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# SHRIMP GROW-OUT CULTURE TECHNIQUES IN THE PHILIPPINES

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The major commercial shrimp species in the Philippines belong to the genus *Penaeus* and *Metapenaeus.* The important penaeid shrimps are: *P. monodon* (giant tiger shrimp or *sugpo*); *P. japonicus* and *P. semisulcatus* (tiger shrimp and *bulik* or *sugpo*); and *P. merguiensis* and *P. indicus* (white shrimp and Indian white shrimp or *putian*). The giant tiger shrimp is the major species cultured in ponds while the others are incidental crops.

There are 210,000 ha of potential and existing brackishwater ponds in the Philippines (Fig. 1). Because most of these are underdeveloped, present technologies are aimed at improving production or encouraging the development of new areas.

Brackishwater fishfarming in the country is primarily centered on milkfish (*Chanos chanos*) (Table 1). Shrimp used to be merely an incidental crop when postlarvae from the wild enter the milkfish ponds. In the last decade, many traditional milkfish growers recognize the market of shrimps, primarily the giant tiger shrimp. Polyculture of milkfish and shrimp was practiced, and the fishfarmers shifted to shrimp monoculture when price of shrimp in the international market went up.

In the mid-70s, SEAFDEC/AQD developed and extended its shrimp hatchery technology, and hatcheries proliferated throughout the country. Seed supply became abundant, encouraging more people to invest in grow-out culture. However, production remained low and inconsistent since the grow-out technology remains largely an art.

When Taiwanese grow-out technology was introduced in the country and research in shrimp was intensified in the Department of Agriculture, University of the Philippines, and SEAFDEC/AQD, new coastal areas were developed particularly in Negros Island where vast tracts of sugarland and rice land were converted to shrimp ponds. Milkfish ponds were also renovated for shrimp culture.

There are four shrimp culture levels in the country, namely: traditional, extensive, semi-intensive, and intensive which vary mainly in pond design, stocking density, feeds and feeding, and water management (Table 2). Only the semi-intensive and intensive culture systems are discussed.

