Seahorse aquaculture: A new paradigm of commercial activity

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Seahorses are unique charismatic livebearers that come under the genus *Hippocampus* spp. These flagship species are easily identified with their distinguishing features such as a horse-shaped head, large eyes, curvaceous trunk, and monkey-like prehensile tail. They are widely distributed in tropical and temperate waters (mostly in the Indo-Pacific region) and different species can tolerate a salinity range of 6-35 ppt. Seahorses are highly in demand for traditional medicines and curio trade purposes in the dried form and live ones are popular in the marine ornamental aquarium trade. As a result, they are vulnerable to overfishing. Since over-exploitation of these charismatic species has resulted in a drastic reduction in their natural populations, aquaculture of seahorses on a commercial scale may help to reduce pressure on wild stocks.

History of seahorse aquaculture

The seahorse *Hippocampus trimaculatus* was first bred in captivity in 1957 at Shantou Mariculture Test Farm, Guangdong Province, South China. From 1970 onwards, serious efforts were made to breed seahorses on a commercial scale in China. During the 1970's and 80's, Australia, Japan, and Venezuela conducted breeding experiments and rearing of seahorses in small-scale systems at research institutes and public aquaria. During the 1990's, considerable expansion of commercial seahorse aquaculture was evident in Australia, USA, and New Zealand, particularly for the big-bellied seahorse, *H. abdominalis*. The large scale culture of syngnathids spear-headed the recognition of the potential of seahorse aquaculture in 1995. South-east Asian countries conducted two workshops in 1998 to promote seahorse culture. In the last decade, extensive research has been done on different varieties of seahorse. Based on the recent studies, researchers suggested that seahorses can also be cultured in the integrated eco-aquaculture systems in a sustainable manner (Zhang and Vincent, 2018).

Global and Indian scenario of seahorse Aquaculture

Increasing demand of seahorses in international arena for ornamental and medicinal purposes has led to commercial culture of the seahorse. There are seven species (*Hippcampus abdominalis*, *H. barbouri*, *H. breviceps*, *H. comes*, *H. ingens*, *H. kuda*, and *H. reidi*) are which are accounting more than 99% of the culture and are traded throughout the world. Australia and New Zealand have developed significant centers for seahorse aquaculture.

There is a huge potential for farming seahorses in India, as there are vast resources found along the Gulf of Mannar and the Gulf of Kutch regions. It also provides an option of livelihood or additional income to the fisherfolk / self-help groups in the coastal belt besides promoting the marine ornamental industry. However, since seahorse farming is otherwise banned in India, research work on seahorses has been restricted to only four institutes within India, namely the:

- Central Marine Fisheries Research Institute, Cochin.
- Centre for Advanced Study in Marine Biology, Annamalai University, Tamil Nadu.
- Marine Biological Research Station, Ratnagiri.
- Maharashtra and Aquaculture Laboratory, CSIR-National Institute of Oceanography, Goa.

Seahorse captive breeding and rearing efforts from the above-mentioned institutes and various researchers from India are summarised in Table 1. Sadly, fishermen still rely on the wild by-catch for market and trade since culture technology of seahorse is not yet commercialised.

Biology of seahorses

Seahorses have distinct morphological characteristics such as a horse-like head positioned at a right angle, a long tubular snout with no teeth, no scales, a body with a series of bony plates and a prehensile tail. They have relatively large eyes, and small, circular openings to the gill chamber. The pelvic and caudal fins are not present in adult seahorses and the dorsal fin helps in propulsion. These species have a reduced anal fin, and the two small pectoral fins are used for stabilisation and steering. Because they are so slow-moving, sea horses are highly vulner-

Table 1. Seahorse captive breeding and rearing research in India.

Species	Author	Institute
H. kuda	Anil et al., 1999	ICAR-CMFRI, Cochin
H. kelloggi	Balasubramanian, 2002	CAS, Tamil Nadu
H. kuda	Naik et al., 2002	MBRS, Maharashtra
H. kuda	Salin et al., 2004	ICAR-CMFRI, Cochin
H. trimaculatus	Murugan et al., 2009	CSIR-NIO, Goa
H. kuda	Pawar et al., 2012	CSIR-NIO, Goa
H. trimaculatus	Murugan et al., 2013	CAS, Tamil Nadu
H. spinosissimus	Pawar et al., 2014	CSIR-NIO, Goa
H. kuda	Murugan et al., 2017	CAS, Tamil Nadu

able to predators and so they can camouflage themselves to match their surroundings. Seahorses are ambush predators, and primarily consume live and mobile prey types such as zooplankton, small crustaceans (amphipods), but also fish fry and other invertebrates. They also ingest smaller organisms that fit into their snout. They take close care of their offspring. Courtship behaviour takes hours to days, and then the mature female transfers its eggs to the male brood pouch known as a marsupium. The male secretes sperm into its pouch and then the eggs are fertilised externally, and embryos begin to develop. Soon after the gestation period, the male ejects the tiny, independent swimming seahorses to the surrounding environment.

