

SHOM TANG MUIK (Bamboo Harpoon for Squids)

This gear consists basically of a bamboo pole 1½-2 m long and 3-4 cm in diameter. The larger end of the pole is split into 8-10 parts for a distance of about 30 cm. The tips of these sections are sharpened. A wooden disc with slightly larger diameter than that of the pole is inserted into the opening of the large end, between the splits, and is pushed gently down to a depth that gives the desired degree of spread to the splits. The regions in front of and behind the inserted disc are then tightly bound with strong hemp string.

Construction

Used as any other harpoon. Fishing is done along the coast on dark nights. A small sampan is used, carrying two persons; one handles the harpoon and the other manages the boat. A lighted lamp is hung on a short pole to attract squid.

Fishing Operation

Squid.

Catch

In Goh Chang area, fishing is done the whole year round.

Distribution of Gear

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A CONSIDERATION OF THE CLASSIFICATION OF FISHING GEAR AND METHODS

by

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ABSTRACT

A review is given of a few papers which have presented classifications of fishing gear and reasons are given for regarding these as unsatisfactory. The 'true' properties of fishing gears are listed and their value as a basis for classification is discussed, and it is concluded that the precise manner of capture is the most characteristic feature of a gear. A classification based on this characteristic is offered.

The diversity of instruments used for the capture of fish and the widely differing nomenclatures of such gears necessitate the formulation of an effective system of classification as a preliminary to the enumeration of fishing methods in any area. Such a classification would simplify both descriptive and comparative work since, if the major property of the gear is accepted as the basis of the classification, the description would require only such additional information as would distinguish it from other gears of the same group.

EXISTING CLASSIFICATIONS

Various classifications have been proposed in the past, generally as a prelude to the systematic description of the fishing gear of a limited area. One of the most important of these was that propounded by Davis (1927), in which he divided the

fishing gear of England and Wales into five major classes, i.e., fixed instruments, drift nets, movable drag nets, baited traps and man-power instruments. This classification was not satisfactory and Davis found it necessary to disregard it where, for the sake of simplicity and greater clarity, gear strictly belonging to one division could be more easily described and explained under another head. It will be observed that the first three classes are determined by the position of the gear during operation vis-a-vis the sea bottom, the fourth by the method by which the fish are brought into relationship with the gear and the fifth comprises a miscellaneous collection of gear, usually operated by one man. Thus it will be seen that the classes are of unequal determination and this alone constitutes a major objection to the validity of the classification. Moreover, consideration of certain local methods establishes the inadequacy of this system for the examination of the fishing gear of South-East Asia. For example, the large Chinese lift net with its supporting scaffolding and lever mechanism is normally used as a fixed instrument in Asia, but a similar net differing in detail only, is operated from boats in parts of Asia and Africa. Smaller versions of the net without a scaffolding and lever system are in common use throughout South-East Asia, one of these—the

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crab lift net being operated as a baited trap. In the classification proposed by Davis these nets would be separated into three distinct classes, but as the nets are so similar in construction and method of operation this is unwarranted. Pearson (1922) quotes an example of a drift net in Ceylon which may be used as a set net or as a seine, i.e. it would be classified as a fixed instrument, a drift net or a movable drag net depending upon its use at the particular time. In Malaya, such an illustration is not available but gill nets of similar design may be set or allowed to drift according to the wishes of the operator. This is particularly true of the small gill net used for the capture of ikan tamban (*Harengula* sp.), which may be attached to a fishing stake or operated from a drifting boat in conjunction with a coconut leaf lure.

The Burma Fisheries Act (No. III of 1905) includes a schedule of fishing implements which are divided into fourteen groups. Although for the purposes of licensing and revenue collection this classification may be adequate, there are many objections to its wider use. In particular, the groups have been based on various features including size, design, the precise mode of capture, the location and the actual method of operation. For example, Group B—Drift & Float Nets, differs from Group C—Plain Fixed Nets, in minor detail only, and the individual nets in each group show wider variation than do the groups themselves. Group F—Purse, Pouch or Bag-nets: includes all bag-shaped nets into which fish enter voluntarily or are carried by the current, and they differ from Group G—Anchored Entrapments only in so much as the latter are constructed from split bamboo. Furthermore, group F includes a surface trawl which has more in common with the drag nets than with the filter nets which largely compose this group. Group M—Miscellaneous is, of course, a most unsatisfactory division as it contains a heterogeneous collection of methods including spears, plunge baskets, boats with jumping platforms, poisons, explosives, fish smothering and collection by hand. The differentiation between obstructions not closing a water-way (Group L) and those doing so (Group N), while of great conservatory importance, cannot be accepted as a basis for classification, since both may operate as set barriers. For example, the yindan in Group L includes barriers set across and enclosing a river or backwater.

Pearson (op. cit.), in his description of the fishing appliances of Ceylon, classified the nets according to their method of operation but held rigid classification to be impossible because nets are frequently used in different ways on different occasions. His classification recognised the following

major groups :—Fixed Stake Nets ; Fixed Net with Bag ; Seine Net with Wings and Bag ; Drag Net ; Vertical Gill Net (with floats at top and weights at bottom) ; Gill Net (without floats or weights) ; Gill Net (floating, not vertical) ; Horizontal Net ; Casting Nets ; Circular Gill Net ; Fish and Crab Traps ; Line and Hook ; *Kottus* (Fish Shelters) ; Spears ; Landing Nets and Sundry Devices. Unfortunately the descriptions are often inadequate for detailed consideration but it is clear that the classification is not valid, since gears in which the method of operation differs have been included in the same group. For example, fixed stake nets include not only complicated fishing stakes and simple filter nets but also the *Kondadi valai*—a typical drive-in net. The latter is similar to the *Vadu valai* (a gear which is in a separate group) “except that it is not supported by stakes”, and it would appear that Pearson has confused design with the method of operation. Similarly fish and crab traps include baited lift nets and gears with non-return devices in which the method of capture is similar, i.e. they are used to trap the catch, but the detail of the operation is very different. Fish traps with non-return devices do, in fact, show a closer resemblance to some of the large fixed stake nets than they do to the baited lift nets.

Hornell (1925 & 1938), in a description of the fishing methods of the Madras Presidency, does not propose any specific classification but he describes the gears in a systematic manner, particularly in his later paper. In a recent book published posthumously (Hornell, 1950), he extends the scope of this work and adds much to comparative knowledge of fishing gear. The book, although systematic in conception, contains no general consideration of all fishing gear, various groups being considered by their evolutionary origin, the precise method of capture employed, the mode of operation, the species taken or the method in which the fish are brought into relationship with the gear.

Tham Ah Kow (1949) summarises the main fishing methods utilised in Malaya and employs a classification in which the principal divisions are nets, lines, traps and miscellaneous methods, a classification in which the last division includes spears, explosives and poisons. Apart from the objection to classifying widely divergent methods of fishing under the single head ‘Miscellaneous’ this classification, like that proposed by Davis, includes determination by constructional design, e.g., nets and lines and by method of operation, e.g., traps. In consequence the classification contains several anomalies, for example set barriers may consist of stone or earthen bunds and may include entrapment devices; in either case such gears could not be

classified as nets. Certain of the less complex traps, e.g., the *ambai* and *jermal* are very similar to gears included as nets and the major sub-division of nets into moving and stationary gears is clearly unsatisfactory as gillnets may be used either set or drifting as the occasion demands. Moreover, nets in which movement is an essential part of the operation, e.g., seines and castnets, are grouped with drift nets in which the movement is of subsidiary importance. On the other hand, the raising movement of lift nets is an operative feature although the gear may or may not be geographically stationary.

There are, no doubt, other classifications to which the author has not had access but it is clear that none proposed to date can provide a suitable basis for the detailed consideration of the fishing gears of more than a restricted area. It is, therefore, desirable to examine the principle on which a valid classification could be constructed.

THE PRINCIPLES OF CLASSIFICATION

A valid classification of fishing gear and methods can be determined only by the recognition and appraisal of their essential properties. These attributes can be summarised as follows :—

1. The precise manner in which capture is effected.

2. The method by which the fish are brought into relationship with the gear.
3. The actual method by which the gear is operated.
4. The power required for operation.
5. The constructional design.
6. The materials for construction.
7. The location of operation.
8. The species captured.

1. Precise Manner in which capture is effected

The actual point, which is to be determined in assessing the precise manner by which capture is effected, is that at which the fish is restrained or possibly killed. Thereafter it is either removed directly from the water by the gear, or is brought to or held in a condition in which it may be so removed, its chances of escape being negligible. It is clear, therefore, that the method by which the fish is brought into relationship with the gear, e.g., the use of bait or guiding barriers, and the subsidiary technique of removal from the water are to be disregarded in this consideration.

The methods can be summarised as follows :—

1. INDIVIDUAL OR SPECIFIC

Methods in which individual fish are the subject of capture operations.

