Chapter - 1

INTRODUCTION

Hook is a simple, easy to operate and selective fishing device. They are counted among the most ancient devices used for fishing (Manoharadoss, 2002; Anon, 2004b). This fishing method has been in existence from the pre-historic times and has survived centuries to attain the current status. It is evident from the excavation of a unique late bronze age copper fish-hook from Bet Dwarka Island, Gujarat, west coast of India that advanced hook fishing technology existed in ancient India also (Gaur and Sundaresh, 2004). Hook forms the indispensable part of any hook and line fishing system. Hook and line fishing is a highly selective, economically viable low energy fishing method well suited for the exploitation of sparingly distributed fishes (Løkkeborg and Bjordal, 1992). The principle of hook and line fishing is to offer partly fixed bait to the fish which then finds itself unable to release the bait so that the fish can be lifted from the water together with the bait (Brandt, 1984). The hook serves the functions of holding the bait, enticing the fish to it and ensuring that the fish shall be unable to spit it out with the bait after swallowing it. It usually penetrates into the mouth of the fish when the bait is taken or when the line is pulled.

The hook and line fishing can be used where other gears can not normally be operated like rocky and uneven bottom grounds, shallow and very deep waters etc. Mathai (2002) has reported that about 12% of all fish catches in the world was made by hooks and lines. It is estimated that 90% of the targeted fish biomass has been removed from large areas of
the oceans in just 50 years of industrial fishing (Myers and Worm, 2003). Keeping this in mind, the International Code of Conduct for Responsible Fishing developed by the Food and Agriculture Organization (FAO) in consultation with member countries of the United Nations (UN) points to the need for concentrating more on the artisanal and small-scale fishing methods, which use selective and energy efficient fishing gears such as hook and line for the sustainable exploitation of aquatic resources, protection of aquatic environment and energy conservation (FAO, 1995).

1.1. Hook and line fishing in India

1.1.1. Marine sector
Hook and line fishing is becoming increasingly important in the Indian fisheries as the tunas are in great demand throughout the world market due to their excellent meat quality and it is a well established fact that India has a great potential for further development in tuna fishing. The long lining system has been identified as the most efficient and cost effective system for harvesting oceanic tuna resources. Long lining consumes only 0.15 to 0.25 kg of fuel to catch one kilogram of fish in contrast to 0.8 kg required by trawling (Gulbrandson, 1986). More than 95% of the world's tuna and tuna like fish harvested commercially are caught using either pole and line or purse-seining or long lining (Vijayan, 2002). In recent years the growth rate of marine capture fisheries sector is showing a declining trend as most of the capture fisheries worldwide have apparently reached their maximum potential production except in some fisheries like tuna fisheries in Indian Exclusive Economic Zone (EEZ). The coastal zone up to 50 m depth of the Indian EEZ is intensely exploited while the region beyond 50 m depth with high potential of oceanic resources like tuna and tuna like fishes are hardly exploited (James, 2005).
In 2004, the total landing of tunnies amount to 45,684 tonnes (CMFRI, 2005). The annual potential yield of tuna and tuna like fishes along the territorial/coastal waters of India is estimated to be 2.8 lakh tonnes of which only about 23% are harvested (James, 2005). This leaves a wide gap for further improvement. Apart from this, the tuna resources in the oceanic waters of Indian EEZ is estimated to be about 2 lakh tonnes which remains almost unexploited due to inadequacies in suitable craft and gear, technical skill, fishing regulations etc. (Vijayan, 2002). While distant water fishing fleets of foreign countries intrude into Indian waters and harvest enormous quantity of tunas, it is highly essential for India to formulate and implement programmes for successful harvesting and utilization of her rich tuna resources. In the context of escalating fuel prices, hook and line fishing has gained much more importance, as it is a low energy fishing technique suitable for the exploitation of deep-sea resources. It has got a promising future in India for the harvesting of under exploited tuna resources in the Indian EEZ. It is practiced by both artisanal and mechanized sectors. It is estimated that a total of 3,94,000 fleets operate from South east and North west regions of Indian coastal line for hook and line operations, which contributed about 32,000 tonnes of fish in the year 2003 (Annam et al., 2004). It is expected that hook and line fisheries sector will grow on phenomenal rate in the years to come. Since huge capital investment is required for new long lining vessels, conversion of existing trawlers for long lining is considered to be pragmatic alternative for addressing this issue. As these converted vessels could be used for trawling in the lean seasons when the tunas are not available, fishing can be conducted round the year.

