



Mass seed production of sand sea bass (*Psammoperca welgenensis*) at the Regional Center for Mariculture Development (RCMD) in Batam, Indonesia

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of sand sea bass
(*Psammoperca
welgenensis*) at the
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Meet the sand sea bass

Sand sea bass is a tropical species found in Indonesian waters, known locally as *ikan mata kucing* ('cat eyes'). Its body shape is much like the Asian seabass although it is darker in colour, which is why it is also known as *gelam* or *kakap hitam* (black sea bass) on Batam-Riau Island. Sand sea bass are a much smaller, reaching a maximum weight of 1kg. They are protandrous hermaphrodites, maturing first as

males at around 75-100g then changing sex with mature females appearing at around 150g. Sand sea bass are a demersal species with a schooling habit.

Although the sand sea bass is still abundant in Indonesian waters, especially around Batam, wild stocks are likely to come under increasing pressure as high demand has seen its market price increase, which is likely to lead to more intensive fishing efforts. At the time of writing, the price of live sand sea bass in Singapore is around



Sand sea bass broodstock.



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Indoor hatchery with larvae rearing tank.

S\$ 15/kg. Anticipating a decline in wild stocks, RCMD have been developing techniques to produce sand sea bass seed as basis for supporting an alternative, farmed supply.

Broodstock management and breeding

Broodstock can be obtained both from wild capture and from fish on-grown in net cages. As many as 10 fish/m³ are kept in circular fiberglass tanks of five ton capacity, with sex ratio of 1 male : 1 female. A flow-through water system is used during the rearing period with around 400% water exchange per day in the broodstock tanks. Broodstock are fed 5% of their body weight daily in fresh trash fish and three times per week with squid. Vitamin C and E are also given once per week to help stimulate gonad maturation.

Environmental manipulation is also conducted to stimulate broodstock to spawn. In RCMD, sand sea bass broodstock spawn naturally every month, following a lunar rhythm and in most cases, spawning occurs over a period of 2–5 days. Spawning takes place at night, mostly around 22.00–24.00. The fecundity is normally around 50,000 – 100,000 eggs per female.

Larval rearing

Fertilized eggs are collected from spawning tanks and transferred into aquaria for incubation. During incubation, the eggs are treated with



Outdoor hatchery and nursery tank.



Sand sea bass larvae.

acriflavine at 5 ppm as a prophylaxis against bacterial infections. Incubation takes around three hours, with eggs then transferred to aerated larval rearing tanks, which are rectangular and of 10-ton capacity. Eggs are stocked in the larval rearing tanks at around 40-50 per m³. Normally, 90-95 % the eggs will hatch after around 17 hours.

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Persian Gulf fish culture in Iran – pointers for success

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Unlike most other Asian countries, aquaculture is not a traditional practice in Iran. The first documented aquaculture activity was in 1927 and the first warm water fish farm began operation in 1961. Due to the social, agricultural and climatic characteristics of Iran, fish and other aquatic organisms have not been a common part of the traditional diet of the people, except in coastal areas. However, with a high population growth rate of 3.2%, fish is becoming increasingly important as a cheap source of quality animal protein, supplementing limited livestock based protein.

The Persian Gulf

The Persian Gulf, one of the warmest in Asia, has an area of 232,850 km², which stretches 930 km from the Arvandrood River to the Sea of Oman

with an average width of 288 km. The average water depth is 38m, with a maximum of 280m. Water temperatures range between 12.3°C and 40°C, and salinity between 37 to 50 ppt. The average water temperature in the Sea of Oman is lower, ranging from 19.8°C to 23°C, because of the greater water depth and its connection to the open ocean.

Marine fish culture from the Persian Gulf is in its infancy in Iran. According to Professor Agius of Fusion Marine International, of all the Near and Middle East countries, Iran bears an unique coastline that offers unparalleled opportunities for marine fish farming. Development of Iran's marine fish aquaculture industry has begun at an opportune moment now that the relevant technology has been applied and proven in Kuwait and Bahrain. This factor significantly enhances the prospect of success.

National interests

Aquaculture research priorities and programs for finfish were laid during 1997-98 for the Khuzistan research center (Ahvaz), Iranian Fisheries Research & Training Organization (IFRTO)². Iran has identified fish aquaculture as a high priority sector for stabilizing and increasing fish production, more specifically to raise apparent per capita fish consumption to 6.5kg³, which is still well below the world average per capita fish consumption of 13.5kg⁴, as seafood has traditionally been a low choice-preference in the Iranian diet.