Precise Manner in which capture is effected	Type of Gears	Remarks
1.1 To seize or grasp.	Manual collection of fish and shell-fish, artificial fish-holes, octopus pots, plunge baskets, etc.	A simple and clear-cut division which includes those methods which have been developed from manual collection to render it more effective, e.g., the construction of artificial fish-holes in the bank of a stream from which the fish are subsequently removed by hand (Burma & India), and the use of earthenware pots in Japan, Italy, etc. for the capture of octopuses. The snare line (<i>Valla vala</i> of the Madras Presidency) is an excellent illustration of the development of manual collection—the line, which is ornamented with young coconut palm leaves, being used to scare the fish towards the operator.
1.2 To rake.	Rakes.	Comb-like instruments operated by drawing through sand or mud, or used for detaching shell-fish from rocks.
1.3 To strike or hit.	Jungle knife.	In certain fresh-water fisheries of Malaya, a <i>parang</i> may be used to strike at and disable fish which are attracted to the operator, who carries a lighted torch. The use of a sickle in the Madras Presidency is, however, more akin to hook fishing as it is mainly used as a <i>guff</i> . This is also true of the <i>Mahu kottanakaduwa</i> of Ceylon.
1.4 To snare.	Snares, loop-fishing.	Snares and loop fishing secure the fish in a loop of twine or wire. Various methods are used to bring the fish into relationship with the snare, e.g., baits, lures, searching.

Precise Manner in which capture is effected	Type of Gears	Remarks
1.5 To choke.	Bait-holder or gorge, baited.	These instruments consist of a small rod tapering to a point at each end and attached in the centre to a line. Fish taking the bait with which it is furnished are secured, the gorge resisting withdrawal. The baited spring gorge (India) is constructed of flexible bamboo. It is set by bending the ends together securing them in an insect which forms the bait.
1.6 To hunt with trained animals.	Cormorants, sucker fish, otters and dogs.	The capture of fish by the use of trained animals is found in Asia, America, Australia and Europe.
1.7 To impale.	Spears, harpoons, arrows and darts.	This is a clear, well-defined division requiring no further comment.
1.8 To hook.	Hand-lines, rod and lines, long-lines, troll-lines, jigs, gaffs.	A well-defined group in which capture is effected by the penetration of a curved point. Hooks may be single or multiple, may be barbed or not, and the methods by which the fish are brought into relationship with the gear may vary.

2. INDISCRIMINATE OR DIFFUSE

Methods, which are usually indiscriminate or diffuse in action, affecting all fish within the area of operation.

2.1 To poison.	Poisons.	The use of toxic substances to stupefy or kill fish is widely distributed throughout the world, a fact which suggests its early origin.
2.2 To suffocate.	Fish smothering.	This is an ingenious method, employed in waters of low oxygen-content, in which air-breathing fish are killed by denying them access to air.
2.3 To stun.	Explosives.	The use of explosives to stun or kill fish, although of comparatively recent origin, is widely distributed in spite of the fact that it is illegal under most fisheries legislation.

3. MULTIPLE OR COLLECTIVE

Methods, in which generally a group or association of fish are the subject of capture operations.

3.1 To enclose.	Set barriers, fish weirs, etc.	Fishing gears in which capture is effected by means of a simple barrier which prevents the escape of fish from a natural area which they have voluntarily entered.
3.2 To screen.	Filter nets and stake nets including <i>ambais</i> , <i>jermals</i> etc.	Instruments set in moving water, with or without guiding barriers, which effect capture by screening out the catch which is prevented from leaving the trap by the force of the current.
3.3 To confine.	Portable fish traps, certain fishing stakes, tubular traps, thorn-lined traps.	Structures which permit ready access but from which exit is hindered or prevented by a structural non-return device.
3.4 To restrain in air.	Jumping platforms with barriers, anchovy boards, platform and verandah nets, pit-falls.	Instruments which effect capture by exploiting the habits of certain fish which readily leave the water, e.g., mullets, the fish being encouraged to do so by the use of an apparent obstruction. It is usually accompanied by scaring and their return to the water is prevented by a pit or intricate obstacle.
3.5 To enfold by raising or lowering a structure.	Liftnets, drop nets, cast nets, thrust or push nets, dip and scoop nets.	Structures which are raised or lowered to trap fish below or above them.

Precise Manner in which capture is effected	Type of Gears	Remarks
3.6 To mesh or entangle.	Drift and set gill nets, encircling and drive-in gill nets, tangle nets, trammel nets.	Netting or similar structures in which capture is effected by the actual meshes, either by gilling in an individual mesh or by tangling the fish in several meshes.
3.7 To engulf.	Drive-in and closing bag nets, clap nets, pouch nets.	Structures in which capture is effected by engulfing the fish which enter the gear voluntarily or as the result of scaring, the capture not being completed until the gear is closed.
3.8 To invest.	Seines, dredges, trawls, purse seines, lamparas, snap nets.	Structures in which capture is effected by investing the fish, the capture being completed by raising the gear.

It will be seen that this principle provides a reasonable basis for an outline classification, although it is to be admitted that difficulties will be encountered in the case of individual gears operated in more than one manner, where the precise method in which capture is achieved differs. The case of a gill net operated as a seine, e.g., the Parrot fish gill net of Hongkong, illustrates this difficulty, but it is unlikely that such a practice is common, particularly in view of the continued development of fishing methods. Clearly a dual purpose gear may be of advantage in a primitive community, but its survival in the face of the competition existing in the more-specialised fisheries will be rare.

Individual or specific methods of capture form a well-defined division except for those in which use is made of trained animals. This particular group contains a heterogeneous collection of methods in which the sole similarity is the use of a trained animal. The animal may be employed in the actual capture operations, e.g., sucker-fish and cormorants; may simply locate and keep the fish engaged while capture is effected by hand, e.g., dogs; or may drive the fish into a net or other structure, e.g., otters. In view of the very specialised nature of the operations it is, however, considered desirable to group the methods in spite of the differing manners in which capture is effected. It may also be argued that the use of rakes and striking implements is only preliminary to manual collection and there is little doubt that this is true in the case of the former. In the latter case, however, a well-aimed blow may kill or seriously injure the fish and render the subsequent method of capture one of minor importance. This method is, however, clearly a development of manual collection and can be considered as such, although in the preceding summary both methods have been separately included for clarity.

The position of the plunge-basket may also be questioned on the grounds of its similarity in operation to both the set barrier and to a lesser extent, the purse seine. This fishing gear consists of a sub-conical basket, open at each end, with an extension of the frame into a series of short spikes at its broader periphery. It is operated in muddy padi-fields or marshy areas by plunging it into the water and pressing the bottom firmly into the ground, any fish that may be trapped within the basket being removed by hand. It has, however, been included as a form of manual collection, of which it is clearly a development, the actual capture being effected by grasping the catch with the hand. Furthermore, although the fish is restrained in the first place by the gear, in soft muddy areas, it may escape by burrowing.

Indiscriminate or diffuse methods of capture form a homogenous division in which the method is directed at the fish within a certain area. It is characterised by the fact that the fish are rendered inactive by the method employed and can, therefore, be collected without difficulty. It may be argued that these methods are not necessarily methods of capture but are used as a preliminary to the manner in which the fish are actually secured. For example, explosives are used to quieten 'wild' tuna in order to permit encirclement by a purse seine. The degree of restraint imposed in this case depends on a number of factors, one of the more important of which appears to be the distance of the fish from the actual point of explosion. Obviously nearby fish are killed or fully restrained and their subsequent collection in a purse seine is merely a question of the subsidiary technique of securing the catch.

Multiple or collective methods of fish capture include all those gears in which the operations are directed at a group or association of fish, the capture

*The term snap net is used to describe small folding nets of laced banyan-bark strips operated by the aborigines of Arnhem Land. These nets are snapped open and shut with a horizontal movement investing any fish that are caught between the wings. (National Geographical Magazine, December, 1949. National Geographical Society, Washington).

of individual fish being incidental to the main operation. In this respect it stands distinct from the individual or specific methods and probably reflects fisheries development parallel to the progress of a primitive community from hunting to trapping.

2. The Method by which the fish are brought or come into Relationship with the Gear.

The study of the methods by which fish are brought or come into relationship with the gear necessitates a knowledge of the movement or pattern of distribution of the fish concerned. Clearly there are two broad patterns, the 'random' move-

ment which cannot be correlated with any physical factor or stimulus and in which no degree of freedom is lost by orientation to any vector, and that in which the fish orientate themselves to a stimulus. Accepting this major division, further differentiation can then be made in the latter group by the nature of the stimulus concerned. It is also desirable in certain cases to recognise that the nature of the stimulus can be resolved into its gross form and its intensity. Complications, however, arise as the information available regarding fish behaviour is limited and in consequence no classification based on this principle can be final or accurate at this stage.

