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Indigenous craft and gears used for crab fishery in Cochin estuary, Kerala, southwest coast of India

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This paper presents an overview of fishing gears and crafts operated for crab fishery in the Cochin estuary. A survey was made in selected areas of the Cochin estuary to study the design and operational details of indigenous craft and gears used in crab fishing. Primary data on crab fishery were collected from fish landing centers and fishing villages through a structured questionnaire. Crab gillnets and ring nets are the dominant artisanal gear supporting crab fishery throughout the study area. Long lines were one of the widely deployed fishing gears for the crab fishery, which is now operational only in limited areas of the Cochin estuary. Incidental catch of crabs is also noted in the stake net and Chinese dip net. The wounding gears and traditional fishing techniques, *viz*., *vazhuka* method and midrib trap, are not deployed in commercial crab fishery as they result in low-value realization. The survey discloses that ring net and crab gillnet accounted for 98% of the crab landing along the Cochin estuary. *Scylla serrata* and *Scylla olivacea* are the essential species contributing to inland crab fishery along the study area. Wooden canoes belonging to 3 to 7 m in length overall (LOA**)** are employed for crab fishing. Migrant fishermen use Coracles and the FRP canoes for crab gill net operations along the stretches of the backwaters.

Keywords: Cochin backwater, Crab gill net, Craft, Gear, Ring net, *Scylla* sp.

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The coast of Kerala is strikingly boarded by a string of backwaters, generally running parallel to the shoreline. Peoples along the banks of estuary depend on these water bodies for their livelihood[1]. Kerala is a critical state that contributes to the inland crab fishery of India. Cochin estuary, situated on Vembanad Lake's northernmost edge, makes a substantial contribution to the crab fisheries with landings of *Scylla serrata* and *Scylla olivacea*, also known as mud crab, is a commercially significant species in the country's live export market. In addition to the above species, occasional landings of *Portunus pelagicus* and *Portunus sanguinolentus* are recorded from the study area[2].

Fishing refers to catching fish and other aquatic animals; it is an age-old profession with an extended history since time immemorial. Fishing gears and nets are devices of different shapes and sizes used to capture aquatic animals of various sizes in water bodies. Fishing gear can be operated from shore as well as crafts. Any floating structure can be considered a fishing craft if we use fishing gears from such floating devices. Fishing crafts provide the platform for fishing gear operations and storage of harvested fish. Every water body has unique craft and gear combinations to suit the fishing requirements in the area of operation. Knowledge of fishing methods, gear, and crafts is an essential prerequisite for enabling scientific exploitation and sustainable management of fishery resources[3]. Over the years, traditional fishing gears and practices have undergone many changes; fishermen attempted modifications in fishing gear design and methods of operation all along with the fishing sector. Though such structural transformations help to enhance catch per unit effort, many of them negatively affect the environment, biodiversity, and sustainability in the form of incidental catches of juveniles and non-targeted species.

Information on the description, design, and operation details of crab fishing gear will enable the formulation of resource-specific fishing gear regulations and policy formulations to conserve the crab resources and aquatic biodiversity of the lake environment. Even though several studies have been focused on documenting the fishing crafts and gear of

the Vembanad Lake[4-9], there was no systematic approach to record the fishing gears and crafts exclusively operated along the lake for harvesting crabs. The present paper attempts to document the design and operation of fishing craft and gears used for crab fishery in the Cochin estuary.

Methodology

Study area

The Vembanad Lake, the largest wetland ecosystem along India's southwest coast, is an ecologically sensitive zone. Cochin estuary, at the northernmost tip of Vembanad Lake, is a tropical positive estuarine system extending between 9°40' & 10°12'N and 76°10' & 76° 30'E, with Thanneermukkom as its southern boundary and Azhikode as its northern boundary[10]. The present study was conducted in the Cochin estuary (Fig. 1) from March 2020- August 2020. As part of the study, a preliminary survey was conducted along the study area to identify areas of active crab fishery. 5 functional crab fishing areas (Munambam, Kadamakkudy, Vypin, Thevara, and Arookutty) were identified and selected for sampling and data collection.

