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# Fishing Hooks: A Review

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Fishing hooks stand out among the simplest and the oldest of such devices. They are not well studied, and the available studies are out dated due to emergence of new models materials and technologies. Methods of numbering of hooks are not standardized. This review dwells into their history and evolution, terminology, properties, classification, numbering, testing procedure and hooking efficiency. The study points to the need for a comparative study of hooks in terms of their relative properties and also as a conservation tool for sustainable development of recreational fishing.

**Key words : Hook, Fishing, Classification, Hooking Efficiency, Circle hook, Corrosion, Hook Numbering**

Fishing hooks and lines are the simplest and the most important among such devices. They are simple, easy to operate, cost effective and selective. Hook and line fishing is becoming increasingly important in the tuna-rich Indian fisheries, as the world demand for tuna itself goes up. The long lining system has been identified as the most efficient and cost effective system for harvesting oceanic tuna resources. The coastal zone up to 50 m depth of the Indian Exclusive Eeconomic Zone (EEZ) is intensely exploited while the region beyond 50 m depth with high potential of oceanic resources like tunas and tuna like fishes are hardly exploited. The total landing of tunnies as in 2004, amount 45,684 tonnes (CMFRI, 2005). The annual potential yield of tuna and tuna like fishes along the territorial/coastal waters of India is estimated at 2,80,000 tonnes, of which only about *23% are* harvested (James, 2005). Harvesting and utilization of India's rich tuna resources using cost effective technologies is crucial. This is essentially important against frequent intrusion into Indian waters by foreign vessels.

The thrust on tourism has opened up recreational fishing activities, the main thrust of which is on angling. Recreational fishing using hook and rod/pole is also gaining importance in India especially in the states of Himachal Pradesh, Arunachal Pradesh, Assam and Kerala. Here also hooks have an important role to play.

The hook and line fishing referred to as a single man handline has changed to automated large-scale longlines. New materials and manufacturing techniques have resulted in different types of high-quality hooks for target fishing. The hooks available in India comprise of different indigenous and imported brands as well as locally made unbranded hooks. Unlike the studies on netting material, very little is done on fishing hooks. Scarcity of research work on the shape and quality of fishing hooks had been reported by Baranov (1977). A few reports are

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available on the properties and characteristics of fishing hooks (Andreev, 1963; Baranov, 1976, 1977; Ko and Kim, 1981; Kitano *et. al.* 1990 and Varghese *et. al.* 1997). Most of the work is found limited to the catching efficiency or size selectivity aspects (Takeuchi and Koike, 1969; Despande *et. al.* 1970; Kartha *et. al.* 1973; Ralston, 1982; Huse and Fernö, 1990; Lokkeberg and Bjordal, 1992; Durai, 2003). Studies on the basic physical properties, mechanical strength properties, corrosion resistance and durability are not much looked into. In this context, a review on the information available on various aspects of fishing hooks is made for further study and development.

*History and Evolution*

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 from water by galvanizing, tinning, gilting, bronzing, enamelling etc to prevent corrosion. Many of the hook patterns today are the outcome of a trial-and-error process. Experience gained from the collective efforts of hundreds of generations of fishermen has influenced the transition. The basic hook patterns have not been subjected to much change during the course of time.

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 and inserted lengthwise into a bait. While the fish swallows the gorge along with the bait, by the pull of the line, it takes up a transverse position across the fish's throat. Even though gorge is hard to conceal, difficult to bait, hard to hook large fish on, and liable to lose its hold while the fish is being hauled, is still used in some places.

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. Neolithic man used hooks made out of bone, shell, or thorn depending on the materials that were easily available to them (Anon, 2004). Available records show that copper hooks were made in Bauchen, 7000 years ago (Anon, 2005a) and were replaced by bronze owing to its superior tensile properties (Helsinki, 1970; Gaur and Sundaresh, 2004).