Using this principle it is possible to group the more important fishing gear and methods as below :—

Method by which fish is brought or comes into relationship with the gear	Fishing Methods	Remarks
1. "Random" Incidence	Manual collection ; plunge baskets ; rakes ; spears ; long lines of unbaited hooks ; hunting by animals ; set barriers ; filter nets & stakes ; scoop nets ; push nets ; cast nets ; drop nets ; lift nets ; gill nets in still water ; manually operated bag nets ; dredges ; trawls ; seines ; purse seines ; poisons ; explosives and fish smothering.	Filter nets and certain fishing stakes which screen the catch from moving water are included as the fish do not orientate themselves to the current but are carried bodily by it.
2. Orientated Incidence		
2.1 Rheotactic	All gears utilising the orientation of fish to a current of water e.g., fish shelters with baited hooks, lift nets operating with coconut frond or other shelters ; certain fishing stakes, e.g., a <i>kelong</i> and <i>belat</i> with guiding barriers sited to obstruct movement in response to currents ; gill and tangle nets.	Gears in which the response of the fish to a current of water brings it into relationship with the gear, a response which may be with, against or across the current. It does not include filter nets in which the current carries small fish and prawns into the net, and it is typified by the salmon 'putcher' used in the Severn district of England. This is a trumpet-shaped instrument into which a salmon, swimming in response to the stimulus of the current, enters and becomes fast.
2.2 Phototactic	All gears to which the fish are directed in response to the stimulus of light.	
2.21 Intensity	Jungle knife ; spears ; gaffs ; dip nets ; lift nets ; certain fishing stakes, e.g., <i>kelong</i> ; purse seines ; beach seines etc.	All gears to the area or range of operation of which fish are directed in response to the intensity of a light source.
2.22 Form	Use of visual lures in manual collection i.e., 'ratlure' (Polynesia), spears, unbaited troll lines and hooks, unbaited traps.	Although lures used in various form of fishing probably stimulate the feeding responses of the fish, it is clear that there is a further fish behaviour mechanism which is visual, i.e., the inherent curiosity of certain fish. Unbaited traps rely upon this mechanism and the curiosity of <i>Stromateus</i> is so great that a shoal can be distracted by an operator in the water while the net is set around them.

Method by which fish is brought or comes into relationship with the gear	Fishing Methods	Remarks
2.3 Chemotactic		
2.31 Feeding Behaviour	Spears, poisons, set barriers, baited loop fishing, gorges, hooks, lift nets, dip and scoop nets; baited fish traps.	Includes all fishing gear in which feeding behaviour is exploited, i.e., all baited gears or gears in which "chumming" is used to attract fish. (Poison is included, as one form of fishing known in Malaya consists of introducing bait containing a stupefying substance into areas believed to be harbouring large fish.)
2.32 Other Chemotactic Responses	Use of noxious fluids to drive fish into entrapments	
2.4 Sound and Other Scarer Devices	Manual collection, plunge baskets, snares (Tonga) lift nets, jumping or platform traps, drive-in and encircling gill nets, drive-in nets, seines, trawl nets.	This includes all gears in which scarer devices are used to direct the fish into the gear. A typical scarer device on a small trawl operated in Singapore consists of a group of shells attached to each warp. Jumping or platform traps include the employment of a device to ensure that fish leap a suspected obstacle, thereby falling into a trap. Some use is also made of a winking light as a scarer device. Clearly this is a phototactic stimulus and should further sub-division of the group be desirable, it should be included as such. In point of fact all scaring is the result of one or more stimuli and this group could be redistributed accordingly if detailed information was available as to the exact nature of the stimulus concerned.
2.5 Other Behaviour Responses	Manual collection with pot and shell lures for octopuses, cuttlefish pots with azalea lure, leaf lure and jigger for cuttlefish, pitfalls, platform traps.	The use of pitfalls may appear an unlikely method of fishing but in Burma they are used in conjunction with fish fences. Air-breathing fish, trying to make their way round the fence fall into the pits and are caught. Platform traps are similarly employed to secure fish trying to leap an obstruction across a water-way. Other methods of note include the use of a female cuttlefish to attract males which can then be secured.

Further sub-division of certain of the relationships established in response to stimuli can be made by the origin and scope of the stimulus. For example, in the case of chemotaxis it is possible to distinguish between natural stimuli, e.g., salinity gradients, and man-provided stimuli, e.g., baited gears and the use of noxious fluids. The latter group can then be further analysed by division into stimuli which attract fish to a specific gear, e.g., baited gears and those which provide a general orientation to the gear, e.g., noxious fluids.

It is clear, however, that this principle provides no basis for the determination of a useful classification of fishing gear. For example, fish may be brought into relationship with gears employing hooks by any of the methods concerned, other than the

use of scarer devices and the extremely rare utilization of the movement of fish away from noxious fluids. Gill nets may be used with scarer devices, may intercept fish moving in response to water currents or may be the subject of random encounter. Furthermore, in the case of certain gears the method by which the fish is brought into relation with the gear may be modified during the actual operation of the gear. For example, the *kelong*, a fishing stake which is widely employed in Southern Malaya, may be operated in certain seasons during the day when it relies on the interception of fish moving in response to a current of water by a guiding barrier, which is an integral part of its construction. During the hours of darkness, however, a light is also employed which undoubtedly increases the catch,

apart from holding the trapped fish above the lift net. Lures of a similar character and structure may attract a variety of species through their response to varying stimuli. Hornell (1950) describes a lure which consists of a coir rope ornamented with strips of palm leaves in a chapter entitled "The Fatal Attraction of the Shadows", but he also mentions a similar lure utilising different foliage to which flying fish are attracted by a reproductive stimulus. The orientation of fish collecting around palm-leaf lures in Malaya vis-à-vis the current suggests a rheotactic response, and there is no doubt that this assembly also provides the stimulus for movement of predatory fish into the area.

3. The actual Mode of Operation of the Gear

Although the actual mode of operation of fishing gear varies widely in detail, in basic character three distinct forms can be recognised as follows :—

1. *Passive or Accepting.*

This includes those fishing gears which accept and retain fish coming into relationship with them.

2. *Active or Searching.*

This includes fishing gears which actively seek and retain the fish, the relationship between the fish and the gear being imposed by the latter.

3. *Diffuse or Indiscriminate.*

Methods which are neither accepting nor searching, but in which all fish within the area of operations are affected indiscriminately.

It will be observed that this division resembles certain of the earlier classifications in which gears

are divided by their geographical movement into moving or stationary methods. There are, however, certain gears which clearly demonstrate the difference between the systems and the inadequacy of the earlier classifications concerned. For example, troll-lines are moving gears but they are passive or accepting methods, the movement being the method by which the fish is lured into relationship with the gear. Similarly, plunge-baskets and purse seines are fixed geographically during operation but are in no way passive or accepting, the searching being carried out by the operators before the gear is set. This suggests that differentiation between active methods might be achieved by division into those in which the gear seeks the fish and those in which the fish is located by the operator before the gear is set. Such a distinction would, however, be purely artificial as there is in fact some conscious or unconscious location of the fish in all fishing methods. That is to say, before the gear is set the operator selects a locality in which he knows from experience that fish are likely to be found or in which there are certain physical features which suggest that fish are present.

Further sub-division by the detailed method of operation would necessitate consideration of the precise method of capture. Similarly, distinction between gears which employ luring or scarer devices introduces a consideration of the method by which the fish are brought or come into relationship with the gear. In either case the classification would involve the use of two principles which is to be avoided if possible. Using the actual mode of operation of the gear as a basis of classification the major gears can, therefore, be summarised as follows :—

The actual mode of operation of the gear	Type of Gear
1. <i>Passive or Accepting.</i>	Loop-fishing ; baited hooks ; anchored unbaited hooks ; troll lines ; set barriers ; fish weirs ; filter and screen nets ; fish traps ; some aerial traps ; lift nets ; drive in and closing bag nets ; gill and tangle nets.
2. <i>Active or Searching.</i>	Manual collection ; rakes ; snares ; trained animals ; spears ; harpoons etc. ; long lines of unbaited hooks (when trawled) ; drop nets ; cast nets ; thrust nets ; dredges ; seines ; lamparas etc.
3. <i>Diffuse or Indiscriminate.</i>	Poisons, explosives and fish smothering.

It is clear, therefore, that this principle offers no satisfactory basis for a detailed classification of fishing methods. Further, were it adopted, it would be necessary to use it in conjunction with other principles in order to obtain a detailed division.

4. The Power required for Operation

The amount of power required for the operation of fishing gear is of great importance in the assessment of costs of production, but it is of little value

as a basis for classification of fishing gear. Power requirements necessitate a study of not only the number of men engaged and the mechanical energy required for hauling, but also of the wind or mechanical force utilized to draw trawls and other moving gear through the water. Difficulties will be experienced in standardising mechanical or wind-derived energy in terms of man-power, particularly as it may not be possible to eliminate variables such as the detailed structure of the gear and the nature of the bottom. Moreover, no division by the nature of power is valid, as the level of mechanisation of the fishing industry is often indicative only of the stage of development of the community concerned, the size of gear, and the standard of living, which in

its turn is an important determining factor in the supply and cost of labour.

In the Colony of Singapore the use of mechanical power in the fishing industry has been discouraged by regulations in neighbouring territories which prohibit fishing but permit the purchase of fish from the indigenous fishermen. Development is therefore, largely restricted to powered fish-carriers, so that the gears of this territory provide a simple example for the consideration of classification by the power required for operation.

The following illustrates the power used in the more important gears :—

MAN-POWER UTILISED IN OPERATION.

