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## The Use and Management of Small Clupeoids in Viet Nam

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## The Use and Management of Small Clupeoids in Viet Nam

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### 1. INTRODUCTION

The seasonal pattern of the monsoon is the main ecological driving force of Southeast Asia, when seasons of abundance and scarcity of food resources alternate according to the stage of the monsoonal circulation. Fermentation of fish and other aquatic organisms is one of the ancient techniques used in this region to ensure the availability of an animal protein and a savory side dish and condimental complement to rice in the seasons when fresh fish is either scarce or unobtainable. Fermentation is a major traditional food processing technique used throughout East and Southeast Asia to produce soy and fish sauces, the dominant condiments throughout the region [ISHIGE and RUDDLE 1987, 1990; KIMIZUKA et al, 1987].

The fish species deliberately targeted for use in the fermentation industry share three basic characteristics. They are (1) readily available in large quantities to permit bulk, low cost fermentation; (2) caught easily and in safe locations, to reduce labor costs and hazard, respectively; and (3) require little highly specialized or expensive fishing gear to catch. In addition, all the species meet certain physical criteria to ensure an easy and even bulk fermentation, and are inexpensive, with few, if any, more valuable economic uses.

Therefore, most marine species routinely preserved by fermentation are small, of low economic value and are seasonally abundant in inshore marine and brackish waters in large shoals that are easily captured with relatively simple gear [RUDDLE 1986]. In contrast, at other times of the year they are scarce or absent in the same locations. Since, with few exceptions, the fish utilized are juveniles, they are of low economic value and, apart from conversion into animal feed, have few alternative economic uses.

To obtain the juvenile fish required for fermenting, the small-scale fisheries that supply the raw material demonstrate a detailed empirical knowledge of the seasonal biological rhythms of fish behavior. I have hypothesized elsewhere that the fundamental biological rhythm exploited by this fishery is the feeding and recruitment migration of juvenile planktivores [RUDDLE 1986]. Thus the fishery depends on the seasonal location of coastal upwellings induced by the prevailing offshore monsoon winds, which give rise to phytoplankton blooms.

Thus the seasonal and diel<sup>1)</sup> behavioral characteristic exploited by the fisheries that supply the fermentation industry is the tendency of the juveniles of the finfish species utilized to aggregate in vast shoals in shallow inshore marine and brackish estuarine waters for feeding. In all cases, this behavioral characteristic permits large quantities of fish to be captured, using relatively simple fishing gear, and in relatively shallow, sheltered and safe inshore waters.

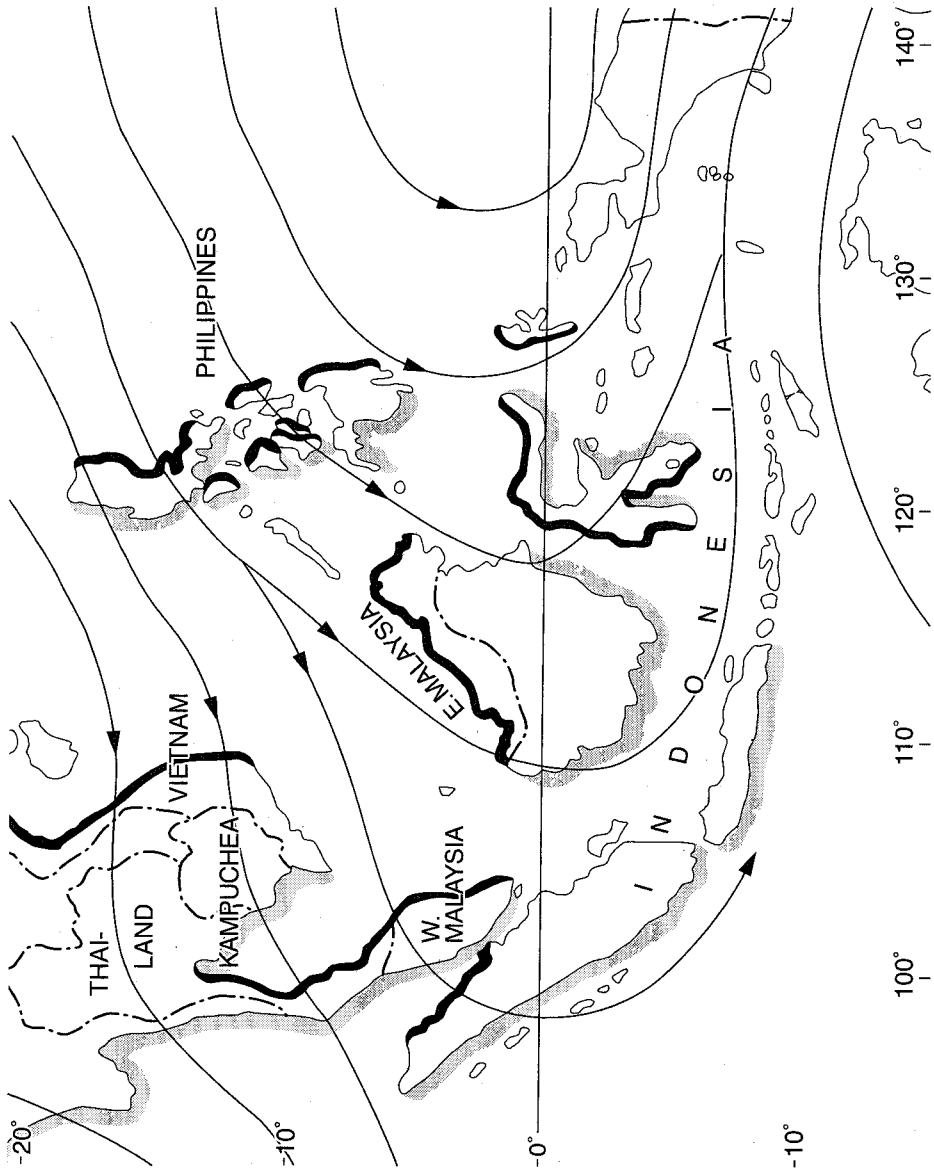
To understand the characteristics that cause certain species to be preferred, the fish species used are examined here in terms of the monsoon seasonality in Southeast Asia, physical oceanographic factors associated with the monsoons that cause local upwelling and therefore an increase in primary productivity in marine waters, and the seasonality of their biological rhythms.

