26 Fishing Methods in India

India, with its long sea-coast and extensive reverine and estuarine waters, has a big wealth of fish fauna. In fact, the success of fisheries in a country depends on proper catch of its fish fauna, for which the use of modernised crafts and gears is a *sine qua non*. In India, a large variety of crafts (boats) have been designed for marine and Inland fishing. The nets or gears and other devices for catching fishes are also numerous and ingenious. But both crafts and gears were invented centuries ago and probably have remained static and have shown little or no change or improvement in India, unlike in other maritime countries. This has hindered or restricted the exploitation for our seas and Inland waters i.e. river, lakes, etc. It is only in the last decade or two of 20th century that some attempts have been made to use motor boats and modern steam vessels for the purpose. Actually the capture of fishes is as important as pisci-culture methods.

In this chapter, the fishing crafts and gears are considered under the following heads :

1) Marine fishing crafts and gears.
2) Inland fishing crafts and gears.

Marine Fishing Crafts and Gears

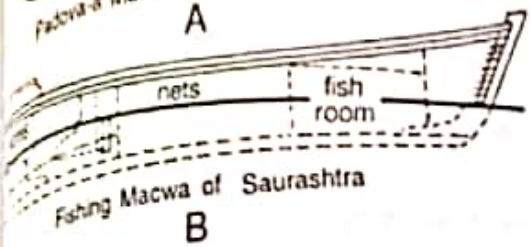
Crafts or boats and gears or nets used in the Indian seas are varied and of several types. They are further grouped into two i.e. crafts and gears of the east coast and crafts and gears of the west coast. Since the gears used on east and west coasts are almost of common type are, therefore described together while the crafts of east coast and of west coast are described in two separate heads as they are unidentical.

[I] Crafts of the east coast

The catamaran (Tamil : lashing timber) is the primitive and the most important fishing craft of the east coast. It is devised according to the local environmental condition and the biological requirements of the water. It is constructed by tying together several logs which are curved and shaped like a canoe. One end of this craft is shaped into a cone which rises above the water level and forms the point from where the raft is controlled. The construction and design of the catamaran is not uniform, therefore, their various types are described below :

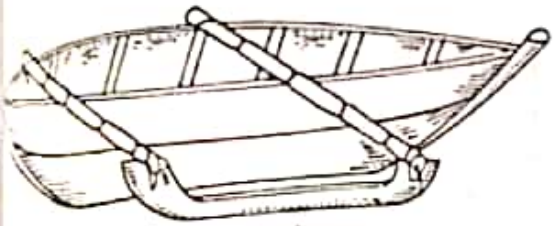
Padava-a Masula boat of Andhra coast

A



Fishing Macwa of Saurashtra

B



Rampani boat of Karwar

C

...g 1 A-C Important crafts used in Indian sea.

... Coromandel type. It is probably the ... Tamil Nadu type. It is made up of 3 - 5 ... the accessory pieces like stem parts and ... sails are added. Rowing sails regulate the ... of the raft. A variation of coromandel ... with 7 logs called Kolamaram which is used ... capture of flying fishes of Nagapatnam.

... Orissa and Ganjam type. It is made up ... which are not tied together by rope, but ... with wood. The planks are cut in such ... that the catamaran takes the shape of a ... This type is mainly used in the coastal water ... and Ganjam district of Orissa.

... Andhra type or Vishakhapatnam type. It ... variation of Orissa and Ganjam type, but ... (5 - 7 metres long) and made of heavy ... The planks used in fitting the sides are ... section logs.

... Boat catamaron. It is made up of 3 logs; ... and fitted into a regular boat-shaped vessel. ... around the Mandapam and Mukkur area.

5. Raft. It is small catamaran of primitive type. It comprises 4 to 5 logs tied together into a tilted structure, to form a raft.

6. Masula boat. It is used extensively on the coromandel coast. It is about 9 metres or less in length. It is constructed only with planks devoid of ribs or frames. It is a non-rigid boat. There are several variations of this type. In Orissa, it is called *Bar boat* and in Andhra *Padava* or *Padagum*.

7. Miscellaneous types. Besides the aforementioned types, there are several other types, constructed slightly differently. Chief among these are the following :

(a) Nauka and Dinghi. These are carved boats of Orissa and West Bengal. Naukas are well-designed large boats measuring $13 \times 3 \times 2$ m.

(b) Tuticorin boat. It is also a carved model, measuring $11 \times 2 \times 1$ m and can ply in inshore waters. These are used more as mother-ships and cargo boats than for purpose of fishing.

(c) Pattiya. It is used in North Orissa and made up of clinker.

(d) Muthupet type. It comprises of two logs placed sideways to the middle one, to form a long and hollow boat. Such boats are used in Ramnad and Tanjore districts.

(e) Shoe-dhonie type. It is shoe shaped boat of Telugu coast between Kakinada and Masulipatam.

[II] Crafts of the west coast

On the west coast, owing to the different conditions of the sea, the types of boats that have evolved are also different. Dug-out canoes, plank-built canoes, outrigger canoes and built up boats deserve mention. Built-up boats are the most highly evolved of indigenous fishing crafts. They are operated on the west coast, north of Ratnagiri and along Mumbai coast. There are minor variations from place to place. Various types of crafts used on the west coast are the following :

1. Dug out canoes. These are made from large logs of wood by scooping out the inner part, the bottom or keel portion being thicker than the sides. These are popular on the Kerala and Konkan coasts. The large sized canoes called

Vanchi or *Odam* are 10 - 22 m long and operate a large variety of nets. The smaller ones, known as *Thonies*, are employed for gill net or drift fishing and for seining. Drug out canoes are also employed on the west coast from Colachel in the south to Kathiawar in the north. These are also used in some parts of Ramnad and Tanjore districts northwards.

2. Plank-built canoes. These are dug-out canoes which are further enlarged with planks on the sides. These are common in Kerala and are applied in boat seine operations. These are popular in Kathiawar and North Mumbai.

3. Outrigger canoes. These are applied in Kanara and Konkan coasts. These boats are with a single outrigger and are locally called *Rampani*, since these are used for the casting of the Rampani net for mackerel fishing. These are regular built-up canoes, the wooden planks being more spread out. The normal size is around 15 × 3 m long, although small-sized canoes are also in use, particularly between Bhatkal and Majali.

4. Built-up boats. These are the most highly evolved of indigenous fishing craft. These are operated on the west coast, north of Ratnagiri and along the Mumbai coast. There are minor variations from place to place. A *Machwa*, the largest fishing boats with its broad hull, pointed bow and straight keel is very popular in Ratnagiri for offshore fishing.

A *Satpati* or *Galbati* has a medium pointed bow, broad beam, straight keel and high gunwale. It is an ideal type for mechanization as a motor engine can be fitted without any change in the design of the locally assembled boat.

Marine fishing gears

Fishing appliances (tackles) employed in sea-fishing largely include the nets of various sizes and designs. Nets may be made of cotton, silk, flax or flax hemp to synthetic nylon or terylene fibres, spinned into thicker twins of many strands. The strands are then interlaced to form webs, keeping the size of mesh in accordance to the size of fish to be captured. The nets made of synthetic fibres are, however, replacing the cotton nets rapidly. Besides, lines and hooks are employed for catching large fishes. The main types of nets used for marine fishing are the following :