1.1.2. Inland sector
Apart from the marine resources, the inland resources of India offer immense scope and potential for developing the capture fisheries, and hook and line fisheries have an important role to play (Jhingran, 1989a,
Indigenous and introduced fish varieties like mahseers, catfishes (Aorichthys seenghala, A. aor, Wallago attu, Silonia silondia, Pangasius pangasius), murrels (Channa striatus and C. marulius) and the trouts (Salmo trutta fario, Salmo gairdneri) form the potential inland hook fishery group in India. This rich availability of favoured species coupled with diverse inland water bodies suitable for hook and line operations offers sustainable development of this sector.

1.1.2.1. Sport fishing / Recreational angling

Sport fishing or “Angling’ started with the invention of angled fish-hook (Tripathi, 2006). Experts opine that the word ‘angling’ has been derived from Greek ‘ankos glen’ (meaning barbed hook) or the Old English ‘anga hook’ (angled hook). Angling is an interesting sport that provides entertainment, nutritious food and foreign exchange. It can also help in the development of several ancillary industries related to tourism.

On the recent advent of large-scale tourism in India especially in states like Kerala, Goa, Himachal Pradesh, Jammu and Kashmir etc. has opened up recreational fishing activities, the main thrust of which is on angling. India has got a tremendous potential in recreational fisheries, especially in the state of Kerala as a result of the fast growing tourism industry (Korakandy, 2000). He has pointed out the long tradition of recreational fishing in India even before independence. But this sector was neglected after the independence. There is a renewal of interest in recreational fishing and the tourism development in the country is expected to give it a further push. Recreational angling (sport fishing) using hook and rod/pole is also gaining importance in India especially in the states of Himachal Pradesh, Arunachal Pradesh, Assam, Kerala etc. (Korakandy, 2000). The type and sizes of hooks have an important role to play here as different regions and targeted species require different hook
designs. It is also important that the recreational fishing needs to be introduced on a responsible manner. For instance, in ‘catch and release’ type of recreational fishing, the captured fishes are released subsequently. Appropriate hook types have to be used to ensure minimum mortality and to conserve fish stocks for continued fishing activities.

The hook and line fishing generally referred to as a single man handline has now evolved to automated large-scale longline systems. Though the basic design of hook has not changed over the time, the material, shape and manufacturing processes have changed. New materials and manufacturing techniques have resulted in different styles of high quality hooks for target fishing. It is important to know the history and evolution of hooks for further studies on this unique fishing gear.

1.2. History and evolution of hooks

From the pre-historic ages, man tried out quite a number of ways of catching fish and hook and line is one method that has survived the centuries. Many present day hook patterns are results of "trial and error" from the Stone Age. Why a particular hook has been designed with a particular gape, bend, shank, barb and eye is the result of experience gained from the collective efforts of hundreds of generations of fishermen. The history of hooks is believed to have passed through the transition phases: from wood, shell and bone of Stone Age to copper, bronze, iron and steel. The present day hooks are well-tempered durable metal hooks mostly of alloys which are specially protected by galvanizing, tinning, bronzing, enamelling etc. to prevent corrosion. The metal hooks must have sufficient hardness striking a balance between strength and flexibility and be resistant to water.
Herd (2003) reported that the fishing hooks had evolved from the Gorges, a device used by many primitive cultures, which is frequently found in prehistoric sites. However Brandt (1984) opined that the modern angling hook has not been developed from gorges even though gorge was certainly older than the curved hook. Gorges were small straight or little bent sticks, made of wood, bone, flint or turtle-shell pointed at either end, tied at the middle or attached to a line knotted through a hole in the centre of the gorge and inserted lengthwise into a bait while fish swallows the gorge along with the bait, by the pull of the line, the gorge takes up a transverse position across the fish’s throat. Gorges with one pointed end and a line fastened at the other end also were in use. Even though gorges are hard to conceal, difficult to bait, hard to hook large fish on, and liable to lose its hold while the fish is being hauled, are still used in some places.