Certain constraints limit a study of this kind. Principal among them is that most hypotheses on the seasonal aspects of fish behavior have been developed and tested in the temperate waters of the Northern Hemisphere. Although a link has been postulated between monsoon winds and the seasonal patterns of spawning and recruitment<sup>2)</sup> of Indo-Pacific fishes [QASIM 1973; WEBER 1976; JOHANNES 1978], and tested with inconclusive results [NAVALUNA and PAULY 1986], in contrast, relatively little comparable work has been conducted in the tropics apart from the fishes of coral reefs, mangroves and seagrass communities. The dearth of research and literature on fish behavior is particularly acute for sandy or muddy continental shelves in the seasonally extremely different marine environments of the monsoon belt. This severely constrains discussion of the relationships between biological rhythms and the supply of raw materials for fermentation, since most such materials are derived from muddy or sandy shelf areas. Perforce, much of the section on monsoon seasonality and the biological rhythms of fishes represents a series of assumptions that in large part still remain to be tested<sup>3)</sup>.

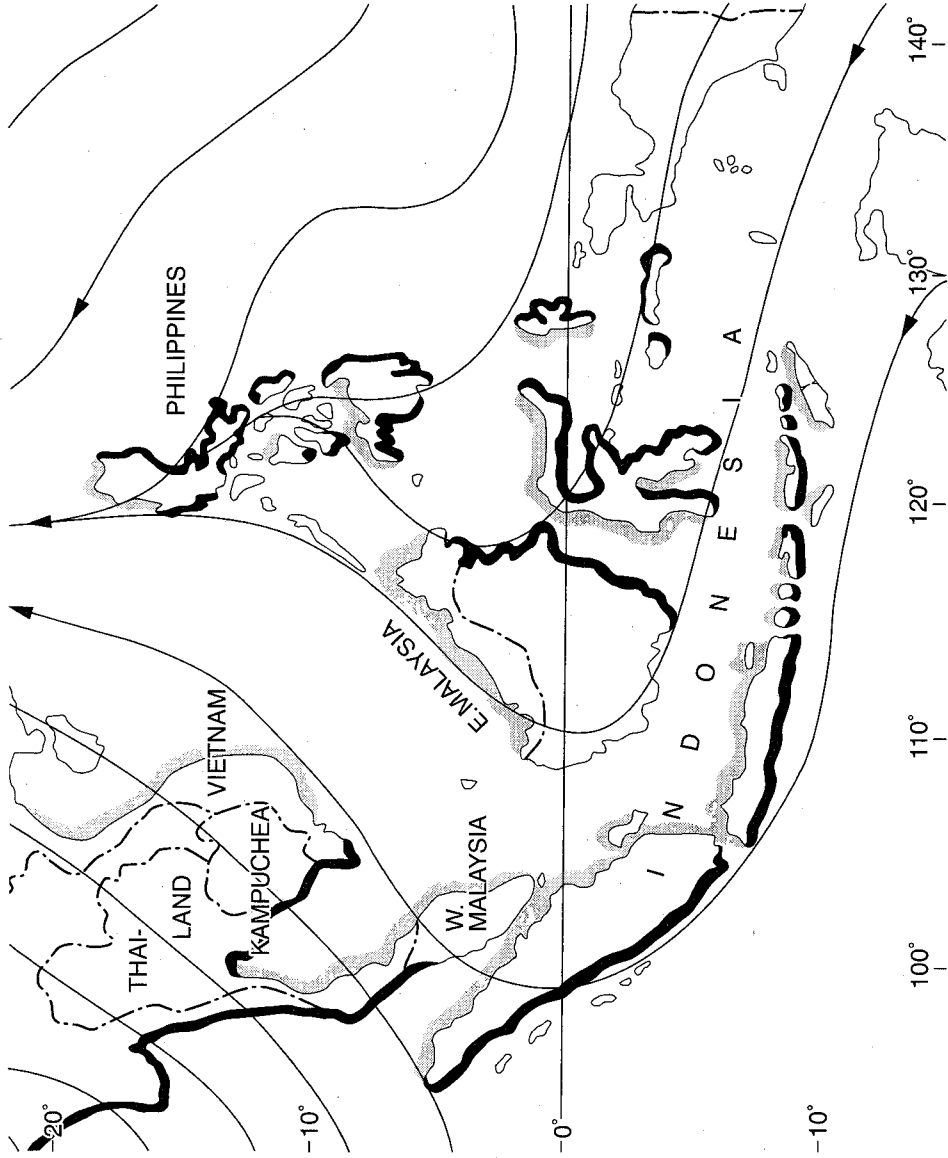
## 2. THE PATTERN OF MONSOON SEASONALITY

The large-scale atmospheric circulation in Southeast Asia is characterized by the northeast monsoon, the southwest monsoon, and two inter-monsoonal periods. The northeast monsoon lasts from about mid-October until March, when air flows basically north to south across Southeast Asia to cause the northeast monsoon (Map 1-2). At this time of the year strong onshore winds and heavy precipitation are experienced along the coasts of Viet Nam, apart from the south- and west-facing coasts in the south of the country. The southwest monsoon season lasts from mid-May until September, when wind and precipitation patterns are essentially the reverse of those prevailing during the northeast monsoon.

The two inter-monsoonal periods mark the transition seasons between the two monsoons. One occurs from late-March through May, when the southwest monsoon advances and the northeast monsoon retreats, and the other occurs from late-September through November, when



**Map 1** Predominant Wind Streamlines and Main Areas of Wind-Induced Upwelling in Southeast Asia during the Northeast Monsoon (stippled areas indicate coastal upwelling; heavy black line indicates coasts with onshore winds)



**Map 2** Predominant Wind Streamlines and Main Areas of Wind-Induced Upwelling in Southeast Asia during the Southwest Monsoon (stippled areas indicate coastal upwelling; heavy black line indicates coasts with onshore winds)

the northeast monsoon advances again. Since they are transitional seasons, the inter-monsoonals are characterized by frequent changes in the direction of the prevailing winds, as retreating monsoons make a temporary resurgence of 1–2 weeks before the new monsoon has become fully established. The length of these inter-monsoonals varies. In some years they may last but three weeks, whereas in others they may extend for up to two months. The September to November transition period is generally of shorter duration than that of March-May.