1	2	3	5 to 7	12 to 18	18 to 25	25 to 30
Manual collection, rakes, spears, poisons, baited loop-fishing, handline, rod and line, long line (Johore Straits), cuttle-fish jig, filter nets, lift nets, dip nets, cast nets, push nets, Chinese drift net (<i>jaring hanyut</i>), Malay <i>selang</i> net, <i>jaring tamban</i> , <i>jaring belanak</i> , troll line (from non-powered boat) and fishing stake (<i>belat</i>).	Spears, harpoons, poisons, filter nets, lift nets, cast nets, drive in gill nets, Malay drift net (<i>jaring hanyut</i>), Chinese <i>selangat</i> net, sunken gill and tangle nets, fishing stake (<i>belat</i>). Fishing stake (<i>kelong</i>)— Set barrier nets—	Hand-operated trawl	Beach seine (small)	Beach seine (large)	<i>Puhat payang</i> (lampara)	Drive in net, <i>Moro-ami</i> and Purse seine.

A single fisherman may also operate a number of fishing gears, for example, twelve to forty baited float lines (*pelontang*), ten to thirty baited crab lift nets or ten to thirty-five baited crab pots. The man-power required for the operation of portable fish traps varies with the size and number of such traps used.

Clearly, therefore, this principle does not afford an adequate basis for systematic study, reflecting as it does a number of features the most important of which are as follows :—

- (1) *Size and Weight of Gear*, e.g., set barriers vary in size from those a few yards in length to structures over 800 fathoms long.
- (2) *Mode of Operation*, e.g., gears which 'search' or employ scarer devices generally have high power requirements.
- (3) *Base from which operated*, e.g., in villages remote from the fishing grounds additional man-power is required for propulsion of the boat and/or carriage of the

gear. Moreover, the operation of a gear from a boat, e.g., spears and cast nets, may necessitate the use of a non-fishing assistant.

- (4) *Mechanical Devices*, e.g., the presence of devices such as the Chinese windlass on *kelongs* or the use of a wheeled cart for transport of gear by land, reduces man-power requirements.
- (5) *Financial Status of Operator*, e.g., the number of small gears, such as baited crab-pots, employed by a single fisherman is often determined by his financial status. In the case of larger gears, operators may increase the number of assistants in times of increased prosperity in order to lessen their individual work. This practice is particularly common on fishing stakes where monthly-paid labour is employed and is sufficiently organised to impose conditions upon the owner.
- (6) *Human variability and behaviour*, e.g., the efficiency of the individual fisherman

is an important factor in determining the man-power required for the operation of fishing gear. The moro ami or drive-in net can be operated by 18 to 20 experienced operators whereas at least thirty less-skilled operators are necessary. These variable factors cannot be readily eliminated and as standardization is, therefore, impossible, it is clear that differences in man-power requirements do not necessarily constitute a significant factor.

5. The Constructional Design

It is important to differentiate between the materials of construction, the availability of which is often a determining factor of design, and the actual constructional design itself. For example, netting

is used in a great number of gears but it cannot be considered a design in itself, being a meshed 'fabric' prepared from a variety of materials. Consideration of constructional design must, therefore, be approached from the specific aspect of the pattern of the gear. This raises immediate difficulties as there are methods of fishing in which no fishing gear is used, e.g., manual collection of fish. The equipment used in certain other methods can hardly be classified by any system based on constructional design, e.g., poisons, explosives and hunting with trained animals. These methods must, therefore, be omitted and the gears with a tangible design considered. In the first place, it is possible to divide constructional design in accordance with the major planes it utilises.

Gears can then be broadly grouped as follows :—

NUMBER OF PLANES OCCUPIED BY DESIGN*

ONE	TWO	THREE
Fish-smothering, snares, hooks, gorges, set barriers, jungle knives, spears, lift nets, drop nets, gill and tangle nets, snap nets, seines without bag, purse seines.	Spears, gorges, hooks, verandah nets, jumping platforms.	Rakes, spears, jigs, filter nets and stakes, aerial traps, lift nets, cast nets, drive in bag nets, portable fish traps, fishing seines with bags, dredges, trawls, lamparas.

It is clear that certain gears, which are grouped together as a result of similarity in design, are operated in entirely different ways. For example, single plane designs executed in closely woven or meshed fabric include fish-smothering, lift nets, drop nets, entangling nets, seines without bag and purse seines, although the modes of operation and detailed construction vary widely. Moreover, spears and hooks are now separated in accordance with the complexity of their design, purse seines are grouped with entangling nets and set barriers, and seines are divided by the presence or absence of a bag. Further sub-division by constructional design is not, therefore, justified and as a basis for classification this property must be rejected.

6. The Materials of Construction

Materials used in the construction of fishing gear

Classification by materials of construction can, therefore, be summarised as follows :—

Material of Construction	Gears	Remarks
1. <i>Inorganic Materials</i> 1.1 Flint and Stone.	Spears, gorges, hooks, set barriers.	Generally primitive gears employed by Palaeolithic and Neolithic man. Set barriers of stone are still employed and Davis (1927) quotes several in use in the United Kingdom.

*Note.—For the purpose of this consideration three major planes are recognised, intersecting each other at right angles.

Material of Construction	Gears	Remarks
1.2 Mother of Pearl.	Gorges and hooks.	
1.3 Metals.	Spears, rakes, knives, arrows, snares, loop-fishing, gorges, hooks, jigs, gaffs, portable fish traps, wire-netting fishing stakes, oyster dredges.	A great variety of metals have been used in the construction of fishing gear and there are even records of hooks of gold. (Radcliffe, 1926.) Portable fish traps and fishing stakes <i>belats</i> in Singapore are being constructed with wire-netting enclosures thus reducing labour costs.
2. Organic Materials		
2.1 Natural wood and other plant materials (excluding fibres).	Plunge basket, rakes, spears, arrows, darts, gorges, hooks, set barriers, filter devices, portable fish traps, fishing stakes, anchovy boards and jumping platform traps, snap nets.	A wide range of woods are utilised, bamboos, rattans and palms being of particular importance in Malaya. The use of laced, banyan bark strips in the snap net reflects the primitive status of the aborigines concerned.
2.2 Fibres.	Snares, loop-fishing, set barriers, filter nets, stake nets, portable fish traps (lobster pots), set stake nets, cast nets, bag nets, verandah nets, all entangling or gill nets, seines, trawls, purse seines, dredges, lamparas.	Fibres include rami, cotton, linen, hemp, sunn (san hemp), silk, gut, spiders' web, and nylon (synthetic). This heterogeneous group includes all gears utilising fibre netting. Fibres also play an important part in hook and line fishing but are subsidiary to the operative feature—the hook. A web spun by spiders into a prepared frame is recorded as in use by Papuans as a dip net, holding fish of up to one pound in weight. (Radcliffe, 1926)
2.3 Other Animal Products. 2.31 Chitin.	Hooks.	A natural fish hook prepared from the thick upper joint of the insect <i>Eurycantha latro</i> , is recorded from Good-enough Island, New Guinea. (Radcliffe, 1926)
2.32 Horn, turtle-shell, bone and ivory.	Spears, harpoons, gorges, hooks.	These materials were used by prehistoric man in some of the earliest fishing gear recorded. Their use at present is limited to primitive and isolated communities.

It is obvious that the great variation in the usage of materials for the manufacture of fishing gear renders them invalid as a basis for classification. It is particularly interesting to note that in this Colony the manufacture of portable fish traps from woven rattan has been discontinued within the last few years, rattan as a material of construction being replaced entirely by wire-netting. This reduces labour charges which are heavy. The original shape, which was clearly determined by the method of weaving, has been retained.

7. The Location of Operation

Hornell (1925 and 1938) in his papers on the fishing methods of the Madras Presidency considered it necessary to adopt a broad classification based on the location of operations, i.e., marine, estuarine and inland. The seasonal nature of the inland fisheries and the remarkable development of estuarine lagoons and creeks in that area support this conclusion. However, in any consideration of classification by location of operation it is

necessary to expand this classification to accommodate localities which have a distinct ecological significance.