1.2.1. Pre-historical hooks

There are no reliable evidences indicating the exact period from which various kinds of fishhooks have been in use, but it is quite probable that the Cro-Magnon Man, who appeared 30 - 40,000 years ago, was familiar with fish hooks and used it in his struggle for survival. The problem faced by archaeologists who are trying to establish the historical facts about fishhooks is that the materials used were not very durable and it is believed that the very first types of fishhooks were made of wood. Neolithic man used hooks made out of bone, shell, or thorn depending on the materials that were easily available to them (Anon, 2004b).

1.2.2. Copper and Bronze hooks

Available records show that copper hooks were made in Bauchen, 7000 years ago (Anon, 2005a). The copper was then gradually replaced by bronze owing to its superior tensile properties. Old civilizations along the
banks of the Euphrates and the Tigris rivers were reported to have utilized copper for making fishing hooks. Many records are available of copper hooks found from this area that are half a thousand years older than Abraham's Mesopotamia (around 1,800 BC) (Helsinki, 1970). Numerous findings of bronze hooks were also reported from Crete and Italy. Helsinki (1970) has also described about very intricately designed hooks that have been excavated from Pompeii and Herculaneum. It is indicative of the fine craftsmanship that was available during that era. Gaur and Sundaresh (2004) have reported about a unique late-Bronze Age copper fishhook excavated from Bet Dwarka Island, Gujarat, west coast of India.

1.2.3. Steel hooks

The tools discovered from some burial mounds indicate that even before the Vikings (8th to the 11th centuries), professional blacksmiths used to make fine fishing hooks made out of wrought iron, which is still in practice in some remote areas (Anon, 2004b). But good quality steel was scarce during that period as all iron cannot be tempered into steel. No reliable records are available on the introduction of fishing hooks made out of good quality steel. According to British angling literature, there were excellent professional hook makers around 1600 AD (Anon, 2004b). On the advent of industrialization, the professional blacksmiths who were making hooks at their houses started small-scale industries, which have now evolved into multinational hook manufacturing companies equipped with sophisticated machines and quality control systems.

1.2.4. Typical fishing hook

The hook serves the functions of holding the bait, enticing the fish to it and ensuring that the fish shall be unable to spit it out with the bait after swallowing it. It usually penetrates into the mouth of the fish when the bait
is taken or when the line is pulled. Understanding the basic parts or components of a fishing hook will make it easier to find the right hook for a particular fishery.

Fig. 1.1. Parts of a typical fishing hook.

Fig. 1.1. depicts the various parts of the hook with their proper names: eye, shank, bend, gape, bite, point and barb. Eye is the portion, where the line is attached to the hook. It comes in a variety of forms like: ringed, looped, tapered, looped tapered, flattened, open, swivel type and needle type. The shank is the leg of a hook, which extends from the bend up to
the eye, and could be short, regular or long depending upon the hook’s design and usage. Short shanks are generally used when fishing with natural baits. Long shank hooks are essential for sharp-toothed fish, and also for fish that suck in their food. The longer shank allows easy removal of hooked fish. Hook shanks are manufactured in many different shapes. The most commonly used are straight shank, curved shank and barbed shank. In straight shank, the hook shank is straight from eye to bend. Shanks are often curved or barbed for specific reasons, e.g. to accommodate a special fly imitation, or to anchor baits, such as worms and soft baits.

Bend is the main distinguishing characteristic of a fishing hook. The gape is one of the most important dimensions of a hook and is the shortest distance between point and shank. It is also termed as ‘gap’ by manufacturers in some non-English speaking countries (Anon, 2002). It has been accepted that there is a relatively standard relationship between gape and hook size but a review of the actual measurements revealed this as not true (Anon, 2002). Bite/throat is termed as the distance from the apex of the bend to its intersection with the gape. If this distance is too short there is a greater chance of fish escaping from the hook. The final part of the hook, the point, is the tip of the hook that penetrates the body of the fish. It occurs in straight, reversed or even curved. There are many types of points to choose from like spear, needle, knife-edge, hollow, rolled-in and diamond/triangular. In some hooks a back ward pointing
sharp barb is provided at the point that prevents the escape of fish, once it is hooked. The barb also helps in holding the bait. Usually one barb is provided pointing to the inner side of the hook while hooks with one to three barbs pointing to the outside are also seen. The spear represents that portion of the hook measured from the bottom of the bent forward to the tip of the point. The term 'heel' is used to refer the portion of the bend, which is affected by the forging process.

