Brief Communication

Captive rearing of Indian mackerel and Indian oil sardine

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In the aquaculture industry, candidate species have been successfully domesticated, bred, and raised in captivity, leading to more sustainable and controlled production. However, the success of domestication efforts depends on various factors, including the biological characteristics of the species, environmental conditions and the availability of suitable feed. Indian mackerel (*Rastrelliger kanagurta*) and Indian oil sardine (*Sardinella longiceps*), are important commercially harvested species in the Indian subcontinent. Challenges in reproducing the natural conditions for these species, their specific breeding behaviours, and nutritional requirements are barriers to their successful domestication and captive breeding.The Vizhinjam Regional Centre of ICAR-CMFRI succeeded in the captive rearing of adult oil sardines and mackerel, sustaining them for a considerable period for the first time in captivity. These specimens were procured off the Vizhinjam coast with the assistance of local fishers, who operated hooks and lines, locally known as 'Aachil,' within a distance of approximately 3-5 km from the shore. 'Aachil' is characterized by the use of a main line made of nylon monofilament twine, which typically ranges from 10 to 12 m in length. At intervals of 0.50 m along the mainline, branch lines are securely tied, each featuring a hook at its distal end. To facilitate the sinking of the line to the desired depth, a 0.5 or 1 kg iron sinker is attached at the end of the main line. The choice of line length depends on the time of day and fishing conditions. During the night, a 15 m long line is employed, while a shorter 7 m long line is used for daytime fishing. The monofilament twines are categorized into various numbers, with the lower numbers indicating thicker twines. For day fishing, number 60 main lines are paired with number 45 branch lines, whereas during night fishing, both main and branch lines are made from number 30 twines. Additionally, the type of hooks used is categorized based on numbers. For fishing operations, hooks ranging from number 13 to 16 are employed, whereas hook number 15 is utilized for catching oil sardines and mackerel. These hooks are covered with striking coloured materials to attract the fishes to the hook. These hand lines are typically operated from 28-foot fiberglass-coated plywood boats (FPB), which are equipped with 9.9 HP outboard engines, usually two of them. A typical fishing crew consists of three to four fishermen, with each crew member responsible for operating a hand line. In addition

Aachil (Hook and Line)

to fiberglass boats, catamarans are also utilized for hand-line fishing operations. Responding to a request from the scientific team at Vizhinjam ICAR-CMFRI, the local fishers were equipped with essential items such as plastic bins and battery-charged aerators to ensure the live fish's well-being after capture. The process involved a transit time of 2-3 hours from the point of capture to the destination, with a survival rate ranging between 30-40% upon arrival. Upon reaching the destination, the live fish underwent a quarantine period of 3-4 days in the designated facility. It was observed that severely injured fishes succumbed within 2 days, while those with lesser injuries demonstrated sustained survival within the system. Regular feed waste removal is done by bottom siphoning and followed by seawater top-up of 5-10% per day. Water quality parameters maintained at salinity 32-34 ppt, water temperature 28.8-29.4 ºC, pH 7.8 and Ammonia less than 0.02 ppm.

Indian oil sardine

Sardines were stocked in 2 ton tanks initially for the quarantine, and the fishes were kept unfed throughout the quarantine period. After a thorough 3-4 day quarantine, once the fish acclimated to the systems, they were transferred to 2 ton flow through tanks. Feeding commenced when the fishes exhibited full activity in the systems, and they were initially provided with marine algae, specifically *Isochrysis galbana* and *Chaetoceros calcitrans* (three carbouy cans each) every morning. In the evening, after water exchange, *Artemia* was given. Daily water exchange was conducted in the morning before algal feeding to enhance survival. The cell density of carbouy cans ranged from 3×10^4 to 3×10^5. The sardine tank maintained only 1 ton of seawater, always covered with appropriate netting to prevent fish from jumping outside. Ensuring water cleanliness and proper maintenance of the flow-through system were deemed essential for maintaining fish health. A stock of 16 oil sardines (average total length and total weight was 15 cm and 47 g respectively) was reared in the 2 ton flow-through system, surviving up to 1.2 years with a growth increment of 2.6 cm before the final fishes were lost. Although fish growth occurred in the system, there was no observable reproductive progress or gonadal maturation within the system. The challenges encountered in the domestication of Indian oil sardine in captivity are multifaceted. The dietary requirements of Indian oil sardines pose a significant barrier, as providing a nutritionally balanced diet that mimics their natural feeding habits in the wild is complex. The reproduction process is another critical aspect contributing to the failure, with challenges in recreating the conditions essential for successful spawning and larval survival. Behavioral adaptations, such as migratory patterns and schooling behavior, further complicate efforts to recreate a natural environment in captivity. Maintaining optimal environmental conditions, encompassing factors like water quality, temperature, and salinity is essential but challenging over extended periods. Collaborative efforts across disciplines involving marine biologists, aquaculturists, and environmental scientists are essential for a holistic strategy.