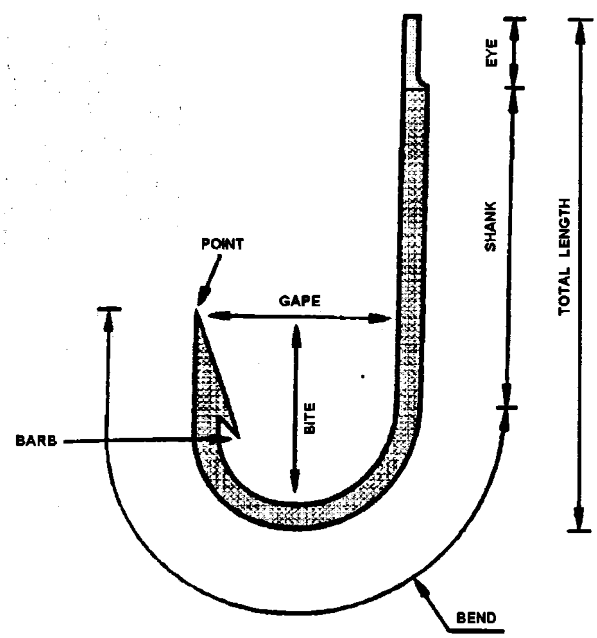


Fig. 1. Parts of a Typical Fishing Hook

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 out of wrought iron. The professional blacksmiths who were making hooks at their houses started small-scale industries and further into multinational hook manufacturing companies equipped with sophisticated hook manufacturing machines and quality control systems.

*Hook Terminology*

The hook serves the functions of holding the bait, enticing the fish to it and ensuring that the fish shall be unable to spit out 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 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. 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 while long shank hooks are essential for sharp-toothed fish, and also for fish that suck in the food. The longer shank allows easy removal of hooked fish. Hook shanks are manufactured in many different shapes. Straight, curved and barbed shanks are common. In straight shank, the hook shank is straight from eye to bend. Shanks are curved or barbed 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 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 it is reported that 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 point, is the tip of the hook that penetrates the body of the fish. It occurs as straight, reversed or even curved. The barb helps in holding the bait and also prevents the escape of fish, once it is hooked. 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.

*Manufacturing Process*

Hooks are made: (a) by using wire; and (b) 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. Usually hooks are manufactured from high carbon content steel wire. 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 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). Wire hooks are cheaper to manufacture but are weak and bend easily while forged hooks are stronger, heavier and expensive. Forged hooks break rather than bend and have sharp points. The next stage involves the creation of the "eye" according to the hook style. The formed hooks are immersed into an acid bath, which dissolves any minute burrs or abrasions, which might have occurred during manufacture resulting in cleaner and sharper hooks. This process is called as chemical sharpening. Manual sharpening using stone or file causes rusting unless stainless steel bars are used.

The most important step is the tempering of the hook which hardens the metal and substantially increases its resistance to unbending resulting in hooks, which are very strong but non-brittle. After tempering, the hooks are 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. This is accomplished by lacquering or electroplating. The common finishes found in the fishing hooks are: 'Japanned Black', red, blued, 'bronze' and tinned.

### *Classification*

Hooks are basically classified into wire and forged and also into barbed and barb-less hooks. Classification can also be made in terms of their shape, point, number of bends, gape, eye, mode of use, targeted species and make/brand (Fig. 2).

Round bend hooks or "J" shaped hooks are the common barbed hooks with a perfect round bend. Limerick hooks have characteristic