1.2.5. Manufacturing process

Modern day fishing hooks are manufactured from high carbon steel wire. Some times, steel alloys are also used. Hooks are basically manufactured by two ways, using wire and by forging (Anon, 2002). In hooks manufactured by bending metal wires, the shank will be circular in cross section, whereas in hooks made by the forging process the shank will be oval in cross section. A wire of a proper diameter is selected and is cut to the exact predetermined length that will be required for a finished hook of a particular size and style. The "point" is made by hand-filing the wire or using a grinding machine or else by diagonally cutting the wire. If a tapered eye is needed in the hook, the forward end of the wire is ground to the appropriate taper. In the next step, the hook's barb is created by cutting into the wire at an acute angle and raising a small sliver of metal resulting in a barb. It is followed by shaping or forming a bend by physically bending the wire to the desired shape and style. For this dies
are used which exactly match the inside radius of the desired hook shape like round bend or Kirby or Limerick bend.

Generally, forging is a term applied to a process of forming metal implements using moulds. In hook manufacturing, it refers to the flattening of the round wire laterally to increase its strength in one plane or direction. The forging process can enhance the strength of the wire up to 20% (Anon, 2001). Commonly, hooks are forged on both sides beginning at a point behind the barb, and extending throughout the bend up to the hook shank. Often the forging will include much of the hook shank. It is effected by placing individual hooks into a press, which flattens the round wire to a controlled thickness. The next stage involves the creation of the "eye" according to the hook style. Wire hooks are cheaper to manufacture but are weak and bend easily. Forged hooks are stronger, heavier and expensive. They break rather than bend and have sharp points.

In modern hook manufacturing process, the formed hooks are immersed into an acid bath, which dissolves any minute burrs or abrasions, which might have occurred during manufacture. It results in a cleaner metal surface and thus, sharper hooks. This process generally called chemical sharpening is followed by many of the modern hook producers. Manufactures like Mustad, Tiemco and Daiichi refer this process as chemically sharpened, whereas Eagle Claw terms it as Laser Sharpening and Partridge calls it Flashpointing (Anon, 2002). Manual sharpening
using a stone or file cause rusting unless stainless steel bars are used. Rusting can be minimised by using cadmium plated or tinned hooks.

The most important step in hook manufacture is the tempering of the hook in which the metal is hardened to improve strength. Hooks are heated to specified temperatures by placing in an oven and then they are immersed in a liquid coolant, which brings about a rapid decrease in temperature. This process hardens the metal and substantially increases its resistance to unbending resulting in hooks, which are very strong but not brittle. The tempering has to be perfect other wise there is a chance of the hooks becoming brittle due to over processing or too soft due to under processing. Achieving a balance between strength and flexibility is very difficult. The formulation of the coolant and technique of tempering is specific for each manufacturer, which is kept as a trade secret. Some manufacturers use electronic tempering process, which enables tempering to be done in a stable condition. After tempering, the hook is cleaned; generally by the tumbling process whereby the hooks are cleaned with an abrasive. The last stage in the hook manufacture is the application of desired finish or protective coating to it. This is accomplished by lacquering or electroplating. The common finishes applied to the fishing hooks are: tinned, nickeled, ‘blued’, ‘Japanned black’, ‘red’ and ‘bronzed’. In ‘blued’, ‘Japanned black’, red and ‘bronzed’ fishing hooks, the surface finish is given by coating it with alkyd resin based coloured coatings. Different methods for formation of Zn–Ni alloy-
based metallic coating include electro deposition, PVD (Physical Vapour Deposition) coating and addition of Zn–Ni master alloy in hot-dip galvanizing bath. The Zn–Ni alloy coatings are superior to pure zinc coating as the former has high corrosion resistance and good weldability. Moreover, nickel can be considered as a viable substitute for cadmium in marine environments. Incorporation of nickel in the galvanized coating makes the alloy layer more compact. The nickel-enriched barrier layer formed during the course of hot-dip galvanization process can effectively prevent penetration of aggressive ions like Cl\(^-\) and ClO\(_4^-\) in high chloride environments. The finished hooks are then inspected for any defects, packed and marketed.