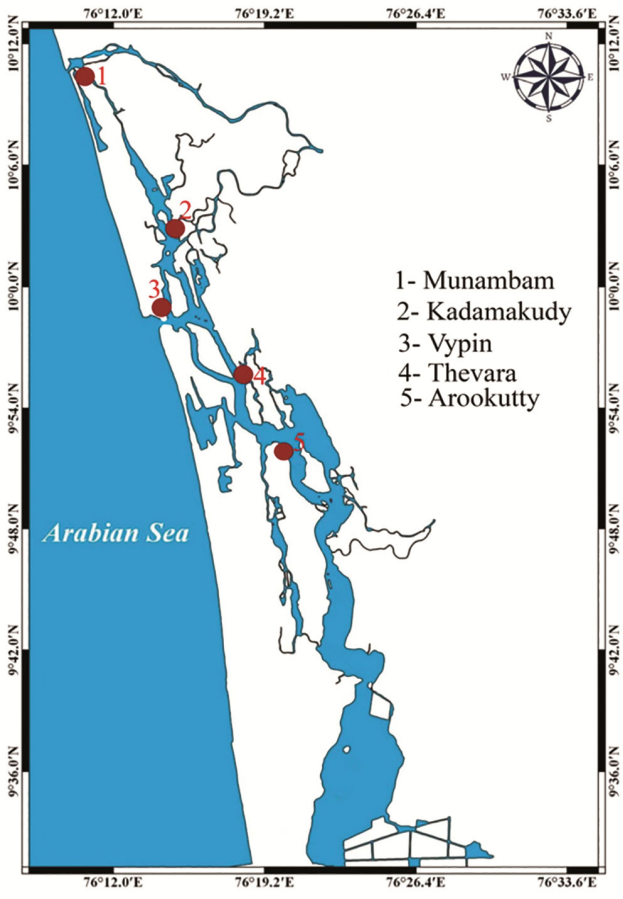

Fig. 1 — Sampling site

Materials and Methods

A pretested structured questionnaire was used for data collection from the selected stations along the Cochin estuary. Representative samples were drawn from selected fish landing centers for data collection. Information on the description, design and methods of fishing gear operation was collected through direct observation and interaction with fishermen. Prior Informed Consent (PIC) was obtained from all interviewed fishermen. Secondary data on fishing methods, their operation, and the knowledge system associated with fishing practices were also collected from previously published literature[1,4-9,11-16].

Results and Discussion

The survey revealed that *S. olivacea* and *S. serrata* contribute to the crab fishery's significant share along the Cochin estuary. Crab fishing season along the Vembanad Lake is confined to months from May to September. More than 300 fishermen engaged in crab fishing around the study area. The quantity of crab landings fluctuated between 500 Kg to 50 Kg /day during peak and lean seasons, respectively. Fishing practices with different craft and gear combinations were employed for crab fishing along the Cochin estuary. It was observed that only two fishing gears, ring net, and crab gill net, were exclusively operated for crab fishing, and among other gears, crabs were landed as by-catch. The crab fishing gears observed in the study area are classified into four types: net fishing gears, hook & lines, traps, and wounding gears.

Gear used in the mud crab fishery

Net fishing gears

Nets are devices made out of interwoven fibers in a grid-like pattern. Fishing nets are usually meshed structures formed by knotting relatively thin twine. Traditional netting materials made out of natural fibers are now replaced with artificial materials in the form of synthetic polymers (Table 1).

Crab gill net

The crab gill net, locally known as *neettuvala*, *mud vala*, and *njanduvala* in Malayalam (Fig. 2 & Fig. 2.1), is a bottom set entangling net, working under the gilling and entangling principle of fishing gears. These nets are exclusively operated in estuaries

