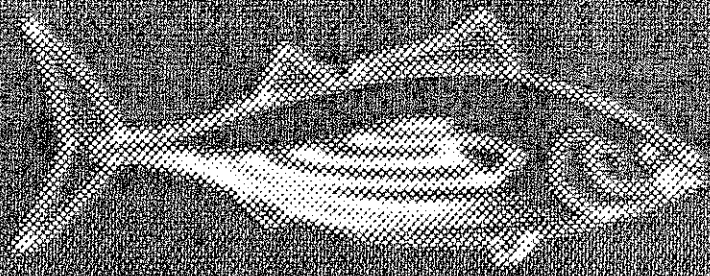


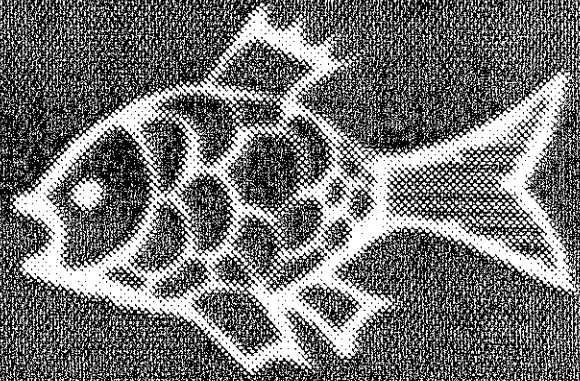
RICHARD J. NEVILL

Ikenoue  
Kafuku

**H. IKENOUE AND T. KAFUKU**  
(Editors)



**MODERN METHODS OF  
AQUACULTURE IN JAPAN**  
SECOND REVISED EDITION



**DEVELOPMENTS IN AQUACULTURE  
AND FISHERIES SCIENCE, VOLUME 24**



**ELSEVIER**

## CHAPTER 12

### Freshwater Pearl Mussel (*Hyriopsis schlegelii*)

Cultured freshwater pearls are small in size and irregular in shape when compared with cultured marine pearls. However, since their color, luster and shape are similar to those of natural marine pearls, they are desirable for making into jewelry (Fig. 12.1).

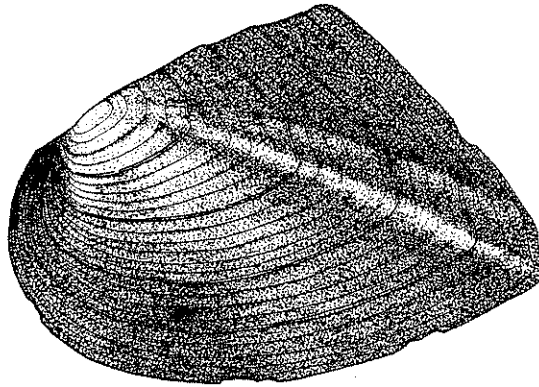
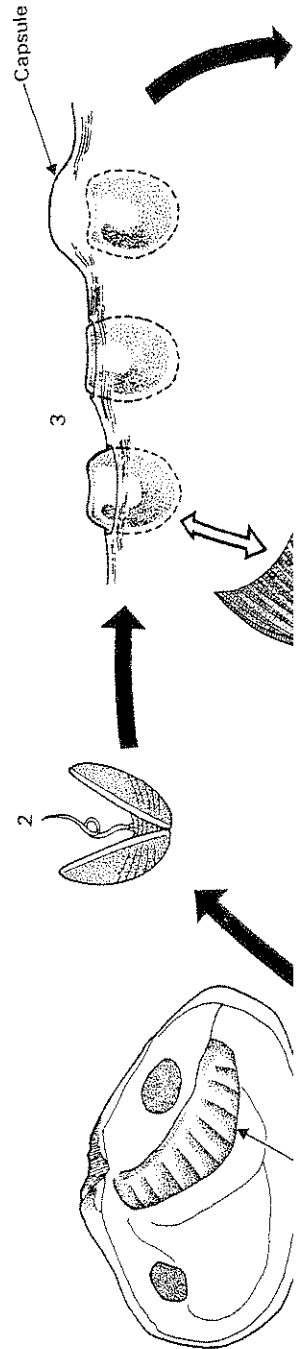


Fig. 12.1 Freshwater pearl mussel (*Hyriopsis schlegelii*).

