

On the Origins, Diffusion and Cultural Context of Fermented Fish Products in Southeast Asia

Kenneth Ruddle
Naomichi Ishige

Abstract

A basic reconstruction is made of the origin and diffusion of fermented fish products in East Asia by combining information on the history of human migrations, cultural borrowing and ethno-linguistics. It is assumed that (1) simple *shiokara* was the prototypical fermented fish product from which the others were elaborated independently; (2) fish preservation was needed only in areas of pronounced seasonality of local fish availability; (3) fish fermentation developed first among sedentary farmers; (4) prior to organized commerce, fish fermentation originated and developed only where salt was easily obtained; and (5) fish fermentation developed in a focal region(s) of continental East Asia, later diffusing to peninsular and insular regions through the migration of peoples, cultural borrowing and commerce.

Ruddle, Kenneth, and Naomichi Ishige. 2010. On the Origins, Diffusion and Cultural Context of Fermented Fish Products in Southeast Asia. In *Globalization, Food and Social Identities in the Asia Pacific Region*, ed. James Farrer. Tokyo: Sophia University Institute of Comparative Culture.

URL: http://icc.fl.sophia.ac.jp/global%20food%20papers/html/ruddle_ishige.html

Copyright © 2010 by Kenneth Ruddle and Naomichi Ishige
All rights reserved

Introduction

The cuisines of East Asia are based on a combination of rice, fish and vegetables, with most animal proteins obtained from aquatic organisms, mainly fish. Throughout East Asia, much of the seasonally available fish is preserved by fermentation, and fermented foods are consumed daily. In that region, eating large quantities of rice is a cheap source of vegetable protein, amino acids and energy. Therefore, a vital individual foodstuff is either a salty side dish or a condiment that facilitates rice consumption. Fermented products are well suited for this, since they are simple to produce and cook, have a long shelf life, and impart *umami*¹ and a salty taste to vegetable dishes (Mizutani et al. 1987; Kimizuka et al. 1992). It is no coincidence that the main regions where fermented fish products are consumed overlap with the main regions of irrigated rice cultivation.

The Generic Products

The term “fermented fish products” is used here to describe the products of freshwater and marine finfish, shellfish and crustaceans that are processed with salt to cause fermentation, and thereby to prevent putrefaction.² Such a wide range of these foods is produced in East Asia that a strict classification by product type must be limited to individual countries or linguistic groups. Therefore we use a simple generic classification (Fig. 1 and Table 1) based on both the nature of the final product and the method used to prepare it. The prototypical product is probably the highly salted fish, which in Japan is known as *shiokara*.³ The product of combining fish and salt that preserves the shape of the original raw fish material we term *shiokara*. This can be comminuted to *shiokara* paste, which has a condiment like character. If no vegetable ingredients are added, the salt fish mixture yields fish sauce, a liquid used as a pure condiment. If cooked vegetable ingredients are added to the fish and salt mixture, it becomes *narezushi*.

1 *Umami* is a category recognized by Japanese as the taste of glutamic acid (O’Mahony and Ishii 1987).

2. Although the same phenomenon occurs with salted fish products, the state of those products described here is altered intentionally by fermentation. Thus such African fermented fish products as *ndagala*, *salanga*, *guedj*, *djege* and *momome*, together with others from various parts of Africa (Essuman 1992), *shidal* (Assam), *nya sode* (Bhutan), *pedah* (Indonesia), *jadi* (Sri Lanka), and *kisrayaruiba* (Siberia), among many others, do not fit into the category of intentionally fermented products discussed here (Ruddle and Ishige 2005). The *liquamen* or *garam* of Imperial Rome was fermented intentionally, and is of the same type as the East Asian fermented fish products (Corcoran 1963; Gamer 1987; Grimal and Monod 1952). However, there is no evidence that the fish sauces of Asia originated by diffusion from the Mediterranean Basin or vice versa. The origins of these geographically distinct groups appear to be different.

3. Since there are no succinct equivalent English terms for these products, we have used simple Japanese terms throughout. They are defined in the next two sentences.

Table 1: Types and Nomenclature of Fermented Fish Foods in East Asia

Country	Fermented Food Product Category					
	<i>Shiokara</i>	Shrimp Paste	Fish Paste	Fish Sauce	Shrimp Sauce	<i>Narezushi</i>
Bangladesh		<i>nappi</i>				
Cambodia	<i>prahok</i>	<i>kapi</i>	<i>Padek</i>	<i>tuk Trey</i>	<i>nam tom</i>	<i>Phaak</i>
China	<i>yujiang</i>	<i>shajiang</i>				
Indonesia	<i>bakasam</i>	<i>terasi udang</i>	<i>terasi ikan</i>	<i>kecap ikan</i>		<i>wadi bakasem ikan masim</i>
Japan	<i>shiokara</i>			<i>shiotsuru ishiri ikanago-shoyu</i>		<i>Narezushi</i>
Korea	<i>jeot</i>	<i>saewoo-jeot</i>		<i>myeol-chi-jeot-guk</i>		<i>Shikhe</i>
Laos	<i>pa daek</i>		<i>pa daek</i>	<i>nam paa</i>		<i>som paa</i>
Malaysia		<i>belacan</i>		<i>budu</i>		<i>pekasam cincalok ikan masim</i>
Myanmar	<i>ngapi-gaung</i>	<i>ngapi seinsa</i>	<i>ngapitaungtha</i>	<i>ngagampyaye</i>	<i>pazunggampyaye</i>	<i>nga(+)<i>ngapi</i></i>
Philippines	<i>bagoong</i>	<i>bagoong alamang dinailan guinamos oyap</i>		<i>patis</i>	<i>alamang patis</i>	<i>burong isda</i>
Thailand	<i>pla ra</i>	<i>kapi</i>		<i>nam pla budu thai pla</i>	<i>nam kapi</i>	<i>pla ra pla som</i>
Vietnam	<i>ca mam</i>	<i>mam ruoc mam tom</i>	<i>mam mem</i>	<i>nuoc mam</i>	<i>nam tom</i>	<i>mam chau</i>