### 3. OCEANOGRAPHIC AND BIOLOGICAL FACTORS

The fish production of any sea area depends on the fertility of its water; <sup>4)</sup> in other words, it depends on the level of primary production of phytoplankton, which constitutes the base of the marine food web. Since the weak fluctuations of solar radiation result in tropical marine waters being continuously well-illuminated and well-heated throughout the year, photosynthesis of phytoplankton is limited only by the depth of light penetration. It usually occurs within the upper 200m of the water column in tropical seas.

However, in tropical seas a strong thermocline usually persists year-round and inhibits the water mixing.<sup>5)</sup> This limits primary production because dead organisms and excreta, which provide the nutrients for phytoplankton growth, sink out of the euphotic zone into the deeper waters beneath the thermocline, where they are not used for primary production. <sup>6)</sup> As a result, nutrients are gradually depleted in the euphotic zone, and the fertility and therefore the fish production gradually declines.

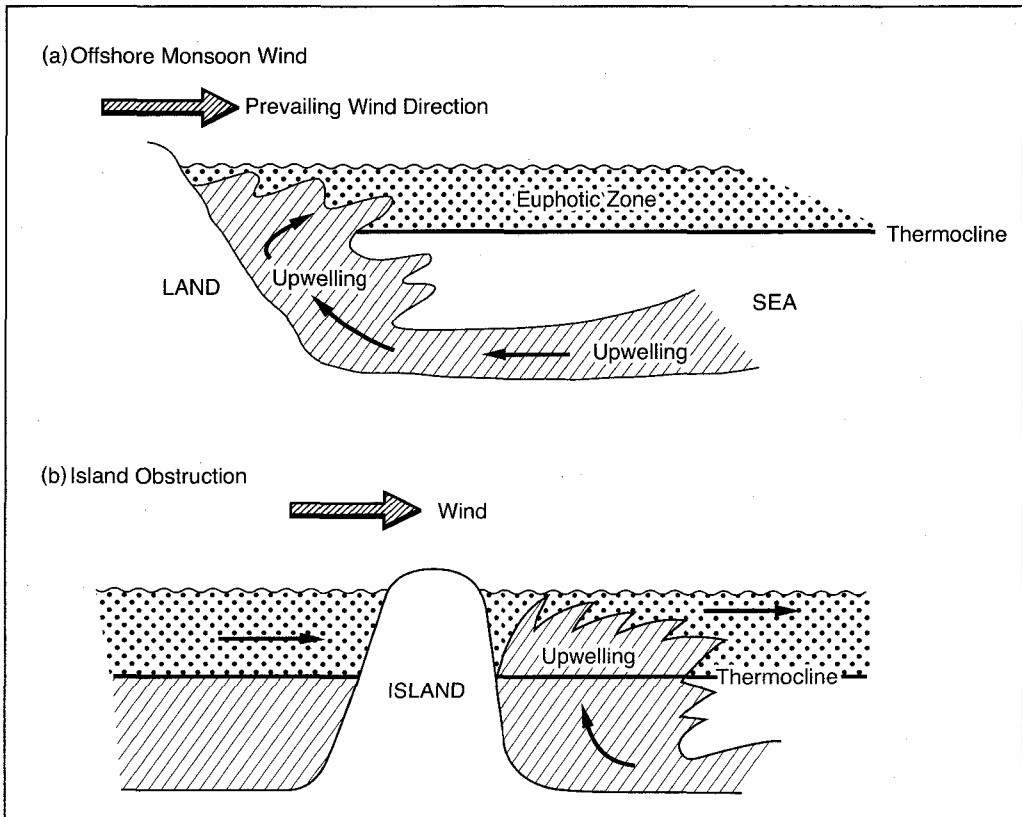
Thus upwelling or vertical water movements that seasonally disrupt the thermocline and restore the temporarily lost nutrients to the productive cycle in the euphotic zone are fundamental to the fertility of the sea and to fish production. When nutrient-laden waters are thus restored to the surface a “burst” of phytoplankton growth occurs, followed by a growth in the zooplankton population, and, in turn, an increase in the population of both planktivorous fish and those piscivores that predate on them. The spawning and feeding patterns of fish are adapted to this seasonal sequence of the loss and restoration of nutrient levels. Thus, the occurrence of upwelling, which is caused by a variety of physical factors, is of fundamental importance to both the fish production of an area and the fishery based on it (Fig. 1a).<sup>7)</sup>

In Southeast Asia, coastal upwelling is caused mainly by the prevailing offshore monsoonal wind. Thus the location of areas of coastal upwelling, and therefore of fishing activities, changes seasonally according to the prevailing direction of the monsoonal winds. During the season of the northeast monsoon, upwelling occurs on western, southwestern and southern coasts, and during the southwest monsoon, vice versa, it occurs on eastern, northeastern and northern coasts.

Conversely, during the monsoon season with prevailing onshore winds the reverse process operates. At this time of the year nutrient-rich waters are kept below the thermocline by the piling-up of surface water against the coast under the pressure of the prevailing wind. Thus without replenishment from below the thermocline, the euphotic zone undergoes a decline in nutrients and a concomitant decline in populations of phytoplankton and fish.

Local upwelling is also caused by obstructions such as islands or submerged raised areas of the seabed. They obstruct the surface current flow induced by the prevailing wind (Fig.

1b).