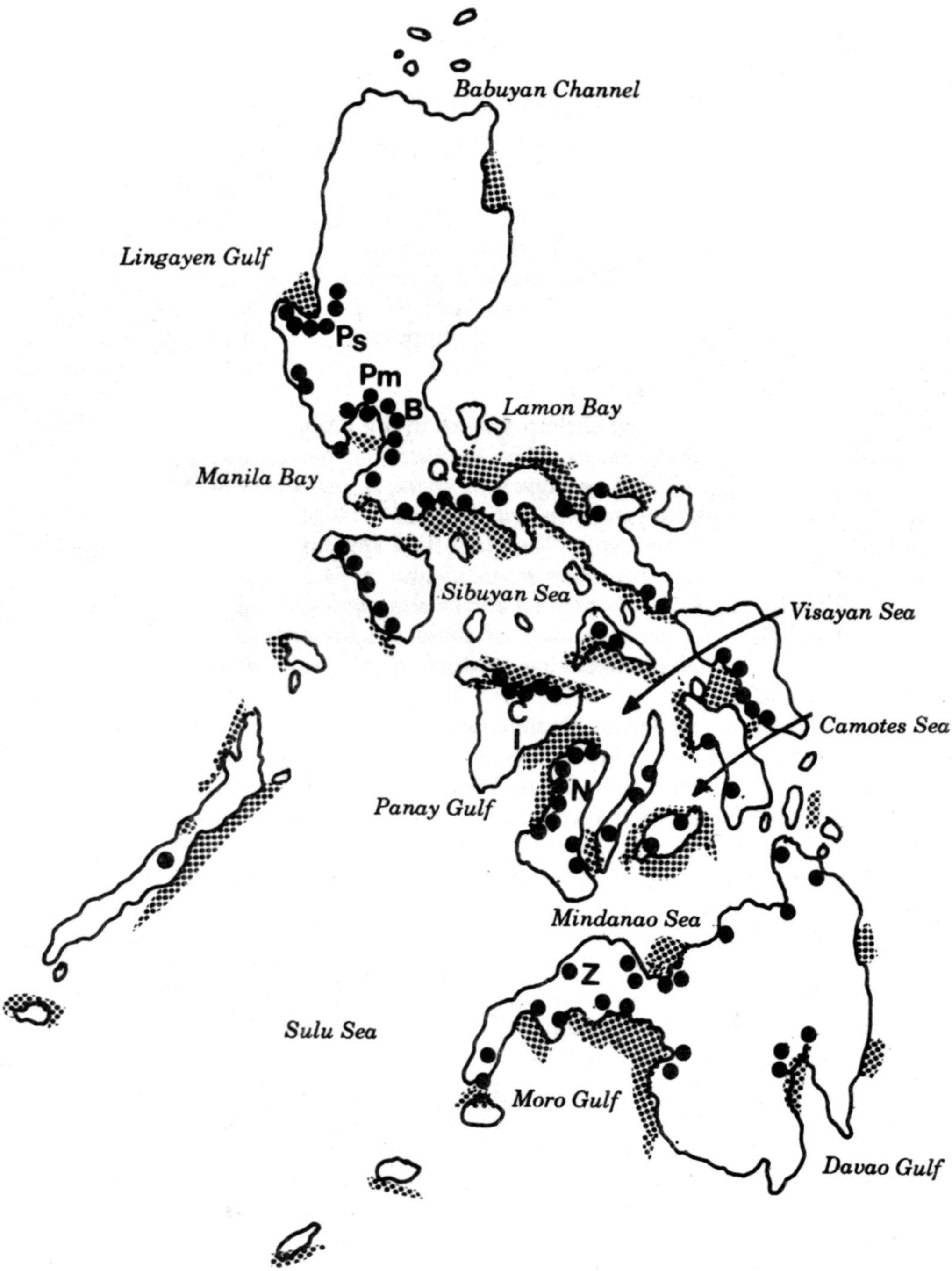


Fig. 1. The Philippines: mangrove areas (▒), fishpond areas (•), and fishing grounds. The eight provinces with the largest fishpond areas are indicated (Ps, Pangasinan; Pm, Pampanga; B, Bulacan; Q, Quezon; C, Capiz; I, Iloilo; N, Negros Occidental; and Z, Zamboanga del Sur) (Camacho and Bagarinao 1986).

Table 1. Brackishwater fishponds in operation

| Region | Total area (ha) | Production (M t)* | | | |
|---|---|---|---|---|---|
| | | *Bangus* | *Sugpo* | Others** | Total |
| NCR | 703 | 503 | 56 | 85 | 644 |
| I | 16,658 | 16,955 | 3,765 | 5,806 | 26,566 |
| II | 1,469 | 680 | 19 | 244 | 943 |
| III | 53,465 | 49,477 | 12,058 | 11,717 | 73,252 |
| IV | 23,281 | 9,062 | 8,035 | 1,973 | 19,070 |
| V | 11,028 | 3,961 | 1,276 | 722 | 5,959 |
| VI | 59,074 | 64,959 | 15,699 | 4,143 | 84,801 |
| VII | 7,110 | 6,771 | 371 | - | 7,142 |
| VIII | 5,977 | 2,349 | 450 | 112 | 2,911 |
| IX-A | 1,540 | 1,293 | 20 | 53 | 1,366 |
| IX-B | 14,861 | 12,961 | 348 | 1,902 | 15,211 |
| X | 4,326 | 2,910 | 156 | 43 | 3,109 |
| XI | 7,248 | 6,012 | 603 | 1,964 | 8,579 |
| XII | 3,940 | 3,264 | 683 | 80 | 4,027 |
| TOTAL | 210,680 | 181,197 | 43,539 | 28,844 | 253,580 |

*Average national yield, 1.2036 Mt/ha/yr. **Tilapia, white shrimp, mudcrab, others. NCR, national capital region.