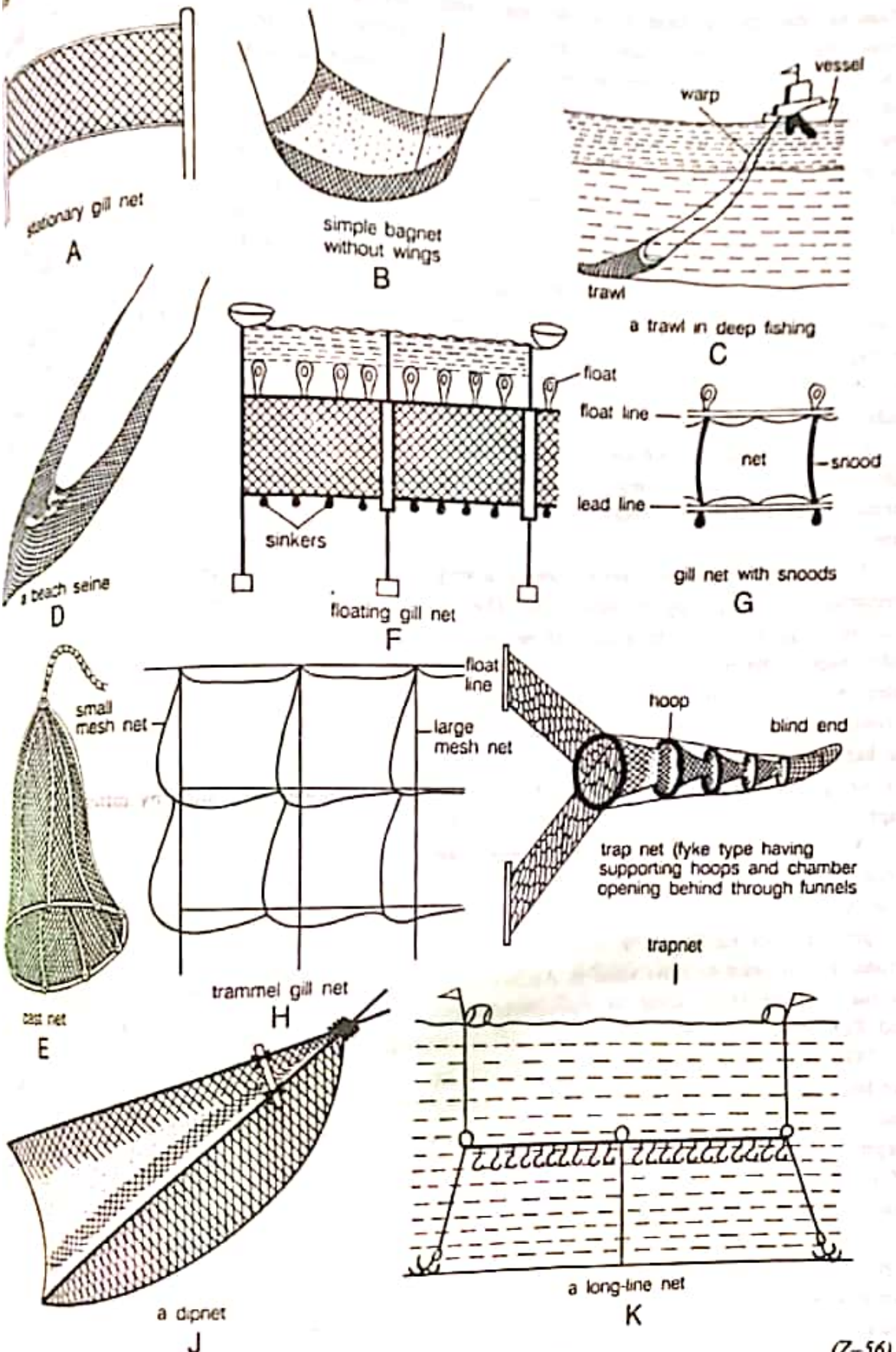
(1) Fixed or stationary nets.
(2) Bag nets and boat seines (Trawl).
(3) Shore seines and inshore drag nets.
(4) Drift nets and gill nets.
(5) Cast nets.
(6) Trap nets.
(7) Dip nets (Scoop net).
(8) Long line and hooks.

1. Fixed or stationary nets. As the name suggests, these nets are fixed in the tidal zones of the inshore waters during low tides. To keep the nets in position, wooden poles called stakes and floats or sinkers are used. These nets are usually rectangular or conical in shape and of different sizes.

Fixed or stationary nets are widely used all along the coast from Bengal in the east to the southern peninsula, on to Kanara, Gujarat and Kathiawar. With the high tide, fishes swim into the net and when the water recedes with the low tide, they get trapped. These nets vary from place to state and are called by different local names.

In West Bengal and Orissa, the conical fixed nets are called *Panch*, *Kathia-kool jal*, *Panch-Kathia-ber jal*, and *Behundi* or *Ghara jal*. The rectangular fixed net used in West Bengal and Orissa are called *Bayd* or *Mal jal*, *Branda jal* in North Orissa, *Kalavali* of Tanjore, *Kalavi valai* of the Gulf of Mannar and Palk Bay. It is also called as *Konda vala*, *Thorku vala*, *Wagai jal*, *Bangela jal* or *Patta bala*, *Jadi* or *Intagi* on the Kanara coast; *Jadi* or *Nitah jal* on Gujarat and Kathiawar coasts. These nets are made by hand mostly by fisherfolk themselves in their homes. The small sized ones are made up of cotton yarn, while the larger ones are made up of hemp or other strong yarn. These are preserved by treatment with certain local extraction of trees or sometimes by coal tar.

2. Bag nets and boat-seines. These nets are generally of conical shape, mostly without bags or wings. Their mesh usually increases from



(Z–56)

Fig. 2. A-K. Important net's types used in Indian sea.

portion to outer end to form a bag-like net. Long tapering bag nets, locally called *Fraga* or *Thuri valai* are operated by two catamarans or canoe in Andhra Pradesh. As the catamarans progresses, the fishes are trapped in the back portion of the net. The trawls used for fishing in mid and bottom water have their mouth open by provision of floats and sinkers on upper and lower margins of mouth. The bag nets may also be fixed to stakes or other objects planted in the sea bottom. They are left horizontally in water to trap fishes moving into the bag. Such nets include *Kola valai* and *Mara valai* of coromandal coast, and *Kaduravala* of Andhra coast.

Mathi-Kolli-vala of Kerala is a specialized bagnet for oil sardine fishing. Another type in Kerala is the *Paithu vala*, which is a large boat seine.

Along the Mumbai and Gujarat coasts, a very interesting type of bagnet called as *Dol* is extensively used. It is a long conical net with a wide mouth. The mouth end is fixed by bamboo poles or stakes and the tapering end is held on to a boat. This type of net is used in waters where the current is strong and high enough to keep the net straight and expanded, so that fishes can be trapped in it.

3. Shore seine and inshore drag nets. Two types of such nets are chiefly in use in our country. The first type called the beach seine and is operated from the beach. It is called *Berjal* in Orissa, *Pedda valai* or *Alivi valai* in Andhra coast, *Periya vala* or *Mada valai* in coromandal coast and *Kara valai* in the Gulf of Mannar.

The bag has a carrying capacity of 100 kg per haul and its wings which are longer, narrower, and tapering towards the wrap ends have meshes larger than those of the bags. The upper float line of the bag is provided with floats and the lower lead line with sinkers. During operation one wing is stretched far off from the shore, normally at right angles to it, until the wrap end of other wing remains just at the beach. The extended end is then brought back to beach by making a large arch and encircling a big section of water. At this time the float line of the net remains just at the surface due to floats and the lead line to the bottom, not permitting any escape of the fishes. Hauling is carried out then either manually or by power machines.

The second type of net called as *Rampani* is the biggest shore seine net of the Indian seas employed for capturing shoaling mackerels and sardines in coastal Karnataka and Goa. It is operated from vessel and the lead line obviously never touches the bottom.

4. Drift nets and gill nets. Drift nets and gill nets are wall-like nets of various sizes and meshes. The yarn is of hemp or nylon and floats are attached to the net to keep it vertical and straight. The net may be dyed into the colours of suitable choice. Normally light coloured nets for turbid water and dark coloured for dark waters are selected. Capture is, however, most successful in the night due to invisibility of the nets. The gill nets are commonly used in Tamil Nadu and Gujarat. The drift nets are the floating types of gill nets, made up of stronger material. These are attached with the wooden floats on the upper side (float line) and with sinkers on the foot rope (lead line). Drift nets are commonly used along the west coast, ~~particularly in Tamil Nadu~~.

5. Cast nets. These are flat and circular in large sized nets, used to capture small size fishes. It has usually a string. These are having weights or sinkers along their margin. The net is cast by the sweep of the arm. When it spreads, fishes are caught in it. It is operated by single fisherman.

6. Trap net. It is a stationary type of net that is passively operated to trap fishes which move into it through the guarded entrance. *Fyke net* is the modified form, constructed to form a long cylindrical bag, with one end (mouth) wide opened and the other end blind. It is operated in shallow waters and used to capture the flounders.

7. Dip net (scoop net). These nets are operated in shallow sea waters to capture schooling mackerels. Its operation is usually done from a boat. The net is lowered down in water to trap the schooling fishes.

8. Long line and hooks. Long lines with hooks are an age-old device. Long line and

used in offshore fishing and are made up threads. These are operated in a position by using floats and sinkers at intervals. Baited hooks are attached to the the large sized fishes, specially sharks while engulfing the bait are caught by

Fishing Crafts and Gears

fishing crafts

devices are employed for fishes from freshwater resources in parts of our country. The craft employed fisheries may be described under two

Rafts are the most primitive type of They are constructed from various materials. In West Bengal and some Tamil Nadu, the stems of banana trees are other to form a floating platform. In Bihar, Ganges, earthen pots called *Chatties* are other to support a light platform of This type of raft is also met with in the ver in Tiruchirapalli and Tanjore districts. ative men invented simple rafts from the ns of the animals. In the upper reaches Ganges, buffalo skins are tied together to rude raft. In the rivers Kaveri and ers fishermen use the coracle made of

ype of West Bengal is a simple type of canoe, made by hollowing out the stem of ra palm. It is applied in paddy fields and areas with shallow waters. Such dug-out Bihar is called *Ekhta* and used very in shallow tributaries of Ganga.

boats. Boats are built from planks and are ve types. They are sturdy and can with rful currents and tides in rivers and large ze of the well known types is dinghi. used in West Bengal in conjection with and dipnets. *Dinghis* are without keels ows and have a tapering bow and stern.