**Figure 1** Principal Causes of Upwelling in the Coastal Waters of Viet Nam

However, those broad patterns of coastal upwelling induced by the prevailing wind are locally distorted by a range of other complex and often interacting physical factors. Local distortions may result from the impact of currents, a major influx of nutrients via discharge of rivers swollen by monsoon rains—as well as being input directly from the rain itself—and by the interruption of winds and currents caused by highly indented and island-studded coastlines. Therefore, although monsoon-induced upwelling may be the prevailing physical factor, particularly in localities with long and uninterrupted stretches of coastline that trend at a constant angle toward the prevailing wind, in many places it may be reinforced, masked, or totally negated by such local factors.

#### 4. THE SPECIES USED FOR FERMENTATION

Although any species of fish can be fermented to produce fish sauces and pastes, by preference, because of the inherent chemical characteristics of certain species, as well as biological rhythms that favor uniform harvesting in bulk, only relatively few species are used

**Table 1** The Principal Marine Species used for Fermentation in Viet Nam

Scientific Name	English Common Name
<i>Spratelloides</i> spp.	Round herring
<i>Sardinella</i> spp.	Sardine
<i>Coilia</i> spp.	Anchovy
<i>Setipinna</i> spp.	Anchovy
<i>Stolephorus</i> spp.	Anchovy
<i>Rastrelliger</i> sp.	Indo-Pacific mackerel
<i>Anodontostoma chacunda</i>	Gizzard shad
<i>Nematolosa nasus</i>	Gizzard shad
<i>Decapterus</i> sp.	Round scad

in Viet Nam (Table 1). In Viet Nam, apart from the Indo-Pacific mackerel, Gizzard shads and Round scad, the fish fermented are all clupeoids (i.e., herrings and herring-like fishes, and engraulid anchovies). Thus, the fishes used are mostly planktivores that depend on the plankton blooms generated by the upwelling induced by the offshore monsoon.

#### Engraulidae (Anchovies)

These small pelagic planktivores occur in immense shoals in coastal and estuarine waters, and are important in the marine food chain. Most stolephorids are caught within a few kilometers of the coast. There is an apparent close relationship between precipitation, salinity, phosphate content, the abundance of phytoplankton and zooplankton, and the abundance of stolephorids. Whereas excessive freshwater influx lessens the quality of the coastal marine environment for these fish and causes them to move to deeper waters, it contributes to nutrient loading, particularly of inorganic phosphorus, which then promotes photoplankton blooms that in turn sustain zooplankton. With the increase in the population of the latter, stolephorids aggregate for feeding, since zooplankton, particularly copepods, is their principal food [THAM 1953, 1955]. Eggs and different growth stages of the fish occupy different habitats [THAM 1974]. Thus spawning may occur offshore and aggregations in coastal waters may be for feeding. Further, different species of stolephorids exhibit different physical and chemical environmental preferences, as well as those for different types of plankters [HARDENBERG 1934; THAM 1953, 1955]. Wind force may also play a part in the distribution of some species.

#### Clupeidae (Sardines and Herrings)

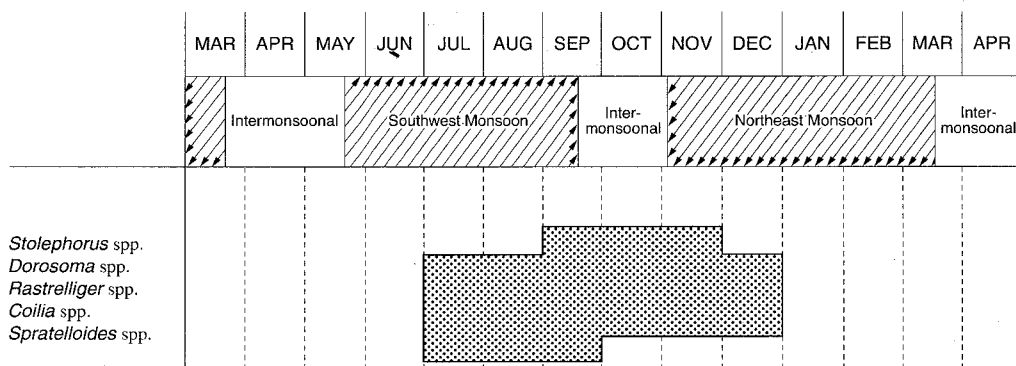
These are mostly moderately small, schooling pelagic planktivores. Clupeids form a large family, the species of which are often difficult to distinguish in the field. Following anchovies, they are the preferred fish for use in fermentation.

Clupeids usually swim near the surface of coastal waters and enter brackish water estuarine areas and occasionally freshwaters. The diet of juveniles consists mainly of phytoplankton but later switches mainly to zooplankton.



## 5. THE RELATIONSHIP BETWEEN FISHING SEASON AND MONSOON SEASONALITY

For the physical and biological reasons discussed above, most coastal fishing in Southeast Asian waters is conducted during the monsoon when the prevailing winds are offshore and coastal upwelling occurs, and during the inter-monsoonal. In the coastal waters of Viet Nam, anchovies (*Stolephorus* spp.) are taken from September until November, i.e., from the end of the offshore southwest monsoon, through the inter-monsoonal, and into the beginning of the onshore northeast monsoon. *Coilia* spp., and *Rastrelliger* spp. are caught over a somewhat longer period, from July to December. Anchovies of the genera *Setipinna* and *Engraulis* are caught only from July to September, i.e., only after the prevailing offshore winds of the southwest and the coastal upwelling that it induces are firmly established (Fig. 2).



**Figure 2** Relationship between the Fishing Season of Selected Fish Species and Monsoon Seasonality in Viet Nam

Although miscellaneous small fish which often constitute a “by-catch” are commonly utilized for fermenting, fish of a fairly uniform size and growth stage and of the same species are preferred for producing fermented sauces and pastes, since they ferment at an even rate and yield a product of uniform quality. Thus fishing efforts to supply the larger factories are directed with certain gear at a particular species and in particular seasons, times and places. Smaller producers are usually supplied mainly from the by-catch of efforts directed at other species.

Most of the marine fish utilized to make fermented sauces and paste are either juveniles or young adults. This can be ascertained by comparing the size of the fish fermented with their total body length when mature. The size of the fish harvested for making fermented fish sauce in Viet Nam is shown in Table 2.