Cage and pen culture systems have been introduced for feasibility studies on the culture of Caspian salmon, rainbow trout, sturgeon, carps and fourteen species of marine finfish⁵. With the development of fish feed technology, fish health management and a better understanding of site selection criteria



Sea cages at Qeshm

and the interactions of aquaculture with the aquatic environment, it is envisaged that these systems will have a significant role to play in contributing to the socioeconomic well-being of coastal communities and the expansion of Iranian aquaculture.

The aquaculture objectives of the Government of Iran are: Transfer of aquaculture technology to Iran; preparation of preliminary work for breeding programs with marine fish; reaching global markets and creation of a motivation for marine fish culture and decrease of production cost by localization of technology and increase in per capita fish consumption.

Potential

Iran has enormous potential to develop its marine finfish resources through modern technology. A government assessment of prospects for sea cage aquaculture development along the Iranian coastline has targeted development of an 8,000 ton industry in the Caspian Sea, and a staggering 25,000 tons in the Persian Gulf and Sea of Oman.

Major nominated candidates for cage culture are silver pomfret *Pampus argenteus*, milkfish *Chanos chanos*, cobia *Rachycentron canadum*, Asian sea bass *Lates calcarifer*, rabbit fish *Siganus canaliculatus* and seabreams *Sparidentex hasta* ('sheim') and *Acanthopagrus latus* ('sobiaty'). Five companies have so far gained principle licenses for cage culture in the Persian Gulf, according to Shilat, the Iranian Fisheries Organization.

Site surveys were carried out at Qeshm island in the summer of 2000, and with the assistance of a Nordic company, Shilat has studied the potential for marine fish farming in the Northern coast of Persian Gulf and Oman Sea. Their results showed good potential for cage culture in strategic areas. A comparative tabulation of growth biomass has been indicated for potential marine finfish candidate species in Iran (table 1).

Candidate species

As aquaculture expands worldwide to meet the growing demand for seafood, species with favourable culture characteristics such as seabream and cobia



Captive grouper stocks.

will certainly be considered as prime candidates for commercial production in Iran. Groupers, cobia, snappers and rabbit fish have good attributes for growout in cages such as their preference for forming schools and ability to adjust to captivity. Cobia initially feed on benthic animals in nature, but are easily trained to consume formulated feed pellets. Grouper and sheim are reasonably tolerant to handling and overcrowding unlike sobiaty. Both sobiaty and sheim reared from 1g to maturity in cages are less stressed and produce higher quality eggs and larvae more easily than wild broodstock. Cobia farming in particular has high potential for large volume industrial production due to its amazing growth (32 g to 8 Kgs in 11.4 months at optimal feeding and temperature⁶). Polyculture of shrimp and milkfish has also shown good results with lower FCR⁷. European seabream *Sparus aurata* has high potential as a culture species for the winter months, reaching 450-550g in a year under offshore cage culture conditions in UAE and Oman.

Nearby Kuwait has an excellent record of scientific development of aquaculture technology for groupers, rabbit fish, blue-fin and yellow-fin seabreams and ecologically adapted hatchery breeding of European sea bream and sea bass *Dicentrarchus labrax*⁹, particularly through the Kuwait Institute for Scientific Research, which has an international reputation for warm water finfish aquaculture research and extension.

Research needs

More work ought to be done on cobia and silver pomfret nursery areas to identify major influences on natural recruitment levels and their distribution, wild spawning and growth patterns, and to refine commercial-scale technology for culture of these species. As one of the species with highest potential, research on breeding cobia could prove critical to the future development of Iranian marine fish farming Industry. There is also interest in utilizing bream *Abramis brama* in polyculture systems³, but this species has shown poor tolerance to low oxygen. Further efforts are needed to find a more suitable stock or to domesticate or genetically improve the local bream to adapt it for polyculture conditions⁵. Morphological changes during the early life stages of king fish and snappers in the wild are currently poorly understood, and applied research is required to develop commercial hatchery techniques for both these and silver pomfret, to allow sustainable production of cheap, high-quality fingerlings. Iran has considerable inland saline ground water resources, whose suitability for aquaculture of rabbit fish and other brackish water species is yet to be investigated.