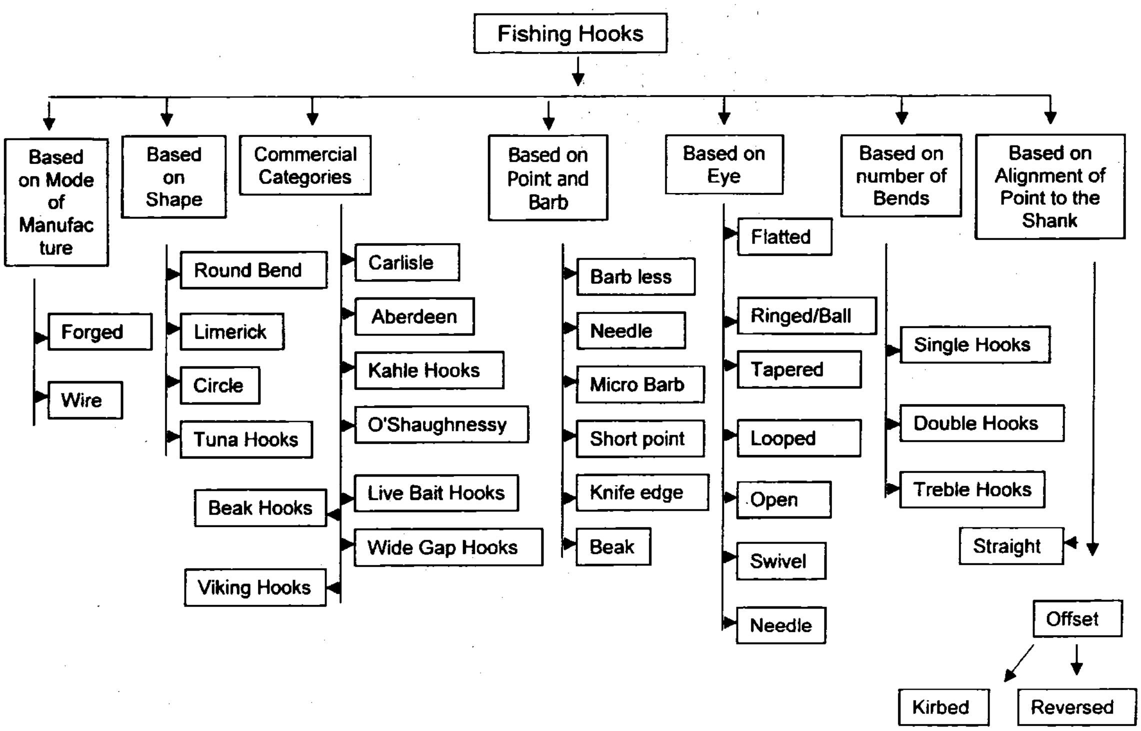


Fig. 2. A schematic representation of hook classification

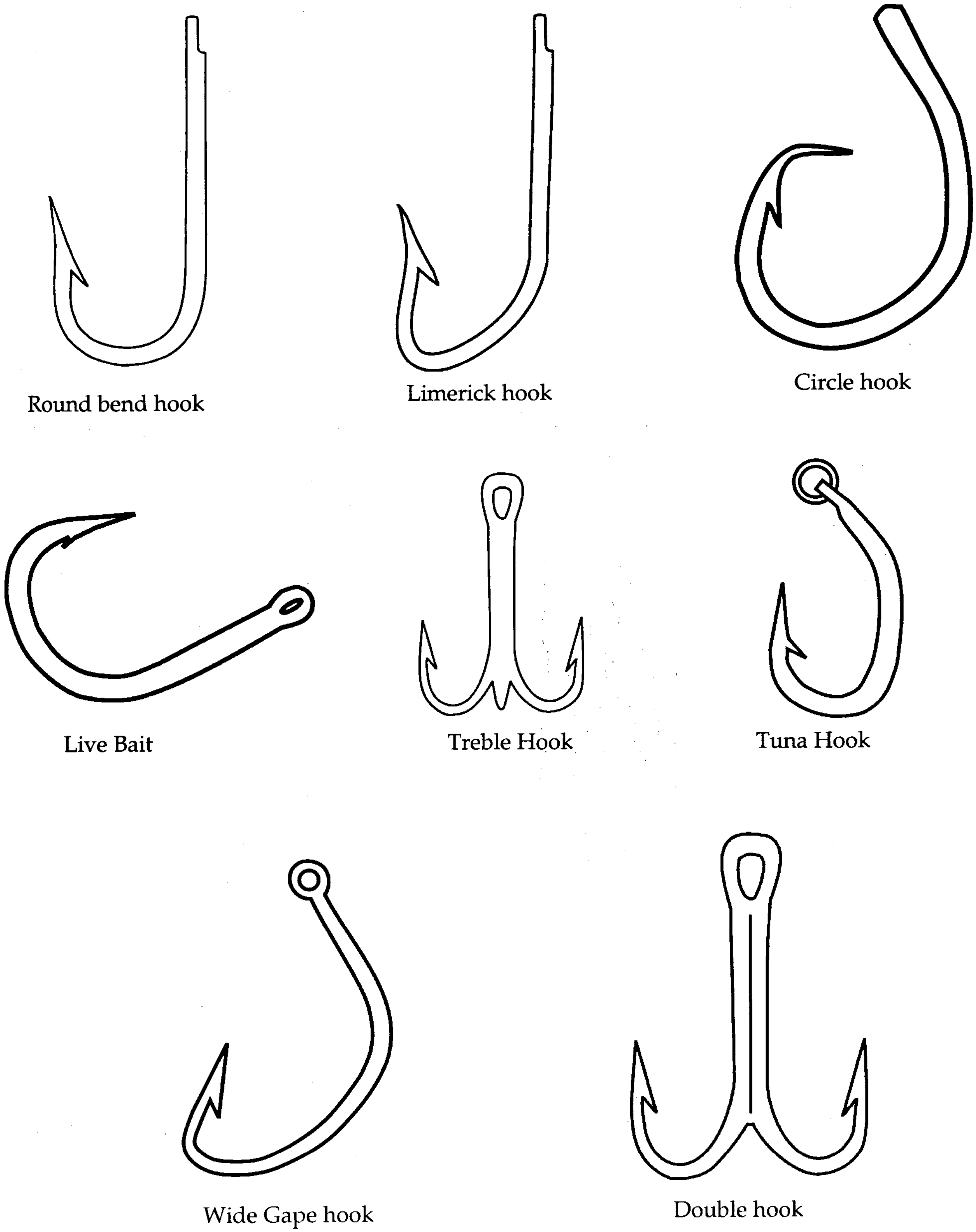


Fig. 3. Important categories of hooks

sharp angle in front of the bend used for tying flies.

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. The effectiveness of circle hook depends on the hook size, fishing style, fish feeding mode and also mouth morphology of the target fish. It is found that they have high catch rate and are easy to use (Brooks, 2004a).

O'Shaughnessy hook is a standard hook, relatively thick, forged with a very strong bend which are not likely to bend out of shape. Sizes range from #3 to as large as 19/0. Aberdeen hooks 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.

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 hooking most of the time. Circle live bait hooks provide a greater chance for a good release of the hooked fish onboard. 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, 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.