## 6. HYPOTHESIS ON MONSOON SEASONALITY AND THE BIOLOGICAL RHYTHMS OF FISHES

Most of the fish fermented are small, pelagic, schooling planktivores (Table 1). Thus their feeding behavior depends on spatio-temporal variations in the location of plankton, which in

**Table 2** Sizes of Fish Harvested for Fermentation in Viet Nam

Scientific Name	TBI Mature (cm)	Size Harvested (cm)
<i>Spratelloides</i> spp.	6–10	5–6
<i>Sardinella</i> spp.	16–25	8–20
<i>Anodontostoma chacunda</i>	14–20	10–12
<i>Setipinna</i> spp.	10–15	7–8
<i>Stolephorus</i> spp.	10–14	5–7
<i>Engraulis</i> spp.	10–15	5–7
<i>Decapterus</i> spp.	25–30	9–12

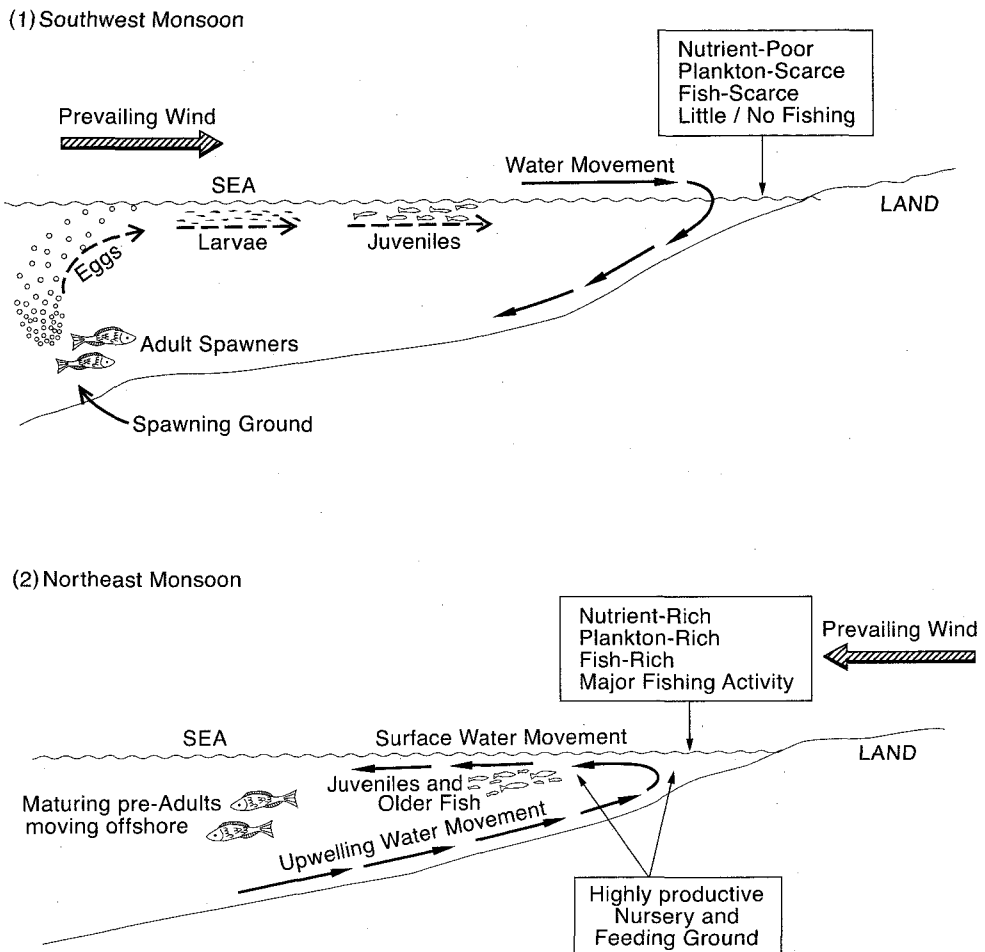
Sources: Table compiled from various sources; “size harvested” abstracted from NGO [1953].

turn depend on monsoonal seasonality. Further, since these fish are subject to high predation pressures it can be suggested that as part of their reproductive strategy they migrate away from inshore zones, where predation rates are extremely high, to spawn in offshore zones where the pressure is less intense.

The larger and less-mobile fishes of the coral reef, mangrove and seagrass habitats studied by Johannes [1978] have adapted to intense inshore predation by ensuring that the eggs are spawned inshore, drift offshore, and then are returned inshore during the season when prevailing winds would not sweep them further out to sea. With the small pelagic fishes of concern here, however, I hypothesized that intense predation inshore leads to offshore spawning migrations at times and in places where the eggs and larvae are assured of being swept coastward. They should also spawn at times and in locations where their eggs would not be flushed further offshore, and, on the contrary, when winds, currents and gyres would ensure a steady coastward drift of eggs, larvae, and post-larval forms. Thus at an early juvenile stage they would arrive at their plankton-rich inshore feeding grounds [RUDDLE 1986] (Fig. 3).

Thus, depending on the distance offshore of the spawning grounds, spawning of the migratory species should occur toward the latter part of the onshore monsoon. This would ensure that the post-larval forms reach inshore waters, where phytoplankton blooms are rich as a consequence of the upwelling induced by the offshore monsoon, either before the winds of the offshore monsoon cause them to drift further out to sea, or just after they have developed the swimming ability as newly recruited juveniles. In the latter case they could swim against the wind-induced current and reach the inshore feeding grounds prior to the intense and persistent development of the monsoon [RUDDLE 1986].

Thus, for example, if the hypothesis is correct, spawning on western coasts should occur at the end of the southwest monsoon so that juveniles can utilize the food supply at the inshore upwelling areas induced by the northeast monsoon, as is the case with the anchovies (*Stolephorus heterolobus* and *S. punctifer*) and slipmouths (*Leiognathus blochii*) in Manila Bay waters.<sup>8)</sup> The spawning of *Rastrelliger brachysoma* and *R. neglectus* off both the west coast of the Gulf of Thailand and the west coast of Peninsular Malaysia, together with *Decapterus* spp. off the latter, is also consistent with the hypothesis that seasonality in food availability influences reproductive seasonality [RUDDLE 1986].