Another common type boat is *Chandi nauka*, which is large and is about 18 m long and 3 m wide. It is used to operate drift nets.

[II] Inland fishing gears

As mentioned above, India has a wide variety Inland waters. The nets used, therefore, are numerous and of diverse types. Few important types are described below, which fall into the following categories.

(i) Trap net, (ii) Hand net, (iii) Drag net, and (iv) Fixed net, (v) Miscellaneous types.

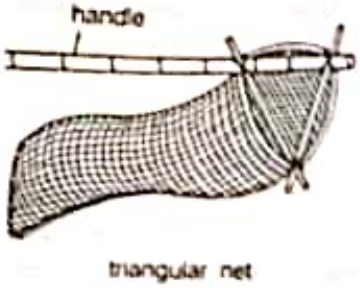
1. Trap net. There are three important varieties of trap nets, used generally in Inland waters of India in general and its state., U.P. in particular.

(a) Basket trap net. It consists of two dome shaped hemispherical baskets, each provided with an opening at the narrow end as shown in (Fig. 3). The opening is guarded by flexible recurved bamboo sticks with their free ends facing towards the inner side. Suitable bait in the form of balls is generally placed in the trap which is lowered in water for sometimes. Fishes that enter the basket are incapable to come out due to the recurved nature of the sticks guarding the opening.

(b) Pot trap net. It is another variety of trapnet and mostly used specially by the poor people of eastern U.P. A wide mouthed earthen pot or vessel is used as a trap. The mouth is closed with a thick cloth having a few holes to provide entrance. Suitable bait placed inside the pot tempts the fish to enter the pot which is placed on the bottom of the pond or lake.

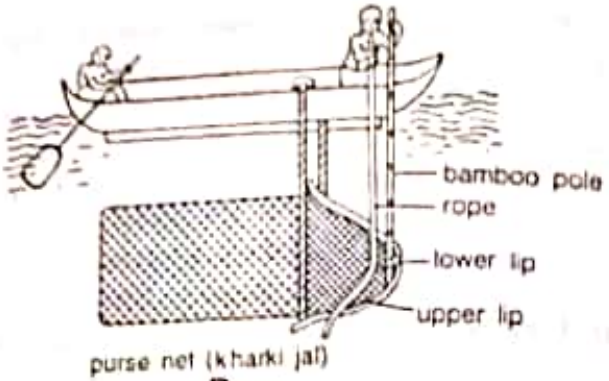
Live fishes like *Channa*, *Clarias* and *Heteropneustes inside* the pot are captured by hand.

(c) Konch trap net. It is very commonly used in shallow muddy waters of summer. It is made up of split bamboo pieces in the form of conical basket with a small circular opening at the top to allow the hand to enter. It is about one metre high. The trap is dropped in the water and the wide mouth is pressed in the soft mud. The fisherman then brings his hand through the top opening and catches the fishes which wriggle in



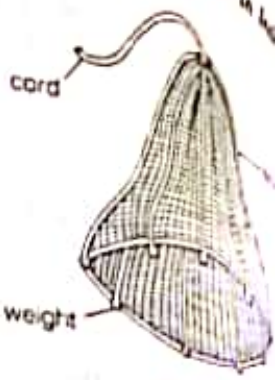
triangular net

A



purse net (kharki jal)

B



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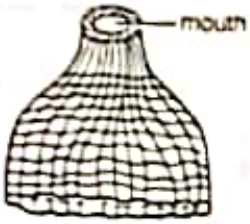
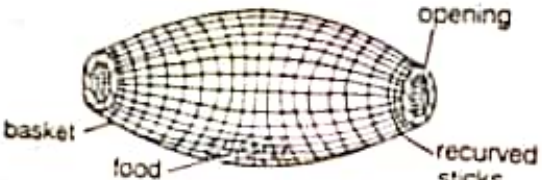


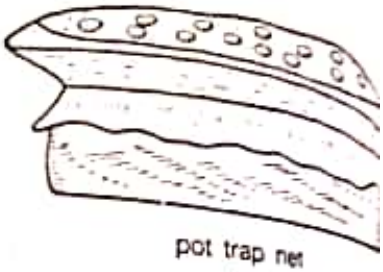
a konch trap net

C



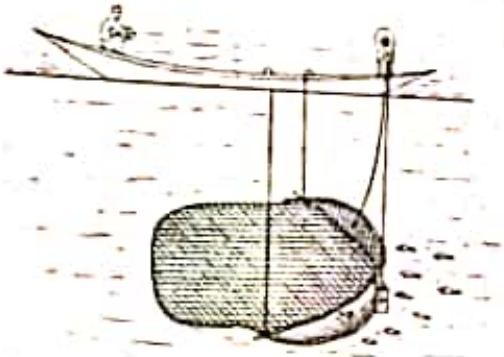
a basket trap net

D



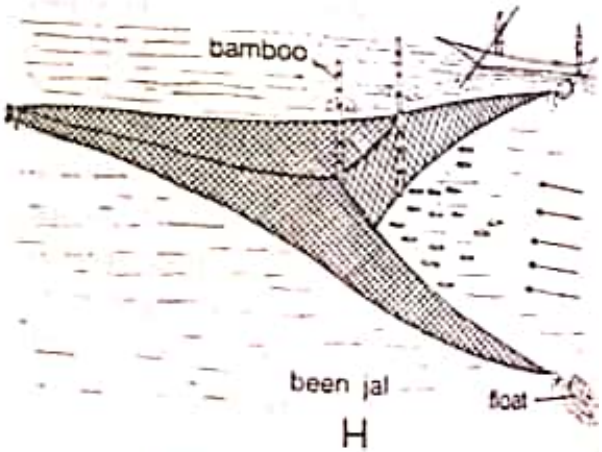
pot trap net

E



shanglo jal

G



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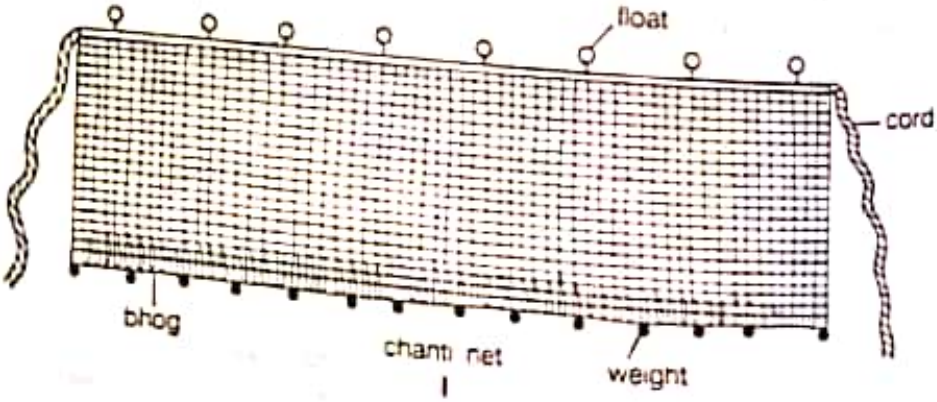

chanti net

I

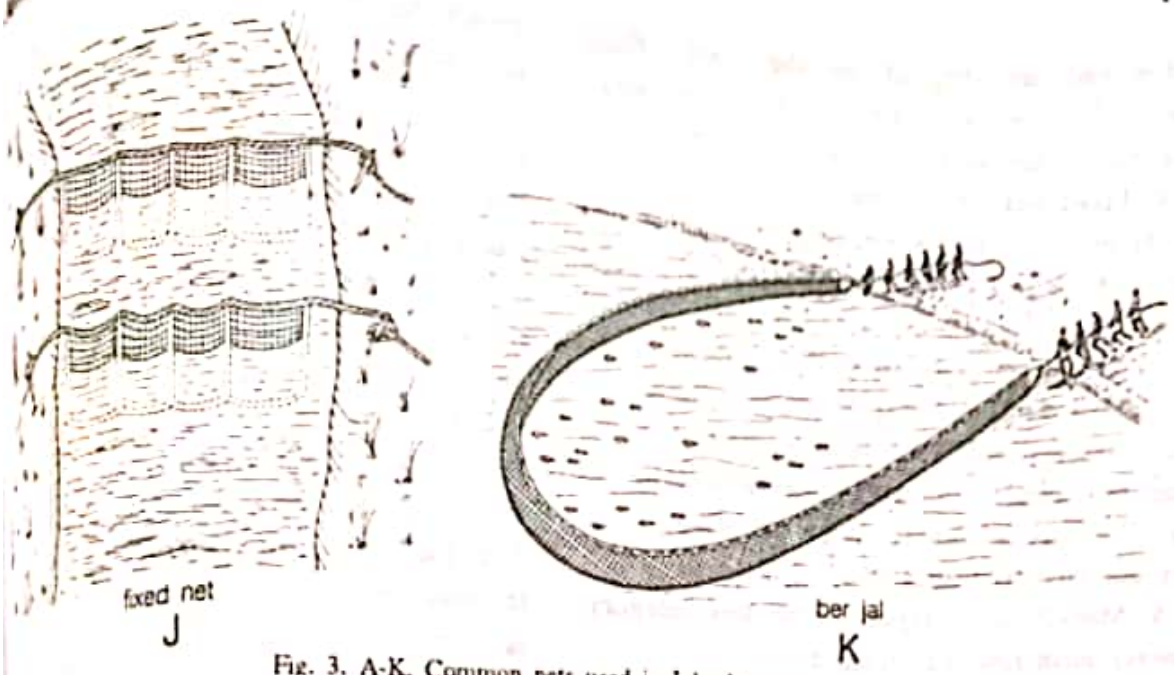

Fig. 3. A-K. Common nets used in Inland waters.

shallow water like *Channa, Heteropneustes,* and *Cuchia eel.* This method proves when a number of fishermen work

Hand net. Main two types of hand nets mainly operated in Inland waters.