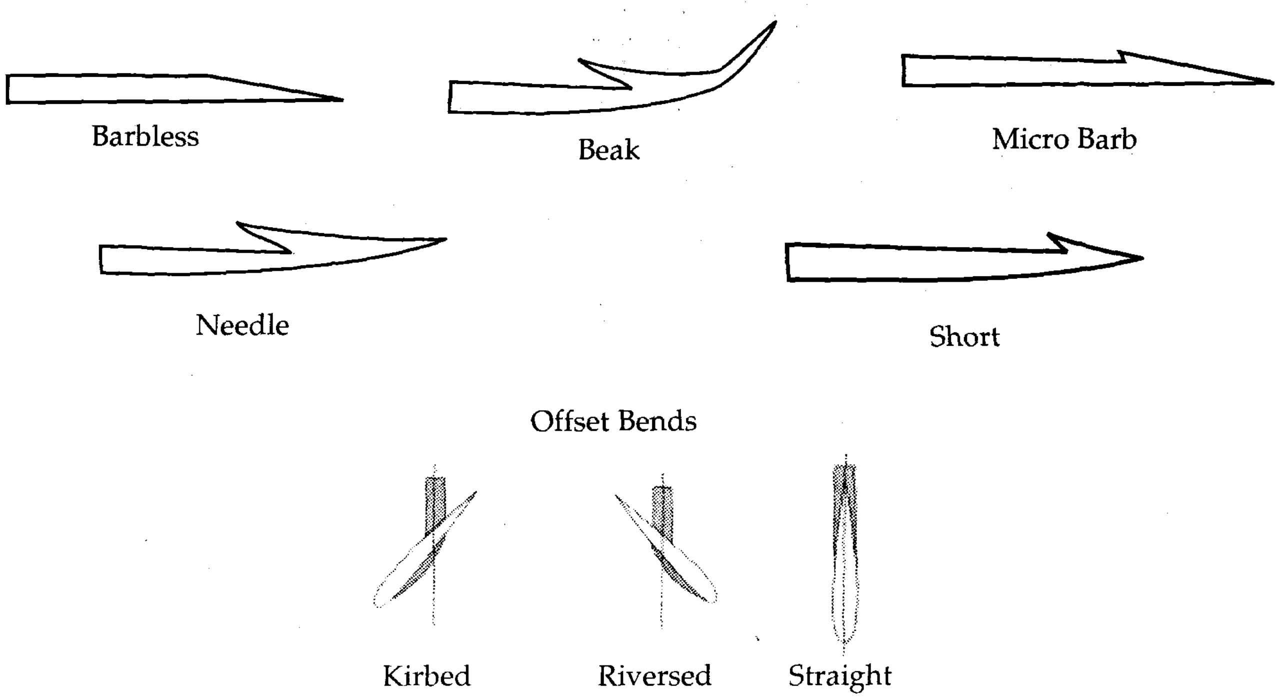


Fig. 4. Classification of hooks based on point and barb

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 thought to be perfected by the Japanese. Viking hooks are 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.

*Based on Point and Barb:* Based on the characteristic of point and barb, the hooks are classified in to five groups (Fig. 4):

Barb-less hooks used widely in tuna fishing, are devoid of any barbs on the point. The absence of the barb helps in easy release and much less handling of the fish. This helps in better survival rate of fish in recreational fishery. The needle point 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 which ensures more efficient hooking of soft-mouthed species.

Based on the alignment of the point with regards to the shank (offset), hooks can be classified into 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 'the most exact and best Hook-maker' of his time, from whom the development can be traced. In reversed bend

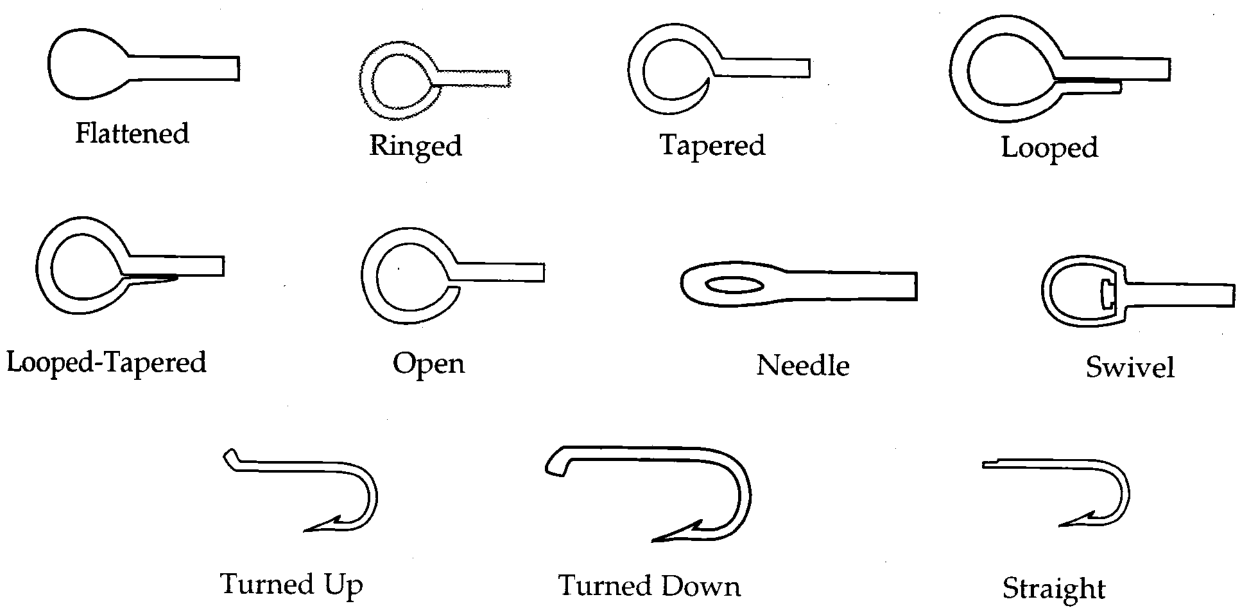


Fig. 5. Classification of hooks based on eye and the angle the eye makes with the shank

hooks, the point bends towards the left of the shank whereas in straight hooks, the point remains straight to the shank.