A classification of fishing methods by the area of location of operation would, therefore, be as follows :—

Location of Operation	Type of Fishing Methods Employed	Remarks
1. <i>Fresh-water Fisheries</i> 1.1 Lakes.	Artificial fish holes, spears, arrows, poisons, explosives, snares, gorges, hooks, portable fish traps, fishing stakes, cast nets, drop nets, dip nets, gill nets and seines.	This list can only be offered as provisional, as the literature on lake fisheries to which the author had access was limited.
1.2 River Systems.	Artificial fish hooks, plunge baskets, spears, arrows, darts, poisons, noxious fluids, explosives, snares, gorges, hooks, set barriers, fish fences with entrapments, portable fish traps, collapsing bag nets, lift nets, scoop and dip nets, drop nets, cast nets, aerial traps, gill nets, seines, drag fences.	The variety of gears operated in river systems is well typified by those employed in Burma, where the river and delta fisheries are of major importance.
1.3 Marshes and Padi-fields.	Plunge baskets, jungle knives, spears, fish-smothering, snares, gorges and baited springs, rod and line, portable fish traps, cast nets, scoop and dip nets.	The restricted nature of the fishing is a determining factor in the type of gear that can be utilised.
2. <i>Estuarine Fisheries</i>	Manual collection, artificial fish holes, rakes, spears, poisons, explosives, snares, gorges, hooks, set barriers, filter nets and stake nets, portable fish traps, fishing stakes, lift nets, drop nets, push nets, cast nets, aerial traps, gill and tangle nets, drive in gill nets, seines and trawls.	The rich estuarine fisheries of South-East Asia are usually exploited by every means which the nature of the area and fisheries legislation will permit.
3. <i>Marine Fisheries</i> 3.1 Littoral.	Manual collection, rakes, spears etc., hooks, gorges, set barriers, portable fish traps, fishing stakes, lift nets, cast nets, drop nets, scoop nets, push nets, some gill nets, (e.g. <i>jaring puput</i>), seines, snap nets.	The accessibility of the littoral fisheries renders them of considerable importance in South-East Asia.
3.2 Coastal or inshore.	Octopus pots, shell collection, spears and harpoons, poison-bait, explosives, trained animals, loop-fishing, hooks, filter devices (in areas with marked tidal stream) portable fish traps, fishing stakes, lift nets, verandah nets, gill nets, tangle nets, trammel nets, seines, dredges, trawls, purse seines, lamparas.	This includes those areas in the comparatively shallow waters near the coast. Coral reef areas have been excluded in view of their very special nature.
3.3 Coral Reef.	Manual collection, spears, harpoons, spear guns, poisons, explosives, hooks, portable fish traps, fishing stakes, cast nets, drive in bag nets, drive in gill nets, seine nets.	The nature of coral necessitates a modification of fishing methods with a resultant increased requirement in both man-power and skill. In consequence the use of explosives, which requires little skill, has grown to the detriment of the resource.
3.4 Pelagic or offshore.	Harpoons, explosives, hunting by animals, loop-fishing, hooks, lift nets, gill nets, seines, trawls, purse seines, lamparas	The pelagic fisheries occupy the upper layers of the sea down to about 100 fathoms. They overflow into the coastal and estuarine areas, and pelagic fish may be taken in typically bottom gears, e.g., herring in trawls.
3.5 Abyssal and bathypelagic.	Hooks, dredges, trawls, grabs.	This includes the slope to and sea floor in the abysses and the intermediate layers of the open sea from, say, 100 fathoms to near the bottom. The resources of these areas are not normally exploited by fishermen although there is a special long line fishery at the Azores for the bathy-pelagic scabbard fish (Irvine, 1947).

The objections to employing the location of operations as a method of classifying fishing methods are obvious and, even if marked differences in such methods could be demonstrated, the absence of limiting boundaries would provide a major obstacle to the use of this principle. For example, pelagic fish enter the inshore or coastal areas and the wide variation in salinity in the estuaries enables some fresh-water and marine fish to enter this area.

Location of operations, therefore, provides no basis for a systematic classification of fishing methods although it is clear that certain areas are more suitable for specific types of gear, e.g., filter devices in estuarine areas, and that, in a few cases, gears may be restricted to one particular locality, e.g., fish-smothering.

8. The Species Captured.

In South East Asia information regarding the catch composition of the various fishing methods is often fragmentary and the collection of detailed knowledge is complicated by the large number of species concerned. This presents an immediate obstacle to the use of this principle as a basis for classification. Moreover, certain methods exploit the entire fishery resources of the area in which they are operated, being virtually indiscriminate in their action, e.g., manual collection, poisons, set barriers, beach seines. In the Colony of Singapore very few gears are specific in their action, a notable exception being the two-man lift net which is solely operated to capture mullets (*Mugil* spp.). On the other hand, there are important fisheries in which the various gears utilised show little similarity, other than in the composition of the catch. For example, *Scomberomorus* spp. and *Chirocentrus dorab* (Forskall) are taken both by the floated line (*pelontang*) and a drift net (*jaring hanyut*). These gears have nothing in common in structure, method of operation or even capital cost. A better known example is to be found in the tuna fisheries which are exploited by purse seines, trolling lines and set pound nets. Clearly this diversity is the result of human ingenuity, capture of the fish being achieved by exploiting any well-established behaviourism.

DISCUSSION

It has been shown that of the varying principles upon which a detailed classification can be based, only the precise manner in which capture is effected provides a satisfactory basis.

Briefly there are certain principles which can be immediately dismissed from consideration as a basis for classification. For example, the materials of construction are of importance only in so far as

their properties permit their use in capture operations, and they can be readily replaced by different materials with similar or more suitable properties. Furthermore, the location of operations and the species captured represent factors for which fishing methods have been devised, and they act as limiting factors to the number of methods which can be used rather than permitting distinction between such methods. Constructional design is entirely subservient to the way in which capture is achieved, and any detailed study of design inevitably involves consideration of this.

On the other hand, the power required for the operation of fishing gear is of great importance from the statistical and administrative aspects of the fishing industry. It has, however, been emphasized that the power required is dependent upon a number of factors and that the efficiency of the individual fisherman is a variable factor which, cannot be simply eliminated. It is not proposed therefore, to utilise the power requirement of the fishing methods in construction of a classification but it is clear that the size of the gear should be used as a minor identifying character.

The method by which the fish are brought into relationship with the gear is primarily a question of the distribution of the fish concerned and the method by which this distribution is exploited. Similarly, the actual method of operation of the gear is the preliminary step whereby the gear is brought into relationship with the fish with a view to employing a precise method of capture.

In consequence, the precise manner in which capture is effected has been utilised as a basis for the preparation of a classification which is included as an Appendix. For the minor details of the classification some use has been made of the method in which the fish are brought into relationship with the gear, the method by which the gear is operated and the dimensions of the gear, but these have been subordinated to the precise method of capture. In the case of those gears, in which this property varies in accordance with the mode of operation, the method for which the gear was designed or is principally employed has been used for determining its position in the classification. Should a gear be a true dual purpose implement, that is, if its normal usage includes more than one precise method of capture, it may be necessary to establish additional groups in the classification. For example, the *kola vala* and *kandadi vala* of Madras appear from Hornell's description to be equally concerned with the gilling of small fish and the entanglement of larger ones. Should this be indeed the fact it would be desirable to establish a new group, 'Gill-Tangle' nets.

Reference to the Appendix will show that there are apparent anomalies which require further consideration. For example, complete barriers may be simple structures in which the fish are stranded when the water recedes, or may utilise traps or other devices to secure the fish. In the latter case it would appear that the barrier might equally well be classed elsewhere, depending upon the nature of the trap or device. The fish are restrained by the barrier and that the method of securing the fish is subsidiary to this. On the other hand, if a trap is used in a natural barrier, or barrier which was constructed for some other purpose, e.g., a bund of a paddy-field, the fish are not the subject of deliberate restraint until they enter the trap. In the consideration of barriers it is important to differentiate between guiding barriers and set barriers. Clearly the latter are devices which, by simple physical obstruction, prevent the escape of fish from a particular natural area which they entered voluntarily. Guiding barriers, on the other hand, are so designed to direct the voluntary movements of fish into a desired area.

The use of non-return devices in certain filter nets would suggest that the gears in question should be grouped with traps containing similar structures. In fact, the net operates by screening out the catch and the non-return devices are only added to boost the retaining action of the current where it is weak or the anticipated catch consists of strongly swimming forms.

The division of Gape Nets by their position vis-a-vis the current is not justifiable except on the grounds that it provides significant information as to the effective length of the fishing day. Certain of the fixed filter nets are, however, operated in batteries connected by a guiding barrier in such a way as to ensure that adjacent gears face in opposite directions. In this case each gear is a fixed individual unit which operates only on one tide, and its productivity is accordingly limited although it must be admitted that its effectiveness is substantially increased by the use of the guiding barriers. Further sub-division of these nets can be achieved, therefore, by their use in conjunction with such barriers or by the use of non-return valves, both of which may lead to an increase in productivity.

Aerial traps may include the use of a horizontal trammel net, e.g., the verandah net, or bushier to trap fish leaping over a suspected barrier. These structures cannot be considered as principally entangling devices, as they are more concerned with retention of the catch than with its actual capture. In certain districts, the push net bears a long bag into which the catch is swept by the movement of the net through the water—an

obvious similarity to certain of the investing gears—but in most cases the catch is not secured until the net is raised and this suggests that the similarity is not of fundamental significance.

In conclusion it is clear from this classification that there is also a need for a standard nomenclature of fishing gear—a nomenclature which could be devised by the expansion of this classification to its logical conclusion. Such an undertaking, however, would require a more detailed knowledge of the fishing gear of this area than is at present available, and from a study of the existing work on the subject it is clear that in many cases the existing descriptions are inadequate or are lacking in details of vital importance.

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APPENDIX

AN OUTLINE CLASSIFICATION OF FISHING GEAR AND METHODS

DIVISION I

INDIVIDUAL OR SPECIFIC

Fishing methods in which individual fish are the subject of the capture operation.

1.1 MANUAL COLLECTION

All methods in which the catch is secured by seizing or grasping with the hands.