Table 1 — Comparison of crab fishing gears operated in Cochin estuary

Type of fishing gear/method	Category	Fishing season	Targeted fishery/ Incidental fishery	CPUE (Catch (kg)/h)
Crab Gill net	Net fishing gear	Year-round	Targeted	1.5
Ring net	Net fishing gear	Year-round	Targeted	0.75
Stake net	Net Fishing gear	Year-round	Incidental	0.2
Chinese dip net	Net Fishing gear	Year-round	Incidental	0.2
Longline	Hook & Lines	Year-round	Targeted	1.0
Hand line	Hook and line	Year-round	Incidental	0.2
Pointed Iron rod (*Kambikol*)	Wounding gear	Year-round	Targeted	0.4
Vazhuka trap	Traps	Year-round	Targeted	0.3
Mid rib trap	Traps	Year-round	Targeted	0.3

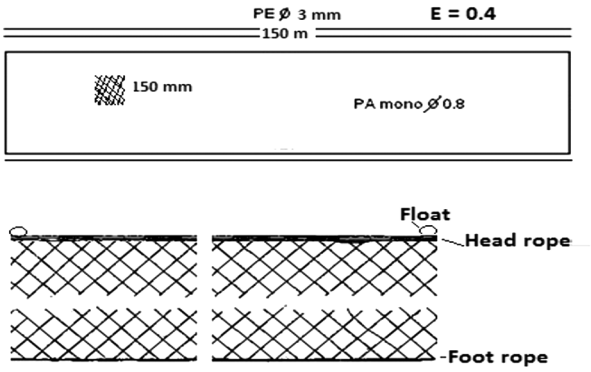

Fig. 2 — Design details of a typical crab gill net

Fig. 2.1 — Gill net

and estuarine environments for catching *S. serrata*[12]. The main body of the crab gillnet is made from nylon webbing panels with mesh sizes of 90 mm, 150 mm, or 160 mm. The main body of the netting panel is mounted to the headline of polypropylene twine having a 3 mm diameter by stapling the meshes through a rolling hitch. Unlike fish gill nets, in crab gill nets, floats are limited only to the two ends of the netting panel.

The net's dimensions are always the fisherman's choice; the webbing panel's length varies from 150 m to 200 m (in vernacular, they measure length by using their hands and denote as 15 *paakam* or 20 *paakam)*. A 300 m long net (30 *paakam*) with a depth of 3.75 to 4.0 m and a 150 mm mesh size is commonly used along the Arookutty region of the Cochin estuary. Webbing panels of 150 mm mesh size having 200 m length and 4.5 m depth *neetuvala* are used in the Vypin region. Crab gill nets have no standard mesh size, which varies with the fishing area. In northern Kerala, in the estuaries and backwaters of Kasargod, Kannur, and Kozhikkod districts, crab gillnets of mesh size ranging from 90 to 160 mm and dimensions100 to 200 m length (L) x 3.0 m to 4.0 m depth (D) are widely used for catching *S. serrata*[12]. The electrical cable used as a foot rope provides the required ballast for the netting panel. In the Valapatanam River, northern Kerala, pieces of thermocol are employed as a float at a gap of 23 to 30 m[12], while it is simply 5-10 m in other locations. The number of sinkers is varied depending on the fishing conditions and the speed of the water currents[12]. Sinkers include lead weights, stones, and cement disks.

In Chilka Lake, the gill net *Noli-jal* is operated for mud crab fishery[17]. Along the Killai estuary, gill nets made out of sun hemp fibers with 10 to 15 mm mesh size and 400 m L x 2 m D webbing panels are deployed for crab fishing.

Nets are set in the water column by stretching between bamboo poles kept at a specific distance[14]. The foot ropes are devoid of sinkers; some fishermen secure the head rope by tying one end to the canoe. In the Vypin region, most fishermen set their net during the morning and gather the crab clinging to the net on the following day. To reduce the chances of fouling of webbing panels, the net is operated for short spells of 15 to 20 min in areas of the lake where the speed of the water current is relatively high. Fishermen in

Fig. 3 — Ring net

north Kerala typically set gillnets late at night and haul it in by the following morning[12]. The gill nets are usually operated at depths between 2-4 m. The quantity of catches varies with the seasons. Seasons have an impact on catch volume. The crab gill nets are exclusively operated for crab fishery in the Cochin estuary, mainly in Vypin, Kadamakkudy, Thevara, and Arookutty regions.