1.2.6. Classification of hooks

Fish hooks come in several shapes and sizes. Basically hooks are classified into wire and forged depending on the manufacturing. They can also be broadly classified into barbed hooks and barb less hooks. Apart from this, fishing hooks are variously classified in terms of their shape, point, number of bends, gape, eye, mode of use, targeted species, make/brand etc (Fig. 1.2.).
Fig. 1.2. A schematic representation of hook classification
1.2.6.1. Commercial categories of fishing hooks

There is no standard classification used at commercial level. They are commercially identified based on their popular name or a particular character. The most common commercial categories of hooks are given below (Fig. 1.3.):
Round bend hooks are the common range of hooks with a perfect round bend, used both in fresh water fishing and in marine waters and are usually barbed. They are also known as “J” shaped hooks. Limerick hooks have characteristic sharp angle in front of the bend used for tying flies. ‘Crystal hook’ is a limerick bend hook in its most extreme way, with a very sharp front angle bend.

Circle hooks have a circular shape with a point that turns inward to the shank at about 90° angle. Atlantic States Marine Fisheries Commission has defined circle hook as a non-offset hook with the point turned perpendicularly back to the shank (Anon, 2003). These hooks, reported even in the prehistoric cultures (Montrey, 2004) have been in use in the commercial longline industry since 1960s (Moore, 2001; Prince et al., 2002). Modern recreational anglers started using these hooks from 1980s only. Circle hooks promote healthy catch and show good size selectivity, minimizing the number of undersized fish hooked. It is found that they have high catch rate and are easy to use (Brooks, 2004a). Circle hooks come in a light wire and a heavy-duty variety and depending on the size and type of fish to be caught, the suitable hook is selected. Brooks (2004a & b) shared his experience with 5/0 and 6/0 circle hooks and stressed its importance, both as a conservation tool and as a tool to increase the hookup to catch ratio. Even when the fish swallows the Circle hook with bait, the hook comes out of the throat without penetrating. As the fish swims away, the hook is pulled to the corner of the mouth where it penetrates into the body. The effectiveness of circle hook depends on the hook size, fishing style, feeding mode and mouth morphology of the fish. Circle hooks minimize the incidence of turtles being hooked and are evolving as a turtle friendly fishing gear (Anon, 2005a).

O'Shaughnessy hook is a standard hook, relatively thick, forged with a very strong bend and not likely to bend out of shape. Sizes range from #3
to as large as 19/0. They are recognized as outstanding for sea angling and heavy freshwater angling. Aberdeen hooks are mostly used in freshwater, in smaller sizes and are also used in saltwater. They are generally made from shaped wire with a perfect round bend applied on a long shank. It can be bent back into shape several times before it becomes too weak. However, once a fish is hooked and the barb has completely penetrated, this hook holds quite well. These hooks are modified with bends in their shanks for use in jig molds. Live bait hooks generally have a shorter shank than other hooks. Whether that is to allow the live bait to swim more freely or to be less apparent to the fish is debatable. These hooks come in regular and circle designs. Regular live bait hooks will be swallowed and result in gut hooks most of the time. Circle live bait hooks provide a greater chance for a good release of the hooked fish onboard – a desirable property in live bait operations. Kahle hooks are also used along with live baits. The curve on these hooks makes them ideal for live bait. Made from the same wire as the Aberdeen hooks, they will bend if hung on the bottom of some structure. However, once a fish is hooked, the design of the hook prevents it from being straightened. Wide gape hooks are made by bending the wire resulting in a wide gape. These hooks are suitable for baiting with shrimp.