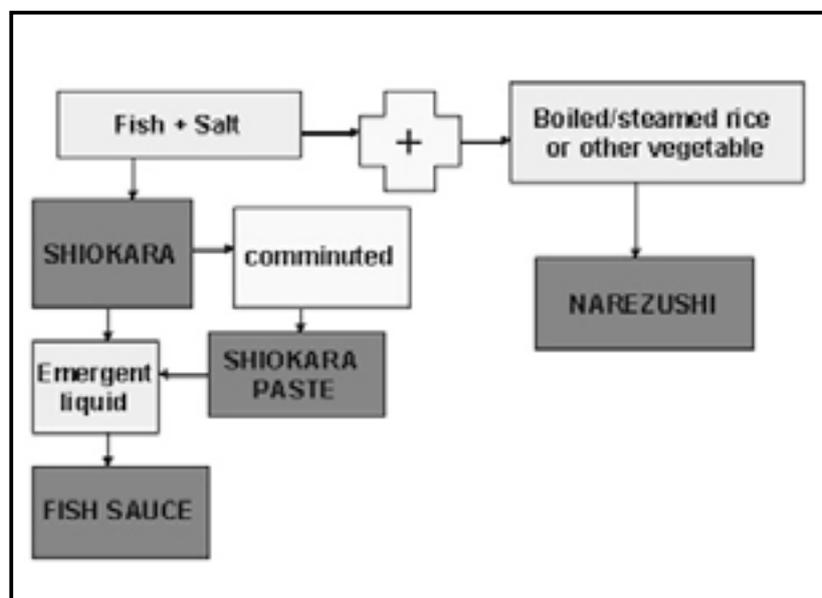


Fig. 1: A generic classification of fermented fish products in Asia



Woman stirring fermentation jars of *shiokara* at Ubon Lat Dam Village, Khon Kaen Province, Northeast Thailand



On Ishigaki Island, Okinawa Prefecture, Japan, *shiokara* is known locally as *suku*, and made from juvenile Rabbitfish (*Siganus* spp.)

(1) *Shiokara*

Shiokara is consumed mostly as a side dish, and is important in the cuisines of Cambodia, Laos, North and Northeast Thailand, Lower Myanmar, the Philippines (Luzon and the Visayas), and Korea. In Japan, *shiokara* was formerly an important side dish, but is now just a specialized, savory product. Among the Han Chinese, *shiokara* is now a local and mostly forgotten food (Fig. 2a). The paste form can be dissolved in water and used as a soup stock or for dipping. The liquid in *shiokara* (the *nam pla deak* of North Thailand, for example) is always drained off during production. *Shiokara* products contain salt plus a range of other ingredients to enhance the taste.⁴ Sometimes a small quantity of boiled rice is added, making it difficult to distinguish chemically between, for example, Thai *pra la* and *narezushi*, although they are defined differently in folk taxonomy.

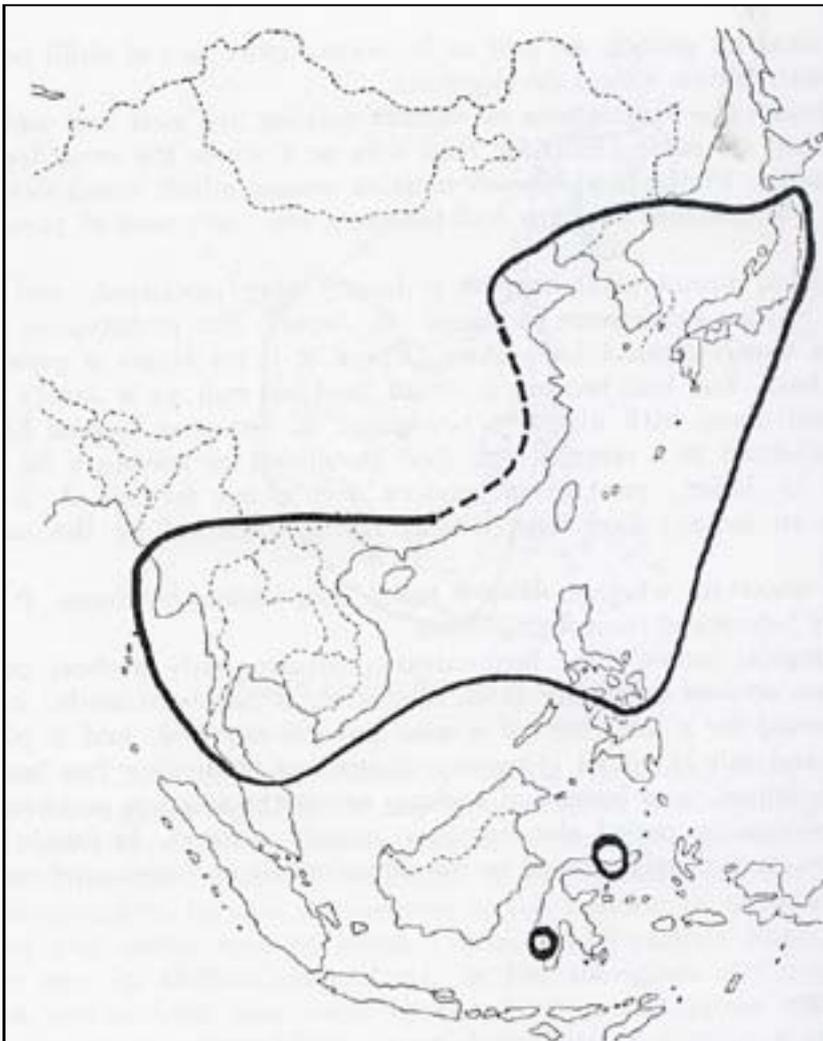


Fig. 2a: The Geographical Distribution of *shiokara*

4. Flavor arises mainly from chemical action. For example, in the production of *pra la*, the *shiokara* of Thailand, rice bran or parched rice powder is added to enhance the aromatic content of the final product. In Thailand, *kem bak nat* is made from chopped fish flesh, fish eggs and diced pineapple. The latter adds a protein-decaying enzyme in addition to imparting a sour taste and fragrance to the product. (Jackfruit and pineapple added to fish sauce in Vietnam also have the same effect.) (Ruddle and Ishige 2005).

(2) Fish Sauce

The preparation of fish sauce is the same as for making *shiokara*. However, particularly in commercial establishments, the intent is to prepare fish sauce and not *shiokara*. The manufacture of fish sauce is scattered geographically (Fig. 2b).