Ring net

Ring net is a circular bag net, having 0.15 to 0.20 m depth mounted to a metallic ring frame of 0.70 to 1.50 m diameter fabricated with mild steel (M.S.) rods of 4 to 6 mm diameter, exclusively used for crab fishing (Fig. 3). Two thicker twines, tied tightly across the ring to keep the bait. To mark the location of the net, a plastic bottle, polystyrene piece, or PVC float is attached to the rope's free end. A cord attached to the hoops by three bridles is used to lower and raise the net. Prawns, Meat off-cuts, and wastes from butcher shops are used as bait attached to the ropes across the frame. The fishing operation of the net is carried out by allowing the baited net to set at the bottom of the lake, where the crabs swim for food and to locate the prey. The fisherman lifts the net from the water at regular intervals to collect the trapped crabs. From a single canoe, 15 to 20 baited ring nets of various diameters are usually set at about a 5 m gap in murky waters. After soaking for 10-15 min, the net is lifted, and a slight jerk collects entrapped crabs. Along the shallow depth zones of the Cochin estuary, round nets baited with pieces of catfish head and salted eel is used for crab fishing[6]. This gear is operated invariably and throughout the year in most parts of north Kerala[12]. Ring net is an exclusive gear used in the Munambam, Kadamakkudy, Thevara, and Arookuttyareas of the Cochin estuary for crab fishing.

Stake net

Locally known as *oonnivala*, stake nets are bag nets with fixed rectangular mouth openings that are kept open against the water current with the stakes to the bottom of the lake. The basic idea is that the organisms that float with the tide are filtered and retained in the cod end[9]. Stake nets are one of the most important commercial fishing gears operated in back waters in Kerala[15].

These nets fabricated by polyamide webbings are serially set at the bottom of the lake by rigging to poles erected at a distance of 4 to 4.5 m against the tidal current. The mesh size gradually decreases from the mouth to the cod end of the net. The upper section adjacent to the mouth opening of the nets is provided with 200 to 60 mm mesh size, followed by 18 to 12 mm mesh size panels at the middle section, and the lower section of the net with the codend is maintained with 10 mm mesh size. The stakes of areca nut palm trunks are piled on the lake's muddy bottom to rig the net. The main stalks are held up by smaller diameter auxiliary stakes that are obliquely tied to the main stake to serve as props. The stakes are put serially at regular intervals to permit the operation of multiple nets Simultaneously. Stake nets primarily target prawns, which drift along with the tidal currents[15], and crabs are landed as a by-catch.

Chinese dip net

Chinese dip nets come under stationary dip/lift nets, locally known as *Cheena Vala* in the local dialect. These nets are fixed along the shoreline closer to bar mouth and estuary areas with tidal action, usually at a depth of 3 to 5 m. Traditional Chinese dipnets were made from teak wood and bamboo poles, which are now replaced with M.S. pipes and rods. This fishing gear works on the lever principle. Superstructures in outward and inward poles extend on either side of a cantilever, spreading throughout about 20 m. The rectangular or square netting panel of mesh size ranging from 18 mm (outer area of panel) to 10 mm (at bag or codend) is rigged to the outer crane or superstructure hanging over the water body. Inward poles or inner crane is mounted with counter weights of stones tied to ropes at different length to maintain an equilibrium of the whole gear assembly. Usually, the Chinese net is operated by a team of 5 to 6 fishermen. To submerge the net, a man walks along