Tuna hooks have a special shape and are used exclusively for tuna fishing. They usually have a ringed eye, short and thick shank with a turned down eye and barbed point. The tuna hook design is believed to be perfected by the Japanese. Viking hooks composed of a wide range of hooks used mainly as fly hooks. Their ‘turned up’ eyes facilitate easy fly tying. A double hook has got two bends, usually on a common shank. They are mainly used in trolling. Similarly, treble hooks consist of three separate hooks forged at the top to make one eye. The design helps to have better holding and hooking power than a single hook. Rotating trebles with points and bends in the hook facing different angles help in
easy penetration and holding. These hooks are widely used in trolling using artificial baits for catching active predator fishes like seer fish, sail fish etc. They are used with dough bait also.

1.2.6.2. Based on point and barb

Based on the characteristic of point and barb, the hooks are classified into the following groups (Fig. 1.4.):

- **Barbless**
- **Needle**
- **Micro Barb**
- **Short**
- **Knife edge**
- **Beak**
- **Offset Bends**
  - **Kirbed**
  - **Straight**
  - **Reversed**

Fig. 1.4. Classification of hooks based on point and barb

Barb less hooks are devoid of any barbs on the point. These hooks are widely used in tuna fishing along with live baits. The absence of the barb helps in easy release of the fish and much less handling of the fish. This helps in better survival rate of fish in recreational fishery. The needle point
ground on all sides has the best penetrating ability but is easily blunted. Micro barb hooks used mainly in fly-fishing come with just a tiny barb, which helps to hook the fish with minimum injuries and better survival rate after release. The point is very short in the case of short point hooks. In knife edge hooks, point is made into a sharp edge resembling that of knives for better penetration of the hook. In beak type of point, the point is given a bend resembling the beak of a bird. This characteristic bent in point is found suitable on a great variety of hooks, especially hooks for bait fishing. The point position ensures more efficient hooking of soft-mouthed species.

Hooks are also classified according to the alignment of the point with regards to the shank (offset). They are kirbed, reversed and straight. Kirbed bend hooks are the world's most popular range of hooks. Available in many different patterns of which all are "Kirbed" a term used for the point bent towards the right of the shank. The very name owes to the legendary hook maker Mr. Charles Kirby in Harp Alley, Shoe Lane, 'the most exact and best Hook-maker' of his time, from whom we can trace the development up to our own time (Mustad Kirby Sea Hooks). In reversed bend hooks, the point bent towards the left of the shank whereas in straight hooks, the point remains straight to the shank.

**1.2.6.3. Based on eye**

Based on the design of the eye, the hooks are classified in to the following groups (Fig. 1.5.).
Fig. 1.5. Classification of hooks based on eye and the angle the eye makes with the shank

Apart from these types, sometimes the hooks are classified according to the angle the eye makes with the shank as given in Fig. 1.5. Here the bend of the hook wire is made near the eye where the eye is to be ‘turned up’, ‘turned down’ or ‘straight.’
1.2.7. Hook numbering and size of hooks

There is no uniform, universally accepted system of hook numbering in practice for designating different hooks. Hook sizes are mostly arrived at by different proprietary standards between different manufacturers. The gape, shank length etc. of standard hook sizes of different companies often differ. Visual familiarity with various hook patterns is the only workable gauge for the fisherman as there is no uniform standard for hooks on which he can rely.

Andreev (1963) described three types of numbering systems used to denote the size of fishing hooks. These are Marine numbering, River numbering and the third based on the gape size of hooks. These systems are interrelated and also related with the weight of the hooks. According to him, the physical parameters of the hook were independent of the shape and nature of the hook.

Baranov (1977) explained about two numbering systems in practice for hooks viz., Sea numbering system and River numbering system. In his paper he also describes about a system in which the size of a hook is expressed in terms of weight (kg) of 1000 hooks.

A comparison of different hook numbering systems is given in Table 1.1.
Table: 1.1. Comparison of Hook Numbering Systems

<table>
<thead>
<tr>
<th>Hook numbers</th>
<th>Marine Numbering</th>
<th>River Numbering</th>
<th>Width of Bend (mm)</th>
<th>Weight of 1000 items (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10/0</td>
<td>36</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9/0</td>
<td>31</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8/0</td>
<td>27</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7/0</td>
<td>23</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6/0</td>
<td>20</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5/0</td>
<td>18</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4/0</td>
<td>16</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3/0</td>
<td>14.5</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2/0</td>
<td>13</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1/0</td>
<td>12</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>11</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>10</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>9</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>8</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