Cast net. In the districts of eastern U.P., called *Ghagaria net.* It is a circular net shape of largest umbrella. A strong cord tied to the apex and a number of lead or weights are fixed all along the margine. It is done by single fisherman. He throws the net spread over the water, keeping the long rope in hand. It has to be done very skilfully when the net falls on the pond surface water spreaded. The net sinks to the bottom and circumference closes due to the attached iron weights. All kinds of small and even medium fishes are entangled in the net. Now the net is taken out by means of the strong cord i.e. rope. This net is extensively used in ponds, lakes, etc. It is used only at such places where there is no hard weeds, sharp stones, etc. are present because once it gets entangled, it is likely to be damaged.

Triangular net. It is very commonly used in parts of eastern U.P. It is a conical net, like butterfly and made up of strings. The mouth of the net is kept open by bamboo sticks in the form of a triangle. One of the sticks is longer than others as a handle. The closed end of the net serves as a reservoir, called locally as *'Bhog'*. This net is operated in shallow waters near the river bank, and is dragged slowly in water with the help of the handle. The fishes enter the reservoir and are collected. This net may be operated from boat also, using a long handle.

3. Drag net. Drag nets are generally used in summer season as the water becomes shallow in the rivers. The common drag nets used in Inland waters are—Chanti net and Mahajal net.

(a) Chanti net. This net consists of stout, tough mesh, to the bottom of which iron or stone weights are tied. On the top, various floats are fixed. The bottom of the float is intervened to form the catching zone. Through the top meshes of the net runs a thick, and strong cord which is held at either ends by a number of fishermen. This is stretched out in the rivers from the bank to bank. The entire net may rotate at a circular point. Fishes are captured in the bhog.

(b) Mahajal (Long drag net). Long drag net, called Mahajal are used in such rivers where the force of water current is fairly strong and the water level is sufficiently high through out the year. One end of the net is tied to a peg on the bank and the other end is fixed on to a boat, which proceeds into the river in an elleptical path and thus, returns to the very place from where it started. In this way the two ends of the net meet

together and are dragged on the bank. Huge amount of fishes are captured, however, small fishes may escape as the meshes are pretty wide.

4. Fixed net. It consists of long rectangular piece of mesh which is stretched from one bank to the other bank of the river and held up by several bamboo sticks in the middle. The net projects about one to two feet above the surface of the water and is kept in this position throughout the night with the help of bamboo sticks. Fishes swimming along the stream are entangled in the bhog. This type of net is commonly used in the rivers and their tributaries of Uttar Pradesh.

5. Miscellaneous types. Under this category, following main nets are included.

(a) Been jal. It is a bagnet set against tidal current. It is tied to bamboo poles or stakes. Floats are tied to the lateral wings. It is used in the capture of small-sized fishes in deltas of rivers of West Bengal.

(b) Shanglo jal. It is a type of purse net used in the upper reaches of estuaries. It is operated from a dug-out canoe.

(c) Ber jal. It is a large-sized seine net for the capture of the fishes in Gangetic waters. It is operated from boats or by wading.

Angling (Line fishing)

This is the ancient method for catch of fishes. The principle of line fishing is to offer a real or artificial bait to entice (allure) the fish. It is carried out by poor fisherman who can not afford to have costly nets. Previously, a thorn was used as a hook, but now metallic hooks of various shapes (Fig. 4) and sizes are used. The simplest form of this gear used in ponds, lakes, and rivers is the 'hand line.'

The hand line consists of one or more hooks attached at the end of a cotton line (dori). Free end of dori is attached with long bamboo stick (2-5 metre long).

The hook having bait remains in the pond nd the bamboo stick is held in hand or fixed ghtly in mud.

The bait is an essential part of the line hing, and has to be intellegently selected as to attract the fishes by its colour, smell, movement etc. Generally, earthworms, prawns, caterpillars beetles, small fishes, frogs etc. are used. Cockroach may be used only when Wallago has to be captured. A mixture made of flour baked rice and pieces of fish flesh may also be used. The live bait is known to be attractive but not always available. The hook is baited in several ways.

In hand lines, there is only one line with sinker and snoods. The size of the line, hook and snood depends upon the fish species to be caught. The hand lines may also carry several hooks to increase the chances of fish capture. Its sub-type is long-line having several hooks to capture various fish types.

Unconventional Fishing Methods

The aforementioned methods i.e. the use of crafts, gears, hooks and line operations etc. are

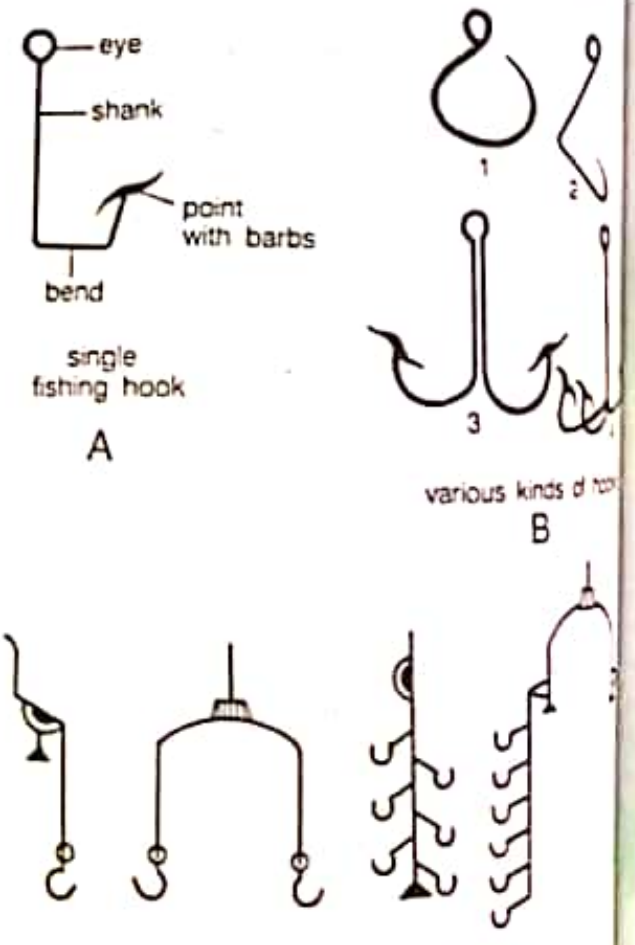

Fig. 4. A-C. Hooks used in fishing

... fishing methods. Unconventional ... methods include electro-fishing, light ... fishing by stunning etc. The common first ... methods are described here.

...rofishing

...ame. Electrical fishing.

...ture. Electric current appears to be ... for fish. It does not affect the growth, ... and the reproductive capacity of the

...antages. Electrical fishing saves time, ... money and man power.

...ent status. Electrical fishing, at present, ... successfully used in several countries and ...mercial scale both for marine and inland

...ciple. In electrical fishing, an electric ...roduced in water between two electrodes ...ode and cathode. Electrofishing operates on ...ciple of concentrating fish in a limited area ... the electrodes, under the influence of an ... field, and then collecting fishes by netting ... other device. Concentrating fish under ... field is based upon behavioural responses ...ons of fish to a certain electric current in ...body. The reaction of fishes (falling in the ... fields) to the three types of electric current ...C. (direct current), A.C. (alternating current) ... interrupted current) is mentioned below :

...eactions of fishes to D.C.

...When voltage appears low, the fishes are not ...fluenced by the electric field and these ...ay escape.