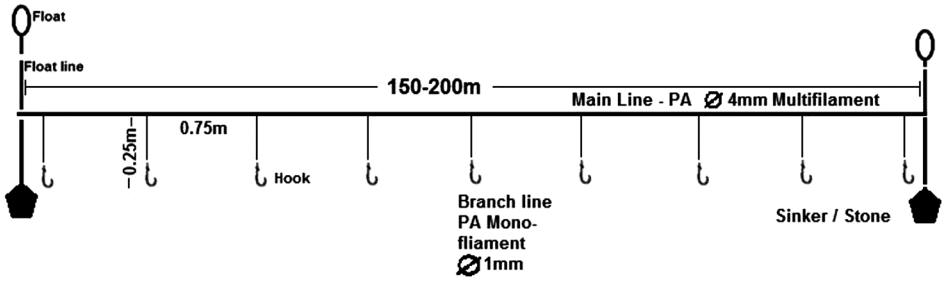

Fig. 4 — Longline- design details of typical Aayiramchoonda

the main beam extended to the waterside, which changes the equilibrium and causes the net to immerse into the water. The net is allowed to soak for a short duration of 2 to 5 min and lifted by pulling the ropes of the inward crane. As the net is raised, the stone rigged to the inner crane comes down one after another and the rest of the ground, thereby lifting the net over the water surface, and then the catch is collected by scoop nets. Crabs are collected as incidental catch in Chinese dipnets.

Hook and line

Hooks and lines were among the simplest fishing gear and were one of the primary tools to be utilized by man for catching fish. The operation of line fishing gears for harvesting crabs has been reported from many parts of India[18] and inland waters of Kerala[7,19,20]. The line fishing gears operated for harvesting crabs can be grouped under the following categories.

Longline

Popularly called *Aayiramchoonda* (in local dialect means thousand hooks and lines) is one of the vital line fishing methods adopted by local fishermen along the Vembanad estuary for harvesting crabs. Regional variations are observed in the designs, constructions, and operational methods of the gear (Fig. 4). Natural fibers (coir) were once used as mainline in crab longline gear, but this has recently been replaced by multifilament PA (polyamide) ropes of 4 to 6 mm diameter and 300 m length. At regular intervals, branch lines of 1 mm diameter and 0.25 m length PA monofilament fibers are attached to the mainline. The branch lines are mounted to the mainline through a marling hitch by leaving a gap of 0.75 m between adjacent lines, which is more than the combined length of two adjacent branch lines, so the chances of entangling two adjacent branch lines are avoided. Baited "J" hooks are tied at the distal end of branch lines. Baits in the form of fish heads, gills, and cephalothorax of the shrimp are used for crab fishing. Sinkers and floats are rigged on either end of the mainline to maintain the line at the desired fishing depth.

Line fishing is carried out from a small wooden canoe of 3 to 4 min length overall (LOA). After reaching the fishing ground, the fisherman drops one end of the mainline rigged with a sinker (stone) and a marker float from the canoe and then slowly paddles through the lake by releasing the remaining portions of the line. On reaching the terminal end, the line is stretched to straighten it and anchors properly by using a stone sinker. In an alternate operation, one end of the long line is tied to a pole that is planted in the lake bottom chosen by the fisherman. Then, as the vessel moves away from the pole, the line is progressively let go. For around 30 min, the line is let to rest calmly at the bottom of the water before being gradually drawn in by moving the craft toward the pole. Crabs can be seen clinging to the bait just below the water's surface, and collected with a scoop net. Baited long lines along the east coast of India and the Kerala coast are standard gear for catching mud crabs[14]. The hooking rate with long lines varies according to the season and the fishing grounds. 47.3% of the mud crab landed in Pulicatlake by long line fishing[21]. This kind of gear was observed in *Thevara* station in the present study.

Handline

It comprises a single nylon monofilament line with a hook fastened to one end. To draw the crab, the line with bait is thrown into the sea (or dangling in front of crevices). The line is gradually lifted once a crab takes the bait, and the crab is then collected with a scoop net. This equipment is used in shallow (3-4 m) intertidal areas exposed during low tide. It is referred to as *choonda* in vernacular.

Wounding gears

These gear usually catch sparsely scattered high-value fish swimming near the surface waters. Some of the wounding gears are used to capture benthic

animals, such as mussels and other shellfish. Important wounding gears operated for crab fishing along the Vembanad Lake are described below:

Kambi –hook for crabs

Mud crab is pulled out from the crevices and burrows along the shores of estuaries and mangrove areas using iron rods that have curved ends. In the vernacular, it is called *kambikol*, used in shallow waters (Fig. 5). It is a straight iron rod with a small "J"-shaped curvature on one end. A *kambi* is a fishing rod made of steel that is 1.5-2 m long and 3-4 mm in diameter. The curved and inward-pointed end works like a barb in a fishing hook and facilitates the retention of the crab on the rod after piercing the crab shell. *Kambi kol* is used in the estuary and inter-tidal areas to dig out mud crabs from their burrows. Fishermen can determine whether the crab is present in creeks by the particular sound created on hitting *kambi* on the carapace. Once the crab clasp using the chelipeds, it holds on tight; this behavior is utilized by the *kambi* method. Such wounding gears are also used in the North Malabar region of Kerala for harvesting crabs[12] and other parts of the country.