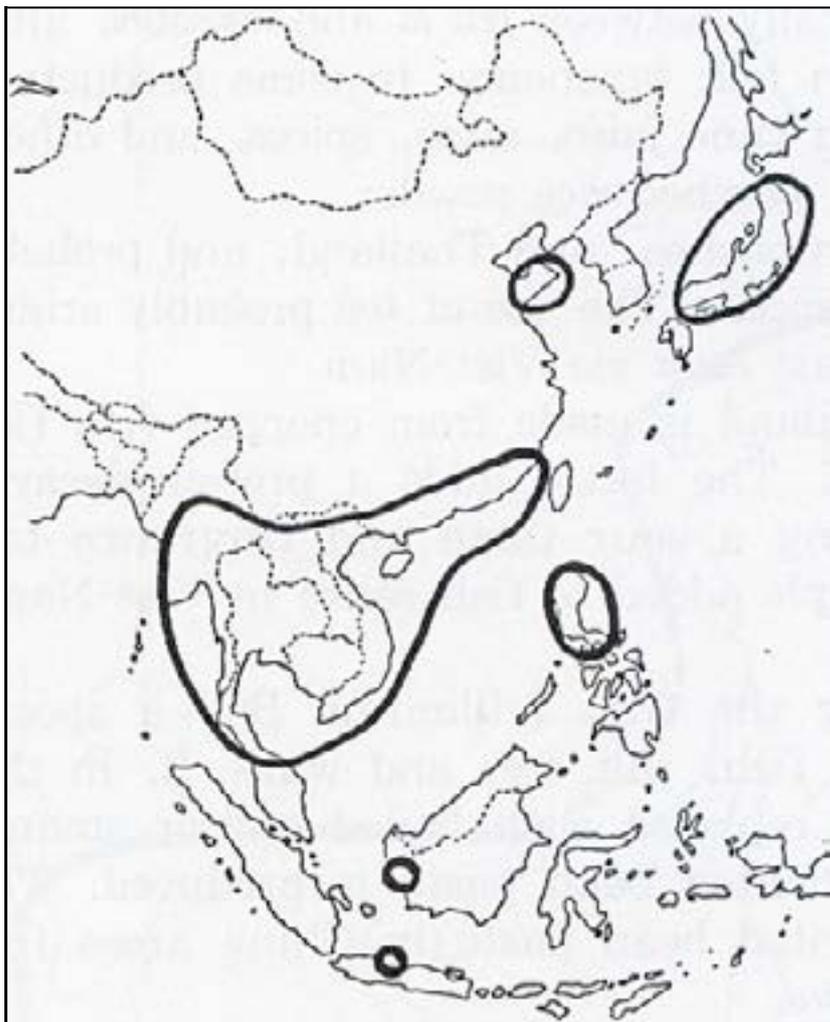


Fig. 2b: The Geographical Distribution of Fish Sauce



Homemade anchovy fish sauce (*nuoc mam*) at Muy Ne Ward, Phan Thiet City, Binh Thuan Province, Vietnam



Concrete fermentation tanks at a modern fish sauce factory in Rayong Province, Thailand

(3) Narezushi

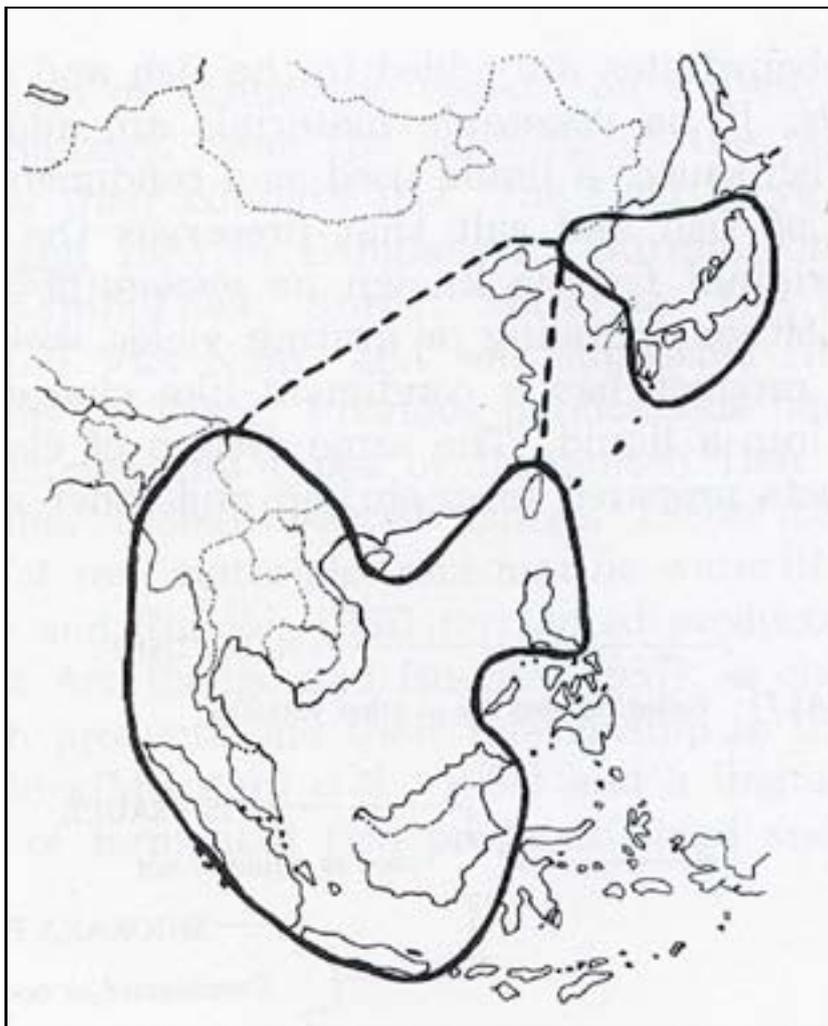


Fig. 2c: The Geographical Distribution of Narezushi

Narezushi results when boiled carbohydrates (normally just rice) are added to the fish and salt mixture used to prepare *shiokara*. This category of foodstuffs now occurs only in Southeast and Northeast Asia (Fig. 2c).



Narezushi (pla som) in the Khon Kaen Market, Thailand



Narezushi (pla som) in the Khon Kaen Market, Thailand

(4) Fermented shrimp products

Uncomminuted *shiokara*, *shiokara* paste and sauce are the three main fermented shrimp products produced in East Asia (Fig. 2d). Superficially, these can be substituted for the fish products in Fig. 1.