**Figure 3** Hypothesis on Fish Behavior and the Monsoons (for a Western Coast) in Viet Nam

## 7. FISHING GEARS AND TECHNIQUES UTILIZED

In Viet Nam a variety of gears has been used to procure raw materials for fermentation. The surrounding and bagging gears and techniques used in the industrial fisheries all exploit the shoaling behavior of planktivores, as well as that of fish with other feeding habits. The variety of gear types used ranges from the large, industrial purse seine operations that supply large-scale fermentation factories, to the simple filter bag nets used to satisfy cottage industry and household needs. Widely used was the "Sardine net," a fixed floating fish shelter made of bamboo, branches and palm fronds, and anchored with ropes and rocks. This was so important to the fish sauce industry that special rules were applied to its use (see below). Formerly, the Sardine net described here was of major importance. But it has now been superseded by purse-seining, which takes the juveniles further offshore, as they migrate toward the coast.

## 8. TRADITIONAL SHRINE-BASED FISHERIES MANAGEMENT

In many parts of Viet Nam there is a long tradition of stakeholders' organization (*van chai*) for local community-based marine fisheries management and mutual assistance. In the Central and Southern regions, in particular, paralleling the situation with agricultural settlements, marine fishing villages erected shrines that served as a focal point for local fisheries management. Rules have been transmitted orally through the generations, and based on them fisheries management tasks performed by the *van* administrative section [RUDDLE 1998].

However, management has traditionally been far more comprehensive than just the governance of natural resources. Thus, for example, the Administrative Section of Duc Thang Hamlet, Binh Thuan Province, observed that Van Thuy Tu provided local government with valuable help in the fields of administration, justice, social affairs, and the maintenance of order and public security [REPUBLIC OF VIET NAM 1963].

Despite decades of turmoil preceding national reunification in 1975, in many places the systems have survived. It is noteworthy that because the salient characteristic of traditional management systems in Viet Nam is regulation of inter-relationships among fisheries stakeholders within the framework of the strong moral authority of the community shrine, rather than governance of fishing and the fishery per se, the core of the systems has proven remarkably resilient [RUDDLE 1998].

Because of the far-reaching changes that were occurring in both general society and the fishery, by the early-1960s officials of Duc Thang Hamlet, Binh Thuan Province, were of the opinion that for local fishery regulations and customs to be handed-down systematically to future generations, they should be expressed comprehensively in a written document [REPUBLIC OF VIET NAM 1963]. Accordingly, a document consisting of 22 chapters and 114 articles dealing exclusively with the local marine fishery was prepared and unanimously approved at a seminar participated in by 29 officials of Duc Thang Hamlet [COUNCIL OF CHAU THANH VILLAGE 1963].

A fundamental aspect of the moral basis of Vietnamese society is the deep sense of gratitude to the ancestors in a community for their labors and struggle to survive and build a prospering community [TRUONG n.d.; RUDDLE 1998]. Further, in earlier times the appeasement of a mysterious and often hostile natural environment was important. This led to a strong belief in the power and salvation of numerous deities. Therefore, after the economic fundamentals of any new settlement were established, villagers constructed a shrine for the village's tutelary genie, ancestral sages and wise elders. In the social context of former times the shrine became the principal cultural and organizational center of a village [cf. NGUYEN 1993; CLAEYS 1943; HUARD and DURAND 1954; HUYNH 1996; LAM 1996; NGUYEN 1996].

From the late-18th century, marine fishing villages enlarged their shrines to make provision for the worship of the Deity of the South Sea (Thain Nam Hai Cu Toc Nyoc Lan). This deity is a "whale" (a local concept that embraces all cetaceans). More importantly, the "Whale Shrine" is the central point of the *van chai*, and so the locus of moral authority of a fishing community's life and the foundation on which local, community-based fisheries management was and remains based. According to Claeys, the cult of "whale" veneration had its origin during the reign of Emperor of Gia Long (1802–1819). In gratitude for reputedly having been saved from disaster

by a whale while at sea in the vicinity of Phu Quoc Island in 1783, Emperor of Gia Long elevated whales to a high grade mandarin. Supernatural powers were attributed to cetaceans, and they were entitled to veneration [CLAEYS 1943; RUDDLE 1998].

The shrine at Van Thuy Tu, Binh Thuan Province, illustrates the historical processes at work. In the late-17th century the southern borders of what is now Viet Nam were in Binh Thuan Province, around present-day Phan Thiet. To stabilize the frontier in newly conquered territory, the Nguyen Lords brought many settlers from the northern provinces of the Ngu Quano Region. The first such settlers gathered in the Phan Thiet area at Duc Thang Hamlet, where general rural occupations gradually gave way as the marine fishery developed. The *van* started in 1697, and so has 300 years of history as an association [TRUONG n.d.; PEOPLE'S COMMITTEE 1995].

The shrine at Van Thuy Tu was established in the winter of 1762 [PEOPLE'S COMMITTEE 1995]. Its initial function was as a shrine to village deities and ancestors. But as the sea fishery developed, this function became auxiliary to the worship of the Deity of the South Sea. It is also known that various kings approved the fishing rights of Van Thuy Tu in 1843 and 1887 (as attested by original documents stored in the shrine). Duc Thang Hamlet, the first fishing village in the region, is regarded as the center from which the whale cult disseminated in Binh Thuan Province.