#### 12.1 Characters of Freshwater Pearl Mussel

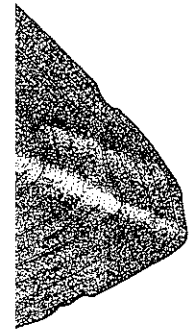
- A. Class: Pelecypoda  
Order: Paleoheterodonta  
Family: Unionidae
- B. Maximum size: 235 mm in shell length, 130 mm in shell height and 58 mm in shell width.  
Biological minimum size: 100–110 mm in shell length.  
Commercial size: Above 100–130 mm in shell length.
- C. Color: Outer surface of the shell is dark grey and inner surface is a pearly color.
- D. External characters: A thick shell of almost rhombic shape with decorticated umbo. A ridge extending from umbo to postero-ventral side of the shell. Fine concentric ornaments and shallow, wide furrows on the shell surface.
- E. Life cycle and ecology (Fig. 12.2):

At one time, freshwater pearl mussels inhabited only Lake Biwa in central Japan. The mussel now inhabits Lake Kasumigaura after transplantation from Lake Biwa.



*opsis schlegelii*)

Irregular in shape when com-  
their color, luster and shape are  
desirable for making into jewelry



*riopsis schlegelii*).

mm in shell height and 58 mm in  
shell length.  
shell length.  
gray and inner surface is a pearly  
rhombic shape with decorticated  
ventral side of the shell. Fine con-  
the shell surface.

d only Lake Biwa in central Japan.  
r transplantation from Lake Biwa.