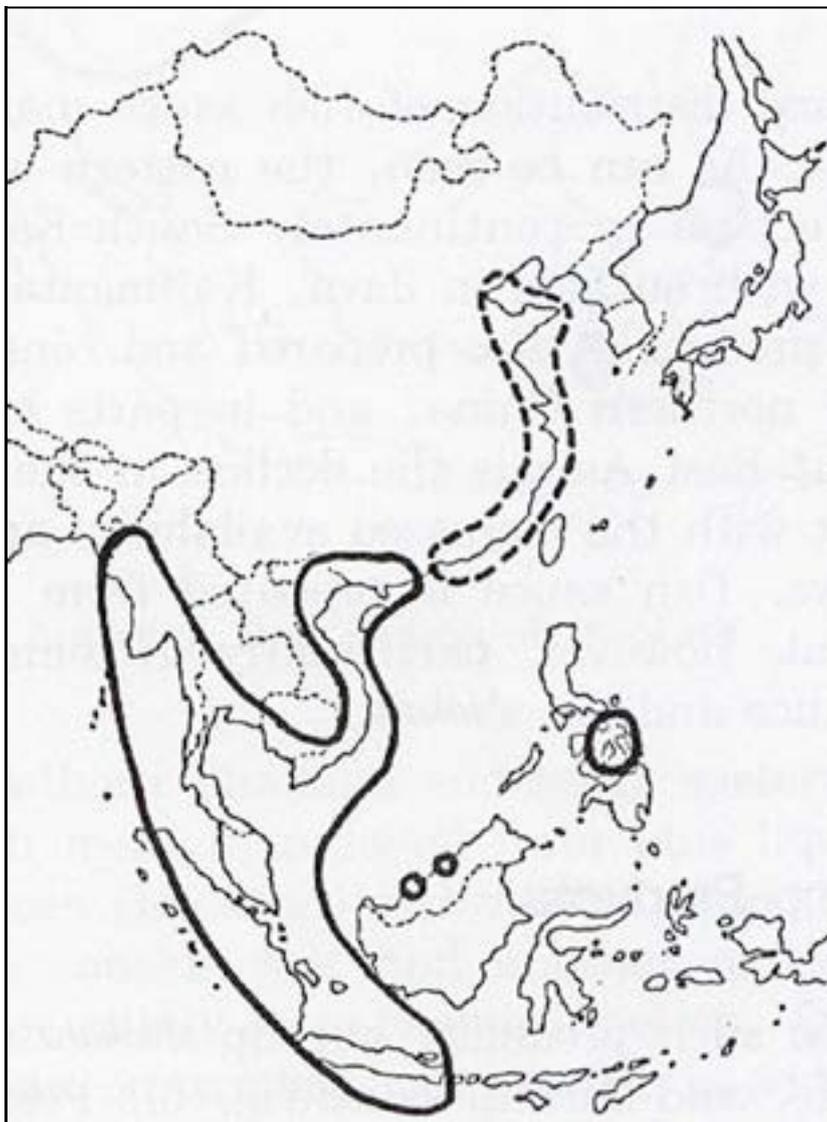


Fig. 2d: The Geographical Distribution of Shrimp Paste



Blocks of sun-dried fermented shrimp paste (*terasi*) ready for wrapping at a cottage industry level producer's house in Rembang, Central Java, Indonesia

Perhaps, during the evolution of fermented fish products, the techniques of making fish *shiokara* were simply applied to the preparation of shrimp paste. However, it is also possible that some shrimp products did not originate as a variant of *shiokara*, because in some areas fermented shrimp paste is produced without salt, as is sometimes the case in Bangladesh, Myanmar, Indonesia, and the Philippines. Some shrimp pastes have a very low salt content compared with fermented fish products, which may be a result of the different compositions of fish and shrimp. Shrimp has a carapace and a higher watery content than fish. Also, the texture of the carapace remains part of the final product, as in Japan and Korea, and in the *bagoong alamang* of the Philippines. In cases where the product is kept for a long period, the carapace eventually decomposes and the product becomes a semi liquid paste (e.g., the *shajiang* of Shandong Province, China). Semi solid shrimp paste, such as the kind prepared in Southeast Asia, requires drying, and since the water content is removed, only a little salt is required. This reduction of the water content produces a stronger tasting kind of shrimp paste essence.

On the other hand, shrimp *shiokara* could have originated from the preparation of sun dried shrimp. Only two techniques, fermentation and sun drying, are used to preserve epipelagic shrimp. Sun drying is the simplest, but it does not overcome the problem of the coarse texture of the carapace and hence the need for comminuting. Comminuting sun dried shrimp without the addition of salt produces an unsalted shrimp paste. However, salting this kind of paste enhances both the taste and shelf life. Thus, despite the lack of strong supporting evidence, the origin of shrimp paste from sun dried shrimp is compelling.



Women removing foreign matter from epipelagic shrimp prior to comminuting them into paste at Klong Kon Village, Samut Songkhram Province, Thailand

The Study of Fermented Fish Products

Studies of East Asian fermented fish products remain few and fragmented and are confined mostly to specialized research. Moreover, most studies deal with chemical analyses. In Southeast Asia, the most comprehensive research was done in Vietnam during colonial times, and focused mainly on chemical analysis of sauce quality,

specifically for taxation purposes.⁵ The early work in Vietnam was summarized by Van Veen (1953, 1965). General reviews of fermented fish products have been published by the Indo-Pacific Fisheries Council (1967), the Tropical Products Institute (1982) and Steinkraus (1983a, 1983b, 1985). These reviews outline the main processing techniques and describe the basic chemical components of the principal products. In addition, scattered reports (e.g., Lee et al. 1993) contain basic chemical analyses from some other countries. Most publications on *narezushi* are in Japanese (e.g., Shinoda, 1952, 1957, 1961, 1966, 1978), and, prior to the work of Ishige and Ruddle (2005), these products were virtually ignored in Western-language publications.