Although attempts have been made to set a standard by measuring the hook in fractions of an inch, the system has never been successful because it merely represents the length of the shank. A hook is really two-dimensional since the gape can vary greatly from one pattern to the next. In general, the commercial measures go from the smallest size 32 (which is barely large enough to hold between two fingers) and count down. As the number decreases, the size increases all the way down to a number 1 hook. At this point the number changes to a designation of “aughts” or zeroes. A 1/0 (pronounced “one aught”) hook is the next larger size to a number 1. A 2/0 is larger still, and this numbering scheme goes as high
as 20/0 (River Numbering). The full size breakdown from smallest to largest looks like this:

(Smallest) 32, 30, 29, 28, 26, ................. 4, 3, 2, 1, 1/0, 2/0, 3/0, 4/0, .......... ............17/0, 18/0, 19/0 and 20/0 (Largest)

All of these hooks come in short, regular, or long shank versions. The most popular brand Mustad hooks range in size from 19/0 down to 32. Size 19/0 is the largest shark hook; size 32 is the smallest fly hook. In Indian Standard IS: 9860 ( Part I ) - 1981, a comprehensive specification for seven different types of barbed fishing hook viz., Single straight flat hooks, Single straight ringed hooks, Single kirbed flat hooks, Single kirbed ringed hooks, Double round hooks, Treble hooks and Single kirbed turned down ringed hooks is given. A method to designate hooks by its type, size as gape width, wire diameter, length and number of this Indian Standard is also given. For example: a fishing hook of single kirbed flat type of size 8.5, wire diameter 0.8 mm and length 18 mm shall be designated as: Fishing hook, single kirbed flat, 8.5, 0.8, 18, IS: 9860 (Part I). However, the hook sizes specified in this system is not at all followed in the industry.

1.2.8. Selection of proper hook

Selection of the right type and size of hook is very critical for successful hook and line fishing operations. A good understanding of different hook pattern, their usage and the numbering system is important for selection of hook for a particular fish. Choice of hook depends on several factors such as the quality of the hook, the size of the targeted fish, its preferred bait, feeding habit, the fishing area (marine/inland) and the size of the line used. The mechanical properties of the hook and the biological aspects of the target fish affect catching process (Lokkeborg and Bjordal, 1992). A large hook is less readily broken or straightened and its wider gap may
allow the hook point to engage more deeply in the mouth cavity. Larger hooks require a stronger force to allow the hook to fully penetrate the inside of the mouth cavity (Johannessen, 1983). Hence large hook may be effective in preventing escape of hooked fish especially larger fish. Generally, fishermen select smaller hooks for smaller fish and bigger hooks for bigger fish based on their experience and acquired knowledge. Here the physical and behavioral characteristics of the targeted fish play an important role. The line size, the type of fish and the type and size of hook are to be matched and should be selected as a package.

The mouth of the targeted fish, its size, shape, structure and fighting pattern also influence the choice of hook. In the case of baited hooks, the hook needs to be large enough to be able to hold the bait and hook the fish, yet it should be sufficiently small enough that it does not hide the bait. A hook with barbs on the hook shank is found to be good for live bait and an offset worm hook for artificial bait. The live bait hook should be large enough that it does get the attention of the targeted fish when it is in water along with the live baits and small enough that it does not kill the bait. The hook should be sharp as dull hooks lead to escape of fish as well as unwanted mortality. The size of the hook and the gape should be proportional to the size of the bait. According to Baranov (1977) the success of the catch from a hook depends on the angle, the spear of hook makes with the direction of the pull. The more acute the angle, the more is the chance of the spear easily penetrating the fish. Treble hooks are used along with dough bait and artificial baits. The cost of the hook also is important. Mechanically sharpened hooks are easy to re-sharpen, which will save money but can cause rusting unless stainless steel barbs are used. Chemically sharpened single-use hooks are sharper, but more expensive.
There are a lot of indigenous and imported brands and models available in the market. This makes the selection of the right hook more difficult. The important brands of fishing hook available in India include Mustad (Norway), VMC (France), Youvella (Korea), Maruto Eagle Wave (Japan), Addya (India), Viaadi (India), Fish (India), Pasupati (India) etc. Besides, there are different centers along the coastal belt of the country where local black smiths make hooks. A comparative study of the hooking efficiencies and the response/behaviour of the fishes towards these hooks would help the fishermen in selecting the right hook.