- 1.11 **Simple**.—Manual collection in which no concentration of the resource is undertaken.
- 1.111 *Without restraining equipment*, e.g., shore collection : trochus, green snail and pearl collection.
- 1.112 *With restraining equipment*, e.g., plunge baskets, jungle knives (used to strike not impale), eel spears (Hawaiian spears in which the operative principle is not piercing but jamming between tooth-like prongs).
- 1.12 **Concentrative**.—Manual collection in which the resource is concentrated by various means.
- 1.121 *Refuge Devices*.—Devices which concentrate fish by providing a shelter or refuge from which the catch is removed, e.g., artificial fish-holes, octopus pots.
- 1.122 *Raking Devices*.—Comb-like devices which facilitate subsequent manual collection, e.g., oyster, mussel and cockle rakes, crab hook (Singapore and Thailand).
- 1.123 *Scarer Devices*.—Devices which are employed to drive or concentrate fish at a specific point at which the operator is situated, e.g., scare-line or vela vala (Madras).

1.2 NOOSES

All devices whereby fish are secured in a simple or complex noose.

- 1.21 **Snaring**.—A noose is slipped over the fish to be secured and is drawn tight, e.g., shark-fishing in Polynesia (Hornell, 1950), *jai* (Malaya).
- 1.22 **Loop-fishing**.—The fish is attracted to a noose by means of a bait or a lure and is secured by drawing the noose tight on to the upper jaw of the fish. The method is restricted to the gar-fish (*Belone* sp.) and may be operated in conjunction with a kite, e.g., in Singapore, parts of Indonesia, and in Melanesia with a looped tassel of spiders' web.
- 1.23 **Tassel-fishing**.—This is an extension of loop-fishing in which the noose is replaced by a tuft or tassel of fibres, the individual teeth of certain fish being secured by their penetration into the fibres to form a multiple system of loops. This method may be used in conjunction with bait, e.g., *rəo pla tong* (Thailand) (Swarnag, 1950) or the tassel itself may operate as a lure, e.g., eel fishing with wool (England).

1.3 BAIT-HOLDERS

Devices consisting of a small rod, tapering to a point at each end and secured in the centre by a line. The gorge is baited and fish taking the bait are secured, the gorge resisting withdrawal.

- 1.31 **Gorges**.—Rigid bait-holders, e.g., Palaeolithic man in Europe and America.
- 1.32 **Baited Spring**.—Flexible bait-holders set by bending the ends together and securing them in the bait, e.g., *barra*, *kai-barsa* and *datia* (India).

1.4 HUNTING ANIMALS

All methods in which trained animals are used for the capture of fish.

- 1.41 **Cormorants.**— e.g. China & Japan.
 1.42 **Otters.**— e.g. Europe, Yangtze Valley (China), Sunderbans (India).
 1.43 **Sucker-fish** (*Echeneis* sp.).—This method had a wide distribution at one time but it is now mainly restricted to Zanzibar, and the Great Barrier Reefs, Australia. (Hornell, 1950).
 1.44 **Dogs.**—The 'orang laut' of South Johore, Malaya, are reported to hunt crabs with dogs. (Williams Hunt—Personal communication, 1951).

1.5 SHARP PROJECTILES

All methods in which the catch is secured by impaling a straight, pointed implement.

- 1.51 **Lances.**—Thrusting implements with a long shaft and a pointed, unbarbed head.
 1.511 *Multident*, e.g. konch (Bengal)
 1.512 *Unident*, e.g. tirok (Malaya), manda (Pearson, 1922) (Ceylon)
 1.513 *Bident*, e.g. manda (Ceylon)
 1.514 *Trident*, e.g. Tilapia lance (Singapore)
- 1.52 **Spears.**—Thrusting implements with a long shaft and a pointed, barbed head.
 1.521 *Multident*, e.g. mandal (Ceylon)
 1.522 *Unident*, e.g. tempuling (Malaya)
 1.523 *Bident*, e.g. dukathi (India)
 1.524 *Trident*, e.g. serampang (Singapore)
 1.525 *Cinqident*, e.g. serampang sotong (Singapore)

Further sub-division can be achieved by use of the number and nature of the barbs, e.g., uni or bi-barbed, hinged or otherwise. Spears may be thrown in which case a line is used to retain them, but these are to be distinguished from harpoons.

- 1.53 **Harpoons.**—Spear-like instruments with a detachable, barbed head.
 1.531 *Multident*, e.g. juti or jutiya or konch (India)
 1.532 *Unident*, e.g. julir (Malaya)
 1.533 *Bident*, e.g. manda (Ceylon)
 1.534 *Trident*.
- 1.54 **Pointed Missiles.**—Pointed missiles propelled from :—
 1.541 *Blow-guns*, e.g. thumbithan (Malabar)
 1.542 *Bows*, e.g. thettal (Malabar)
 1.543 *Cross-bows*, e.g. parangi pathu (South India)
 1.544 *Spear-guns*, e.g. Philippines.

1.6 HOOKS

All methods in which capture is effected by the penetration of a curved point.

- 1.61 **Gaffs.**—A hook device, used without line to capture and land fish, e.g., sickle (Madras), malu kottanakaduwa (Ceylon). It does not include the use of instruments for securing fish after capture by other methods, e.g., salmon gaff, aulun biliya (Ceylon).

- 1.62 **Hook and Line.**—A hook device operated in conjunction with a line by which fish secured on the hook can be hauled to the operator.
- 1.621 **'Foul Hooking'**.—Methods employed whereby the hook penetrates a part of the fish not being the mouth.
- 1.621.1 *Simple.*—Devices in which a simple hook effects capture, e.g., taung-gyin (Burma), jota (Bengal), rawei tidak umpan (Malaya), bed rao pla kabem (Thailand).
- 1.621.2 *Complex.*—Devices in which a compound hook or jug is employed, e.g., chandit (Malaya), kahawa (Ceylon).
- 1.622 **'Clean Hooking'**.—Methods employed whereby the hook penetrates the mouth of the fish.
- 1.622.1 *Troll-lines.*—The hook is drawn through the water or 'trolled', usually from a boat, e.g., troll lines and surf-whiffing.
- 1.622.2 *Angling.*—Devices which consist of a limited number of hooks (usually not more than three) which are generally attached at the distal end of a vertical line. The gear is operated in a restricted locality and is not trolled, e.g.,
- 1.622.21 Rod and line
- 1.622.22 Hand line
- 1.622.23 Floated line.
- 1.622.3 *Trap Lines.*—Devices consisting of a single hook and line which are set to operate automatically, the fish being secured by releasing a spring device, e.g., joran taut and kiding (Malaya, also Bengal).
- 1.622.4 *Long Lines.*—Devices which consist of a number of hooks attached along the length of a horizontal main line by snoods, e.g., dab lines, long lines.

DIVISION 2.

INDISCRIMINATE OR DIFFUSE

Fishing methods which are usually indiscriminate or diffuse in action affecting all fish within the area of operation.

2.1 POISONS

All methods in which capture is achieved by the use of a toxic substance which poisons or stupefies the fish.

- 2.11 **Indiscriminate or Diffuse.**—Use of toxic substances by poisoning the water, e.g., *Derris* sp. (Malaya), *Tephrosia* sp. (Africa).
- 2.12 **Specific.**—The use of toxic substances through poison bait or poisoned projectile, e.g., poison bait (Singapore), poison whaling with harpoon (Ainus, Aleuts, etc.) (Govt. St. Settles., 1896.)

2.2 SUFFOCATION

This includes a single method practised in waters of low oxygen-content, in which capture is effected by denying air-breathing fish access to that element.

- 2.21 **Smothering**, e.g., fish smothering (Burma)

2.3 EXPLOSIVES

All methods in which explosives are used to stun or kill fish. It does not include the use of explosives to propel missiles.

- 2.31 **Indiscriminate**, e.g., 'dynamiting'
- 2.32 **Specific**, e.g., explosive whale harpoons.

DIVISION 3.

MULTIPLE OR COLLECTIVE

Fishing methods in which generally a group or association of fish are the subject of the capture operation.

3.1 ENTRAPPING STRUCTURES

All methods of fish capture achieved by use of an enclosure which affords free access but from which escape is hindered or prevented in a variety of ways, the precise method being utilised for subdivision of the group.