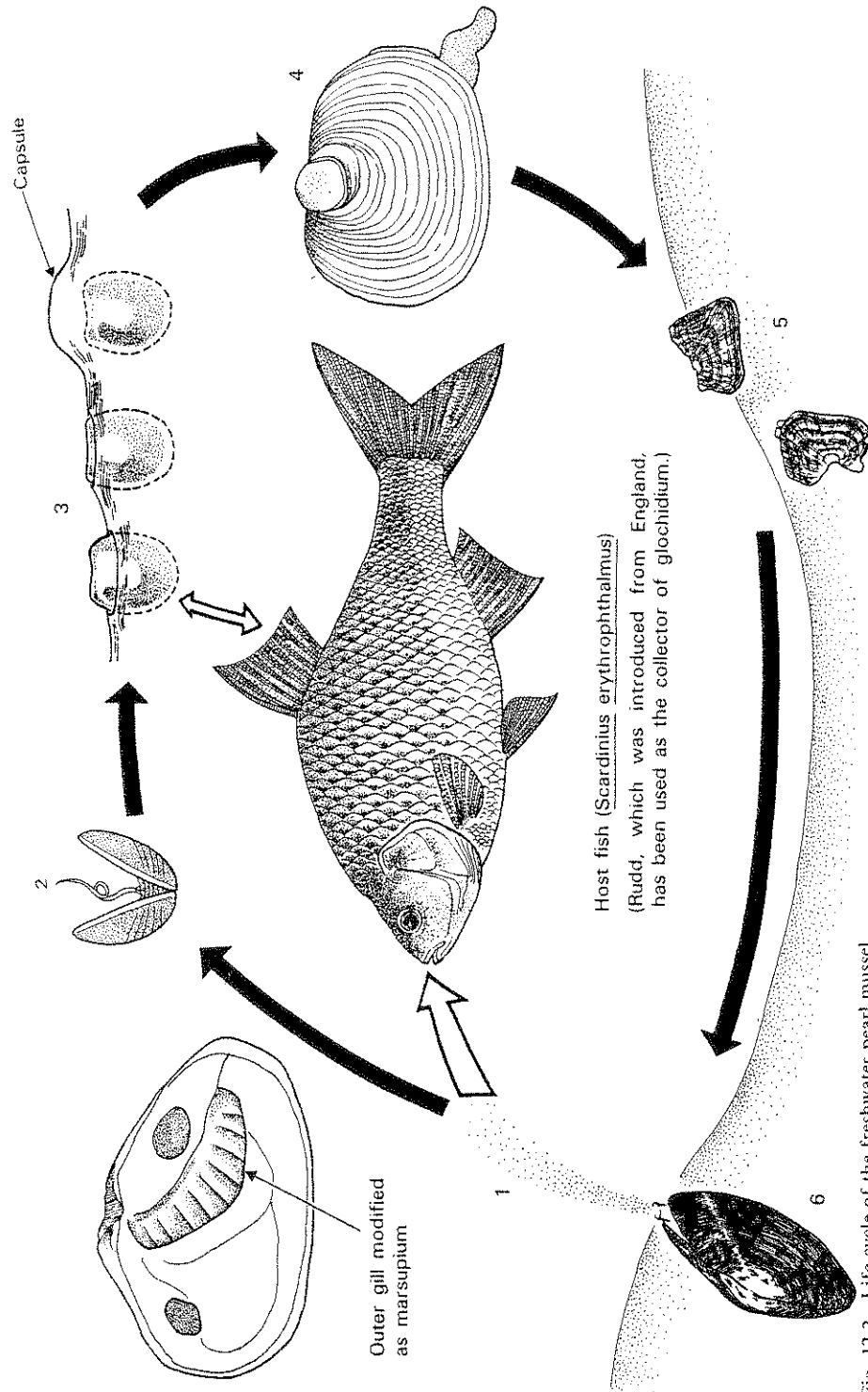


Fig. 12.2 Life cycle of the freshwater pearl mussel.  
1, Discharge of glochidium; 2, Glochidium; 3, Enclosure of glochidium on fish gill or fin; 4, Young mussel; 5, Young mussel on bottom; 6, Adult.

The habitat of the mussel is shallow water with a silt bottom, less than 10 m deep in Lake Biwa and 2.5–5.0 m deep in Lake Kasumigaura.

Spawning of the mussel takes place from April to August. The peak of the spawning season is in May and June when the water temperature is 20–25°C. In the female, the ripe eggs pass from the ovaries to the suprabranchial chambers and there are fertilized by sperm discharged from a male and brought into the female together with water. The number of eggs kept in one female is 400,000–500,000. The eggs attach by mucus in the water tubes of her gills, which enlarge to become brood chambers (marsupia). After 9 days at the water temperature each egg develops into a minute larval glochidium, 0.3 mm wide, with two valves closed by an adductor muscle, and a long larval thread. They are shed into the water through the female's exhalant siphon, are scattered by the water current. They can open or close their shells but cannot move independently. Glochidia clamp to the gill filaments of fishes, being carried in the respiratory water of the latter. In a few hours, they are covered with capsules formed by the host's epithelium. The parasitic larvae feed and grow by absorbing nutrients from the host's body fluids and spend a parasitic life for 16 days at 20°C. At the end of the parasitic life, the young mollusk opens and closes its valves, extends its foot, and escapes to the bottom to become free-living. The mussel attains sexual maturity at 4 years when the shell length becomes 10–11 cm. The longevity of the mussel sometimes exceeds 40 years.

## 12.2 Present Status of Freshwater Pearl Culture in Japan

Freshwater pearl culture is practiced only in Lake Biwa and in Lake Kasumigaura (Fig. 12.3). In 1935, commercial production of freshwater cultured pearls began in Lake Biwa. Production was interrupted by the outbreak of World War II but was resumed in 1946. Pearl production in Lake Kasumigaura began in 1963.

The annual production of the freshwater pearl rose from 4.0 tons in 1967 to 7.2 tons in 1971 and 1972 but dropped off gradually to 5.6 tons in 1977. From 1977 to 1984, the annual production fluctuated around 6 tons but started to quickly decrease from 1985 to less than 1 ton in 1989 (Fig. 12.4). The main reasons for the quick decrease were decrease in culture ground due to pollution of the lakes and fast development of freshwater pearl culture in China. Production in 1989 was 0.5 ton in Lake Biwa and 0.4 ton in Lake Kasumigaura. The total area of 70 culture farms was 100 hectares in Lake Biwa and 6 farms totaled 4 hectares in Lake Kasumigaura in 1989.

The color and shape of the freshwater pearl are similar to the once world-famous Persian Gulf natural pearl. After extinction of the industry in the gulf, a considerable portion of the Japanese cultured freshwater pearls was exported to the Middle East as a substitute for the natural pearls.

The price of the pearls was about US\$2,000 per kg in 1989. In that year, 4 tons of freshwater pearls were exported, earning US\$8,000,000.