1.3. Background and scope of the study

Hooks of different shape, size and make are used in fishing gears like long lines, drop lines, troll lines and hand lines. As early as in 1976 it was reported that more than 30,000 different kinds of fishing hooks are being produced on an industrial scale (Baranov, 1976). A large variety of indigenous and imported, branded and unbranded hooks made of different materials are available in the market. A widely accepted brand of hooks in India is the Mustad brand. Of late, fishing hooks and lines, of varying quality and price manufactured under different brands in India and abroad are available in the market.

As newer materials and technologies are being used in the manufacture of fishing hooks, there is great need for systematic studies on their properties and performance. Earlier studies on fishing hooks, have lost their relevance due to the arrival of new technologies and materials. Many of these hooks do not have any reference or standards with regard to their physical and mechanical properties, chemical properties, resistance to corrosion etc. The quality and performance of these hooks are quite varied from one type to other. Different manufacturers classify or number their hooks differently. This makes selection of the right hook very difficult.
Fishermen can not afford this much uncertainty in the performance or service life of hooks as a sizable portion of their investment (about 5 to 20% of the total cost of a hook and line fishing gear) goes into the purchase of fishing hooks. Since there are no well-defined standard methods for classifying fishing hooks, there is a pronounced need for a unified standard for designating fishing hooks.

In spite of their historical and technical importance in the fishing sector, fishing hooks did not receive the required attention of researchers so far and very little is done on their classification, physical and mechanical properties, material composition, corrosion resistance and fishing performance of fishing hooks. Fishing hooks and their properties as a fishing gear have not received adequate attention in India also. Studies so far conducted in India are mainly focused on fishing efficiency of the hooks. Physical and mechanical properties, material composition, corrosion resistance and fishing performance of fishing hooks are not much studied. Details like different types of fishing hooks available in the country, their classification, sizes etc. are difficult to find and research on this line is almost absent in India. Studies on the basic physical properties, mechanical strength properties, corrosion resistance and durability are not much looked into. Whatever work that are made have now become out dated due to emergence of new models, materials and technologies as the introduction of new technologies and materials have significantly influenced modern-day fishing methods and practices (Hameed and Boopendranath, 2000).

Properties like hook shape, hook size/number, resistance to unbending force or hook failure under load etc. have a direct influence on the fishing performance of hook. The fishing hooks available to the fishermen are not uniform in their physical and mechanical properties and a high level of variation is seen in their quality and prices also. The difference in the
material used for manufacture of hooks and the differences in manufacturing process, design etc. can be attributed to these variations in quality and performance (Anon, 2002). Since there is no standard way to express the physical strength, corrosion resistance and fishing efficiency of fishing hooks, it is difficult to compare fishing hooks.

In this context, a detailed study on the various properties of fishing hooks, their design aspects, physical and mechanical properties, chemical composition, corrosion resistance, comparative fishing performance etc. are greatly needed. This will ultimately help in the promotion of size and species selective, low energy hook and line fishing for the exploitation of untapped resources of the high seas and inland waters. Besides, the substitution of costly imported fishing hooks with less costly Indian hooks if possible would help to save considerable amount of foreign exchange.

Further, there is a scope for improving the existing hook designs and techniques. In order to realize all these, a detailed study of hook designs, their manufacturing process, mechanical and fishing performance etc. has to be undertaken as such information is hard to find and most of the commercial manufactures will not disclose such information. This study is an attempt to make such information available so that further advancements can be made, especially in India. Hence this research work was carried out with the following objectives:

1.3.1. Objectives of the study

- To evaluate availability and cost of fishing hooks in India.
- To evaluate the physical and mechanical properties of different types and sizes of hooks.
➢ To standardise the hook numbering system.
➢ To correlate the mechanical strength with the chemical composition of hooks.
➢ To evaluate corrosion resistance of hooks and probable corrosion protection/prevention measures.
➢ To compare the fishing performance of hooks.

*******************************