During the first half of the last century, a blunt iron hook nailed to a slice of the bamboo split was used to capture crabs living in burrows[22]. Modification of such hooks in the form of blunt iron hooks driven to the lower end of the bamboo stick is employed for hooking the crab from its burrow at Uttarbhag[18]. *Aankdi* and *Dharkan* are similar curved hooks used to collect crabs in Bombay[23].

Indigenous fishing gear and methods

Those who live in association with lakes and inland water bodies catch crabs differently. Some such methods are no longer in use today.

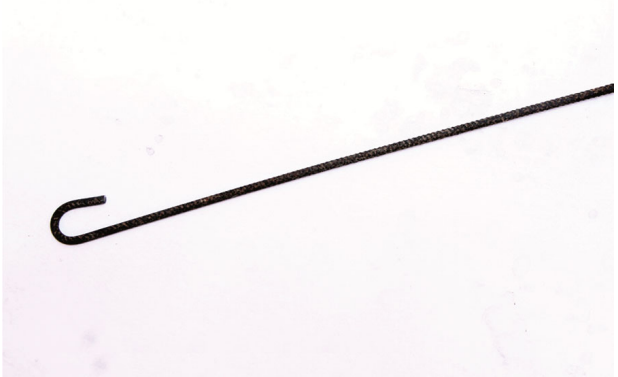

Fig. 5 — Kambi- Hooks for crab

Vazhuka trap

Vazhuka trap is an indigenous method used for crab fishing in Vembanad Lake. The term *Vazhuka* indicates a peel made from green coconut leaf rachis (Fig. 6). To fabricate this device, two peels from the green coconut leaves rachis are tied together by an overhand knot to get the required length and design specification. The prey fish (bait) is stringed through its operculum at the end of the *vazhuka*; a stone is also hung to the tip to submerge the gear. After soaking it for five to 10 min, the fisherman lifts the *vazhuka* and collects the trapped crab with a scoop net.

Mid-rib trap

This trap is made up of the midrib of the coconut leaves. This midrib is locally known as *eerkil*. After removing the green leaf portion, the midrib is made into a noose. Such noose formed by midrib traps can be reinforced with knots made with nylon monofilament fibers, which reduce the chance of deformation of the noose. Baited noose attached with a lead weight is soaked for a few minutes; to allow the crabs to prey on the bait. When the crab takes the bait, its appendages get snagged in the noose, and the knot gets tightened around, thereby getting trapped. These traps can be operated to catch crabs, prawns, and fish.

Crafts used in the crab fishery

Fishing craft refers to any mobile platform that allows fishermen to use their equipment. It could be a floating log of wood, an inflatable hide, a raft constructed out of a few banana stems, dugout and a plank-built canoe to large vessels. Wooden canoes are primarily used craft in the mud crab fishery along the estuary and inland water

Fig. 6 — Vazhuka trap and scoop net (Unni George, OMKV fishing)

Fig. 7 — plank- Built Canoes (Hari Praved, CUSAT)

bodies. In Kerala, small canoes of 4-6 m LOA are commonly utilized for crab fishery[12].

Dug–out canoes

These are carved from tree trunks of the required size. In Kerala's rivers and estuaries, canoes made of mango trunks are common[12]. However, due to a shortage of canoe-building-size tree trunks, this form of canoe is no longer being built in Kerala or other regions of the country[24]. The terms "*thoni*" or "*paathi*" refer to medium- and small-sized dugouts, with a size ranging from 3-4 m LOA, that are typically used for line fishing and gill netting.