...When voltage crosses certain threshold limit ...e value, a reaction called *electrotaxis* is ...ented by fishes. If the fish is oriented ...transverse position to current direction, ...en it turns parallel to it with its (fish) ...ad directed towards the anode. If in a ...llel position to the current direction, the ...dy of fish starts vibrating.

...a fresh pulse is given, the fish turns ...llel to the current direction and starts ...ming towards the anode. It is called ...otaxis.

(4) The fish gets stupified before reaching the anode. These appear incapable to swim and may turn upside down. Such reaction is referred to as *galvanonacrosis*.

(5) Further, if the electric current is switched off, the narcotized fishes may be able to recover completely.

(b) Reactions of fishes to A.C.

(1) Above the threshold value of voltage, the fishes represent *Oscillotaxis*. All the fishes between the electrodes take up a position transverse to the current direction.

(2) Swimming is ceased and fishes are narcotized.

(3) Body colour fades.

(4) If the electric current is switched off, the fishes do not recover immediately.

(5) For about half an hour, the fishes remain in a state of hypnosis. After the period of hypnosis is over, the fishes return to their normal motion.

(c) Reactions of fishes to I.C.

(1) Above the threshold value of voltage, fishes represent *electrotaxis*. They undergo heavy vibrations and start moving towards the anode.

(2) If the electric current is gradually increased and then abruptly decreased, the fishes turn about and move (orient) towards the cathode.

(3) I.C. has the maximum narcotizing effects on the fishes. A.C. comes next and D.C. in the last place.

Current applied in commercial fishing. In commercial fishing, A.C. and D.C. are used in freshwater, while I.C. is used in seawater.

Methodology of electrofishing. Anodic effects are produced to capture fishes on commercial scale both in freshwater and sea water. In case of freshwater, two electrodes are immersed in water; the anode ard cathode being 2 : 3 in size. The anode carries a hoop net at its base. The stunned fishes assembled at the anode are removed by the hoop net. The electrodes are handy,

45 Economic Importance of Fishes

Fishes are used by human beings in different forms from time immemorial. Millions of human beings suffer due to hunger and malnutrition, and fishes form a rich source of food and provide good staple food to tide over the nutritional need of man. Most of the captured fishes are utilized as food, while others are distasteful and considered unsuitable for human consumption. Similarly, the materials discarded during fish processing also become a waste. Such fishes and discarded materials become an important source of raw materials to fish bye-product industries and are used to produce several useful bye-products. Present chapter deals with the economic importance of fishes as food value and their bye-products.

Food Value

The per capita consumption of fish has been 3.2 kg on an average upto 1992 (5.13 kg for fish eating population / year) as against estimated requirement of 11.0 kg. Pisciculture has the potentiality of popularity due to its on-the-spot food characteristic, balanced nutrients and above all, affordable price.

Fish is rightly considered as the "Poor man's diet." It costs much less in comparison to its food value. It is an almost zero-carbohydrate food, good for diabetics and other such patients. Table 1 outlines the nutritional composition of different fish species. Fish is a rich source of protein, vitamins and minerals with approximate composition as crude protein 14.2-22.8%, fat 0.6-2.4% and energy 76-161 Kcal/100 gm. A special feature of fish flesh food is content of vitamin B_{12} which is almost absent in plant food and also a good source of calcium and vitamin A. Fish also contains poly unsaturated fatty acids which are known to provide protection against cardio vascular diseases. This has got advantages over the other meat food. Fish proteins comprise all the ten essential amino acids in desirable strength for human consumption, namely lysine (high concentration), arginine, histidine, leucine, isoleucine, valine, threonine, methionine, phenylalamine and tryptophan. This accounts for the high biological value (BV) and protein efficiency ratio (PER) of fish flesh than the other flesh food like meat. Fish has a BV, net proten utilised (NPU) and PER of 80, 74 and 35, respectively as compared to meat (74, 76 and 3.2). Further, unsaturated fatty acids belonging to limolinic acid series, present in fish flesh and fish oils are considered to be essential for the prevention of coronary heart disease.

[II] Marine fishes

Elasmobranchs	:	*Sphyraena, Pristis, Scoliodon* and *Trygon.*
Teleosts	:	*Sardinella, Latis, Chanos chanos,* Pomfret, Mumbai duck, *Chirocentrus.*

2. Fish Bye-products

[I] Fish oil

The most important fish bye-product industry is fish oil, which acts as a vehicle for fat soluble vitamins i.e. A, D, E, and K, as well as a source of essential fatty acids for the structure of cell and functions of cell membrane. The oil of fish is categorised into two main types viz; the fish liver oil and fish body oil.

1. Fish liver oil. Chemical composition of fish liver oil is as follows :

Fat	—	55-75%
Proteins	—	5-10%
Water	—	20-36%
Cholesterol	—	0.46-1.32%
Vitamins	—	A and D
Iodine	—	158.7-166.6%

Of the aforementioned composition, the vitamin A, vitamin D and also vitamin E, constitute the most important part of the fish liver oil. Their quantities may, however, vary from fish to fish and from season to season. Cod liver oil, for example, is rich in fat but poor in vitamin A (1000-3000 IU per gm). Halibut and Tuna are rich in vitamin A contents (5,000-30,000 IU per gm). but poor in fat. The livers of sharks generally have the highest contents of vitamin A (15,000-10,00,000 IU per gm) and also highest fat content. Vitamin E present in fish liver oil, exerts a protective action against vitamin A oxidation.

Shark and Cod (*Gadus callarius*) liver oil are well known in pharmaceutical industries. In fact, the prime value of sharks and rays lies in their liver oil. As food fishes, they rank lower than bony fishes on account of their 'urea' flavour. For commercial purposes, the larger the sharks, the better their livers, which yield more oil. Depending upon extraction from fresh or stale livers, oil is grouped into 3 types :

(1) Pale cod liver oil.
(2) Light brown oil.
(3) Brown oil.

Pale cod liver oil is obtained from liver of the fishes, that are brought alive to the shore. They are sacrificed and their livers are separated and heated by steaming in jacketted vessels (under 2 kg/sq. cm of pressure). During heating, the cell membranes of liver cells burst and excuded, oil is collected. This oil possesses highest medicinal value. Vitamin D is independent of vitamin A. In general, the less the oil content of the liver, the greater is the vitamin D content.

Light brown liver oil is procured from disintegrated livers of fishes. Like pale oil, it is also used for medicinal purposes in pharmacy.

Brown oil is not usually preferred in pharmacy because of its extraction which is done from liver of stale fishes. The use of brown oil for various other purposes is, however, noteworthy.

Besides vitamin A, D, and E, other important component of fish liver oil is cholesterol or the crude form of the liver oil is used for tanning leather, tempering steel, preparation of soaps, etc. Practically, no cod liver oil is produced in India, but shark liver oil is frequently produced. The following sharks are exploited for their liver oils : *Carcharhinus melanopterus, C. gangaticus, C. limbatus, Sphyrna blochii, Pristis cuspidatus, Scoliodon walbeehmi,* etc.

2. Fish body oil. Fish body oil is obtained from the entire body parts and not exclusively from the livers. Generally, it is procured from non-edible fishes or from the wastes, discarded during the processing. More usually, the herrings (clupeoids), sardines, salmon, mackerel, sharks, etc. are supposed to be the best for extraction of body oil. The fishes are first crushed to make a pulp. The pulp is subsequently cooked in steam and pressed to remove the oil and water from the body. The residue is dried and powdered to form fish meal.

The body oil is less valuable as compared to the liver of the fish. It is poor in vitamin A and

Species	Moisture (%)	Protein (%)	Fat (%)	Minerals (%)	Carbon (%)	Energy (kcal/kwt)	Ca (mg%g)	P (mg%g)	Fe (mg%g)
(Hilsa)	73.7	19.5	2.4	1.5	2.9	111	530	235	0.9
(Rohu)	76.7	16.6	1.4	0.4	4.4	97	650	175	1.0
(Mrigal)	75.0	14.5	0.8	1.5	3.2	98	350	280	1.1
(Katlasu)	81.0	14.7	1.0	1.3	2.0	76	320	380	0.8
(Mangur)	78.5	15.0	1.0	1.3	4.2	86	210	290	0.7
(Singhi)	68.0	22.8	0.6	1.7	6.9	124	670	650	2.3
(Chital)	75.0	18.6	2.3	1.0	3.1	108	180	250	1.0
	72.3	14.2	10.8	1.0	1.7	161	180	130	0.5
	79.0	14.3							
	53.7	21.8	2.5	2.0	2.2	89	790	200	1.1
			19.4	2.2	2.9	273	180	280	2.1

March, 1998.

phagus fishes have higher protein do fish with other feeding habits. ibility coefficient and BV of the protein species to species. Pelagic species herrings, mackerel, tuna, etc), have high oils concentrations, particularly that of which is largely responsible for the meaty their flesh.

flesh also contains measurable amount nding upon the fat content, the fish may ified as :

ly - Fat content more than 8%.

rage fat - Fat content between 1-8%.

n - Fat content less than 1%.

ough fat is distributed in all tissues but in is present in extraordinary amounts, which excess of the amount normally required function. Such fats are called depot fats. cipal sites of the depot fats in fishes are head tissues, roe, liver, skeletal tissue, ecies connective tissue and viscera (pyloric al mesenteries). Liver in fish is often the e with large deposits. However, brain e highest concentration of fat and heart

principal minerals in fish are Ca, Mg, P, , Mn, Br, I and Cu.

ng few fishes, all are edible. Those e flesh is more watery and tasteless is on account of carnivorous habit and having enough small bones are not utilized as food. In some fishes in which the flesh is poisonous or with repulsive odour, are also not used as food. In general, herbivorous fishes are more tasteful, this is why carps are preferred much as food. Although freshwater fishes are given preference over marine fishes for food, but marine fishes form the bulk supply of food of the world population.