Table 2. Comparative features of various technology levels of shrimp culture

| | Traditional | Extensive | Semi-intensive | Intensive |
|---|---|---|---|---|
| 1. Stocking density ($pc/m^2$) | 0.5-1.5 | 3.5 | 6.15 | 10 and above |
| 2. Maximum pond size (ha) | 30 | 1.5 | 1.5 | 0.70 |
| 3. Minimum water depth (m) | 1.0 | 1.0 | 1.1 | 1.2 |
| 4.Aerators (/ha) | None | None | 4-8 units at 1 hp | 4-8 units at 1 hp |
| 5. Feeds | Fresh diet | Commercial; fresh diets | Commercial feeds | Commercial feeds |
| 6. Water supply | Tidal; brackish-water | Tidal; brackish-water | Pumping; fresh-, sea-brackish-water; river | Pumping; fresh-, sea-water |
| 7. Production (Mt/ha/yr) | 0.2 - 0.8 | 0.8 - 3.0 | 3.0 - 7.0 | 7.0 - 10.0 |

## Semi-intensive and intensive culture

***Pond preparation.*** The pond bottom is sun-dried for 15 days or until the pond bottom cracks and the surface turns whitish. The sluice gates are sealed to control water level and to prevent entry of unwanted organisms. Dried ooze is removed from the pond bottom by scrapping.

Ponds are plowed to further dry the pond bottom. Then, 1 t/ha of hydrated lime is applied to obtain a soil pH of 7-7.5. Note that only 50% of the required lime is initially applied, the remaining 50% after the second plowing. The second plowing is made towards the gate where the bottom is more depressed and unwanted species hide. The remaining 50% of the lime required is applied with 21-0-0 to kill crabs and other crustaceans. Teaseed powder is also applied for the same purpose two days before the pond is filled with water.

A water depth of 1 m is maintained. Dikes and gates are checked for leaks and these are immediately repaired. Salinity of incoming pond water is preferably the same as in the source of fry. Floating debris and filamentous algae are removed.

The appropriate number of paddle wheels is installed and positioned parallel to the dikes for 1-ha or bigger ponds or oblique to the dikes for smaller ponds. The number of paddle wheels installed varies with days of culture (DOC), expected survival, and average body weight (ABW):

- if survival is <80% and ABW is <35 g

| *DOC* | *No. of units* |
|---|---|
| 1-90 | 4 |
| 91 to harvest | 6 |

- if survival is >80% and ABW is >35 g

| *DOC* | *No. of units* |
|---|---|
| 1 - 75 | 4 |
| 76 - 120 | 6 |
| 121 to harvest | 8 |

***Sampling of stock.*** Regular sampling is necessary to monitor growth and survival, indices useful in adjusting the amount of feed given to stock. Sampling is scheduled every 15 days preferably early in the morning or late afternoon. The number of shrimps in the feeding trays is an adequate estimate when shrimps are still small but cast net must be used for bigger shrimps. Different parts of the ponds must also be sampled.

***Water management.*** Water quality should be frequently monitored. Change of pond water is usually adequate to maintain good water quality aside from helping introduce new food organisms and stimulating the molting of shrimps. If pond water remains stagnant for long, organic wastes may rapidly decompose, and depletion of oxygen may affect shrimp growth.

Tidal exchange of pond water is normally practiced in traditional shrimp farms. One half of the water is drained during low tide and replenished during rising tide, the exchange done within 5 to 7 days of the spring tide. Refertilization takes place after the last day of water replenishment.

Water pumps are used in semi-intensive and intensive cultures. For semi-intensive culture, the pump is used only during neap tide because tidal water can facilitate exchange during spring tide. About 50% of pond water is changed. For intensive culture, frequent changes are essential to reduce decomposing food and to maintain optimal oxygen level. One-third of pond water can be changed by adopting a flow-through system.

Salinity

The ideal salinity for *P. monodon* is 15-25 ppt although it can tolerate a much wider range. A refractometer is used to determine salinity before, during, and after every water change.

Dissolved oxygen

The ideal DO level for shrimp is 4-8.5 ppm. This is maintained through water replenishment and the use of paddle wheel aerators. When oxygen depletion occurs, paddle wheels are immediately operated and, if necessary, additional units are installed. Water exchange by overflow (10%) is also initiated.

Transparency and color

The ideal water transparency is 30-40 cm and this is monitored by a secchi disc. If transparency goes below 30 cm, water is changed and closely monitored for algal collapse that is usually indicated by a change in the color of water. If the latter occurs, 50% of the water is again changed. Algae, again, is allowed to grow until the later stages of culture. Greenish water though ideal is difficult to maintain, but can be done with frequent replenishment and longer paddle wheel operation.