In 1982-1985 Ishige and Ruddle conducted a comprehensive field survey on the fermented fish products industry, from the catching of the raw materials to their culinary use in Bangladesh, Cambodia, China, India, Indonesia, Japan, Korea, Malaysia, Myanmar, the Philippines, Taiwan, Thailand, and Vietnam (Ishige and Ruddle, 1987, 1990; Ruddle and Ishige 2005).⁶ The field survey was conducted using questionnaires and structured interviews of factory managers, household producers, market vendors, wholesalers, and consumers. Study of related literature covered the cultural and historical contexts in terms of the products' origin, diffusion and history, particularly for China, Japan and Korea, with information being culled from historical cookery books, character dictionaries, general descriptions, and other documents. Where such documentary materials were not available, Ishige and Ruddle briefly examined the culture history of Southeast Asia and interpreted ethnolinguistic evidence based on the local terminology for fermented fish products. In these ways, it was possible to trace the likely origins and routes of diffusion, together with the development of fermented fish culture in Southeast Asia. To understand the common culinary applications of fermented fish products, 273 samples were obtained during field research, of which 38 typical samples were analyzed chemically.

Culture History and Human Ecology

(1) Human migrations in Indo-China

Since the widest variety of fermented fish products and their principal dietary role occurs in continental Southeast Asia, this area should be regarded as one center of their origin. In that region, early human settlement was in those areas most suited to cultivating irrigated rice. Therefore, freshwater fish species naturally occurring in

5. See in particular Autret and Vialard Goudou (1939), Blache and Goosens (1954), Boez and Guillerm (1930a and 1930b), Chevey and Le Poulain (1940), Lafont (1950), Mesnard and Rose (1920), Nguyen and Vialard Goudou (1953), Rose (1918, 1918b, 1918c, 1918d), and Vialard Goudou (1941, 1942a, 1942b, 1942c, 1942d, 1943).

6. The Ajinomoto Company, of Tokyo, supported the study by Ishige and Ruddle.

local hydrological systems would have been fermented. These products continue to be best developed from the area west of the Annamite Mountains to Lower Burma, where the main populations are Thai-Lao, Burmese and Khmer (Ishige and Ruddle, 1987; 1990; Ruddle and Ishige 2005).

The Burmese originated from an area in Chinese Central Asia and Tibet where there was no fisheries tradition, so it is unlikely that they prepared fermented fish prior to their southward migration. Further, the Thai-Lao originated in Yunnan, where the only historical reports on fermented fish products concern *narezushi* (Shinoda 1952; Ishige 1986). There are no Chinese historical documents indicating the preparation or use of fermented fish products among the minority ethnic groups that lived south of the Yangtze River (1952; 1986). Many of these peoples were Thai-Lao. Most likely, the Thai-Lao adopted the use of fermented fish from the earlier inhabitants after entering the Indo-Chinese peninsula, and therefore fermented fish products did not originate in China (Ishige and Ruddle, 1987, 1990; Ruddle and Ishige 2005).

It is likely that fermented fish products were made in the Indo-Chinese peninsula before the in-migration of the various ethnic groups. However, only philological evidence supports our suggestion that *narezushi* was known in the area and that the Han Chinese learned of it during the course of their extremely prolonged expansion south of the Yangtze. It appears that *narezushi* was prepared by the rice cultivators of Southeast Asia, and was taken from there to China. *Narezushi* remains common in Laos, Cambodia, and North and Northeast Thailand, i.e., in the Mekong Basin.

Although the present day inhabitants of this area are Laotians and Khmers, the Mekong Basin was formerly co-extensive with the Khmer civilization (Coedès 1962). In this respect, the hypothesis that rice cultivation originated in Yunnan and spread down the Mekong Valley into Laos, Thailand and Cambodia, with Myanmar and Vietnam as branches (Shinoda 1977), is important, because this coincides with the center of *narezushi* and other fermented fish production.

It is probable that irrigated rice cultivation and the associated rice field fishing originated in Yunnan and diffused southwards down the Mekong Valley. However, given the marked seasonality of fish abundance along the Mekong Valley (e.g., Khumsri et al. 2009; Ruddle 1987), it can be assumed that a need arose to preserve fish for times of scarcity, which eventually gave rise to fish fermentation. The center of salt production, the ecological zonation of irrigated rice cultivation, and the seasonal behavior of fish stocks all support this hypothesis.

(2) The availability of salt

Preparation of fermented fish products requires plentiful amounts of salt, which in itself would determine their origin and distribution. In the interior of continental Southeast Asia, a salt-bearing red sandstone stratum extends from Yunnan to the northern Indo-Chinese peninsula (Sinanuwong and Takaya 1974a, 1974b). Salt is collected throughout that region by farmers of irrigated rice but not by shifting cultivators, further suggesting that fish fermentation arose in this area. On the Korat Plateau of Northeast Thailand, for example, salt in the underlying sandstone dissolves during the wet season and is brought to the surface by capillary action during the dry. Salt seems also to have been collected by the earlier Khmer occupants of the region, from whom the ancestors of the present population acquired it. Northeastern Thailand is also that part of Asia where the cuisine depends most heavily on fermented fish products, and there, too, local salt is readily available. In terms of salt supply, it may therefore be surmised that the Khmer, Cham and Mon were the peoples most intimately concerned with the history of fermented fish products.

(3) Seasonal ecological conditions in rice cultivation zones

The relationship between seasonal hydrological conditions and inland fisheries in the different agro-ecological zones of rice cultivation is also important. Mountainous areas are inhabited mainly by shifting cultivators, who do not cultivate irrigated rice and who live where the fish fauna is sparse. Early irrigation networks developed in intermontane basins and alluvial fans within the mountains are flooded in the rainy season and suffer drought in the dry. During the dry season, fish populations are limited only to the larger watercourses and to mud fish in pools and swamps. In the wet season, however, the fish and other aquatic fauna is widely distributed throughout the flooded area. Seasonally abundant fish caught at the end of the wet season are therefore preserved by fermentation for year-round use. In contrast, upper deltas areas have large and abundant watercourses, and are widely flooded during the rainy season. Since fresh fish is available throughout the year, there is generally no need for preservation. Lower deltas are annually subject to extensive and prolonged flooding. In general, as in the Chao Phraya Basin of Thailand, rice cultivators have settled these areas relatively recently. Since fish is always abundant, preservation is not necessary in lower delta areas. Finally, in such rain fed plateau areas as the Korat Plateau of Northeastern Thailand, rice cultivation developed locally in interior drainage basins. In such locations, the regional hydrological system becomes integrated only in the wet season, which is also when the fish fauna becomes widely distributed over the area, rice fields included. In contrast, the fish catch is small and confined to limited areas during the dry season. This strong seasonal contrast in resource availability makes the preservation of the wet season catch imperative.