Production of seahorses

Production cycle

Brooders are raised in indoor tanks and fed with lipid and vitamin-rich diets for maturation. During mating, male fertilises and broods the eggs which have been produced and deposited into its pouch by the female. After a period of 9-45 days of gestation, the fully developed young seahorses are ejected from the pregnant males. One day old fry are thereafter stocked in the indoor tanks and fed with live feed such as copepods or enriched *Artemia* nauplii. After 30-40 days, the juveniles are fed with frozen *Acetes*, *Mysis* or adult *Artemia* and are reared either in indoor tanks or outdoor sea cages. Once the juveniles become adults after 3-6 months, they are conditioned for breeding and the cycle continues. The other marketable size is adults of 10 cm, which are traded for traditional Chinese medicine, curios and marine aquariums in the domestic/international markets (Figure 1).

Currently, there are two types of production systems practiced globally, which are as follows:

Intensive monoculture system

The broodstock obtained from wild are kept in indoor tanks and fed with a diet containing vitamins A, C and E. During spawning season, females transfer around 200-2,000 ripe eggs to the pouch of the males. Embryo development takes place in this pouch in 10-20 days at the optimum temperature range of 26-28°C. The fry are fed with copepods, enriched rotifers and *Artemia* nauplii from birth to 40-days old age. After 40 days of rearing of the fry, the seahorses are transferred to outdoor cages and stocked @ 500/m^3. As they grow stocking is reduced to 200/m^3 by the end of the rearing period. During the grow-out period, they are weaned to frozen feed (*Mysis* and *Acetes*) twice a day. All the seahorses are harvested by net with a 40 cm diameter and 1 mm mesh size. After harvesting, seahorses are placed in oxygenated tanks and transported live for sale to exporters.

Integrated aquaculture system

IMTA (integrated multi-trophic aquaculture): Seahorses are cultured with shrimp / oyster in this system (Figure 2). Shrimp are benthic and feed on detritivores present at the bottom of the pond and the oysters are placed close to the surface of water and feed on phytoplankton. Seahorses are farmed inside cages and feed on zooplankton. In this way, the seahorse culture is synergistic with the production of shrimp and oysters, improving profitability.

Figure 1. Seahorse production cycle.

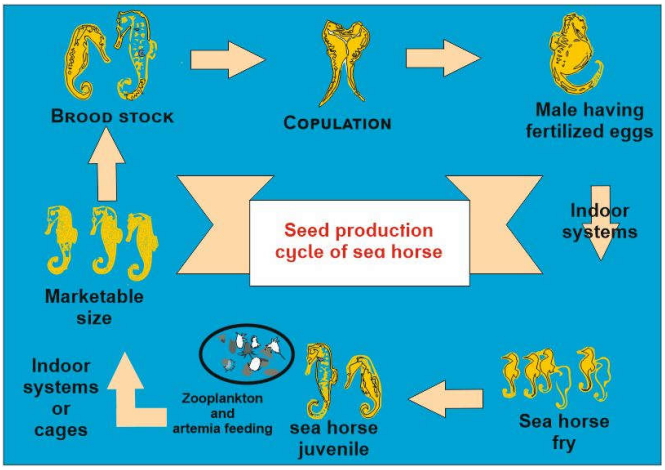
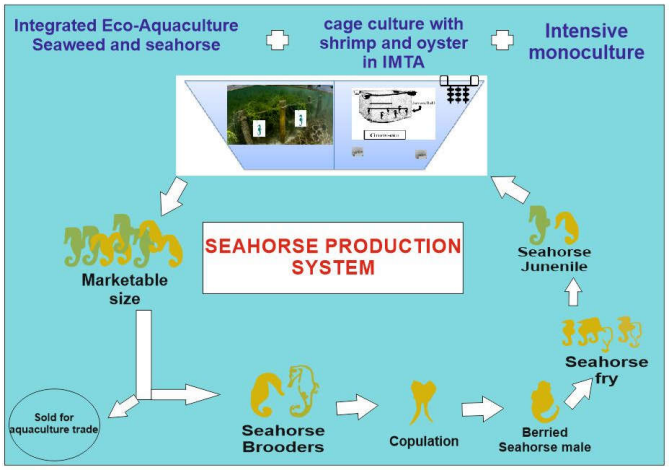


Figure 2. Seahorse production sytems.



Integrated eco-aquaculture: Seahorses are cultured with seaweed (Figure 2). Seaweed provides a holdfast and a prey growth environment for the seahorses, besides also controlling the water quality. Seaweeds not only provide convenient and abundant prey but also adjust the light intensity in the system since the seahorse is dependent on its vision to capture prey and needs a certain light intensity in the system.

Diseases and control measures

The major diseases which infect seahorses are vibriosis and mycobacteriosis. Vibriosis can be treated by application of antibiotics or vaccines. Gas bubble disease is another condition where gas becomes entrapped in the brood pouch and subcutaneous layer of the tail segment, which may be due to gas supersaturation or infectious agents. This can be treated by aspiration and antibiotics respectively. Apart from these, cultured species are vulnerable to infections caused by fungi, cestodes, marine leeches, trematodes, microsporidians and so on. Good husbandry practices and prophylactic measures can reduce the risk of disease significantly.

Conclusion

Seahorse culture is a new avenue in aquaculture which can help to reduce pressure on depleted natural populations. By adopting integrated multi-trophic aquaculture and integrated eco-aquaculture systems, populations of various species of seahorse may be enhanced in the shallow marine aquatic habitats of tropical and temperate waters. Besides taking up its commercial farming, researchers and farmers around the world need to address issues of market access and trade to build a well-managed and sustainable business.

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