*Based on Eye:* Based on the design of the eye, the hooks are classified in to the following groups (Fig. 5).

Based on the angle the eye makes with the shank there are 'turned up', 'turned down' or 'straight' types.

*Numbering & Size*

There is no uniform, universally accepted system of hook numbering for designating different hooks. Hook sizes are mostly arrived at by different proprietary standards. 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.

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 (1976) explained about two numbering systems in practice for hooks viz., Sea numbering system and River numbering system. He also describes a system in which the size of a hook is expressed in terms of weight (kg) of 1000 hooks.

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)

Hooks come in short, regular, or long shank versions. The most popular brand Mustad hooks range in size from 19/0 down to 32. In Indian Standard IS: 9860 ( Part I ) - 1981, a comprehensive specification for seven different types of barbed fishing hook is outlined (Anon, 1981). A method to designate hooks by its type, size, wire diameter, length and number of this Indian Standard is also given. 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)*

*Testing*

The selection of a hook for a particular end-use depends on its quality. Unbending load, breaking load, corrosion resistance and material composition are the important parameters tested to assess the quality of a fishing hook. Physical dimensions of the hook comprise total length, shank length, gape, bite length, wire diameter and weight. The life of a hook is assessed by the sharpness and hardness of the point as low quality materials result in weak and dull points.

*Physical Dimensions:* Physical dimensions like total length, gape and bite length are measured by placing the hook on a graph paper and taking the values from the graph coordinates. Shank length is measured from a point immediately behind the hook eye to the beginning of the bend. Gape is measured as the distance between the point and the hook shank. Wire diameter measurement is taken on the round unforged portion of the hook wire using a micrometer. Weight of the hooks is recorded using high accuracy electronic balance weighing

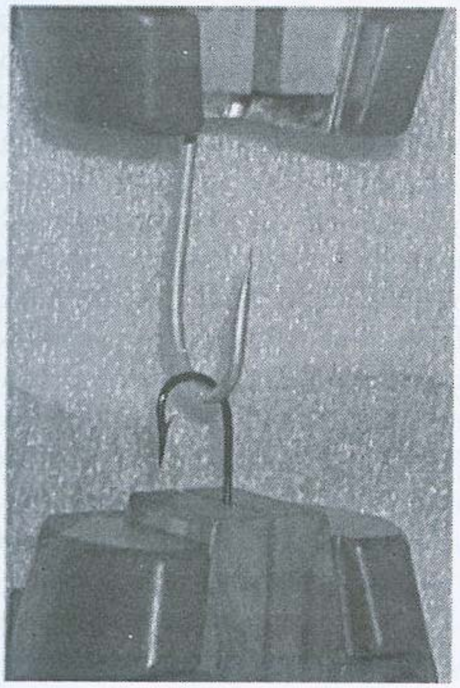

Fig. 6. Testing of Unbending Load

ten or more hooks at a time and taking the mean weight.

*Mechanical tests:* In unbending test, the load that it takes for the hook to straighten out or to break is measured which gives an indication of the load a particular hook can withstand (Fig. 6).

Practically hook failure occurs when the point move 60° from its original position. The measurement of the load required to deform the hook bend equal to the bite length or that required to deform the bend by 60° from the original position or break occurring before attaining 60° is measured (Anon, 2002).

Ko and Kim (1981) tested six kinds of hooks for breaking and unbending due to plastic deformation of the material using dynamometer. The tests were carried out at a speed of 290 mm/min and 780 mm/min respectively. Varghese *et al.* (1997) carried out the unbending test of hooks by recording the load required for deformation equal to bite length. Indian hooks were found to be more fragile and liable to deformation under load than imported hooks. According to Andreev (1963) the breaking load of the hook was independent of the shape and nature of hook.