In Thailand, for example, fish fermentation is most highly developed in the Korat Plateau, followed by the northern intermontane basins. However, in the upper delta region, around Nakhon Sawan and Ayutthaya, fermented fish products are little used in this fish-rich region, which nowadays supplies other regions with fish for fermenting. In the lower delta and coastal zone, fermentation is a recent industry and depends on marine fish. In mountainous areas, eating fermented fish is a recent phenomenon, resulting from contact with lowland Thai markets.

(4) The ethnolinguistic evidence

In the absence of documentary evidence, a general history of human migration plus ethnolinguistic evidence can be used to reconstruct the probable history of the diffusion of fermented aquatic product production in continental Southeast Asia (Ishige and Sakiyama 1988).⁷ Just a few basic points are made here.

In the Khmer and Mon languages, *prahoc* denotes fermented fish products in general and is sometimes used to refer specifically to *shiokara* and *shiokara*-paste. This term occurs in Myanmar, Cambodia and part of Thailand, and probably originated in the old stratum of languages of the Indo-Chinese Peninsula to denote fermented fish products. The Khmer term *phaak* (*narezushi*) was derived from *prahoc*. *Kapi* (*Ngapi*) originated from Burmese and was borrowed by the Thais and Cambodians. In Myanmar, *ngapi* is the generic term for “fermented fish,” whereas in the Cambodian and Thai languages it refers only to shrimp paste. In fact, the term *pra-la* and its cognates are of Lao-Thai origin, and were introduced to the people of the Mekong and Chao-Phrya valleys by Lao and Thai immigrants. The Burmese, who penetrated the region of Mon-speakers, used the term *ngapi*, which was later adopted by Cambodians and Thais to denote shrimp paste. *Mam* is a Vietnamese term used generically to denote fermented fish products, which are more specifically defined by the addition of adjectives. *Mam* was also borrowed by Cambodian and Thai-speakers. Although the terminology differs, the common concept of fish sauce (“fish water”) is expressed linguistically by similar devices throughout Southeast Asia, as in *nam pla* (lit. “water of fish”) in Thai, or *nuoc mam* (lit. “water of fermented fish”) in Vietnamese. The concept of liquid emerging during *shiokara*-making is similarly expressed as *nam pla-daek* (lit. “water of *shiokara*”) in Thai.

7. Dictionaries played a vital role in this part of the research. Those consulted were Chantrupanth and Phromjakgarin (1978), Headley et al. (1977), Moussay (1971), Romah (1977), Sakamoto (1976a) and (1976b), Shorto (1962), Shintani (1981), Smith (1967) and Thongkum and Gainey (1978).

Conclusions: Culture History and Conundrums

As a rule, fermented fish products are added to vegetables and eaten with rice. They serve mainly as a salty and *umami* condiment that assists in the consumption of large quantities of rice. These products are not side dishes, and their role as an animal protein complement to rice has been exaggerated. Further, their chemical composition does not vary by fish species.

Throughout Southeast Asia, fermented fish products are indispensable for economically poorer populations, who consume them daily in relatively large amounts. However, as household incomes improve, consumption decreases in favor of either delicatessen-like fermented fish products, or increasingly commercialized products such as fish sauce, which displace the coarser, traditional village items, like fish paste.

Whereas previous studies have been concerned with marine fish, our research reveals that freshwater species are more important, especially in the Mekong Basin, where these products probably originated among cultivators of irrigated rice. In mainland Southeast Asia, many varieties of fermented products coincide with the geographical distribution of wet rice cultivation and fishing in rice fields and their irrigation canals.

In contrast, the origin and diffusion of fermented aquatic products in Northeast Asia and the Philippines remains unknown; it is not known if Chinese fish fermentation techniques originated in China, or in Southeast Asia. Further, the route(s) of diffusion from coastal China to Korea and Japan remains unclear. And it cannot be confirmed if *shiokara* in the Philippines originated locally or was introduced from continental East Asia. In China prior to the Han Dynasty, fermented meat and fermented aquatic products were already in existence (Ishige and Ruddle 1987, 1990). They were fermented with salt, grain mold *koji* and wine.⁸ In later eras, soybeans and grains replaced meat and fish. Fermented vegetable crop products of this kind spread widely through Northeast Asia and supplanted those based on aquatic organisms, with the exception of Korea, where *shiokara* (*joet-kal*) remains an important side dish (Lee 1984). The simplicity of the processing techniques and uniformity of the final products is undoubtedly one explanation for their wide geographical diffusion throughout East Asia.

Based on the production technique used, it cannot be said if *shiokara* diffused from one or several sources, or originated independently. Apart from continental

8. *Koji* is a fermentation starter.

Southeast Asia, where freshwater fish are common, *shiokara* is made from marine fish. In China, *shiokara* was made along the entire coast; however, it became a “relict” food with scattered distribution. The origin of *shiokara* made of freshwater fish with the addition of *koji* and rice wine is unknown. This variation is mentioned in ancient Chinese documents as *yujiang*, but it cannot be ascertained whether the product is of local origin or if it came from Southeast Asia. Further, it is not known whether it originated from *shiokara* made with marine fish, nor is it known if the method originated from a simple salt plus fish *shiokara*, a process that was gradually refined to produce *yujiang*. An alternative hypothesis is that, as in Southeast Asia, *yujiang* existed before the development of *shiokara*, based on freshwater species. It is possible that fermentation is not related to the use of *koji* in *shiokara*-making. In the Later Han Dynasty (25-20 AD) Shandong Province was occupied by people of Southeast Asian origin, and therefore *koji* could have originated in Southeast Asia.

The deliberate production of fish sauce as a special product is relatively recent. Historically, a liquid natural by-product of *shiokara*-making was used as a condiment, as in Cambodia, Japan, Myanmar, the Philippines, and Northeast Thailand, prior to the commercial manufacture and wide distribution of fish sauce as a specific product. The culinary use of the liquid by-product of *shiokara*-making occurs throughout Southeast Asia. However, the making of true fish sauce has reached its highest level of development in Vietnam. There is no evidence to demonstrate whether fish sauce originated in China or in Vietnam. Fish sauce made from freshwater species also exists in the same region, though its origin is also unknown. In Indonesia, fish sauce is a relatively new product introduced by either the Chinese or the Malays.