- 3.11 **Simple Enclosures.**—A device which, by simple physical obstruction, prevents the escape of fish from a certain natural area which they entered voluntarily.
- 3.111 **Complete barriers.**—Permanent or semi-permanent structures of stone, earth, wood or netting erected to block the escape of fish from an area. The water may escape through the structure or be removed by baling. Such barriers may be submerged at times of flooding, tidal or otherwise, or may have an entrance which dries out before the main area of the enclosure, e.g., in South Devon, Wales, Queensland, America (Davis, 1927), Bengal (Hornell, 1950), Madras (Hornell, 1925 & 1938), Burma.
- 3.112 **Complete barriers with entrance.**—Complete barriers which contain an entrance to facilitate the movement of fish into the area. The entrance is closed by the operator thus completing capture. These traps may be operated in connection with ground bait and/or bush shelters, e.g., in Cameroons (Hornell, 1930), Burma.
- 3.113 **Set barriers.**—Structures of netting, screens of rattan, brushwood etc., which are set so as to cut off an area which later dries out. These barriers are typically employed in tidal waters where a large expanse is uncovered at low-water. They require to be set for each operation, e.g., block (Thailand), ampang (Malaya), bawun and paik-bawun (Burma), stop nets (Thames Estuary—Davis, 1927).
- 3.114 **Tidal-operated barriers.**—Structures of netting or other materials which allow the passage of the fish on the flood-tide but which prevent escape on the ebb-tide through a device operated by the tidal stream itself, e.g., baulk nets (Morecambe Bay, U.K.), roa nets (Davis, 1927).
- 3.12 **Screening Devices.**—Structures set in moving water which screen or filter out the catch, the force of the current ensuring its retention. These devices may be used with guiding barriers and, where the current is not strong or the anticipated catch consists of strongly swimming species, non-return devices may be used to increase productivity.
- 3.121 **Stream Nets.**—Filter devices similar to 'tidal-operated barrier' nets which are not, however, set to enclose an area completely but form a shallow horizontal bagging in which fish are trapped, exit being prevented by the force of the current, e.g., stream nets (England—Davis, 1927).
- 3.122 **Gape Nets.**—Filter devices with a distinct mouth into which fish are carried by a moving current.
- 3.122.1 **Static.**—Gape nets fixed in respect of their direction of operation, i.e., they remain in the same position at all times of the tide, e.g., ambai (Malaya and Thailand), valu vala (Madras), bandu dela (Ceylon), dashiami (Japan), hose nets (England), kyapazat (Burma).
- 3.122.2 **Oscillatory.**—Gape nets which are free to swing in the current and thus can fish on both the ebb-and flood-tides.
- 3.122.21 **Swing Nets.**—Gape nets which are buoyed and anchored in such a way as to facilitate change in direction in response to changes in the direction of the current, e.g., swing net (England), ambai (Thailand), pompang (Malaya), pinledamin (Burma).
- 3.122.22 **Stow Nets.**—Gape nets which are suspended from an anchored boat or raft, e.g., stow net and double trawl (England), paikgan (Burma).

- 3.123 *Screen Nets*.—Filter nets which consist of an inclined screen on to which fish are carried and stranded by a current of water.
- 3.1231 *Staked*.—Screen nets fixed in respect of their direction of operation, usually employed with a guiding barrier, e.g., jermal (Malaya), various fish fences with sloping platforms (Burma).
- 3.1232 *Pendulous*.—Screen nets which are lowered from a boat or raft, e.g., pazunbaung and hle-damin (Burma).
- 3.13 **Structural Non-Return Devices**.—Structures which permit the free and voluntary entrance of fish but which hinder or prevent its escape by a structural non-return device.
- 3.131 *Tubular traps*.—Structures tubular in form, the diameter of which is carefully adjusted to approximate closely to the average girth of fish to be caught.
- 3.131.1 *Smooth*.—Tubular traps in which fish enter the trap and are held only by the closeness of the fit, e.g., salmon putcher (England), murrel trap (India)—Hornell, 1925 & 1938), uringate (Africa), also in Philippine Islands Fiji, Borneo.
- 3.131.2 *Thorn-lined*.—Tubular traps in which fish enter the trap and are held by the closeness of the fit in conjunction with a thorn lining, e.g., in Fiji and Bismarck Archipelago.
- 3.132 *Funnel Traps*.—Structures in which entrance is easy but from which exit is rendered difficult by a non-return device in the form of a funnel. They also include traps in which fish enter a large chamber through a narrow aperture at the end of converging walls, exit being rendered difficult by the fact that the walls on the inside of the trap diverge from the aperture.
- 3.132.1 *Portable Traps*.—Rigid funnel traps usually small in size which are movable and are complete in themselves, e.g., zale and bon-pin (Burma), bubu (Malaya), bubo (Philippines), nassa (Italy), lobster pots (England), susa (Fiji), unagi kago (Japan) and throughout South-East Asia.
- 3.132.2 *Set or Pound Traps*.—Non-rigid funnel traps usually constructed of netting which are set to exploit seasonal fisheries and can be subsequently removed and set elsewhere, e.g., fishing pounds (Mediterranean), daibe ami (Japan), keddle nets (England), seraku valai (Ceylon).
- 3.132.3 *Palisade Traps*.—Rigid funnel traps which are erected as semi-permanent structures and which intercept the catch by means of guiding stakes or leads, e.g., belat and kelong (Malaya), poh and poh lemut (Thailand), sero (Indonesia), kandi and akulwetiya (Ceylon), bashuwin and lutgyi (Burma), sardine weir (Canada).
- 3.133 *Mechanical Traps*.—Structures which permit the free and voluntary entrance of fish but which prevent its escape by means of a shutter or spring-trap operated by the action of the fish.
- 3.133.1 *Weighted Shutter*.—Mechanical traps in which a weighted shutter falls and imprisons the catch, e.g., tok (Burma), balboob (Philippines).
- 3.133.2 *Spring Shutter*.—Mechanical traps in which a shutter activated by a spring, usually made of bamboo, imprisons the catch, e.g., in Malayasia.
- 3.14 **Aerial Traps**.—Traps exploiting the habit of certain fish which leave the water when confronted by an obstacle.
- 3.141 *Pitfall traps*.—Entrapments which consist of complete barrier with a pit dug near each end, into which some fish fall in trying to make their way round overland, e.g., nga-dwin (Burma).
- 3.142 *Jumping Traps*.—Entrapments which exploit the habit of certain fish in jumping over an obstacle.
- 3.142.1 *Without scaring*.—Complete barriers with a platform usually of netting or bamboo on to which fish fall in trying to leap the barrier, e.g., kon-sin and kon-paik (Burma), kattu valai (India) and in Malaya.

- 3.142.2 *With scaring*.—Methods in which certain species are constrained to jump a trapped obstacle by the use of scarer devices.
- 3.142.21 *Verandah nets*.—Encircling nets to the outer side of which is attached a floated horizontal trammel net, e.g., tiweek (Palestine) and in Mauritius (Hornell, 1950).
- 3.142.22 *Boat & Raft traps*.—Boats and rafts into which the fish are constrained to leap by the use of scarer devices, e.g., chali (Bengal), changodam (South India), anchovy boards (Hongkong), tazaung (Burma), catch boats (Thailand), seriat (Malaya), also in Malta, China, Africa & Malayasia.
- 3.15 **Lift & Drop Entrapments**.—Structures, usually consisting of a sheet of meshed fabric, which are raised or lowered to trap fish above or below the gear.
- 3.151 *Lift Nets*.—Structures which are raised to trap fish passing over or lying above them.
- 3.151.1 *Vertical*.—Lift nets which are raised vertically, an oblique or sideways movement being of no significance in the capture operation.
- 3.151.11 *Baited*.—Vertically operating lift nets which are baited. (This does not include the use of ground-bait to attract the fish).
- 315.111.1 *Crab-traps* in which fabric entangles the catch, e.g., bintur (Malaya), kakula watta (Ceylon).
- 315.111.2 *Fish-traps* in which fabric encloses, e.g., fukuro ami or file-fish nets (Japan), hoop nets (England), etc.
- 3.151.12 *Unbaited*.—Vertically operating lift nets which are not baited, but to which the fish may be brought into relationship with the gear by scattering ground bait or scaring etc., e.g., ya-gwin (Burma), endi balai (Madras), pukat tangkul & tangkul (Malaya), cheena vala (Madras), shiso hari ami (Japan), atoli dela (Ceylon) and in Hongkong.
- 3.151.2 *Oblique*.—Lift nets which are drawn or pushed obliquely before hauling, the oblique movement being of significance in the capture operation.
- 3.151.21 *Scoop & Dip nets*.—Lift nets which are pushed through the water in a complex scooping movement, before raising, e.g., athangowa (Ceylon), dawkat (Burma), arippu vala (Madras), tama ami (Japan) and world-wide distribution.
- 3.151.22 *Push nets*.—Lift nets which are pushed along the bottom in an oblique collecting movement before raising.
- 3.151.221 *With scaring*, e.g., pala delah (Ceylon).
- 3.151.222 *Without scaring*, e.g., push & thrust nets (Malaya, Burma, Thailand, Indonesia, etc.).
- 3.151.23 *Screen nets*.—Lift nets which are drawn through the water obliquely in a simple linear movement before hauling, e.g., boke ami & yat-sude ami (Japan), pukat sudu (Malaya), etc.
- 3.152 *Falling Nets*.—Structures which are lowered or allowed to fall, thus trapping fish passing or lying below them.
- 3.152.1 *Cast nets*.—Conical or bell-shaped nets with a weighted periphery, which are thrown to cover an area, and which trap fish lying below them as they fall to the bottom or as the weighted periphery closes.
- 3.152.11 *Stringed*
- 3.152.12 *Stringless*. } Distribution throughout the world.
- 3.152.2 *Drop nets*.—Nets which are dropped or allowed to fall without a preceding casting movement, e.g., metkun (Burma), chochin ami or lantern net (Japan), tereben (Lake Chad), chak-jal (India).

3.2 ENTANGLING STRUCTURES

Structures of meshed fabric in which the fish jams or entangles itself in the actual fabric.