Nutrition is another area where research could bring substantial benefits to Iran's fledgling marine finfish aquaculture industry. High-quality customized vegetable protein diets need to be formulated for herbivorous species such as rabbit fish, and nutrition-

Table.1 Growth biomass indications for potential candidate species in Iran

Species	Stocking size	Stocking density	Culture Period	Final weight
Grouper <i>Epinephelus coioides</i>	50g	30-40/m ³	7-8 months	500-700g
Sobaity <i>Sparidentex hasta</i>	1.5g	25/m ³	12 months	500-700g
Sheim <i>Acanthopagrus latus</i>	1.5g	25/m ³	12 months	350-700g
Rabbit fish <i>Siganus canaliculatus</i>	3.5g	25/m ³	11 months	300-350g
Asian Sea bass <i>Lates calcarifer</i>	100g	40/m ³	6-7 months	550- 600g
Cobia <i>Rachycentron canadum</i>	30 g	4-6/m ³	11-12 months	6-8 kg

ally efficient feeds are also required for sheim, as current farming trials show slower growth rates during the early culture period (5 to 200g).

Constraints

There is no significant stock enhancement of finfish in the Persian Gulf due to the lack of knowledge and facilities for breeding marine fish. While aquaculture of bream and perch are underway, these are largely experimental trials or on a pilot scale. Studies on the eggs and larvae of marine finfish in Iran have stemmed only from the consideration of fisheries management rather than from aquaculture.

Ultimately the rapid growth of marine finfish aquaculture in Iran will depend on the specific seafood requirements of the market. Price is determined by many factors such as consumer eating habits, regulations, competition and choice in products. Iranian seafood consumers are very sensitive to price changes, and high prices, particularly for farmed vs wild product, will reduce the interest of people in purchasing unfamiliar seafood.

The government had been holding fish exhibitions, fish cookery training courses and broadcasting documentaries that promote aquaculture for domestic fish consumption. However, the limited number of excellent sites suitable for intensive marine fish farming in Iran may restrict the size of the industry initially.

Outlook

Recently, culture of high-value or highly desired marine finfish such as cobia, grouper and sobaity have attracted the attention of Iranian investors. New investments are on the rise along the Bushehr and Qeshm coastline for cage farms with interesting signs of development. Private entrepreneurship and favourable international cooperation with France are helping to develop finfish culture in Iran. Technology purchased from experienced regional consultants (Kuwait, Bahrain) by national investors and also joint-ventures with technologies brought by foreign partners across the seas are crucial for growth in this sector.

Although trials to produce new marine finfish species are ongoing in most of Europe, no real replacement candidate has been found for the European sea bream and sea bass, which are currently experiencing a price slump. Mass production of new candidate species at a cost-effective price will determine the scale of development success in warm water marine finfish culture. Within Shilat, there is increasing interest in enhancement of wild stocks through release of hatchery-reared juvenile fish.

With commercially-proven trials for blue-fin and yellow-fin sea bream in the warmer Middle East waters, and considering their status as preferred species in Arab countries¹⁰ and stable pricing, these species may be viable alternatives for Iran too. One strong recommendation is to strengthen the research co-ordination at national and international levels where there are such overlapping

interests to fill gaps in knowledge in need-based areas.

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Marine finfish health issues of relevance to Australia and the region

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Harvesting barramundi (*Asian seabass*) from sea cages, Northern Territory.

In 2003-2004 the total Australian fisheries gross value of production was A\$2.2 billion, of which aquaculture provided about 34%. Marine finfish aquaculture forms an important component of aquaculture production in Australia. In South Australia the sea-cage farming of southern bluefin tuna (*Thunnus maccoyii*) was the most valuable aquaculture industry with a gross value of production of A\$242 million. Pearl production is probably now second in value to tuna, while the Tasmanian based Atlantic salmon (*Salmo salar*) industry comes third with a gross value of A\$115 million. The next most valuable marine finfish aquaculture industry is probably barramundi (*Lates calcarifer*) farming - but barramundi farms are a mixture of marine and freshwater systems, and it is not easy to separate the statistics. The largest barramundi farm is a marine sea cage farm in the Northern Territory, which intends to increase production to over 1,000 tonnes (see <http://www.abare.gov.au/pdf/Barramundi.pdf> for information on barramundi farming). The full Australian fisheries statistics are available for free download from <http://abareonlineshop.com/>.