Indian mackerel

Following a 3-4 day quarantine period, mackerels were initially transferred to flow-through systems, subsequently transitioning to 5 ton Recirculating Aquaculture Systems (RAS). Fifteen mackerels were successfully stocked in the RAS tanks and reared for a duration of nine months. The mackerels displayed an average total length of 23 cm and a total weight of 142 g. In the RAS tanks, the mackerels were nourished with a diet primarily consisting of algae, including *Isochrysis galbana, Chaetoceros calcitrans*, and *Nanochloropsis* sp. Depending on the availability of algal species, 2-3 carbouy cans of any two species were provided daily in the morning after switching on the systems. The mackerel's remarkable adaptability and predatory skill were evident as it demonstrated versatile feeding behaviors, encompassing both particle and filter feeding strategies. This adaptability enables the mackerel to effectively prey on a diverse range of organisms within its ecosystem. Previous feeding studies on mackerels involved providing them with wild-caught mysids, crustacean larvae, diatoms, and artemia based on availability. The swimming behavior aroused a special interest to maintain mackerels in tanks renowned for its ability as a predator in aquatic environments, employs a distinctive swimming technique known as undulatory locomotion. This method relies on the coordinated contraction and relaxation of muscles along the fish's streamlined body, initiating a rhythmic wave-like motion. This undulating motion begins at the head and progresses sequentially down the body toward the tail. The harmonious combination of undulating body movement and tail fin action results in forward propulsion, allowing the mackerel to navigate through water with remarkable quickness and speed. The streamlined body shape minimizes water resistance, making this method of swimming energy-efficient. After one month of successful survival in the RAS, a significant phase was introduced in the feeding regimen for mackerels. Boiled mussels and chopped squids were incorporated into their diet, provided at a rate of 1% of the mackerels' body weight. This dietary modification aimed to induce gonadal maturation, complementing the regular

Underwater view of mackerel in the RAS at Vizhinjam Regional Centre, ICAR-CMFRI

intake of algal and other feed items. A noteworthy aspect of mackerel domestication emerged with its newfound ability to consume squids and chopped mussels. This adaptation in their feeding behavior adds an attractive dimension to the mackerel's domestication process, showcasing its versatility in accepting a diverse range of prey items beyond its traditional diet. This observation underscores the success and adaptability of mackerels in captivity, marking a noteworthy milestone in their dietary habits during the domestication process.

As the fishes approached their spawning season, a notable development occurred in one individual, a transparent tissue growth on the cephalic region. Remarkably, this fish survived with the growth in tanks for up to three months but unfortunately perished thereafter. Subsequently, the remaining fishes exhibited similar cephalic tissue growth before meeting a similar fate. Interestingly, biological examinations of the deceased fishes revealed a complete absence of gonadal maturation. Investigations into the pathogenic significance of the transparent tissue were conducted to discern potential diseases in captivity. However, results suggested no specific pathogenic cause; rather, the phenomenon appeared linked to environmental, nutritional, or immunological reactions. Further exploration into mackerel's natural behavior revealed their tendency for spawning migration and a preference for specific environmental conditions conducive to successful spawning. The captive environment, lacking these essential features, posed challenges to successful breeding and spawning. To address this, creating suitable habitats in captivity, mimicking ecological parameters effectively, becomes pivotal for rearing mackerels and enhancing breeding and spawning success. Additionally, before attempting domestication, a detailed study of the habitat preferences of adult and spawner mackerels in the wild is imperative. Continuous research coupled with technological advancements will play a crucial role in refining our understanding and overcoming challenges associated with the captive breeding and domestication of mackerels. This ongoing effort holds the key to unlocking the potential for successful domestication of these fishes in captivity.