Barramundi

What is Barramundi?

The barramundi or Asian sea bass, is a species of catadromous fish in the family Latidae of the order Perciformes. The species is widely distributed in the Indo-West Pacific region from South Asia to Papua New Guinea and Northern Australia.

Origin of name

Barramundi is a loanword from an Australian Aboriginal language of the Rockhampton area in Queensland meaning "large-scaled river fish". However, the name was appropriated for marketing reasons during the 80s, a decision that has aided in raising the profile of this fish significantly. *L. calcarifer* is broadly referred to as Asian seabass by the international scientific community, but is also known as Australian seabass.

Description

This species has an elongated body form with a large, slightly oblique mouth and an upper jaw extending behind the eye. The lower edge of the preoperculum is serrated with a strong spine at its angle; the operculum has a small spine and a serrated flap above the origin of the lateral line. Its scales are ctenoid. In cross section, the fish is compressed and the dorsal head profile clearly concave. The single dorsal and ventral fins have spines and soft rays; the paired pectoral and pelvic fins have soft rays only; and the caudal fin has soft rays and is truncated and rounded. Barramundi are salt and freshwater sportfish, targeted by many. They have large, silver scales, which may become darker or lighter, depending on their environments. Their bodies can reach up to 1.8 m (5.9 ft) long, though evidence of them being caught at this size is scarce. The maximum weight is about 60 kg (130 lb). The average length is about 0.6–1.2 m (2.0–3.9 ft). Its genome size is about 700 Mb, which was sequenced and published in Animal Genetics (2015, in press) by James Cook University.

Barramundi are demersal, inhabiting coastal waters, estuaries, lagoons, and rivers; they are found in clear to turbid water, usually within a temperature range of 26−30 °C. This species does not undertake extensive migrations within or between river systems, which has presumably influenced establishment of genetically distinct stocks in Northern Australia.

Lifecycle

The barramundi feeds on crustaceans, molluscs, and smaller fish (including its own species); juveniles feed on zooplankton. The barramundi is euryhaline, but stenothermal. It inhabits rivers and descends to estuaries and tidal flats to spawn. In areas remote from fresh water, purely marine populations may become established. At the start of the monsoon, males migrate downriver to meet females, which lay very large numbers of eggs (several millions each). The adults do not guard the eggs or the fry, which require brackish water to develop. The species is sequentially hermaphroditic, with most individuals maturing as males and becoming female after at least one spawning season; most of the larger specimens are therefore female. Fish held in captivity sometimes demonstrate features atypical of fish in the wild; they change sex at a smaller size, exhibit a higher proportion of protogyny and some males do not undergo sexual inversion.

Recreational fishing

Prized by anglers and sport-fishing enthusiasts for their good fighting ability, barramundi are reputed to be good at avoiding fixed nets and are best caught on lines and with fishing lures. In some parts of the world like Australia, the barramundi is used to stock freshwater reservoirs for recreational fishing. These "impoundment barramundi", as they are known by anglers, have grown in popularity as a "catch and release" fish.

Commercial fishing and aquaculture

The fish is of commercial importance; it is fished internationally and raised in aquaculture in Australia, Singapore, Saudi Arabia, Malaysia, India, Indonesia, Vietnam, Israel, Thailand, the United States, Poland, and the United Kingdom. A Singapore investment firm has invested in an upcoming barramundi fish farm in Brunei just to name few.

Aquarium use

Juveniles are a popular aquarium fish, and can be very entertaining, especially at feeding time. In aquaria, they become quite tame and can be hand-fed; they are not aggressive, but their feeding reflex is violent and sudden, so they cannot be kept with any tank mates small enough to be swallowed

As food

With half the calories of salmon, barramundi is still packed with Omega-3 fatty acids (known to promote both brain and cardiovascular health. It has a mild flavour and a white, flaky flesh, with varying amount of body fat.

Barramundi are a favourite food of several region’s apex predator, saltwater crocodiles, which have been known to take them from unwary fishermen. Nile perch—a similar fish found in the Afrotropical realm, or sub-Saharan Africa—is often mislabelled as barramundi.