Temperature

A depth of 1 m ensures that pond water temperature does not fluctuate much. Because the country is tropical, seasonal temperature fluctuation is small though at certain months of the year (November to early March), temperature is too cold for the shrimp (24°C). At this time, feeding is adjusted and rearing period is extended.

pH

The pH is indicative of fertility or potential productivity. Water with pH 7.5-9.0 is suitable for shrimp. Water pH below 5.0 retards shrimp growth; it can be raised by adding lime to neutralize acidity. Likewise, water of excessive alkalinity (pH 9.5) is harmful to shrimp. Ponds with abundant phytoplankton have high pH when temperature is high and low pH when temperature is low. Excessive plankton growth can be corrected by water change.

***Predator control.*** Filters placed in water intake pipes or gates do not prevent all predators from entering the ponds. Small fishes and eggs can go through the filters and drain canals when the gates are opened during pond preparation. Predators and competitors can be seen in feeding trays or along the dikes.

Teaseed cake is the most common chemical used to eliminate fish predators. It is applied at 20-40 ppm (weight by volume) during the 45th to 50th day of culture, coinciding with the first water exchange. Shrimp at this time weighs 5 to 10 g. Teaseed cake is applied in the morning, preferably during a sunny day for best results. About 60% of the pond water is drained before teaseed is applied; the required amount of powder which was dissolved in a container overnight is broadcast around the ponds. The pond is refilled 5 h after application.

***Feeds and feeding management.*** Feed is the largest operational cost in shrimp farming. Great attention should be taken to ensure efficient utilization of feeds, enabling shrimps to attain the desired size at the targetted time frame. It is also necessary to know the feeding habits and behavior, nutritional requirements, and feed conversion ratio of shrimp.

Generally, traditional culture is fully dependent on natural food organisms (*lab-lab, lumut,* phytoplankton, *Najas graminae, Ruppia maritima*). In semi-intensive culture, supplemental feeds (moist/wet feed, dry pelleted feeds, formulated pelletized feed with 40% protein) are given although natural food organisms remain the major source of food. In intensive culture, shrimp is completely dependent on artificial diet (Tables 3-5).

***Feeding method.*** Feeds may be broadcast or placed in feeding trays. If feeds are broadcast in big ponds, a dugout banca is used so that feeds can be given in the middle of the pond. Feeding trays, on the other hand, are placed strategically at different parts of the pond. The trays vary in size (1-10 $m^2$), and they can be made of bamboo strips and polyethylene screen. Normally, there is one tray per 10 to 100 $m^2$ of pond area. The trays are located along the sides (usually nine of them) and the middle (six) of the pond. The number of feed monitoring trays depend on the size of the pond. For example:

| Pond area | No. of trays |
|---|---|
| 1 ha | 6 |
| 1-2 ha | 8 |
| 2-3 ha | 10 |
| 3 ha | 12 |

During feeding, 1 % of the total amount of ration is placed in each tray. The trays are inspected after every feeding to determine if the feeds have been consumed. Adjustment is then made. Feeding may be adjusted after water change, teaseed application, or when there are abnormal changes in the pond environment. Feeding trays can also be used to determine survival rate and to monitor health of shrimp.

***Procurement of fry.*** One of the factors that ensure the success and profitability of shrimp farming is the supply of good quality postlarvae (PL). Generally, semi-intensive and intensive farming depends on hatchery bred PL while traditional farmers get 80% of their PL from the wild.