In order of importance, the principal freshwater and marine fishes consumed as food in our country, are listed below.

[I] Freshwater fishes

(i) Major carps	:	*Catla catla, Labeo rohita, L. calbasu, Cirrhinus mrigala*
(ii) Catfishes	:	*Wallago attu, Mystus* (M.) *aor, Mystus* (M) *seenghala, Mystus* (M) *cavasius, Pangasius pangasius, Bagarius bagarius, Silonia silondia, Eutropichthyes vacha*
(iii) Herrings	:	*Hilsa ilisha, Clupea* spp. *Setipinna phasa, Gadusia chapra*
(iv) Feather backs	:	*Notopterus notopterus, N. chitala*
(v) Live fishes	:	*Clarias batrachus, Heteropneustes fossilis, Channa* spp; *Anabas testudineus*
(vi) Mullets	:	*Mugil cornula*
(vii) Miscellaneous	:	*Labeo bata, L. gonius, Tor* sp, *Puntius* spp; *Barilius, Nandus nandus, Chela, Colisa* spp; *Mastacembelus* spp; *Anguilla bengalensis*
(viii) Exotic spp.	:	Grass carp, silver carp, golden carp, big head carp.

(Z-56)

contents, and glycerides of both saturated and unsaturated fatty acids, but it is having high contents of iodine. The iodine value of sardine body oil is about 193% and that of salmon oil is about 16%. Better quality of highly refined fish body oils may be used as edible oil. The medium fish body oil is unsuitable for human consumption hence, it is used in manufacture of laundry soaps, candles, paints, varnishes, cosmetics, lubricants, sodium, printing inks, insecticides, plastics and various chemicals like ammonium salts and halides etc. It is also used in tempering the steel and in coating boat bottoms to protect them against the decay and rot. It is also used as fungicides on various plants.

Sardine oil Industry is well established cottage industry in west coast of India. Sardine oil is obtained from *Sardinella longiceps*.

[II] Fish meal (food for cattle)

Fish meal is prepared from waste fishes left over after extracting oil from the fish. It is also prepared from non-edible fishes of both, the small and large sizes.

Fishes are chopped and boiled to extract the oil. They are then covered with canavas and screw-pressed to form the cakes, that are then dried. Dried cakes are sometimes pressed in hydraulic presses to recover oil and are redried in steam, before being sterlized and packed for marketing. The chief fishes that are used to prepare fish meal include sardines, mackerels, sharks, rays and the silver bellies.

Chemical composition of fish meal

Protein	—	60-70%
Fat	—	2-15%
Minerals	—	10-20%
Calcium	—	5 ± 1%
Phosphorus	—	3 ± 1%
Iron	—	Trace amount
Iodine	—	Variable amount

Fish meal is also rich in fat soluble vitamins like A, D, and K along with water soluble vitamins like vitamin B_1 and B_{12}.

Fish meal constitutes a valuable source of food for pig, poultry and the cattle. Some good quality of fish meal is mixed with maize flour to form fish flour to be used by human beings specially in biscuits and cakes making factories.

[III] Fish manure

Surplus fishes or those unfit for human consumption or when the fishes get rotten due to bad preservation, are used as fertilizers for coffee, tea, tabacco, and rubber plantation because it is rich in nitrogen and phosphates. During peak season, when there is a large supply of fishes or they are landed in spoiled conditions, they are sun dried by spreading them on the beach. The dried fishes are ground and converted into manure.

Fish manure prepared from the dried and putrid fishes are of three kinds viz, the fish manure, prawn manure and the fish guano.

Fish manure is prepared by mixing ash with the dried fishes. The resulting mixture contains about 5-7% nitrogen and phosphate. It is considered ideal for manuring plants.

Prawn manure is also prepared in the same manner from the leftouts of prawn (e.g. head, tail and body exoskeletons). It contains about 5-6% of nitrogen, 3-4% of phosphate and a small amount of lime.

Fish guano is prepared from the fish materials left after the extraction of oil. It contains 7-10% of nitrogen and phosphates and considered a rich nutrient for the plants.

[IV] Fish hydrolysed protein

As mentioned earlier, the flesh of certain fishes is not preferred by human for consumption. These fishes are used to prepare an easily digestible fish protein by the following procedures.

(1) Fish flesh is minced, washed and boiled with dilute CH_3COOH at 80°C.

(2) A thorough washing of boiled flesh is made to remove the CH_3COOH (acetic acid).

(3) Washed flesh is dried, pressed and treated with petroleum to remove the fat contents.

(4) Fat free flesh is hydrolysed with 10% caustic soda at 50°C and the liquid so formed is neutralized with 85% CH_3COOH.

(5) Neutralized liquid is spray dried to obtain cream coloured powder of hydrolysed protein. The hydrolysed protein contains about 35% of easily digestible proteins. It is a valuable food for convalescents and for those suffering from the nutritional deficiencies.

[V] Isinglass

It is a high grade collagen produced from the air bladder or swim bladder of catfishes, carps, sturgeons, cods, etc. It is in the form of shining powder. The Russian isinglass is prepared from the air bladder of salmon, perches and other catfishes, but it is of poor quality. For preparing isinglass, the air bladder is washed to remove blood and other matters. Outer layer is scraped and the remaining inner most layer contains pure isinglass. When dissolved in hot water, forms a gelatin having adhesive property.

Isinglass is used principally for the clarification of wines, beer and vineger. To a limited extent, it is used for preparing jellies and special cements. Formerly, it was used as a substitute of gelatin in confectionery.

[VI] Fish glue

Fish glue is a sticky substance and is prepared from different wastes (e.g. bones, scales and fins etc.) discarded during processing. These are washed, ground and cooked with acetic acid in steam. Liquid is separated and condensed to form the fish glue. It is used as an strong adhesive for papers, files, wood, leather and glass. Glue is obtained chiefly from cods and sturgeons.

[VII] Fish leather

The skin of some fishes, particularly those of sharks and rays are sometimes used by mankind, and is popularly called 'Shagreen'. The skin of these fishes are used for making polishing and smoothing materials in place of sand paper. Specially coloured *Shagreen* is used for covering jewel boxes or for other ornamental coverings. The dried and treated skin is also used for preparing ladies shoes, money bags, belts, suitcases, etc. Dried and spiny skins of Globe-fishes are used as a war helmet by natives of some islands in south seas. *Scoliodon* skin is a good source of *Shagreen*. It is used as an abrasive for polishing furnitures, metals, etc. Greenland sharks (*Somniosus microcephalus* are killed because their skin is used for book binding.

[VIII] Fish pearls

The material obtained by scraping the silvery coating of the scales of certain cyprinid fishes like *Alburnus* and gold fish, is used for polishing the hollow glass beads. These beads are then filled with wax and marketed as artificial fish pearls, used in jewellary.

[IX] Fish soap

The fins of sharks are dried and exported specially to China where they are used for the preparation of soaps.

[X] Fish insulin

The large sized fishes are dissected so as to remove the pancreas for obtaining insulin. Pancreas of the Sharks is ich in insulin.

[XI] Aesthetic value

As a hobby, some beautiful coloured fishes are cultured in aquaria for the decoration of houses. For *Example* : (Gold fish (*Carassius auratus*), Angel fish (*Pterophyllus*), Mollusc fish (*Macropodus*) and different species of *Colisa*.

[XII] Fishes in relation to public health (larvicidal and scavanger fishes)

The causative agents for few diseases are insects, crustaceans and molluscs, the inhabitant of aquatic environment. Several species of fishes are known larvicidal in nature and feed upon insects and their larvae viz; mosquito larvae. Since larvicidal fishes feed upon larvae of mosquito, they help in biological control of malaria and filaria. The important exotic and indigenous larvicidal fishes are mentioned in Chapter 40. Young forms of practically all fishes found in plains eat mosquito larvae. Fishes are cheaper and non-toxic as against chemicals for control of mosquitoes. *Chanda* spp. feed upon cyclops which spread Guinea worm.

others feed upon the molluscs and dead and matters acting as scavangers. Certain water fishes like *Clarias batrachus*, *H. fossilis* *Bagarius bagarius* feed on excreta.