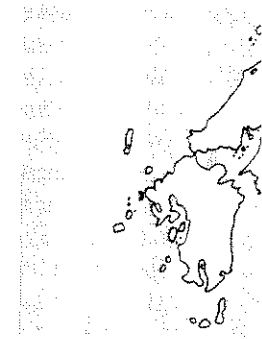


Fig. 12.3 Distribu-  
1, Lake Kasumigau

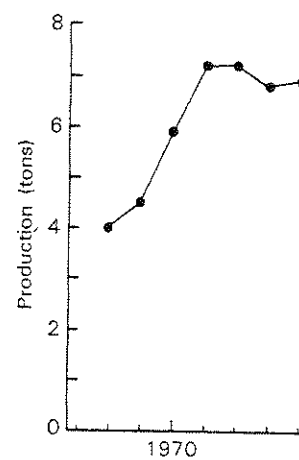


Fig. 12.4 Annu:

tom, less than 10 m deep in

ust. The peak of the spawn-  
erature is 20–25°C. In the  
rbranchial chambers and  
nd brought into the female  
female is 400,000–500,000.  
s, which enlarge to become  
ater temperature each egg  
with two valves closed by an  
d into the water through the  
rent. They can open or close  
clamp to the gill filaments of  
er. In a few hours, they are  
n. The parasitic larvae feed  
fluids and spend a parasitic  
e, the young mollusk opens  
e bottom to become free-liv-  
the shell length becomes 10-  
. 40 years.

e in Japan

Lake Biwa and in Lake  
ction of freshwater cultured  
d by the outbreak of World  
Lake Kasumigaura began in

from 4.0 tons in 1967 to 7.2  
6 tons in 1977. From 1977 to  
ons but started to quickly  
.4). The main reasons for the  
ollution of the lakes and fast  
oduction in 1989 was 0.5 ton  
total area of 70 culture farms  
ectares in Lake Kasumigaura

ilar to the once world-famous  
industry in the gulf, a con-  
er pearls was exported to the

n 1989. In that year, 4 tons of  
00.

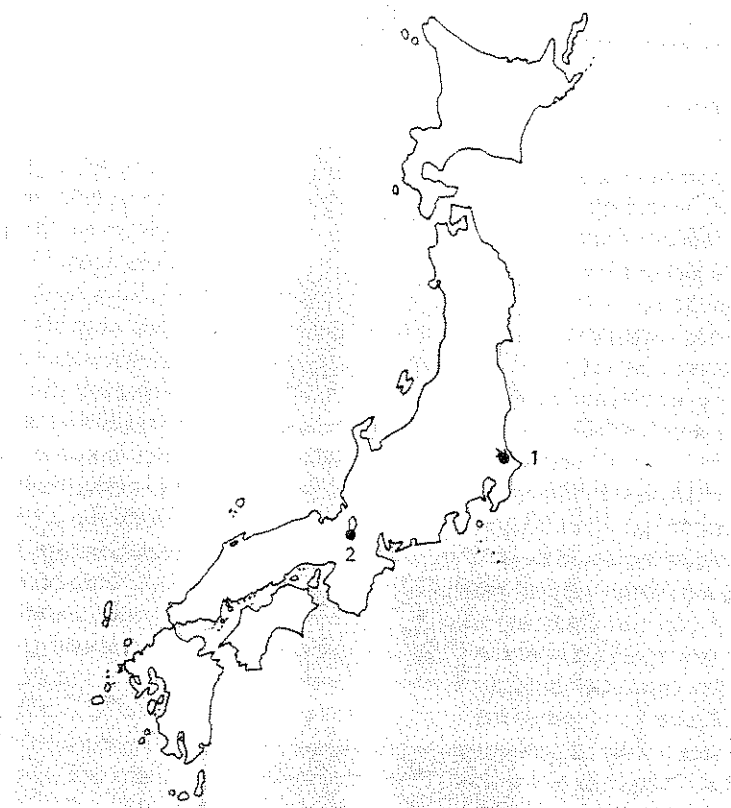


Fig. 12.3 Distribution of freshwater pearl culture farms in Japan.  
1, Lake Kasumigaura; 2, Lake Biwa.

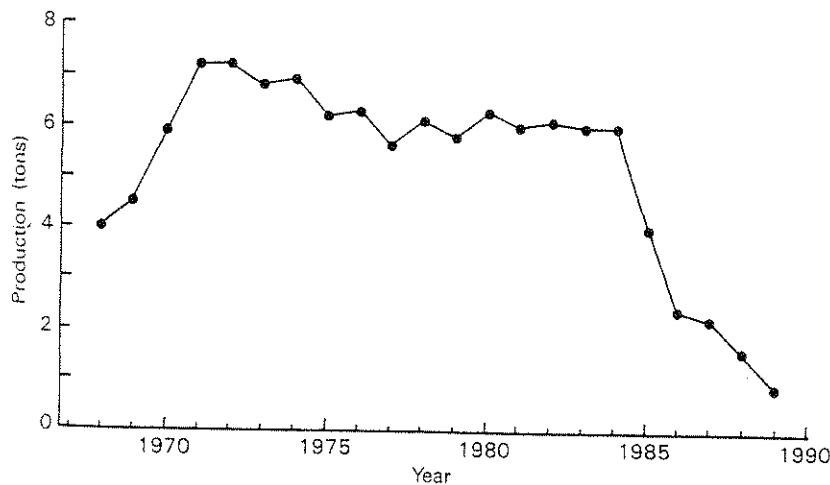


Fig. 12.4 Annual production of freshwater pearls in Japan.