Table 3. Recommended feeding rates for *Penaeus monodon* as percent body weight per day

| Average body weight (g) | Feeding rate (%) |
|---|---|
| 1.5 | blind feeding |
| 1.5 -5 | 9.0 - 6.5 |
| 5-10 | 7.0 - 5.5 |
| 10 - 15 | 6.0 - 4.5 |
| 15 - 20 | 5.0 - 35 |
| 20 - 25 | 4.0 - 3.0 |
| 25-30 | 3.5 - 2.5 |
| 30-35 | 3.0 - 2.0 |
| 35 - up | 2.5 - 1.5 |

Table 4. Recommended feeding frequencies for shrimp

| Average body weight (g) | Feeding frequency (%) |
|---|---|
| 1.5 | 2-3 x |
| 1.5 - 5 | 4 x |
| 5 - 10 | 5 x |
| 10 - 15 | 5 x |
| 15 - 20 | 5 x |
| 20 - 25 | 5 x |
| 25 - 30 | 5 x |
| 30 - 35 | 5 x |
| 35 - up | 5 x |

Table 5. Recommended feed ration distribution (%) for shrimp at different feeding frequencies and feeding schedules

| Feeding frequency (per day) | Ration distribution (%) | | | | | |
|---|---|---|---|---|---|---|
| | 6 am | 10 am | 2 pm | 6 pm | 10 pm | 2 am |
| 2x | 40 | | | 60 | | |
| 3x | 30 | | | 40 | 30 | |
| 4x | 25 | 15 | | 30 | 30 | |
| 6x | 25 | 10 | 10 | 10 | 25 | 20 |

The various devices used to collect shrimp fry from the wild are:

1. Twig - small bunches of twigs are suspended close to or placed on the bottom of shallow lagoons, estuaries, and coasts. The fry are collected during low tide by placing the scoop net under each bunch of twigs as it is lifted up.

2. Fry lure - 20-m lure lines are made of saltwater grass. These are usually set along beaches and banks of rivers. Shrimp fry is collected as it is lifted up.

3. Scoop nets - in areas where aquatic weeds are abundant, a scoop net can be used to collect shrimp fry that cling to the weeds.

4. Push or scissor nets - the nets, with or without cod ends, are used along beaches, lagoons, bays near shore, and estuaries. They are operated by hand or boat.

5. Fry trap - this stationary gear consists of a wing and a collecting chamber. The cod end of the collecting chamber is kept afloat by bamboo raft and the wing is fixed with bamboo poles against the incoming water.

6. Sagnet or *bayakos* - this stationary gear consists of a wing and a cod end with a non-return valve. It is usually 20-30 m long.

The shrimp hatchery has become an important source of fry. The advantages of hatchery-bred fry are size uniformity and its availability in bulk. Although wild fry are good for stocking, its supply is inconsistent.

***Nursery operations.*** Generally, shrimp farmers prefer direct delivery of hatchery-bred PL to the farm. In intensive culture, PL are generally stocked directly to grow-out ponds. In traditional (and some intensive) ponds, they are stocked first in nursery ponds or cages and then transferred to grow-out ponds after 45 days.

<u>Nursery pond</u>

The size of nursery pond ranges from 500 to 2,000 $m^2$ with water depth of 40-70 cm. Ponds are prepared prior to stocking using standard pond preparation techniques, and stocked with 50-150 fry per $m^3$ depending on size of fry.

<u>Nursery cages</u>

Synthetic cages (0.3 $m^3$, 0.5-1 mm net mesh) supported by bamboo or wooden frames are installed. Inverted mosquito nets or *hapa* nets may also be used. The cages are kept afloat by raft or synthetic floats and set in rivers, lagoons, or within the pond itself. They are usually stocked with 1,000-2,000 fry per $m^3$ of water. Feeding screens similar to that used in ponds are also installed in the cages.

<u>Stocking of fry</u>

Shrimp fry are very sensitive to abrupt changes in temperature and salinity. They should be acclimated to pond conditions before being released by gradually mixing the container water with pond water. The container is kept afloat in the pond until water temperature has stabilized, and fry can be slowly released. Optimum stocking density depends on size, natural mortality, pond productivity, and culture system employed. The fry are best stocked during the coldest part of the day, i.e., early in the morning (0700 - 1000 H), late in the evening (2100 - 2400 H), or when there is incoming tide.

## Problems

Several environmental and technical problems result from intensiveculture system.

***Environmental problems.*** Less than one-third (110,000 ha) of the original mangroves are left in the country. Many important shrimps, fishes, and molluscs feed and seek shelter in the mangrove ecosystem. Deforestation as a result of mangrove conversion into ponds causes the gradual loss of critical habitats, lowering catch in natural fishing grounds including fry and broodstock needed for aquaculture. A wide array of economic goods and services including materials for fuel and construction as well as fish and shoreline erosion control is no longer available to coastal communities.