For sports and games

forms an important outdoor game for lakhs people in our country. They catch various of fish and consume them.

Fish biscuits

biscuits are prepared in Chile and Morocco. flour (already described) is blended with mixture before baking.

As bait

fishes are employed as bait for catching fishes and other animals. Flying fishes are used as bait for catching turtles in the sea. forms of *Lamprey*, *Rsbora*, *Channa* and other fishes are also used as baits for game fishes and species of large fishes.

Fish cartilage for cure of cancer

recent scienific report (2004), it has been that Sharks are disease resistant, hence these become the victim of any disease. So much are imune to cancer. The cartilage of therefore, is used in making medicines for of cancer.

Fishes for employment generation

fishes form a rich source of food, millions are employed in fishing industries and upon fisheries for their livelihood in various ways. Besides those who directly catch the fishes for marketing, there are equally large number of people engaged in subsidiary industries like preservation, canning, transport, refrigeration and in the manufacture of fish products and bye-products. Fisheries sector in India provides employment to about 24 lakh full time fishermen and 36 lakh partially engaged fishermen. Around 10% of these are engaged in allied activities related to fishing like marketing, net mending, fish curing and processing (Yojna, March, 1998).

Harmful fishes

Actually, the harm caused by fishes is negligible in comparison to its benefits. Certain fishes viz., sharks and rays are extremely dangerous and cause injuries and even death to swimers and fishermen in tropical and subtropical seas. Sharks also damage the nets of fishermen. Some fishes inflict wounds with their stings and introduce poison which is very painful e.g. *Squalus*, *Trygon*, etc. Among freshwater bony fishes, *Heteropneustes fossilis*, *Clarias batrachus*, etc., introduce poison by the pectoral spine. Similarly, scorpion fishes or toad fishes are the main bony marine fishes which inflict painful wounds.

Some fish species are the intermediate hosts of various parasites causing diseases in human and other animals. Some marine cartilaginous fishes give electric shocks by their powerful electric organs. Some fish species viz., *Tetraodon* spp. have poisonous flesh and may prove fatal to man. Carnivorous fishes eat away the larvae of useful insects.

IMPORTANT QUESTIONS

...ay on the economic importance of fishes.
...e the following — (i) Fish hydrolysed protein (ii) Fish manure (iii) Fish oil.

of the fishes and keep them in palatable state for a few days. However, this method is not suitable, when the intention to keep fishes for a period of more than two weeks.

[II] Deep freezing

For deep freezing, captured fishes are cleaned, gutted, sorted and trimmed to suitable sizes. They are frozen either immediately with in 30 minutes of their catch (quick freezing) or within a period extending from 3 to 72 hours (slow freezing). The freezing is achieved in ice, mixed with salt. Addition of salt brings the temperature gradually down from —1°C to – 18°C. By deep freezing, fishes may be preserved for a very long period. Preservation by deep freezing often causes loss of flavour and slight damage to tissues, Sometimes, the fish becomes tasteless. This may be prevented by wrapping the fishes in wax paper or cellophane and by glazing the fish. Glazing preserves the colour and flavour of the fishes. It should be emphasized that deep frozen fishes should be immediately used after thawing, because surviving microbes begin to multiply rapidly as soon as the frozen fish is warmed.

[III] Freeze-drying

It is a complecated process and requires considerable establishment. As it is a costly and laborious process, only the best fishes are treated. The fishes are first frozen and then dried by sublimation i.e., the ice is converted into water vapour without melting into water. The flavour, colour and nutritive value of the fish remains fully preserved. The fish is first cooked, if it meant for immediate consumption, after opening the packet or tin. The fish is frozen to –20°C by placing it in a freezing chamber. Fish trays are then transferred to a chamber containing horizontal heating plates for drying in a vacuum. The dried fish is packed or canned in air conditioned room.

[IV] Salting

Salting is a form of pickling and is a very old and common method of preserving fish in India and also throughout the world. In salting, the fishes are treated with salt (NaCl) solution. Salt dehydrates the killed fishes by osmosis and enters their body tissues to increase concentration to the saturation point. A concentration of salt above 25% stops further multiplicaiton of microbes and even kills them, specially the halophobic microbes. However, few strains of bacteria like halophilic, remain unaffected causing pink or dun spoilage of the fishes. Normally, 20 kg of pure salt is required for each 100 kg of fishes. It is found that only oily fishes require more salts.

Methods of salting. Three methods of salting have been evolved.

(1) Dry salting,
(2) Wet or brine salting, and
(3) Cold salting.

(a) Dry salting. In this method, fishes are first cleaned, and rubbed with salt powder and then packed in tubs or in cemented tanks. Dry salt powder is sprinkled in between layers, as the fishes are arranged in the container (Fig. 1). The ratio of salt to fish varies from 1 : 3 to 1 : 8 depending on local practice, weather conditions and type of fish. After 2-3 days, the fishes are removed from the tubs or container and dried in the sun for 2-3 days. Dry salt practice in pits for fish preservation is done along the east coast of India and in Andhra Pradesh. Such preserved fishes are of inferior quality but find good market among the poor classes.

(b) Wet or brine salting. Wet-salting is mostly practised on the Konkan coast. Cleaned fishes are packed in large containers having a concentrated salt solution (20-30%) and stirred daily till properly pickled. Large-sized fishes like the Indian salmon, seerfishes and black pomfrets are gutted first and inside is cleaned. Also, longitudinal slits are made in the flesh to allow penetration of salt. Salt is applied in the following successive stages. On the first day, half of the salt is rubbed into the incisions and the fishes are stored on the cemented floor of the curing yard. On the second day, the fishes are shuffled so as to bring the bottom layer on top and half of the remaining salt is rubbed and the fishes are

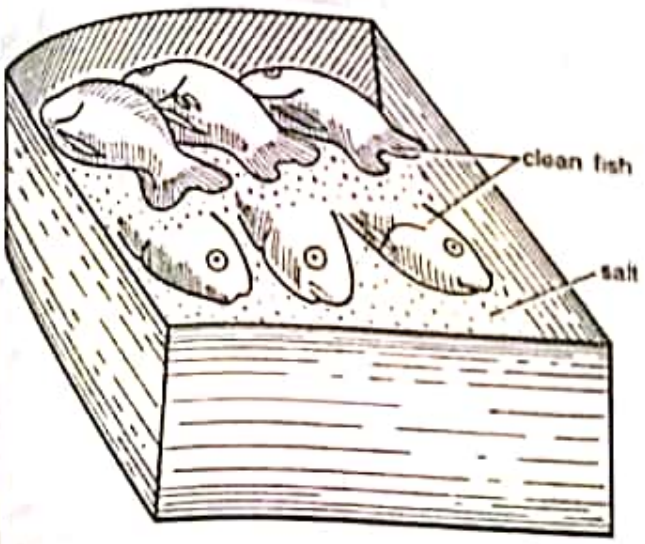

Fig. 1. Salted fishes in container.

stocked. The stock is left undisturbed for 7-10 days. The salty water that oozes out from the fishes is allowed to drain off. Wet salted fishes may be sold without drying. It does not keep good for long and, therefore, has to be used within 3-4 months.

(c) Cold salting. This is done by spreading powdered salt and crushed ice on the fish. About 22-26 *lb* of powdered salt per 10 kg of fish is usually recommended. After salting, the preservation is done in cold rooms, having a temperature range of 2-3°C.

How to use salted fish. Before use, salted fish should be soaked in freshwater overnight. Change of the water atleast once during this time is required. The soaking removes the salt. The longer the fish is soaked, the more salt is removed. After the fish has been soaked, it can be used in any way like fresh fish.

[V] Smoking

Smoked fish is not as popular in India, as it is in Western countries like Norway and Sweden because the peculiar smoky flavour is not relished by Indian fish eaters. However, small quantities of surplus fishes are smoked in Chennai and Orissa. Sardines, mackerels, seerfish, pomfret, jew fish and hilsa, are considered good varieties for smoking.

Fishes are first cleaned and gutted and then soaked into salt solution or brine. They are taken out from the salt solution and are suspended on rods in smoke house. Smoke house (Fig. 2) is merely a shed or a box over a fire, which is controlled so that it produces smoke instead of flames. The fishes are merely hung inside the smoke house (from head to tail), so that they are surrounded by smoke. It takes about six hours to smoke fishes so that they can be eaten or stored.