Fishing hooks are also tested to measure the load it takes for a hook to break. Here the load is applied continuously up to the level at which the shank breaks. Practically this is not of much significance as the chances of escape in a hooked fish is mostly by the straightening out of the bend rather than by the breaking of the hook.

*Corrosion Resistance:* Corrosion resistance, an important criterion in the quality evaluation of a hook, may vary depending on the type of the material, the type and thickness of the coating, fishing conditions, water temperature, pH value and type of bait. It can be assessed by the corrosion resistance test using a salt spray chamber or electro chemically by measuring the corrosion potential. The salt spray test is carried out in Salt Spray Chamber in accordance with the ASTM B-117 norms (ASTM, 1973). The loss of weight due to corrosion after a period of exposure inside the salt spray chamber is calculated; which in turn is used to calculate the rate of corrosion. 98 hours of salt spray exposure of fishing hook is equivalent to 365 days in sea water (Varghese *et al.* 1997). Wuertz (Personal communication) has described about a 'Modified ASTM B-117 Salt Spray Test' in which the fishing hooks were exposed in a salt spray cabinet for 21 days (504 hours) to compare the performance of two different rust preventive coatings used for Mustad hooks.

Kitano *et al.* (1990) studied the corrosion resistance of tuna long line fishing hooks. In this study, seawater immersion test and electric potential measurements were conducted, using various anti-corrosive materials to evaluate their corrosion mechanism and resistance to corrosion. The results showed that the method of attaching aluminum to the fish hook was the most effective and even low-priced aluminum proved to be effective. Varghese *et al.* (1997) used Acetic Acid-Salt Spray (Fog) testing (ASTM, 1974) to analyse the corrosion resistance of Indian and imported fishing hooks. The Indian hooks were found to be comparable with imported hooks in material composition and corrosion resistance.

Corrosion can be minimized by using cadmium plated or tinned hooks. It is reported that hooks coated with stainless steel had 3% surface rust, duratin, 8% and double nickel 30% surface rust after a given number of hours of testing in salt spray chamber (Anon, 2004).

*Selection of 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 and the size of the line used. The mechanical properties of the hook and the biological aspects of the target fish affect catching process (Lokkeberg and Bjordal, 1992). A large hook is less readily broken or straightened and its wider gape 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). Generally, fishermen select hooks based on their experience and acquired knowledge. 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.

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 so that it does get the attention of the targeted fish when it is in water along with the live baits and small that it does not kill the bait. The hook should be sharp as dull hooks lead to escape of hooked 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 (1976) 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. Mechanically sharpened hooks are easy to re-sharpen, which save money but can cause rusting unless stainless steel barbs are used. Chemically sharpened single-use hooks are sharper, but more expensive. The cost of the hook also is important in the selection of hook.

A lot of indigenous and imported brands and models of hooks are available making the selection 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.

*Hooking Efficiency*

The hooking efficiency is influenced by the size and species of the target fish. Hook efficiency can be expressed as the number of successful hooking divided by the number of attempts or number of fish caught divided by number of fish taking the bait (Number of bites). Hooking rate is generally expressed as the number of fish caught per hundred hooks (Gibson, 1979). Despande *et. al.* (1970) studied the hooking rate and efficiency of 'Mustad' hook 4/0. Kartha *et. al.* (1973) studied the effectiveness of round bend hooks (Mustad) of different denominations using different baits. The responses of cod (*Gadus morhua* L.) and haddock (*Melanogrammus aeglefinus* L.) to baited hooks were analysed by Huse & Fernö (1990) to determine their behaviour patterns, which could form the basis for improved longline hook design. Sulochanan *et. al.* (1989) have analysed the hooking rate of tuna in the Arabian Sea with particular reference to yellow-fin tuna, *Thunnus albacares*. In this study, the catch index for all tuna and that separately for yellow-fin tuna were 1.54% and 1.43% respectively.