Narezushi originated in the Mekong Basin, and might be of Khmer origin. Shrimp paste originated in continental Southeast Asia, probably among the Cham and Mon peoples Indochina, from where it diffused southwards to insular Southeast Asia.

References

- Au`tret, M. and A. Vialard Goudou. 1939. *Les Acides Aminés du Nuoc Mam*. Hanoi: Imprimerie d'Extrême Orient.
- Blache, J. and J. Goosens. 1954. Monographie Piscicole d'une Zone de Pêche au Cambodge. *Cybrium* 8: 1-49.
- Boez, L. and J. Guillerm. 1930a. Pouvoir Protéolytique de la Flore Anaérobie de la Saumure Indochinoise (Nuoc Mam). *Comptes Rendues des Séances de la Société de Biologie CIII*: 1054–1056.
- Boez, L. and J. Guillerm. 1930b. Le Facteur Microbien dans la Fabrication de la Saumure Indochinoise (Nuoc Mam). *Comptes Rendues des Séances de la Académie de Sciences* 190: 534–536.
- Chantrupanth, Dhanan, and Chartchai Phromjakgarin. 1978. *Khmer (Surin) Thai English Dictionary*. Bangkok: Chulalongkorn University Language Institute.
- Chevey, P. and F. Le Poulain. 1940. *La Pêche dans les Eaux Douces du Cambodge*. Report No. 5, Indo-China Institute of Oceanography. Saigon: Gouvernement Général de l'Indochine.
- Cœdès, Georges. 1962. *Les Peuples de la Péninsule Indochinoises*. Paris: Dunod.
- Corcoran, Thomas H. 1963. Roman Fish Sauces. *Classical Journal* 58(5): 204–21.
- Essuman, K.M. 1992. *Fermented Fish in Africa: A Study on Processing, Marketing and Consumption*. Fisheries Technical Paper 329. Rome: FAO.
- Gamer, G. 1987. Antike anlagen zur Fischverarbeitung in Hispanien und Mauretanien. *Antike Welt. Zeitschrift für Archaologie und Kulturgeschichte* 18(2): 19–28.
- Grimal, P. and T. Monod. 1952. Sur la Véritable Nature de "Garum." *Revue des Études Anciennes* 54: 27–38.
- Guillerm, J. 1930. L'Explication Scientifique d'un Phenomene Empirique, la Production du Nuoc Mam. *Transactions of the 8th Congress of the Far Eastern Association of Tropical Medicine* 1:122–132.
- Guillerm, J. 1931. *L'industrie du Nuoc Mam en Indochine. Exposition Coloniale Internationale*. Paris and Saigon: Section Scientifique and Imprimerie Nouvelle Albert Portail.
- Headley, Robert K., Kylin Chhor, Lam Kheng Lim, Lim Hak Kheang and Chen Chun. 1977. *Cambodian-English Dictionary*. Washington D.C.: The Catholic University of America Press.
- IPFC (Indo-Pacific Fisheries Council). 1967. *Fish Processing in the Indo Pacific Area, Regional Studies No. 4*. Bangkok: IPFC.
- Ishige, Naomichi. 1986. Narezushi in Asia: A Study of Fermented Aquatic Products (2). *Bulletin of the National Museum of Ethnology*, 11(3): 603–668.
- Ishige, Naomichi and Kenneth Ruddle. 1987. Gyosho in Southeast Asia - a Study of Fermented Aquatic Products. *Bulletin of the National Museum of Ethnology* 12(2): 235–314.
- Ishige, Naomichi and Kenneth Ruddle. 1990. *Gyosho to Narezushi no Kenkyu (Research on Fermented Fish Products and Narezushi)*. Tokyo: Iwanamishoten.
- Ishige, Naomichi and Osamu Sakiyama. 1988. Gyosho to Narezushi no Kenkyu (An ethnolinguistic Study of the Nomenclature of Fermented Fish Products in Northeast and Southeast Asia). *Bulletin of the National Museum of Ethnology* 13(2): 383–406.
- Kimizuka, Akimitsu, Tadashi Mizutani, Kenneth Ruddle, and Naomichi Ishige. 1992. Chemical Components of Fermented Fish Products. *Journal of Food Composition and Analysis* 5(2):152–159.
- Khumsri, Malasri, Kenneth Ruddle and Gansesh P. Shivakoti. 2009. Rights and Conflicts in the Management of Fisheries in the Lower Songkhram River Basin, Northeast Thailand. *Environmental Management* 43(4): 557–570.
- Lafont, R. 1950. *L'industrie du Nuoc Mam au Cambodge*. Bulletin Economique Reprint: Saigon.
- Lee, S. W. 1984. *Hankuk Sikpum Munhwasa (Korean Dietary Culture)*. Seoul: Kyomunsa.