- 3.21 **Gill nets.**—Entangling structures in which the fish becomes tightly jammed or otherwise trapped in an individual mesh. This includes a great number of gears and it is suggested that sub-division be made by approximate mesh size. Further sub-division can then be made by the depth of the net in meshes which reflects the conditions under which the net is operated, whether it is floating or sunken, anchored or free and as to the method by which the fish are brought into relationship with the gear. A classification of all the gill nets in this area is clearly beyond the scope of this paper even if it were possible from the limited information available, but to illustrate the method the gill nets of the Colony of Singapore are classified below :—
- 3.211 $\frac{1}{2}$ inch Bar.
- 3.211.1 *Floating.*
- 3.211.11 206 meshes deep.—Jaring tamban—a floating drift net used for the capture of tamban.
- 3.211.12 250 meshes deep.—Jaring tamban—a drift or anchored gill net, which, is employed for the capture of bait fish (In this Colony the net is used only as an anchored gill net, but its use with a cocoanut-leaf lure from a drifting boat is recorded from Penang, Govt. St. Settles., 1896).
- 3.211.2 *Sunken*—nil.
- 3.212 *One inch bar.*
- 3.212.1 *Floating.*
- 3.212.11 19 meshes deep.—Jaring selangat (Chinese)—an anchored, floating gill net into which fish are driven by scaring.
- 3.212.12 $22\frac{1}{2}$ meshes deep.—Jaring puput—a floating gill net (actual bar $\frac{5}{8}$ inches), the principal catch being the half-beak. (Hemirhampidae).
- 3.212.13 30 meshes deep.—Jaring belanak—a floating drift net, the principal catch being belanak (Mugil spp.).
- 3.212.14 99 meshes deep.—Jaring selangat (Malay),—a floating drift net, the principal catch being kapas (Gerridae) and kerong (Theraponidae).
- 3.212.2 *Sunken.*
- 3.212.21 23 meshes deep.—Jaring tenggelam—a sunken, set net.
- 3.213 $1\frac{3}{16}$ inch bar.
- 3.213.1 *Floating.*
- 3.213.11 24 meshes deep.—Jaring karang—an anchored, floating gill net into which fish are driven by scaring.
- 3.213.2 *Sunken.*—nil.
- 3.214 $1\frac{1}{2}$ inch bar.
- 3.214.1 *Floating.*
- 3.214.11 105 meshes deep.—Jaring hanyut—a floating drift net of $1\frac{1}{2}$ or $1\frac{3}{4}$ inch bar, utilised in the parang (*Chirocentrus dorab*) and tenggiri (*Scombermorus* sp.) fisheries.
- 3.214.2 *Sunken.*—nil.
- 3.22 **Tangle Nets.**—Entangling structures in which the fish becomes entangled in several meshes of the fabric, e.g., jaring ketam (Malaya); sashi ami (Japan); crab or brat nets (England). Possibly the kola vala and kandadi vala (Madras), which are said to gill small and entangle large fish, should be included here, but their position must be determined on the relative importance of each method. Should productivity by both methods be similar, a new sub-head 'tangling gill nets' will be necessary.

- 3.23 *Trammel Nets*.—Entangling structures which consist of an inner, loosely-hung sheet of small-mesh netting with two outer 'armourings' of larger mesh. Fish striking the net pass through the armouring, forming a bag of the smaller lint which is constricted by the mesh of the further armouring, e.g., in Europe.

3.3 ENGULFING STRUCTURES

Structures into which fish enter voluntarily or are driven as the result of scaring, the mouth or entrance to which is then closed.

- 3.31 **Closing Pouch Nets**.—Bag-shaped or similar receptacles into which fish enter voluntarily, the entrance or mouth of the bag then being closed or raised to prevent escape.
- 331.1 *Pendulous*.—Closing pouch nets which are suspended from a boat or other structure, e.g., shangla-jal and kharki-jal (India).
- 3.312 *Set*.—Closing pouch nets which are set on the bottom, the head-line usually being floated to the surface.
- 3.312.1 *Complete Bag*, e.g., tatta (Burma), chavittu valla (Madras).
- 3.312.2 *Incomplete Bag*, e.g., sankakugata oshikiami or triangular large set net (Japan).
- 3.32 **Drive-in Nets**.—Closing pouch nets into which fish are driven by scarer devices, the mouth of the bag then being closed or raised to prevent escape, e.g., paik-ta-se (Burma), oikomi ami (Japan), muro ami (Philippines), moro ami (Singapore & Indonesia).

3.4 INVESTING STRUCTURES

Structures which are dragged or hauled through the water, investing or enclosing any fish which are encountered. It also includes those gears which are set round a shoal of fish, thus enclosing it, capture being accomplished subsequently by pursing the bottom of the net, or by the use of subsidiary fishing gear.

- 3.41 **Snap Nets**.—Hinged or folding nets which are operated by snapping shut, thus investing any fish lying between the wings, e.g., Arnhem Land.
- 3.42 **Seines**.—Structures consisting of netting or similar material, which are set to enclose or partially enclose an area of water and through which the net is dragged to the shore or a boat.
- 3.421 *Drag Seines*.—Seines, consisting of a wall of netting, which may contain a bag but which are not extended by the use of long wings or warps, and are not set to encircle an area, e.g., gyan-taik, paik-chido (Burma), pond seines (Carp ponds, Malaya), ligkop (Philippines), pukat kisa (Malaya), vadi vala and tellikanni vala (Madras), etc.
- 3.422 *Haul Seines*.—Seines consisting of a wall of netting, with a bag or bags, modified by long wings and/or warps—
- 3.422.1 *Beach Seines*.—Haul seines specifically designed for use in shallow water, e.g., pukat tarek (Malaya), hiki ami (Japan), rampani seine (Madras), maha dela (Ceylon).
- 3.422.2 *Boat Seines*.—Haul seines specially designed for use in deep water.
- 3.422.21 *Floating*, e.g., vakku vala & odan vala (Madras), katumaran dela (Ceylon) etc.
- 3.422.22 *Sunken*, e.g., pukat payang (Malaya), Chinese-Danish seine and payang besar (Thailand), lamparas & Danish seines.
- 3.423 *Encircling Seines*.—Seines consisting of a wall of netting which is set to encircle and restrain a shoal.
- 3.423.1 *Hold*.—Encircling seines in which the catch is held in the net, being removed by subsidiary methods, e.g., large yellow croaker seine (Hongkong), Cornish pilchard seine (England).
- 3.423.2 *Purse*.—Encircling seines in which the catch is secured by pursing the foot-line, thus completing the enclosure. The net is then hauled and the catch removed directly, e.g., purse seines, ringnets, etc. (India, Thailand, Malaya, Hongkong, China, Japan).

- 3.43 **Bag Nets.**—Investing structures, sub-conical or bag-like in shape which are drawn through the water and which engulf the fish that are encountered. They differ from seines, in-so-much as they do not enclose an area but rather work it.
- 3.431 *Dredges.*—Engulfing bag nets which have a rigid lower boundary to the mouth, e.g., oyster dredge and shank nets (England), sokoribune (Japan), tanggok trepang (Kedah, Malaya), crad pling (Puket, Thailand).
- 3.432 *Trawls.*—Engulfing bag-like nets which have a non-rigid lower boundary to the mouth.
- 3.432.1 *Bottom Trawls.*—Trawls which are dragged along the bottom.
- 3.432.11 *Beam.*—Bottom trawls with a rigid upper boundary to the mouth, e.g., all beam trawls.
- 3.432.12 *Extended.*—Bottom trawls without a rigid boundary to the mouth, which is kept open by the way in which it is dragged or by otter boards.
- 3.432.121 *Pareja.*—Bottom trawls in which the mouth is extended by the use of two vessels, each hauling a warp attached to one extremity of the headline, e.g., pukat gong-gong (Malaya), utase and (Japan), junk trawl (Hong-kong), etc.
- 3.432.122 *Otter.*—Bottom trawls in which the mouth is extended by otter boards, thus allowing a non-rigid trawl to be operated by one boat, e.g., all otter & V.D. trawls.
- 3.432.2 *Floating Trawls.*—Trawls which are dragged through the water but which do not disturb the bottom. These instruments are usually much lighter in construction than bottom trawls and may be dragged near the surface or in mid-water, e.g. :
- 3.432.21 *Surface*, e.g., nishohiki ukihiki ami (Japan),
- 3.432.22 *Mid-water/Surface*, e.g., Danish floating trawl.

13

AN ATTEMPT AT CLASSIFICATION OF FISHING METHODS

by

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ABSTRACT

A proposal is made for the classification of fishing methods on the basis of a list of four chief activities in fishing and of eight basic forms of gear and fishing devices.

The nature of fishing methods depends on the way certain activities in fishing are combined with the use of certain forms of gear.

There are 4 chief activities in fishing.

A. The gear is active and at the same time the centrepont of fishing, mostly a boat, is active.

B. Only the gear is active.

C. The medium, the water, is active.

D. The fish are active.

The methods under A and B are called active methods, those under C and D are passive fishing methods. This broad distinction was already known before 1938, vide Schna-kenbeck, 1937, but was not further analysed.

There are 5 basic forms of gear and 3 basic kinds of fishing devices namely :

1. The V-shaped collector.
2. The surrounding wall.
3. The entangling mesh.
4. The hook.
5. Harpoons and missiles.
6. All contacting devices except 4 & 5.
7. Diffusing devices.
8. Deceiving devices.

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