George *et. al.* (1991) experimented 4/0 round bend indigenous hooks along with imported Mustad hooks. They have compared the hooking rate of sharks for the two types of hooks and found that both are comparable. Prince *et. al.* (2002) have compared the performance of circle hook and "J" hook in recreational catch-and-release fisheries for billfish. They have reported that circle hooks used on sailfish had hooking percentages that were 1.83 times higher compared with "J" hooks. Like wise in a fishery resource survey of the Indian EEZ around Andaman and Nicobar Islands conducted by Fishery Survey of India (FSI) during August 1989 to December 2002, the overall hooking rate recorded for tuna hook was 1.85% (John *et al.*, 2005).

**Hooking Mortality and Survival**

Korakandy (2000) reported that India has got tremendous potential in recreational fisheries, especially in the state of Kerala as a result of the fast growing tourism industry. He has pointed out the long tradition of recreational fishing in India even before 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. But recreation fishing needs to be introduced on a responsible manner as captured fishes are released subsequently in 'catch and release' type of recreation fishing. The survival of the released fish often depends on the severity of the wound and the handling of the catch. Appropriate hook types have to be used for minimum mortality and to conserve fish stocks for continued fishing activities. The design of the hook itself, when used properly, prevents fish from being hooked in the gut thus promoting lip hook rate, which reduces the mortality. Fishes caught by hooks are generally hooked in the mouth, particularly in the jaw or in the alimentary tract if the hooks are swallowed (Lokkeberg *et. al.*, 1989; Huse & Fernö, 1990; Lokkeberg & Bjordal, 1992). Hook shape can be designed to decide the depth of penetrating the inside of the mouth of a particular species of fish. Injuries to internal organs as a result of deep hooking or hooking in locations other than the mouth significantly increase release mortality (Anon, 2003).

Circle hooks seem to be a promising type of hook to reduce release mortality (Anon, 2003). These hooks are designed to move to the corner of the fish's mouth and set themselves as the fish swims away. The more a fish is swimming away from the pull point, the more likely the hook will move to the rear corner of its mouth (Anon, 2005b). Circle hooks promote healthy catch and show good size selectivity, minimizing the number of undersized fish hooked. Even when the fish swallows the Circle hook with bait, the hook comes out of the throat without penetrating. 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. Circle hooks are also reported to minimize the incidence of turtles being hooked and are evolving as a turtle friendly fishing gear (Anon, 2005c).

Significantly lower release mortality in striped bass when using non-offset circle hooks, as opposed to conventional "J" hooks is reported (Lukacovic, 2001; Lukacovic & Uphoff, 2002). Studies by Prince, *et. al.*, (2002) on billfish, Skomal, *et. al.*, (2002) on bluefin tuna, Falterman and Graves (2002) on yellowfin tuna, and Trumble, *et. al.*, (2002) on Pacific halibut also showed significant decrease in release mortality while using circle hooks. Cooke, *et. al.*, (2003) reported that circle hooks can be used for reducing release mortality in rock bass. But the use of circle hooks on bluegill showed no significant benefit (Cooke, *et. al.*, 2003).

A study by Ayvazian *et al.*, (2002) with five hook types on the mortality rate, injury type and injury location on fish to find out the short term mortality following catch and release angling of tailor fish (*Pomatomus saltatrix*) showed that treble hooks produce significantly higher mortality rate than single barbed and barb less hooks. Treble hooks cause multiple injuries and require increased handling time to disengage hooks from the multiple penetrations, most of which are superficial. Single barbed and barb-less hooks even though cause a single injury, significant mortality is caused due to penetration of internal organs such as oesophagus, gills and stomach. Muoneke & Childress (1994) reported that single hooks, especially when used in conjunction with natural baits, resulted in higher mortality than treble hooks.

Though there are many studies on the injury types and mortality rates by using circle hooks and other hooks in other parts of the world, the authors could not find similar studies in the Indian context. Such studies are necessary for sustainable exploitation of resources in view of the angling related tourism development being promoted in many states of India.

## Conclusion

While the base material and technologies of hooks change frequently, systematic studies on properties and performance are vital. Available brands and models of hooks have no uniform technical specification and numbering system. Hence, studies focused on physical and mechanical properties, design issues and fishing performance are crucial. Fishing hooks need to be standardized and standards available need updating. This would lead to better fishing practices taking into consideration the need for sustainable exploitation of resources.

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