Marine aquaculture activity has been supported by the active involvement of both government and industry with respect to fish health issues. Those affecting Australia are much the same as elsewhere in the region. The activities fall into three categories:

- Those activities associated with planning and policy;

- Issues associated with disease outbreaks and
- Routine surveillance and monitoring for disease.

Planning and policy

Australia has invested heavily in planning and policy activities associated with fish health. The success of the 'AQUAPLAN' or National Strategic Plan for Aquatic Animal Health between 1998 and 2003 has been followed by a new plan (AQUAPLAN 2005-2010). This new strategy, which has been endorsed by the Australian states and territories, outlines the objectives, projects, emergency preparedness and response arrangements for the management of aquatic animal health in Australia. There are seven key strategies within AQUAPLAN:

- Enhanced integration and scope of aquatic animal health surveillance in Australia.
- Harmonisation of approaches to aquatic animal health in Australia.
- Enhancement of the aquatic animal emergency disease preparedness and response framework.
- Education and training in the aquatic animal health sector.
- Welfare standards for aquaculture.
- Appropriate use of therapeutics for aquatic animal health management.
- Aquatic animal health as part of ecologically sustainable development.

While focussed on Australia's needs, it is certain that these strategies will produce outputs of value to the region.

The Fisheries Research and Development Corporation, which is the leading Australian agency concerned with planning, funding and managing fisheries research and development, has also funded a new aquatic animal health subprogram. The sub-program web page is at <http://www.frdc.com.au/research/programs/aah/index.htm> and is well worth a browse. The subprogram will hold a scientific conference on aquatic animal health in Cairns 26-28 July 2005.

Australia also has a national aquatic animal health technical working group who provide technical advice on animal health issues and which is responsible for the development of, amongst other things, the Australian and New Zealand Standard diagnostic procedures. There are only a few at present - these can be found (for free) at: <http://www.scahls.org.au/>.

Disease outbreaks

Issues associated with disease outbreaks have, thankfully, been rare. *Streptococcus iniae* has proved problematic for barramundi culture, particularly those farms exposed to freshwater run-off. Nodavirus in barramundi and other species has also been a problem. A recent national workshop determined that histology was probably still the most cost effective method of screening juvenile fish (<30 days) for nodavirus, though an effective nested PCR is available. However, it is not always possible to detect nodavirus by non-destructive means in potential broodstock,

and false negatives are a problem. The full report on the development of the nested PCR and its validation, together with the development of an immunohistochemistry test (IHCT) and an indirect immunofluorescent antibody test (IFAT), can be purchased on-line from the FRDC website: *N J Moody Aquatic Animal Health Subprogram: development of diagnostic tests for the detection of nodavirus. FRDC Report 2001/626.*

Routine surveillance and monitoring

All of the Australian states and territories with marine aquaculture industries carry out surveillance and monitoring for aquatic diseases in partnership with industry. The results of this activity can be seen in the quarterly reports sent to NACA <http://www.enaca.org/modules/mydownloads/viewcat.php?cid=78>

Surveillance and monitoring is not carried out uniformly across all industries and all diseases but, because of the number of different tests and the costs involved in maintaining expertise in different test methodologies, surveillance and monitoring tends to be targeted at those industries and diseases for which data is required in support of movements within Australia and exports to overseas countries. For example, Tasmania invests heavily in surveillance and monitoring in support of the salmonid industry while Western Australia, which is generally too warm for salmonids, spends more effort on the mollusc and crustacean diseases that are important to the state. Queensland, the Northern Territory and Western Australia (the northern states of Australia) also have developed a memorandum of understanding to share disease information and expertise when required. There are also national initiatives to set up a more formal network of diagnostic laboratories that could share the diagnostic load and assist each other with quality assurance and new test development. This laboratory network concept will be developed as part of the national AQUAPLAN strategy. Watch the FRDC subprogram website, and the SCAHLS website for more information as this initiative develops.

Diseases of cage-cultured marine fish in Korea

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Olive flounder (*Paralichthys olivaceus*) and Black rockfish (*Sebastes schlegeli*) account for more than 70% of total production of marine finfish aquaculture in Korea. Other species such as red seabream (*Pagrus major*), Grey mullet (*Mugil cephalus*), Rock bream (*Oplegnathus fasciatus*), Sea perch (*Lateolabrax japonicus*), make up the other 30 % of total production. Thus, disease outbreaks up to date have been most frequently reported from those two species.

