Review Article

A Comprehensive Overview of Mud Crab (*Scylla Sp*.) Farming Practices in India

Abstract

The genus Scylla, commonly known as mud crabs, is frequently found in mangrove habitats, brackish waters, coastal regions, ponds, and intertidal swamps, making them a rapidly growing exportable resource in India. Farming mud crabs serves as a vital income stream for fish farmers throughout the country. The increasing demand for mud crabs in the export market as an alternative to shrimp has led to heightened collection of wild seeds for cultivation, thereby posing a threat to natural populations. To promote sustainable crab farming and alleviate pressure on wild stocks, it is essential to focus on the availability of seeds, which is a crucial factor for successful farming. Additionally, crab fattening proves to be lucrative due to its quick turnover and high survival rates. This practice is particularly advantageous for small-scale operations, providing an extra source of income for local fishermen. This review article aims to consolidate existing knowledge on the ecology and biology of mud crabs.

Keywords: Aquaculture, Fattening, Mangrove, Cages, Estuarine

Introduction

Mud crab farming has been a traditional activity in Southeast Asia, primarily involving the capture of juvenile crabs from their natural habitats and fattening them for market. However, the demand for mud crabs is currently inadequate, resulting in overfishing in several regions. The genus Scylla is prevalent across the Pacific and Indian Oceans. Mud crabs are typically located in estuarine environments and coastal areas, with substantial populations often found in conjunction with mangrove ecosystems, making them highly suitable for aquaculture [1]. Crabs from the genus Scylla, commonly referred to as green crabs or mangrove crabs, serve as a significant secondary crop within traditional shrimp and fish farming practices throughout Asia. The rising importance of live mud crabs as an export commodity has created considerable opportunities for crab farming, especially given the growing demand for mud crabs in both domestic and international markets [1].

Mud crabs have frequently been recognized as a key species for enhancing coastal aquaculture diversification in several Asian countries, including China [2], Philippines [3], Indonesia [4], Malaysia [5], Thailand [6], Vietnam [7], Japan [8], Bangladesh [9], Sri Lanka [10], Myanmar [11], and India [12]. Currently, crab farming has become quite prevalent in India. As the second-largest fish producer globally, India contributes 7.56% to the world's fish production, with an estimated 1.6187 million tonnes of seafood valued at Rs 57,586.48 crore (approximately US$ 7,759.58 million) in the 2021-22 period [13]. Among this, crab exports (excluding imitation products) reached about 6,938 tonnes. Mud crabs are particularly well-suited for export to both foreign and domestic markets due to their resilience and ability to endure extended periods out of water in low temperatures. Furthermore, mud crabs are less prone to diseases, relatively easy to farm, and can survive without water for a certain duration [14]. This species is highly sought after in both domestic and international markets for its delicious meat and high nutritional content, which includes a variety of essential nutrients [15].

The key factor influencing the success of mud crab farming is the availability of seeds. Currently, the demand for crab seeds heavily relies on wild catches. As a result, maintaining consistent production levels throughout the year poses significant challenges for the cultivation industry. The commercial viability of larval crab culture has not yet been established for farm stocking, leading to a reliance on wild-caught crabs, supplemented by techniques for rearing and fattening crabs primarily in mangrove areas. Major crab-producing countries, such as China, Vietnam, Indonesia, and the Philippines, benefit from their abundant mangrove ecosystems, which provide ideal habitats for crabs to live and hide [16]. Additionally, mangroves offer valuable natural food sources. In India, mud crab farming is widespread, and during the early 1990s, the focus was on enhancing meat quality by rearing recently moulted crabs in mud ponds or cages for short durations (20–30 days) [17]. However, recent efforts have shifted towards cultivating meaty wild crabs (over 300 g), yet most farmers still rely on wild-caught seed stocks for pond stocking [18]. The inconsistent success rates of larval crabs remain a significant hurdle in advancing mud crab aquaculture.

While the technology for mud crab hatcheries has been implemented successfully, the survival rate of larvae transitioning to seeds remains low, largely due to significant cannibalism [19,4,20]. This review article provides an overview of the existing knowledge on mud crab ecology concerning population biology and management, and highlights key priorities for future research aimed at promoting sustainable practices in mud crab aquaculture and fisheries.

Taxonomy

Literature on mud crab fisheries and ecology indicates that the identification of the species in question often remains ambiguous, particularly in regions where multiple "types" of mud crabs have been documented. This uncertainty complicates the ability to make broad generalizations from existing research, and much of the biological and ecological information currently available will require revaluation once it can be attributed to specific species [21]. Until recently, the taxonomic classification of the genus Scylla has been significantly muddled. Numerous researchers have historically reported the presence of more than one species. Estampador [22] conducted a revision of the genus, utilizing factors such as burrowing habits, coloration, morphological traits, and chromosome structure to identify three species and one variety of Scylla in the Philippines: *S. oceanica, S. tranquebarica, S. serrata*, and *S. serrata var. paramamosain*. This level of diversity within the genus was further supported by Serene [23], who recognized four distinct forms of Scylla in Vietnamese specimens, based on spination and coloration. Kathirvel and Srinivasagam [24] also reviewed the taxonomy of mud crabs in India, noting the existence of at least three species of Scylla. Conversely, the ongoing uncertainty surrounding species identification has led many researchers to adopt the stance of Stephenson and Campbell [25], who concluded that there was insufficient evidence to differentiate species beyond the single term *S. serrata* (Forskal).