**Photo 1** The shrine building at Van Thuy Tu, Phan Thiet



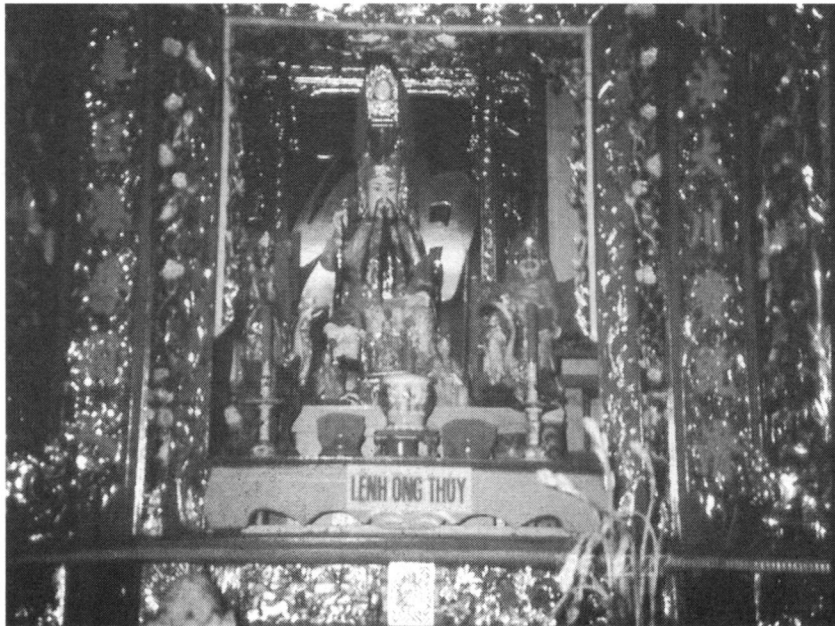
**Photo 2** Large whale skull and other whale bones venerated in the shrine at Van Thuy Tu



**Photo 3** Ceramic urns containing the bones of smaller cetaceans venerated in the shrine at Van Thuy Tu



**Photo 4 and 5** Views of the alters in the shrine at Van Thuy Tu



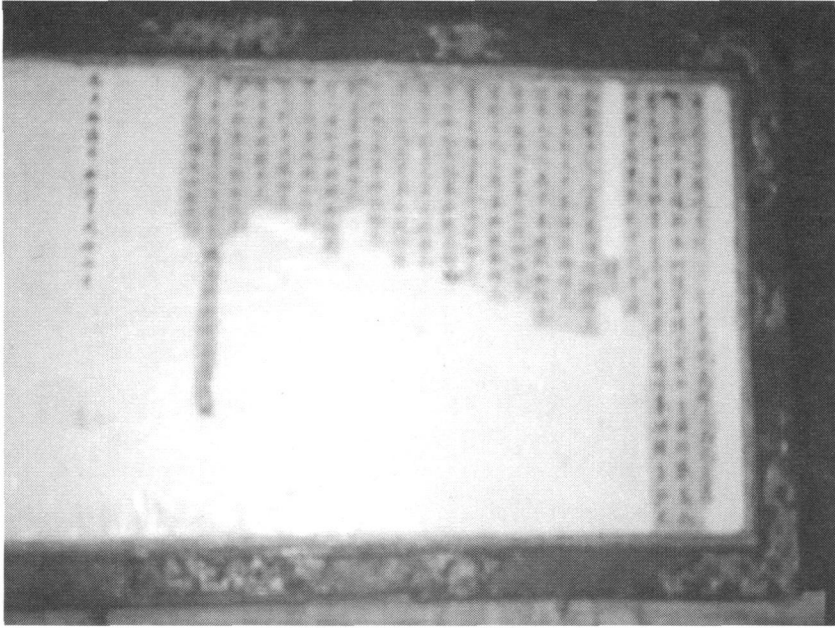


**Photo 6** Painting of the sacred whale on the wall of the shrine at Van Thuy Tu



**Photo 7** Painting of a mythical dragon on the wall of the shrine at Van Thuy Tu





**Photo 8** A portion of the original title issued in 1843 by the king to the Van Thuy Tu, and preserved in the shrine



**Photo 9** A small container of *nuoc mam* being made by a fishing household in Phan Thiet.

## 9. THE STRUCTURE OF TRADITIONAL OF COMMUNITY-BASED FISHERIES MANAGEMENT IN VIET NAM

In addition to shrine management and the conduct of ceremonies, in Viet Nam the traditional *van chai* system was structured to address principally [RUDDLE 1998]:

- (1) mutual assistance among fishers;
- (2) the behavior, rights and obligations of fishing boat owners, captains and crew members;
- (3) disposal of the catch;
- (4) governance of fishing operations (rules for the main gear types and pertaining mainly to eligibility, seasonality and profit-sharing);
- (5) conciliation of fisheries conflicts, the resolution of which is not stipulated in current local rules or higher laws; and
- (6) sanctions (punishment).

Only the first four items are examined in further detail below. Although the details vary considerably by locality, the underlying principles of the veneration of deities and ancestors, combined with the sacred obligations of mutual assistance, remain important.

### (1) Mutual assistance among fishers

The linkage between festivals and mutual assistance in the codification document implies that mutual assistance is a sacred duty of *van* members [REPUBLIC OF VIET NAM 1963]. It demonstrates the traditional moral authority of the *van*. It is reiterated within the document that the Sea Gods must be solemnly and sincerely worshipped by fishing boat-owners and fishers.

### (2) The behavior, rights and obligations of fishing boat owners, captains and crew members

Several rules cover boat-owners' behavior when seeking to hire a captain and crew. They are required to know for whom the captain and crewmembers worked during the previous season. They are forbidden to offer enticements to lure men away from other boat-owners, and must not "scramble among themselves" to hire a captain and crew.

Formerly, all *van* contractual rules regarding the rights and obligations of crewmembers concerned cash advances and loans from the boat-owner. Such financial arrangements are still made, but maximum amounts allowable are no longer set by *van* rules. Contracts specify the financial arrangements [COUNCIL OF CHAU THANH VILLAGE 1963].

### (3) Disposal of the Catch

In Viet Nam remuneration of harvesting labor is extremely complex and varies greatly by fishing port and gear type. However, everywhere it is based on a share of the annual catch value, after all costs have been deducted, among boat-owners, captains and crewmembers. Boat-owners, captains and crewmembers are entitled to sell the catch at the landing site for prices that are published daily.