Over the last few years, reports of bacterial disease have been increasing in marine finfish aquaculture as the industry grows. The incidence of mixed infections (disease involving more than two causative agents) is also increasing in Korean aquaculture; two species of bacteria are commonly found from diseased fish and sometimes bacterial and parasitic disease occur together.

Edwardsiella tarda infection is the most problematic bacterial disease in olive flounder aquaculture. *E. tarda* infection can occur throughout the year as olive flounder is usually cultured in indoor recirculating systems, which can maintain water temperature above 20°C. Mixed infections with *Streptococcus* spp. or *Lactococcus* spp. also frequently occur, leading to high cumulative mortalities. Almost 40 % of bacterial infections in Korea are due to these two bacteria. Fortunately, vaccines have recently become available, hence it may be possible to prevent this disease in future.

Other bacterial diseases such as *Flexibacter maritimus*, *Vibrio anguillarum*, *Vibrio ichthyenteri* infections are also common, and due to the increasing prevalence of antibiotic-resistant strains, they can sometimes be very difficult to treat.

Scuticociliatosis is probably the most serious obstacle in olive flounder culture in Korea. Several species have been implicated as the causative organisms of the disease; *Uronema marinum*, *Miamiensis avidus*, and *Philasterides dicentrarchi*. At first, the disease was thought to be restricted to spring, when the water temperature is between 14-17°C, and only olive flounder fry were known to be susceptible. However, since the late 1990s, the disease has been observed to occur throughout the year. Moreover, the age of host fish and the number of species known to be susceptible has also increased. Several treatments have been successfully applied to treat early stages of scuticociliatosis including formalin, yellow mud and ketoconazole. In the case of heavy infections, there seem to be no effective treatment. Other less notorious, but commonly found parasites affecting marine fish aquaculture in Korea are *Microcotyle sebastis*, *Benedenia hoshinai*, *Cryptocaryon irritans*, *Trichodina* spp.

Iridovirus infection is a serious pest in marine fish aquaculture in Korea. Since its first report in 1998, iridovirus has been reported from south coast to the east and west coasts of Korea. Rock bream culture has been affected most seriously and mass mortalities frequently occur, sometimes in excess of 90%. Other species such as black rockfish and sea perch also seem to be susceptible to the infection, though to a lesser degree. These situations cause huge economic loss. Although research is still in progress, vaccination is reported to be effective for controlling iridovirus infection under experimental conditions. Immunostimulants such as beta-glucan also seem to be effective for reducing mortalities.

One of the problems of marine finfish aquaculture in Korea is that the incidence of disease is increasing, whether this is due to changes in management practices, changes in pathogens or simply due to increased awareness and reporting by a growing industry is not entirely clear. However, mixed infections and introduction of new diseases does appear to be increasing. Other problems such as insufficient quarantine process are also the obstacles against the prompt countermeasures.

The National Fisheries Research & Development Institute (NFRDI) operates a Mobile Hospital for Fish Disease every year, to prevent spread of infection and educate local farmers about disease prevention. Developments in vaccine research are promising; in addition to edwardsiellosis, vibriosis and iridovirus infection, vaccines for lymphocystis and streptococcosis are being researched in Korea, which will hopefully assist the industry to improve health management in future.



Mass seed production of sand sea bass

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The larvae are fed rotifer (*Brachionus* sp), *Artemia* and artificial diets as they progress through the rearing cycle. After 12 days, water exchange in the rearing tanks is maintained at about 10 – 20% per day, and this is increased up to 40% by day 30-45. The survival rate of the larvae during this stage is around 50 – 60 %. At the moment RCMD can produce more than 500,000 sand sea bass larvae per cycle.

Nursery

After the sand sea bass seed reach 2.5-5cm in length, or normally after 45 days rearing period, they can be transferred to nursery tanks, for which we use rectangular fiberglass tanks of 2 ton capacity, equipped with aeration and flow-through water exchange systems. Seed are stocked in nursery tanks at a density of 1,000 seeds per m³. The juveniles are fed *ad libitum* with artificial diets three times per day (morning, afternoon and late afternoon). Grading must be conducted in every two weeks during the nursery stage. Careful attention to hygiene is important to prevent disease. Waste is siphoned from the tank bottoms one hour after feeding.

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