lake bottom or 12–15 mussels are placed in a 30 cm<sup>2</sup> basket and hung at a density of 3–5 baskets per m<sup>2</sup>. The period of pre-operation culture is 1–3 years.

### 12.3.2 Operation

One day before the operation to implant mantle pieces, the mother mussels are taken from the pre-operation culturing grounds to the operation house. After washing, the operation mussels are placed ventral side up in a shallow basin filled with water. Cell mussels are kept in a basket. Usually, two cell mussels are sacrificed for every three operation mussels. The room temperature of the operation house should be warm so the mussels open their valves easily, making the operation easier. Operations are performed between October and April when the marsupium is not yet formed in the mussel. Freshwater pearls are produced mainly by non-nucleated operations. Nucleated operations are practiced only on a limited scale. Pearls produced by non-nucleated operations are irregular in shape.

The cell mussel is opened by cutting the adductor muscle. Then the mantle of the cell mussel is cut off in a strip about 0.5 cm wide and 7.0 cm long, which is then cut into small square pieces, 0.5 cm by 0.5 cm (Fig. 12.6). The valves of the operation mussel are opened 1–1.5 cm wide with a shell opener and a wooden plug is inserted to keep the valves open. By pushing the visceral part and the gills aside with a spatula, the inside surface of the mantle of the operation mussel is exposed. Small holes are made on the surface of the mantle with a special apparatus that resembles a needle (Fig. 12.7). Care must be taken not to pierce through the mantle. A mantle piece previously prepared from cell mussels is then picked up with a small hook and put in a hole. The mantle piece must be inserted so that the shell side faces the inside of the operation mussel. The locations for inserting the mantle pieces are shown in Fig. 12.8. In an operation mussel of 10 cm in shell length, 20–40 mantle pieces are used. The mantle piece placed in the hole of the mantle gradually forms a pearl sac, which excretes pearl substances and forms a pearl inside. In the case of nucleated

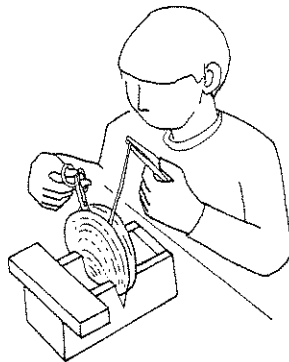


Fig. 12.6 Taking the mantle strip from the cell mussel.

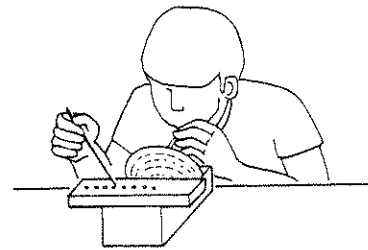


Fig. 12.7 Putting the mantle piece in an operation mussel.

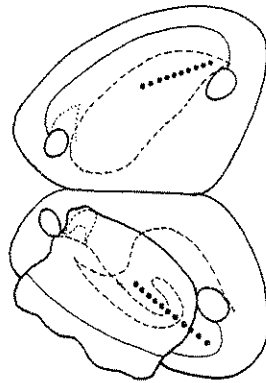


Fig. 12.8 Locations for inserting mantle pieces in an operation mussel.

operations, a nucleus and a mantle piece are put together in the hole so that the nucleus and the mantle piece firmly contact each other. The mantle piece forms a pearl sac around the nucleus and accumulates pearl substances on the surface of the nucleus. Post-operative mussels are again placed ventral side up in a shallow basin filled with water and then are temporarily hung in clean water for a short period before being transported to the culturing grounds.