Biological features

Body elongates, compressed, with a deep caudal peduncle. Head pointed, with concave dorsal profile becoming convex in front of dorsal fin. Mouth large, slightly oblique, upper jaw reaching to behind eye; teeth villiform, no canines present. Lower edge of pre-operculum with a strong spine; operculum with a small spine and with a serrated flap above origin of lateral line. Lower first gill arch with 16 to 17 gill rakers. Scales are large. Dorsal fin with 7 to 9 spines and 10 to 11 soft rays; a very deep notch almost dividing spiny from soft part of fin; pectoral fin short and rounded, several short, strong serrations above its base; dorsal and anal fins both have scaly sheaths. Anal fin rounded, with 3 spines and 7 to 8 short rays. Caudal fin rounded. Colour in two phases, either olive brown above with silver sides and belly (usually juveniles) or green/blue above and silver below. No spots or bars present on fins or body.

Profile

Historical background

Lates calcarifer, known as seabass in Asia and barramundi in Australia, is a large, euryhaline member of the family *Centropomidae* that is widely distributed in the Indo-West Pacific region from the Arabian Gulf to China, Taiwan Province of China, Papua New Guinea and northern Australia. Aquaculture of this species commenced in the 1970s in Thailand, and rapidly spread throughout much of Southeast Asia.

Among the attributes that make barramundi an ideal candidate for aquaculture are:

- It is a relatively hardy species that tolerates crowding and has wide physiological tolerances.
- The high fecundity of female fish provides plenty of material for hatchery production of seed.
- Hatchery production of seed is relatively simple.
- Barramundi feed well on pelleted diets, and juveniles are easy to wean to pellets.
- Barramundi grow rapidly, reaching a harvestable size (350 g – 3 kg) in six months to two years.

Habitat and biology

Barramundi inhabit freshwater, brackish and marine habitats including streams, lakes, billabongs, estuaries and coastal waters. Barramundi are opportunistic predators; crustaceans and fish predominate in the diet of adults.

Spawning seasonality varies within the range of this species. Barramundi in northern Australia spawn between September and March, with latitudinal variation in spawning season, presumably in response to varying water temperatures. In the Philippines barramundi spawn from late June to late October, while in Thailand spawning is associated with the monsoon season, with two peaks during the northeast monsoon (August – October) and the southwest monsoon (February – June). Spawning occurs near river mouths, in the lower reaches of estuaries, or around coastal headlands. Barramundi spawn after the full and new moons during the spawning season, and spawning activity is usually associated with incoming tides that apparently assist transport of eggs and larvae into the estuary.

Barramundi are highly fecund; a single female (120 cm TL) may produce 30–40 million eggs. Consequently, only small numbers of broodstock are necessary to provide adequate numbers of larvae for large-scale hatchery production. Larvae recruit into estuarine nursery swamps where they remain for several months before they move out into the freshwater reaches of coastal rivers and creeks. Juvenile barramundi remains in freshwater habitats until they are three–four years of age (60–70 cm TL) when they reach sexual maturity as males, and then move downstream during the breeding season to participate in spawning. Because barramundi is euryhaline, they can be cultured in a range of salinities, from fresh to seawater. When they are six–eight years old (85–100 cm TL), Australian barramundi change sex to female and remain female for the rest of their lives. Sex change in Asian populations of this species is less well defined and primary females are common.

Although some barramundi have been recorded as undertaking extensive movements between river systems, most of them remain in their original river system and move only short distances. This limited exchange of individuals between river systems is one factor that has contributed to the development of genetically distinct groups of barramundi in northern Australia, where there are six recognised genetic strains in Queensland, and a further ten in the Northern Territory and Western Australia.

Production

Production systems

Seed supply

While barramundi fingerlings are still collected from the wild in some parts of Asia, most seed supply is through hatchery production. Hatchery production technology is now well established throughout the culture range of this species.

Rearing fingerlings

Barramundi broodstock are held in floating cages or in concrete or fibreglass tanks. They may be maintained in either fresh or seawater but must be placed in seawater prior to the breeding season to enable final gonadal maturation to take place. Barramundi show no obvious external signs of gonadal development and must be examined by cannulation to determine their gender and reproductive status, although milt can be expressed easily from male fish during the spawning season.