### (4) Governance of Fishing Operations

Gear rules are widespread in Viet Nam. Many were established to overcome gear externality

problems (i.e., operational incompatibilities among gear types). However, as at Van Thuy Tu, where detailed rules were applied to the 11 main gear types used, rules pertained mostly to eligibility, seasonality and profit-sharing among boat-owners, captains and crew. The overriding principle of eligibility rules is that boat-owners are eligible to participate in a given fishery if they can supply the requisite number of boats and gear, as well as meet all expenses for the entire season.

At Van Thuy Tu special rules were applied to the Sardine net, because, being a major fishery and employing a fixed fish sheltering device, there was a greater inherent potential for conflict than for other gear types. Since this gear targeted an important fishery (sardine, the basis of the local fermented fish sauce [*nuoc mam*] industry), it was governed by an elaborate and specific set of rules. These pertained to eligibility, fishing season, territory, conservation, outsider's rights, removal of fish shelters, monitoring and accountability, and catch-sharing [RUDDLE 1998].

(a) Eligibility Only boats that constructed a fish shelter and set the net could practice this fishery, unless the owner's permission had been obtained to use the site (see below). To be eligible to participate, a boat must construct at least one shelter.

(b) Fishing season The season opened from the first lunar month, except for late entrants who begin in the fifth month, and ended on the fifth day of the ninth month, when the season's income was shared. If after that day abundant fish remained and sea and weather conditions were still favorable, fishing could continue. The same sharing rules as for the main season governed the income from this extended season.

(c) Territory To avoid gear conflict, individual Sardine nets had to maintain a separation of at least 300 m. Sardine net owners were required to mark their sites with a distinct sign of ownership. Further, fishers using other gear, particularly nylon nets, seine nets and baited-lines, were forbidden from fishing around the Sardine nets belonging to other persons.

(d) Conservation The use of attraction lights on the fish shelter was forbidden because, although a large catch would be taken on the first night, thereafter few fish could be caught. Blast fishing was also prohibited.

(e) Outsider's rights Boats that had set their own Sardine net had the right to fish from another's site. However, as soon as the boat that "owned" the site approached and signaled, an outsider boat had to cease fishing immediately. Should the outsider boat fail to comply immediately, and delay the owner's fishing, the latter could claim the entire catch from its site from the outsider boat. However, the owning boat was forbidden from taking any direct punitive action at sea (such as cutting the offending boat's anchor line, or dropping its anchor in the offending boat's fishing net).

(f) Removal of fish shelters In order that the entire community could benefit from this fishery, rules governed the removal of shelters at the end of the fishing season. Fishers could remove only their own fish shelter; shelters could not be removed before the 21st day of the ninth lunar month, in case others wished to continue fishing after the season closure, on the fifth day; and fishers who stopped fishing before the end of the season had to leave their shelters intact until the 21st day of the ninth month, for the use of others.

(g) Distribution of catch rules Rules defining access to harvested fish are widespread in the Asia-Pacific Region [RUDDLE 1994]. These are an extremely important set of rules in many

societies, since in terms of equity within a community access to fish once harvested can be as or more important than access to fishing grounds.

(h) Monitoring and accountability If rights are to be meaningful, provision must be made within the system for monitoring compliance with rules, and backing-up this by imposing sanctions on violators. Under most community-based marine resource management systems in the Asia-Pacific Region, monitoring and enforcement are generally undertaken within the local community; resource users policing themselves, and being observed by all others as they do so [RUDDLE 1994]. This was the case at Van Thuy Tuy, where the Sardine net fishery was monitored by the fishers, who were required to report to the *van* officers any violations concerning the location or lack of maintenance of fish shelters.

Further, *van* rules governed the use of the Sardine net, so crucial to the traditional economy of Phan Thiet. A detailed contract had to be drawn-up at the beginning of the fishing season at a special meeting of captain and crewmembers. Details of the season's work assignment, rewards, punishments, rations, and the like had to be specified, and the agreement recorded in a minutes of the meeting. A detailed record of expenses and other accounts was required. To avoid conflict, each fishing unit had to employ a bookkeeper, who could be neither a family member nor relative of the boat-owner, captain or any crewmember, to maintain "clear and impartial" accounts for the season. The bookkeeper was paid with three percent of the season's profits, as was the person in charge of selling fish and collecting sales money. As a further safeguard, the boat-owner and crewmembers also had to keep an account book for comparison.

## 10. CONCLUSION

Nowhere are fisheries management systems immutable. They change, often rapidly, in response to both a wide range of external stresses and internal pressures [RUDDLE 1993]. In the case of Viet Nam, a complex and turbulent political history has had a major impact on traditional community-based management systems.

But a second major cause of change has been the impact of motorization of fishing vessels and gear introductions that have witnessed the decline of fixed gear concomitant with the introduction of mobile techniques, especially purse-seining and trawling. As a consequence, in many locations many of the traditional rules that governed fisheries have become irrelevant. That has been the case at Van Thuy Tu, where the Sardine net is no longer used, having been replaced by purse-seining, and thus the rules governing its use are no longer applied. However, we are fortunate in still having the detailed records of this and other gears written down 40 years ago by the fisheries specialists of this community. Their vision was admirable and deserves to be widely emulated.

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Nam, funded by JICA.

## NOTES

- 1) Diel refers to a 24-hour cycle that includes a daylight and a night period.
- 2) Recruitment means an increase in the natural population resulting from the addition of juveniles.
- 3) As it did in 1986, when I first advanced them [RUDDLE 1986].
- 4) Here, "fish production" means "biological production" as opposed to the "yield of a fishery". The latter obviously depends also on a variety of cultural, economic and technical factors.
- 5) A thermocline is a layer of water in a thermally stratified area that separates an upper, warmer, lighter and oxygen-rich zone from a lower, colder and oxygen-poor zone.
- 6) A euphotic zone refers to the upper layers of a body of water into which enough sunlight penetrates to permit the growth of green plants.
- 7) These vertical water movements in the marine environment are extremely complex. The discussion here has been greatly simplified.
- 8) For a detailed exemplification of this rhythm see INGLES and PAULY [1984], in which data for 56 species of 112 commercially exploited teleost fish stocks are analyzed.

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