and a group of them conveyed the rice cultivation to the eastern coast of Madagascar.

**Ancient kingdoms in the lower basin of the Yangtze River and rice cultivation**

The development of rice cultivation may not seem to do anything with the rise and fall of ancient kingdoms, but it had done much with their destination. It is noteworthy that emergence of ancient kingdoms,
called Yue and Wu in the lower basin of the Yangtze River was recorded from 6 century BC in the Spring and Autumn Period (Chunqiu era, 770-403 BC) of Chinese history. Historical records for them were available much later than those for Shang Dynasty and Zhou Dynasty in the Yellow River basin, i.e., later by about 1 000 and 500 years, respectively. The inhabitants in Yue and Wu were regarded as a sort of barbarian called ‘Yi’ from the viewpoint of the center of civilization in the Yellow River basin. Wu and Yue were recorded in Shiji by Sima Qian with detailed depictions of fierce battles between them. Gou Jian, the king of Yue in 5 Century BC and a contemporary of Confucius, was once severely defeated by Wu, a neighbor kingdom in 494 BC, but later he patiently recovered his power and finally conquered Wu in 473 BC. Gou Jian was recorded to have established a coastal fortress at Langya in Shandong Peninsula in 468 BC, from where he commanded a hegemony over some leading kingdoms in the Yellow River basin called Zhongyuan. The emerging power of ancient people in the lower basin of the Yangtze River is symbolized by their attempt to invade some kingdoms in the cultural and political center of the Yellow River basin. No book on Chinese history has ever mentioned the basis of their emergence, but apparently the advantage of developed rice cultivation in the humid region must have provided the momentum to these peoples. In fact they had gradually constituted a granary in China taking place of preceding agricultural area in the Yellow River basin.

However, they were under the incessant pressure from the cultural and political dominance in the Yellow River basin. The ancient Yue kingdom was conquered by one of neighbor kingdoms Chu in 334 BC, and the people fled to South along the coast and settled in many minor kingdoms, called collectively ‘Hundred Yue’ (Baiyue) which comprised Ouyue, Minyue, Nanyue and so on. A founder of modern rice research in Japan, H. Ando [14] and an eminent scholar of history and folklore in Japan, M. Oka [15] once considered that after the collapse of the ancient kingdom of Yue, a part of the refugee must have fled into southern Korea and Japan and transmitted rice cultivation. A circumstantial evidence cited by these authors was the archeological findings of primitive rice cultivation in Japan which were dated back to 4 century BC.

One characteristic feature of the Wu and Yue people was the remarkable mobility with boats. In historical records there were descriptions about how they relied on their skill of operating boats in rebellious attempted against the pressure of central imperial power. They considered that they would flee away in boats and hide themselves somewhere when their rebellion failed. In the era of Han Dynasty the inhabitants in the lower basin of the Yangtze River were so rebellious that in the 4th year of the mighty emperor Yuan Ting (113 BC) of Han Dynasty, one hundred thousand men from the Yangtze and Huai Rivers were ordered to go in fleets to suppress them. Under such pressures they migrated toward south and throughout Indochina peninsula with their life styles. Under the pressure as well as owing to their growing potential, they also migrated themselves into Northeastern Asia, like Japan and Southern Korea, together with rice cultivation. The civilization of Northeast Asia has been influenced by the ancient tradition based on rice cultivation, which was characterized by manual or family labor, while organized enforced laborers as well as the draft cattle were essential for cereal production in arid zones. That type of cultivation has provided a unique basis for cultural and religious aspects in the East Asia. Such a tradition would better be detectable through deeper insight into its unique origin of agriculture.

REFERENCES

6 Werth E. Grabstock, Hacke und Pflug. Ludwigsburg.