Barramundi broodstock are usually fed with 'trash' fish or commercially available baitfish. In order to improve the nutritional composition of the broodstock diet, and prevent diseases associated with vitamin deficiencies, a vitamin supplement may be injected into, or mixed with, the baitfish prior to feeding.

Pre-spawning behaviour involves the male fish pairing with a female and rubbing its dorsal surface against the area of the female's genital papilla, erecting its fins and 'shivering'. In the absence of such displays, egg release may occur but they are not fertilised. Spawning occurs

34–38 hours after injection, usually around dusk, and may be accompanied by violent splashing at the water surface. Barramundi will often spawn for up to five consecutive nights.

At spawning, the sperm and eggs are released into the water column and fertilisation occurs externally. Barramundi eggs are 0.74–0.80 mm in diameter with a single oil droplet of 0.23–0.26 mm diameter. The eggs are collected from spawning tanks using fine mesh (around 300 μm) egg collection nets through which tank water is diverted. If barramundi are spawned in cages, the cages are lined with a fine mesh 'hapa' net that retains the eggs inside the cage, enabling their later removal to the hatchery.

Fertilised eggs undergo rapid development and hatching occurs 12–17 hours after fertilisation at 27–30 °C. Newly hatched larvae have a large yolk that is absorbed rapidly over the first 24 hours after hatching, and is largely exhausted by 50 hours after hatching. The oil globule is absorbed more slowly and persists for about 140 hours after hatching. The mouth and gut develop the day after hatching (day two) and larvae commence feeding from 45–50 hours after hatching.

Hatchery production

Barramundi are generally reared using 'green water' intensive techniques, in circular or rectangular concrete tanks or in circular canvas tanks up to 26 m^3 capacity. A microalgal culture (usually Tetraselmis spp. or Nannochloropsis oculata) is added to the rearing tanks at densities ranging from $8–10×10^3$ to 1–3×105 cells/ml. Intensively reared barramundi are fed on rotifers (Brachionus plicatilis) from day two (where day one is the day of hatching) until day 12 (or as late as day 15), and on brine shrimp (Artemia sp.) from day eight onwards. Both rotifers and brine shrimp fed to barramundi are cultured on microalgae or commercial enrichment products to increase levels of highly unsaturated fatty acids. The freshwater cladocerans Daphnia and Moina have been used to supplement, or replace, brine shrimp as prey for intensively reared barramundi larvae. Overall survival for intensively-reared barramundi larvae from hatching to about 10 mm TL generally ranges from 15–50 percent. More recently, compounded microdiets have been used to partly or totally replace brine shrimp in the intensive larval rearing of barramundi.

Barramundi fingerlings are also produced using extensive (pond-based) rearing procedures. Pond areas used for the extensive larval rearing of barramundi range from 0.05 to 1 ha and may be earthen or plastic lined. They are relatively shallow (<2 m) to promote maximum production of phytoplankton and to prevent stratification. Larval rearing ponds are managed through the application of inorganic and organic fertilisers to produce a 'bloom' of suitable zooplankton concomitant with the introduction of the newly hatched barramundi larvae. Barramundi larvae are stocked at densities of 400 000–900 000/ha. Continued pond management focuses on supporting adequate zooplankton populations for the developing larvae, and ensuring that water quality criteria are maintained. Barramundi are harvested from the ponds when they reach 25 mm TL or greater (about three weeks after stocking), and are then transferred to nursery tanks. Survival of extensively reared barramundi averages about

20 per cent, but is highly variable, ranging from zero to 90 percent. Production rates of up to 640 000 fish/ha have been achieved in extensive rearing.

Nursery

Barramundi juveniles (1.0–2.5 cm TL) may be stocked in floating or fixed nursery cages in rivers, coastal areas or ponds, or directly into freshwater or brackishwater nursery ponds or tanks. The fish are fed on minced trash fish (4–6 mm) or on small pellets. Vitamin premix may be added to the minced fish at a rate of 2 percent. This nursery phase lasts for 30 to 45 days; once the fingerlings have reached 5–10 cm TL they can be transferred to grow-out ponds.