- Mesnard, J. and E. Rose. 1920. Recherches Complémentaires sur la Fabrication du Nuoc Mam. *Annals de l'Institute Pasteur* 34: 622–649.
- Mizutani, Tadashi, Akimitsu Kimizuka, Kenneth Ruddle and Naomichi Ishige. 1987. A Chemical Analysis of Fermented Fish Products and Discussion of Fermented Flavors in Asian Cuisines, a Study of Fermented Fish Products. *Bulletin of the National Museum of Ethnology* 12(3): 801-864.
- Moussay, Gérard. 1971. *Dictionnaire Cam Vietnamien Francais*. Phan Rang: Centre Culturelle Cam.
- Nguyen, A.C. and A. Vialard Goudou. 1953. Sur la Nature de l'Acidité Volatile de la Saumure Vietnamienne "Nuoc Mam." *Comptes Rendues des Séances de l'Academie des Sciences* 236: 2128–2130.
- O'Mahony, Michael and Rie Ishii. 1987. The Umami Taste Concept: Implications for the Dogma of Four Basic Tastes. In *Umami: A Basic Taste*, eds. Kawamura, Yojiro and Morley R.Kare. 75–93 New York and Basel: Marcel Dekker.
- Romah, Del. 1977. *Tu Dien Viet Gia Rai (Vietnamese Jarai Dictionary)*. Hanoi: Nha Xuat Ban Khoa Hoc Xa Hoi.
- Rose, E. 1918a. Etude Comparée de Diverse Sauces Alimentaires Européennes et Sino Annamites. *Bulletin Economique de l'Indochine* (n.s.) 131: 525–535.
- Rose, E. 1918b. Les Nuoc Mam du Nord (Nord Centre Annam et Tonkin), Composition Chimique et Fabrication. *Bulletin Economique de l'Indochine* (n.s.) 132: 955–972.
- Rose, E. 1918c. Le Nuoc Mam (Eau de Poisson). *Congrès d'Agriculture Coloniales, Section de Pêcheries Coloniales*. Saigon: Ardin.
- Rose, E. 1918d. Note au Sujet du Nuoc Mam Condensé. *Bulletin Economique de l'Indochine* (n.s.) 134: 1–8.
- Ruddle, Kenneth. 1987. The Ecological Basis for Fish Fermentation in Freshwater Environments of Continental Southeast Asia: with Special Reference to Burma and Kampuchea. *Bulletin of the National Museum of Ethnology* 12(1): 1–48.
- Ruddle, Kenneth and Naomichi Ishige. 2005. *Fermented Fish Products in East Asia*. Hong Kong, International Resources Management Institute. <http://www.intresmanins.com>.
- Sakamoto, Yasayuki. 1976a. *Mongo Goishu (A Mon Lexicon)*. Tokyo: Institute for the Study of Languages and Culture of Asia and Africa, Tokyo University of Foreign Languages.
- Sakamoto, Yasayuki. 1976b. *Kanbojiago Shoo jiten (A Khmer Japanese Dictionary)*. Tokyo: Institute for the Study of Languages and Culture of Asia and Africa, Tokyo University of Foreign Languages.
- Shinoda, Osamu. 1952. Chugoku ni Okeru Sushi no Hensen (Sushikoo Sono 1) (Historical Change of Sushi in China [A Study of Sushi 1]). *Seikatubunka Kenkyu (Journal of Domestic Life and Culture)* 1: 69–77.
- Shinoda, Osamu. 1957. Sushinenpyoo Shina no Bu (Sushikoo Sono 9) (Chronological Table of Sushi in China [A Study of Sushi 9]). *Seikatubunka Kenkyuu (Journal of Domestic Life and Culture)* 6: 39–54.
- Shinoda, Osamu. 1961. Sushinenpyoo sono 2, Nihon no Bu (Sushikoo Sono 10) (Chronological Table of Sushi in Japan [A Study of Sushi 10]). *Seikatubunka Kenkyuu (Journal of Domestic Life and Culture)* 10: 1–30.
- Shinoda, Osamu. 1966. *Sushi no Hon (The Book of Sushi)*. Tokyo: Shibatahoten.
- Shinoda, Osamu. 1977. *Zotei Komeno Bunkashi (A Cultural History of Rice)*. Tokyo: Shakaisisoshia.
- Shinoda, Osamu. 1978. *Sushi no Hanashi (The Story of Sushi)*. Kyoto: Shinshindoo.
- Shorto, Harry L. 1962. *A Dictionary of Modern Spoken Mon*. London: Oxford University Press.
- Sinanuwong, Somsri and Yoshikazu Takaya. 1974a. Saline Soils in Northeast Thailand. *Southeast Asia Studies* 12(1):105–119.
- Sinanuwong, Somsri and Yoshikazu Takaya. 1974b. Distribution of Soils in the Khorat Basin of Thailand. *Southeast Asia Studies* 12(3):365–382.

- Steinkraus, Keith H. 1983a. *Handbook of Indigenous Fermented Foods*. New York: Marcel Dekker.
- Steinkraus, Keith H. 1983b. Traditional Food Fermentations as Industrial Resources. *Acta Biotechnologica* 3: 1–12.
- Steinkraus, Keith H. 1985. Indigenous Fermented Food Technologies for Small Scale Industries. *Food and Nutrition Bulletin* 7(2): 21–27.
- Shintani, Tadahiko. 1981. *Radego Betonamugo Nihongo Goishuu (Rade-Vietnamese Japanese Lexicon)*. Tokyo: Institute for the Study of Languages and Culture of Asian and Africa, Tokyo University of Foreign Languages.
- Smith, Kenneth D. 1967. *Sedang Vocabulary*. Saigon: Bo Giao Duc.
- Thongkum, T.L. and J.W. Gainey. 1978. *Kui(Suai) Thai English Dictionary*. Bangkok: Chulalongkorn University Language Institute.
- TPI (Tropical Products Institute). 1982. *Fermented Fish Products: a Review. Fish Handling, Preservation and Processing in the Tropics Pt. 2: 18-22*, London: TPI.
- Van Veen, A.G. 1953. Fish Preservation in Southeast Asia. *Advances in Food Research* 4: 209–232.
- Van Veen, A.G. 1965. Fermented and Dried Seafood Products in Southeast Asia, In *Fish as Food v.3 Processing*, ed. Georg, Borgstrom, Pt. 1, 227–250. New York: Academic Press.
- Vialard-Goudou, A. 1941. Teneur en Bases Volatiles et en Acides Volatiles de la Saumure Indochinoise (Nuoc Mam). *Revue Médicale Française d'Extrême Orient* 19: 1061–1071.
- Vialard-Goudou, A. 1942a. Les Composants Minéraux de la Saumure Indochinoise (Nuoc Mam) II. Calcium, Magnesium et Fer. *Revue Médicale Française d'Extrême Orient* 19: 589–594.
- Vialard-Goudou, A. 1942b. Etude Chimique de la Saumure Indochinoise (Nuoc Mam), Recherche et Dosage de l'Indol et des Corps Indologenes. *Revue Médicale Française d'Extrême Orient* 20: 853–858.
- Vialard-Goudou, A. 1942c. Etude Chimique de la Saumure Indochinoise (Nuoc Mam), les Acides Amines: Dosage de la Tyrosine Totale. *Revue Médicale Française d'Extrême Orient* 20: 859–876.
- Vialard-Goudou, A. 1942d. Etude Chimique de la Saumure Indochinoise (Nuoc Mam), Recherche et Caracterisation de Quelques Produits de Degradation: Acide Butyrique, Acide Lactique, Derives de l'Imidazol (Histamine) et Tyramine. *Revue Médicale Française d'Extrême Orient* 20: 960–963.
- Vialard-Goudou, A. 1943. Etude Chimique de la Saumure Indochinoise (Nuoc Mam), Recherche et Dosage de l'Acide Indol B. Acétique. *Revue Médicale Française d'Extrême Orient* 9 10: 879–887.