### 12.3.3 Culture of post-operative mussels

The post-operative mussels are transported to a pearl farm in the lake and cultured by the hanging method (Fig. 12.9). At the pearl culture grounds, bamboo

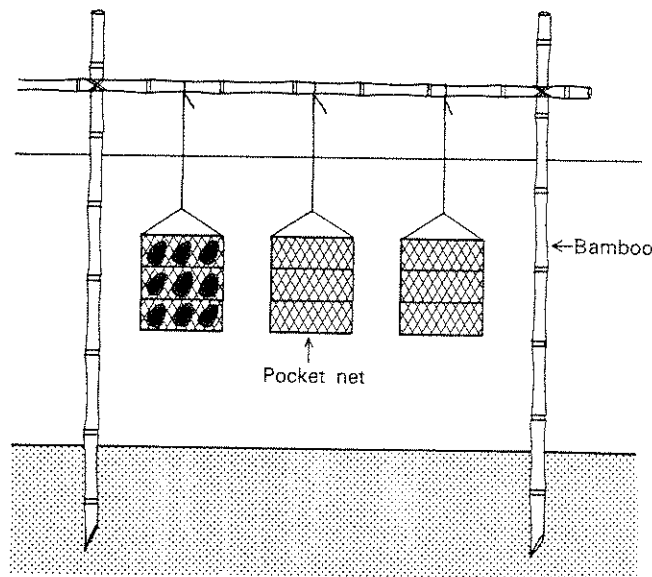


Fig. 12.9 The hanging method of freshwater pearl culture.

poles are fixed vertically tied across these poles horizontal bamboo pole deeper in winter. Ten to are cultured for 2 to 3 y and baskets and mainten period.

### 12.3.4 Harvest, polishing

Pearls are collected ei one from the pearl sacs v commonly practiced nov considerably in nature. operated on again. Colle soft cloth.

Pearls are bought by l are then exported abroa Switzerland, Germany ar ported to Southeast Asia

T. Nakanishi, *Rep. Fish. Exp.*  
 S. Mizumoto, *Rep. Fish. Exp.*  
 K. Kida *et al.*, *Rep. Fish. Exp.*  
 A. R. Chan, *Fresh Water Pea*  
 Y. Furukawa *et al.*, *Rep. Fish*



poles are fixed vertically on the bottom at 2 m intervals. Other bamboo poles are tied across these poles horizontally 40–50 cm above the water surface. The mussels are placed in nylon bags or baskets and hung at a depth of 50–60 cm from the horizontal bamboo poles. The hanging depth should be shallower in summer and deeper in winter. Ten to twenty mussels are usually cultured per m<sup>2</sup>. These mussels are cultured for 2 to 3 years before the harvest of pearls. Cleaning of the mussels and baskets and maintenance of the bamboo racks are necessary during the culture period.

#### 12.3.4 Harvest, polishing and sale of pearls

Pearls are collected either by crushing the mussels or by taking out pearls one by one from the pearl sacs while keeping the mussels alive. The latter method is more commonly practiced nowadays to save the mother mussels, which have dwindled considerably in nature. Two to three years must pass before the mussels can be operated on again. Collected pearls are washed with salt water and polished with a soft cloth.

Pearls are bought by buyers at auctions and undergo an export inspection. They are then exported abroad, with the U.S.A. being the largest importer followed by Switzerland, Germany and Hong Kong in that order in 1989. A small quantity is exported to Southeast Asian countries for medicinal purposes.

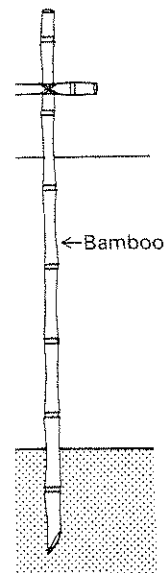
#### REFERENCES

- T. Nakanishi, *Rep. Fish. Exp. Lab. Shiga Pref.*, (Japanese) 1, 24 (1950).
- S. Mizumoto, *Rep. Fish. Exp. Lab. Shiga Pref.*, (Japanese) 3, 24 (1954).
- K. Kida *et al.*, *Rep. Fish. Exp. Lab. Shiga Pref.*, (Japanese) 12, 23 (1960).
- A. R. Chan, *Fresh Water Pearl Culture*, 122, G. H. Q., Nat. Ret., Sec. (1949).
- Y. Furukawa *et al.*, *Rep. Fish. Exp. Lab. Shiga Pref.*, (Japanese) 18, 59 (1963).

operation mussel.

er in the hole so that the  
The mantle piece forms a  
nces on the surface of the  
side up in a shallow basin  
water for a short period

arl farm in the lake and  
culture grounds, bamboo



arl culture.