Cannibalism can be a major cause of mortalities during the nursery phase and during early grow-out because barramundi will cannibalise fish of up to 61–67 percent of their own length. Cannibalism may start during the later stages of larval rearing and is most pronounced in fish less than about 150 mm TL; in larger fish, it is responsible for relatively few losses. Cannibalism is reduced by grading the fish at regular intervals (usually at least every seven–ten days) to ensure that the fish in each cage are similar in size.

Ongrowing techniques

Most barramundi culture is undertaken in net cages. Both floating and fixed cages are used; these range in size from 3×3 m up to 10×10 m, and 2–3 m depth. In Australia and the United States of America, a number of barramundi farms have been established using recirculation freshwater or brackishwater systems with a combination of physical and biological filtration. These farms may be located in regions where barramundi could not otherwise be farmed because of consistently low temperatures (southern Australia, north-eastern United States of America). The major advantage of such culture systems is that they can be sited near to markets in these areas, thus reducing transport costs for the finished product.

The stocking densities used for cage culture generally range from 15 to 40 kg/m^3, although densities may be as high as 60 kg/m^3. Generally, increased density results in decreased growth rates, but this effect is relatively minor at densities under about 25 kg/m^3. Barramundi farmed in recirculation production systems are stocked at a density of about 15 kg/m^3.

Barramundi are also farmed in earthen or lined ponds without cages; a technique known in Australia as 'free ranging'. Juvenile barramundi (20–100 g) are cultured in brackishwater ponds at 0.25–2.0 $fish/m^2$. In Asia, barramundi may be polycultured in brackishwater ponds with tilapia (Oreochromis spp.) as a food source.

Feed supply.

Most barramundi are now fed on compounded pellets, although 'trash' fish is still used in areas where it is cheaper or more available than pelleted diets. Barramundi fed 'trash' fish are fed twice daily at 8–10 percent body weight for fish up to 100 g, decreasing to 3–5 percent body weight for fish over 600 g. Vitamin premix may be added to the trash fish at a rate of 2 percent, or rice bran or broken rice may be added to increase the bulk of the feed at minimal cost. Food conversion ratios (FCRs) for barramundi fed on trash fish are high, generally ranging from 4:1 to 8:1.

Barramundi fed pellets are generally fed twice each day in the warmer months and once each day during winter. Larger farms may use automatic feeder systems, though smaller farms hand-feed. Barramundi have achieved FCRs of 1.0–1.2:1 under experimental conditions, but in commercial farm conditions FCRs of 1.6–1.8:1 are usual. FCR varies seasonally, often increasing to over 2.0:1 during winter.

Harvesting techniques

For barramundi farmed in cages, harvesting is relatively straightforward, with the fish being concentrated into part of the cage (usually by lifting the net material) and removed using a dip net. Harvesting barramundi 'free-ranging' in ponds is more difficult, and requires seine-netting the pond or drain harvesting.

Handling and processing

After harvesting, the barramundi are placed in an ice slurry to kill them humanely and preserve flesh quality. In Australia, most farms do not process the fish, but sell them 'gut in'. Some larger Australian farms have processing facilities to process fillet product from larger (2–3 kg) fish. Fresh barramundi is generally transported packed in plastic bags inside styrofoam containers with ice. There is a limited market for live barramundi in Australia and in Southeast Asia. Fish are usually transported live in tanks by truck.

Barramundi diseases and parasites

Early-stage diseases

The first disease to harm barramundi is viral nervous necrosis (VNN), an epizootic disease caused by nodavirus. Encountered in fry as young as 10 days old, VNN causes mortality up to 100 percent.