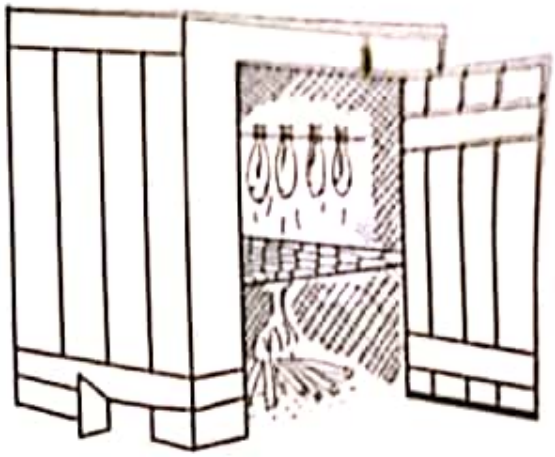

Fig. 2. Smoke house.

Smoked fish does not last as long as salted fish, because it must be refrigerated, frozen or canned, if it is to be stored.

Smoking removes additional moisture and increases the flavour of the fish flesh. Smoke has a preservative effect, which is ascribed to its phenolic constituents.

[VI] Drying

The object of drying is to remove moisture (dehydration) from fish tissues. This helps to arrest bacterial and enzymic putrefaction. When moisture contents reduce upto 10-20%, the fishes are saved from being spoiled, provided they are stored in dry conditions. Sun drying is the most ancient method. In India, over 35% of the total catch of sea is cured in the sun.

Small marine fishes, such as ribbon fish, silverbellies and Mumbai ducks, are spread on the open sandy beach. Sometimes, mats made of coir or palm leaves are used for spreading the fishes. Often, fishes like Mumbai ducks are hung on bamboo or wooden rods or on ropes stretched horizontally between poles (Fig. 3). Large and

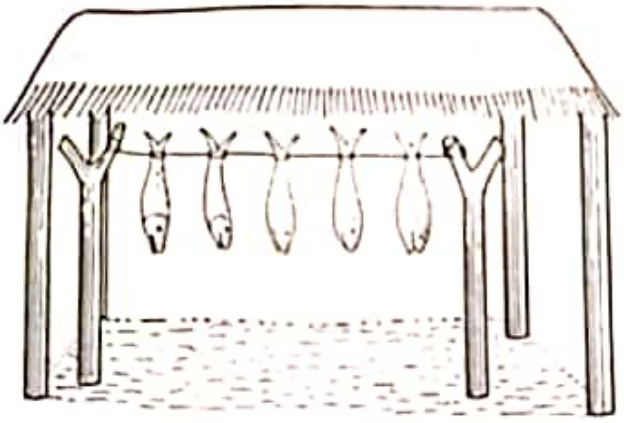

Fig. 3. Drying the fishes in shade.

medium-sized fishes are usually gutted and salted before drying.

Fish drying can be achieved either naturally or by artificial means.

Natural drying. In natural drying, the caught fishes are cleaned and dried in the sun shine, so called sun-drying. It is actually not the ideal way of preservation. It has certain disadvantages. It is not hygienic. It is slow and results in much loss through putrifaction and spoilage and the dried fish develops a peculiar odour. It can be carried out only in dry, well aerated climate receiving sunshine, which is not too hot. It, thus depends upon the environmental factors and availability of space. So much so, only the thin fishes can be preserved by this method, because the fat fishes have much flesh allowing microbial decomposition to continue in deeper parts of their body.

Artificial drying. In artificial drying, the killed fishes are cleaned, gutted and decapitated. They are then cut lengthwise to remove large parts of their spinal column, followed by washing and drying them mechanically. This process yields a high quality product, which retains the natural flavour and nutritive values.

[VII] Canning

This process of fish preservation was initially evolved in Europe and now introduced in other countries including India. It retains the natural flavour of the fish. Whenever available in large quantities, sardines and mackerels are canned on the west coast of India like Calicut, Goa and Mumbai. Canning involves packing of fishes in the boxes to preserve them for a long time. Canning is a complicated process and costly machinery and technical expertise is required. Hence, the canning products are costly. The process includes packing of fishes in tin boxes which are sealed airtight and sterilized by heat. Pasting, pickling and spicing are indigenous methods of the east. The fishes are cut into slices, salted and dried.

The fishes used for canning are gutted out and cut into pieces of suitable size. Their head, tail, fins and viscera are removed and the pieces are dipped in brine to remove blood etc., from the tissues. Pieces are now immersed in hotwater or exposed to the steam to remove adhering materials which could not be removed by cleaning with cold water. Pieces are salted and dried.

They are then mixed with a spicy paste ground by mixing vineger, red chillies, mustard, garlic, turmeric and tamarind in oil medium. For pickling, usually mackerel and sardines are used. Finally the processed pieces are sealed in containers, preferably tin boxes or jars. The sealed containers are again subjected to heat treatment to kill completely the microbes left in the flesh of cut pieces of fishes. Containers are tested before their transportation to the market.

Processing. Fish processing includes all the processes discussed above as cleaning, freezing, drying, salting, canning etc. Fishes may also be processed into edible meals and oils (that are obtained as bye – products of the fish industry, described in Chapter 44). Fish meal is prepared from discarded body parts of the fish as fins, gills, gut, etc., by processing. Major part of the fish catch is consumed as fresh, preserved or in salted form, but there is good scope for various bye – products of the fish industry.

Demerits of fish preservation. Although the preservation and processing constitute a very important aspect of the fish industry, it has certain drawbacks as well, particularly with respect to retaining quality of fish flesh. The demerits are described here briefly in the following points :

If proper hygienic measures are not adopted during the processes like cleaning, gutting and evisceration etc., more harm would be resulting to the preserved material owing to increase in the microbial population.

Poor or incomplete preservation leads to decarboxylation of flesh amino acid i.e. histidine to histamine. The histamine and few other related substances collectively named saurine, are the common causes of fish food poisoning.

Drying reduces weight, nutritive value and the digestibility of the fish flesh.

Chilling brings about denaturation of the fish flesh. It is because of the ice crystals formed during chilling and causing mechanical damage to the muscles. Cell membranes burst, structures get deformed and the fish flesh loses much of its flavour, and taste. The flesh becomes dehydrated and loses its texture too.

(5) Excess salting allows growth and multiplication of salt tolerent bacteria, causing 'Pink eye' spoilage of fish flesh.

(6) Salting combined with smoking results in loss of protein (about 1-5% due to salting and 8-30% due to smoking).

(7) Smoking also promotes rancidity of fat contents of flesh and hence diminishes digestibility of fat products.

(8) Canning leads to much loss of vitamin B_1, pantothenic acid, and ascarbic acid.

IMPORTANT QUESTIONS

Write an essay on fish preservation and processing.

Give the reasons for spoilage of fishes. Describe the methods of fish preservation.

Short notes on the following — (i) Short duration preservation (ii) Long duration preservation (iii) Refrigeration (iv) Deep freezing (v) Freeze-drying (vi) Salting (vii) Smoking (viii) Drying (ix) Canning (x) Demerits of fish preservation.

46 Fish Preservation

Preservation of fishes is a very important part of commercial fisheries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of taste, odour, flavour, nutritive value and the digestibility of their flesh. Fishes are quickly perishable commodities and are spoiled if not properly preserved. During peak period, large quantities of fish are caught and require proper preservation so as to be available during lean period. After preservation, fishes can be transported to long distances for consumption. In India, with its tropical and subtropical climate, the problem is more acute, as heat and moisture promote fish deterioration. Landed fishes may ordinarily remain fresh for not more than 8 hours and begin to decompose rapidly after that.

Reasons for Spoilage of Fishes

Fish spoilage occurs chiefly due to three acting agents :

(1) Microbial action,
(2) Enzymatic action, and
(3) Chemical action.

[I] Fish spoilage due to microbial action

Microbial action involves chiefly bacterial spoilage of the fish flesh. A large number of bacteria present on the body, gills and gut of the fish find a good medium for development due to high moisture (75-80%) contents in the fish flesh. More bacteria are further added during handling and storage in unclean places. Fishes get cuts, abrasions etc., during catching operations, leading to haemorrhage. These provide an ideal environment for bacterial activity which are most destructive to the fish. Proteins in the fish flesh are degraded by proteiolytic microbes such as *Pseudomonas*, *Proteus*, *Chromobacterium*, *Halobacterium*, *Micrococcus*, etc. The carbohydrates present in small amount in the fish flesh are degraded by carbohydrate fermenting microbes like *Streptococcus*, *Leuconostoc*, *Micrococcus*, etc. Fat contents of the fish flesh are decomposed by relatively few gram negative bacteria. Degradation occurs through the processes mentioned as below :

$$\text{Proteins} \xrightarrow{\text{Proteolytic microbes}} \text{Amino acids + amines + ammonia + } H_2S + CO_2$$

$$\text{Carbohydrates} \xrightarrow[\text{microbes}]{\text{Fermentive}} \text{Acid + alcohols + gases}$$

$$\text{Fats} \xrightarrow{\text{Lipolytic microbes}} \text{Fatty acids + glycerol}$$