Reproduction

A common behaviour observed in Scylla populations is the offshore migration of females for spawning. The distances these females travel can vary by species and are influenced by environmental factors. The high number of females with spent ovaries found in coastal populations of *S. serrata* suggests that many are capable of returning to the coast after spawning [26]. According to Heasman [26], certain areas may have conditions favourable for larval development within inshore coastal waters. Consequently, migration may serve more as a dispersal strategy rather than a necessity for ensuring optimal larval survival conditions [27].

Seed production

Female mud crabs are assessed for ovarian maturity by inspecting the clear membrane located between the first abdominal segment and the carapace. Mature ovaries appear dark orange, while crabs with immature ovaries, which are light yellow, undergo eyestalk ablation on one side [28]. When females release their eggs, they attach to the pleopod hairs on the abdominal flap. Berried crabs may lose some or all of their eggs due to various factors,

including fungal infections, unsuccessful fertilization, nutritional deficiencies, or environmental stressors. Prolonged incubation can lead to egg infections from fungi and filamentous bacteria, as well as infestations by protozoans. Such infections hinder embryonic development and increase egg mortality by limiting oxygen exchange through the egg membrane [28,29]. Each spawning event can yield between 0.8 to 4 million zoeae in *S. serrata* weighing 350-525 g, 0.7 to 3 million zoeae in *S. tranquebarica* weighing 240-300 g, and 0.4 to 2.7 million zoeae in *S. olivacea* weighing 360-465 g. Hatching typically occurs 7 to 14 days after spawning at temperatures ranging from 26.5 to 31°C [30].

Nursery culture

The final step involves transferring crablets to a nursing pond. The area of the pond typically ranges from 200 to 800 m². In some cases, hatcheries may incorporate net cages within the ponds. Crabs measuring less than 1.0 cm are raised to a size of 1.5-2.0 cm CW in these net cages at a density of 20-50 per m² (Phase 1). Some farmers opt for larger crabs and therefore grow them to 3.0-4.0 cm CW in ponds that are lined with nets or have net fences along the dikes, at a density of 5-10 per m² (Phase 2). The culture period for each phase lasts between 3-4 weeks, depending on the target size for pond stocking [30]. If the culture period is shorter than 4 weeks, the stocking density can be increased. During this time, the crabs are fed a mix of at least two types of food, including minced low-value fish, shellfish, chicken scraps, boiled corn, or specially formulated feeds, provided at satiation once or twice a day.

Grow out culture

Crab juveniles are raised to marketable size in earthen ponds or within net or bamboo pens located in mangrove or tidal areas. Following the application of lime to the earthen ponds, pest and predator populations are controlled using tobacco dust, tea seed, or a mixture of hydrated lime and ammonium sulfate. The inner sides of pond dikes are secured with nets or bamboo matting, and 30-50 cm wide plastic sheets are placed along the top of the fence to prevent crabs from escaping. In both ponds and pens, juveniles are stocked at a density of 0.5-1.5 individuals per square meter [31]. Their diet consists of fish, molluscs, crustaceans, and waste materials such as animal hides, entrails, and fish offal, provided at a rate of 10% of the crab biomass per day during the first month. This feeding rate is then reduced to 8% in the second month and 5% in the third month, continuing until the end of the culture period [32]. Water depth is maintained at 80 cm and is replenished during high tides.

Mud crab fattening

The process of fattening mud crabs offers humans a significant source of food rich in protein, essential minerals, and energy, while their shells can provide an alternative protein source for animals. Additionally, this practice gives fishermen an extra income stream beyond traditional fisheries, proving to be economically viable [33]). The method primarily involves capturing juvenile crabs from natural habitats and fattening them over a brief period to create a value-added product [34]. This is achieved by enhancing the meat content and developing the gonad mantle in the body cavity of female crabs to promote maturation [35]. Female mud crabs with immature gonads are less sought after in both international and domestic markets [36].

Integrating fattening methods in both the pond bottom and floating cages could be the most effective strategy for enhancing mud crab aquaculture, utilizing both the bottom and surface areas of the waterbody [37]. Food waste from the floating cages often settles at the pond's bottom, leading to the accumulation of harmful gases; however, the presence of bottom crabs can help maintain a safe and clear environment. Additionally, uneaten feed from finfish provides another resource for bottom crabs to fulfil their nutritional requirements by recycling available nutrients [37].

Marketing

The marketing system relies on various factors, including demand, supply, and the import-export framework. Understanding the marketing system clarifies the current state of crab farming. This sector offers promising opportunities for profitable exports, especially in markets like Japan and the USA. Crabs are an important source of protein for people of all ages, and their size, high meat yield, and delicate flavor make them highly sought after as quality food products (Dana et al., 2024).

Conclusion

The mud crab industry is experiencing rapid growth globally, particularly in India. The establishment of hatcheries and advancements in breeding techniques have led to a significant increase in mud crab production over the past few years. To further enhance the overall performance of mud crabs in captivity and ensure the sustainability of the industry, artificial seed production is crucial. This process not only boosts global production but also alleviates pressure on natural resources, while providing livelihoods for millions of people.

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