Plank-built canoe

In Kerala, modern canoes are plank built and are widely used in inland fishing operations (Fig. 7). Wooden planks are connected to coir ropes and reinforced by a layer of pitch/tar along the seams to make them watertight. For this kind of construction, various types of wood are employed. Mango wood, Sal wood, *Anjili,* and *Ven teak*, among others, are often used woods. Plank-built canoes ranging from 3 to 7 m LOA, having 0.6 to 0.85 m breadth and 0.25 to 0.5 m drafts with a rounded hull, are generally used for crab fishery. For long service life, such canoes are treated with traditional preservatives like fish oil, cashew nut shell oil, etc.

FRP canoes

Fiberglass-reinforced plastic (FRP) canoes are fabricated in different size classes. Wooden canoes coated with FRP sheathing are commonly operated along the inland water bodies of Kerala[12]. Small and medium size FRP canoes are used for gillnet, stake net, and line fishing operations along the estuarine area. Larger FRP canoes are operated for marine fishing along with the inshore and the coastal regions of all maritime states of the country (Fig. 8).

Fig. 8 — FRP Canoes

Fig. 9 — Coracle

Coracle

Coracles are rounded, lightweight, flat-bottomed floating crafts fabricated with bamboo strips and covered with palmyra leaves or synthetic sheets. These canoes are usually manufactured with locally available materials to suit local fishing conditions. The migratory fishermen from Karnataka introduced the bamboo strip coracle crafts to Kerala[25]. In the vernacular language, they are popularly known as *Kotta-thoni*. The coracles operated along the inland water bodies of Kerala have a 2.0 to 2.5 m diameter and 0.15 to 0.25 m drafts (Fig. 9). Multiple layers of fabric, plastic sheets, or bamboo strips reinforce the craft's outer edge. Coal tar also waterproofs the outside surface in one or two coatings. Migratory fishermen from Karnataka operate gillnets from such crafts along different parts of Vembanad lake[26] and estuarine areas *viz.*; Kadamakkudy and Vapllarpadam region near to Cochin bar mouth.

Conclusion

The survey revealed that ring net and crab gillnet accounted for 98% of the landing along the Cochin estuary. Crab gillnet was harnessed for the artisanal crab fishery in Munambam, Kadamakkudy, Vypin, Thevara, and Arookutty. Ring net is another exclusive gear used for crab fishing along the Cochin Estuary, except in Vypin. In Munambam, ring net use is restricted to near shallow regions because of the unique water current conditions prevailing in the area. Once extensively used for crab capture, gill nets now replace

long lines. Throughout this survey, longline fishing was observed only in the Thevara region. It was observed that crabs land in stake nets and Chinese dip nets as incidental catch. The stake net operation adversely affects the crab population through juvenile fishing. Wounding gears and methods are not practiced in the estuary for commercial crab fishing as it draws poor demand for such harvest. Among gill nets, as the mesh size is large enough to facilitate the escape of juvenile crabs, under-sized crabs are seldom observed in the catch. The juveniles, which are accidentally entangled, will be discarded back into the estuary by fishermen. Comparison of catch per unit hour (Table 1) of various types of fishing gears deployed for crab fishing operations revealed that the crab gill nets, followed by ring nets, recorded the highest value of CPUE (Kg) along the area under the study. A combination of crab gill nets, ring nets, and *kambi* hooks are carried on board the wooden canoes of different sizes (3 - 7m LOA) for crab fishery along the lake waters. Based on the aquatic environmental conditions, fishermen select suitable gear for fishing operations. Such combinations of craft and gear support the sustainable crab fishery in the Cochin estuary. Because of its low market demand, the fishermen used to release the juveniles (carapace width < 10 mm). Migrant fishermen use coracles for crab gill net operations along the backwater stretches. The study discloses that over the period, traditional fishing gears and practices have undergone considerable modifications, mainly through interventions of local fishermen, which supported the livelihood of the local fishing community and contributed towards the inland fish production of the state.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_22(04)(2023)899-907_SupplData.pdf

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Conflict of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

Authors' Contributions

AKA: Methodology, Survey, Data collection, Analyses, Writing an original draft, and Photos.SAV: Supervision, Review and edit, and design diagrams. CER: Review and correction. AJ: Conceptualisation, Supervision

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