From 25 days of age, a new bacterial disease identified by the team of Intervet Norbio Singapore as “big belly disease” is responsible for severe clumping of internal organs, abdominal distension and muscular atrophy. Caused by a newly described (*Vibrio)* species, it causes severe mortality. Subsequently in the life cycle, new-found iridovirus infection is responsible for an acute hemorrhagic syndrome that causes acute mortality in fingerlings as small as 1 g. Associated mortality can reach 85 percent. In addition, *Tenacibaculum maritimum*, a Gram-negative filamentous bacterium, can induce severe skin lesions in fish after handling and/or stocking, with outbreaks of mortality reaching 30 percent in fish of 1 to 100 grams.

Grow-out diseases

During the first month of cage farming, barramundi are most susceptible to monogenean parasites, specifically skin and gill infestation with *Neobenedenia* species. Infested barramundi quickly develop skin and tail rot, and mortality can reach 100 percent if parasite treatment is not performed in time.

Once fish reach 300 grams, they become more resistant to parasite infestation. *T. maritimum*, coupled with skin parasite infestation, can have a combined detrimental effect. T. maritimum can cause mortality all cycle long due to massive scale drop. Based on current knowledge, the most devastating disease of the grow-out cycle is streptococcosis. A systemic bacterial disease due primarily to *Streptococcus iniae*, it is characterized by massive mortality in large to market-size fish. Mortality can vary 30 to 80 percent over a period of a few days to a few weeks.

Stress reduction

To ensure maximal chances of success, health strategies for most barramundi farming should be based on husbandry practices designed to reduce the number of stressors in play at a single time. Before deciding on a handling procedure, one should always keep in mind fish biology and possible detrimental consequences. For example, cannibalism is a serious problem in barramundi juveniles. Regular grading provides a uniform fish size that reduces cannibalism. However, too much grading might possibly induce *T. maritimum* infestation. After vaccination, the transfer of juveniles into the sea at sizes as large as possible (15-20 grams) provides fish the best chance of survival for the rest of the cycle since they are more robust. However, it puts more pressure on the nursery phases to hold higher biomass and, therefore, a higher risk of disease outbreak. In general, the fish environment should be maintained in a constantly optimal state with the lowest possible level of stress.

Nutrition, immune modulation

Optimized nutrition is of major importance in the defense against disease, especially for stress-related problems caused by environmental changes such as water temperature fluctuations or by necessary husbandry practices, including grading, vaccination and transfer.

To maintain good health, a high-quality diet should be used, and this can be complemented by the use of supplementary immune modulators. If a farm is expecting the appearance of a regular disease problem, the feeding of an immune modulator product prior to the disease situation can help fish resist the challenge. Some sites experience continual stress from high temperatures or particular pathogens throughout certain seasons. During these periods, immune modulators can be fed continuously for 10 days every 30 days to give fish an improved chance of resisting clinical outbreaks and help them recover quickly from any diseases that may occur.

Parasite management

Parasites are part of the natural ecosystem, and complete eradication is extremely unlikely. However, it is possible to design an effective parasite prevention plan to control parasite pressure before it gets dangerous. It is advisable to first try any new treatment regime in a small time/dose-response experiment to discover the appropriate chemical and dose for a given farming system. It is necessary to understand parasite cycles in order for treatments to be effective. In the case of barramundi, fish are infected with monogean trematodes that lay eggs on nets to complete their life cycle. In consequence, it is very important to also treat the nets. Currently, the most effective technique for managing parasites is bath treatment using a tarpaulin.

Metaphylaxis

Mass medication of animals with therapeutic levels of drugs, typically antibiotics, is sometimes called metaphylaxis. At times when some animals are diagnosed as clinically diseased and others may be subclinically affected, all the animals may be treated with the intention of controlling further disease. Metaphylactic treatments are typically used during high-risk periods for disease, such as after weaning fish from live preys to dry feed or after transport, to reduce the incidence of poststocking mortality. The use of antibiotics must be done responsibly to avoid the development of resistance and presence of residues. The choice of antibiotic should be based on antibiotic sensitivity testing and regulatory status, and its application should be supervised by fish health professionals or veterinarians to ensure that the dose and duration are correctly applied.

Importantly, withdrawal periods must be respected. In addition, banned antibiotics should not be used. Finally, it is very important that antibiotics are obtained from trustworthy sources to ensure quality and the desired concentration of the active ingredient in the product.

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