In the 1980s, red tide predominated in some coastal areas in the country and adversely affected the mariculture industry. Demand of fishes and molluscs declined due to cases of paralytic shellfish poisoning.

Accelerated development of shrimp farms in many areas of the country, particularly in Negros Island, led to excessive extraction of ground water. Most intensive ponds mixed the freshwater with seawater to provide good quality water to cultured shrimps. As a result of this excess, the water table lowered, seawater intruded in domestic ground wells, the supply of ground water declined, and land subsided in some areas.

***Site selection.*** The common problems of shrimp farmers regarding site selection are water supply, acid sulfate soils, typhoons and floods, and limited area for expansion. Brackishwater ponds traditionally use tidal fluctuation to supply water in higher areas. Areas reached only by extreme springtides are costly to develop. Low areas, on the other hand, will require formidable dikes. Aside from the tide, shrimp farms in many areas of the country require large volume of clean freshwater. In intensive shrimp farms, freshwater is important especially during a long dry season when salinity becomes very high due to rapid evaporation.

Acid sulfate soils are mostly found in ponds developed along dense mangrove vegetation. This is a problem especially during the first few years of operation. Acid sulfate results from the accumulation of pyrites (iron sulfides) in coastal soil. Since breakdown of pyrites is minimal in submerged soil, ponds often have low productivity and mass kills sometimes occur.

Typhoons and floods are common problems faced by farmers in northern Philippines. Most shrimp farms are in the flood plains and some are constructed within the typhoon belt especially farms in the Pacific side. Frequently flooded shrimp farms bring risk to life and property. Often, this is a result of poor planning and environmental impact assessment. This problem can be minimized with proper site selection.

Shrimp farmers are unable to expand their farms because of government regulation prohibiting conversion of mangrove areas to fishponds. Some areas, however, have underutilized ponds which can be developed.

***Design and construction.*** Most of the existing shrimp farms in the country are converted from milkfish farms. It is difficult to adopt more recent innovations of pond lay out such as those used in Taiwan or other countries due to the high cost of development. Farmlands in Negros (central Philippines) that were converted to shrimp farms (10 ha or more) are difficult to manage. Only a few shrimp ponds continue to operate.

Despite the proliferation of engineering firms, several mistakes are still being committed in pond design. Proper drainage and strict separation of supply and drainage canals are still not given adequate consideration. Also, most fishfarms have their gates built close to the river without provision for strong water current and eventual sedimentation.

***Pests and diseases.*** Intensification faces serious disease and parasite problems because ponds usually create conditions conducive to disease outbreaks. Once an outbreak occurs, treatment maybe too expensive for large-scale application. In shrimp, common diseases are caused by virus, bacteria, fungi, and protozoa. Some are caused by chemical agents.

***Others.*** Some farmers claim that financing is a major constraint in shrimp intensification. Site development, equipment, and other support facilities require major capital investment. Capital is also needed particularly for the purchase of supplemental feeds which comprise about 50-60% of the operational cost. When a lot of capital is involved, the problem is compounded because financing assistance requires high collateral and high interest rate. Government development banks require collaterals and the banking institutions do not grant loans to fish pond lease agreement (FLA) land holders. Shrimp growers also complain of high cost of inputs, like fertilizers, pesticides, chemicals, and feeds which increase more rapidly than the market price of produce.

There are also social problems affecting the shrimp industry. One is the monopoly by big businessmen who often have joint ventures with foreign investors. The difficulty of FLA holders to secure loans breeds discontent. Another is displacement of labor as the daily subsistence of small-scale fishermen and some agricultural workers is endangered by intensification. Since intensive shrimp ponds depend on hatchery-bred fry, only a few benefit from employment. In traditional and extensive farms, many fry gatherers are benefitted. Furthermore, a number of sugarland and overland workers or farmers are being displaced, since the conversion of agricultural lands for shrimp culture now requires only three maintenance workers for every 5 ha in contrast to sugarland farms that need 8-10 laborers.

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