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# ON THE COMPARATIVE CATCH EFFICIENCY OF HAND-OPERATED AND WINCH-OPERATED TRAWLS*

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## I. INTRODUCTION

THAT the motorization of the indigenous fishing crafts and the introduction of modern designs of mechanized fishing boats provide the background impetus for an improvement of the existing fishing gear and methods is too well known. Some of the maritime States in India have completed the first phase of the general 'mechanization' programme, namely—the installation of engines for propulsion in the existing fishing boats (Setna, 1955; Deshpande, 1958; Gurtner, 1958; Kuriyan and Balasubramanyan, 1959). The next step obviously is the introduction of modern fishing gear to increase the catch-per-unit effort and thereby to be in commensurate with the extra capital outlay. Chidambaram (1952) and John *et al.* (1959) review the attempts made earlier for the introduction of new gear in Indian waters.

"Trawls" are effective modern gear provided they are operated by skilled personnel. Although extensive work have been done elsewhere on the design, construction and operation of the different types of trawls, very little information is available on record about the comparative catch efficiency of hand-operated and winch-operated trawls with which the present communication deals.

## II. PLACE OF EXPERIMENT, FISHING GROUNDS AND PERIOD OF OPERATION

Experimental trawl fishing is being conducted both on the East and West Coast of India from fully and partly mechanized vessels. In the sea off Cochin, where the present study was made, otter trawl for shrimps is the most popular gear operated from the different motor fishing boats.

Two motorized fishing vessels 'Tarpon' and 'Sagarkumari' attached to the Government of India Off-shore Fishing Station, Cochin, were selected for carrying out the present study. Observations of fishing operation under-

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* Contribution No. 23.

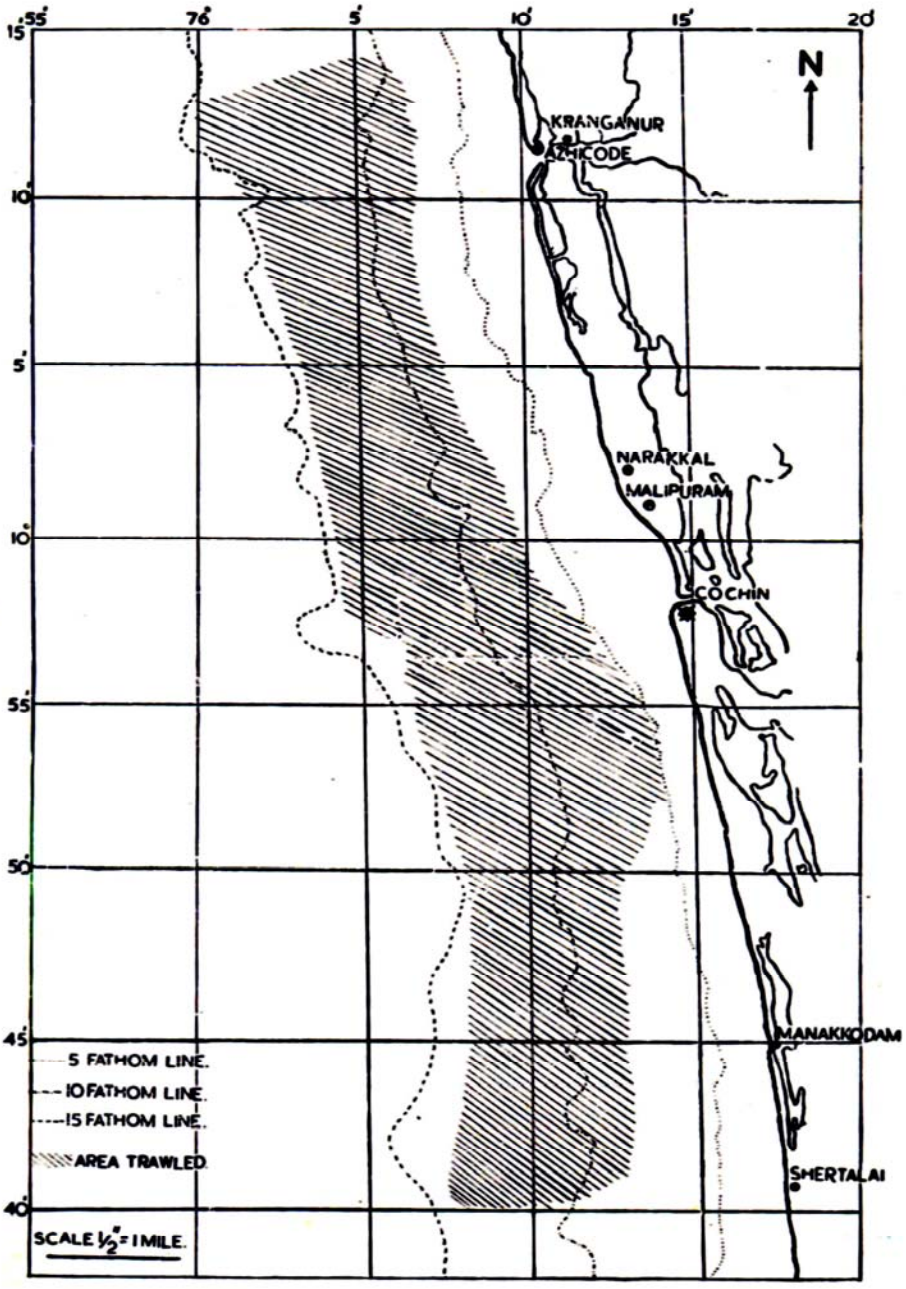


FIG. 1. Chart showing fishing grounds off Cochin.

taken by these vessels commenced from 1-12-1958 and continued up to 31-3-1959. During the period of four months, 71 fishing trips were made by each vessel. The fishing grounds were within 9° 40′-10° 14′ N. latitude and 76° 0′-76° 14′ E. longitude.

Particulars regarding the size of the net, fishing grounds, depth of water, length of warp used for each drag, duration of the drag, and catch per haul, etc., were recorded.

## III. Particulars of Fishing Vessels

Both the vessels are identical in design and power of engine provided and other essential details. The vessel 'Tarpon' is, however, equipped with a power-driven mechanical winch whereas the vessel 'Sagarkumari' is devoid of any mechanical fishing equipment.

The specifications of the vessels along with the other details are tabulated in Table I.

TABLE I

*Showing the specifications and other details of the vessels*

| Specification | 'Tarpon' | 'Sagarkumari' |
|---|---|---|
| Design .. | Medium-sized fishing vessel with transom stern | Medium-sized fishing vessel with transom stern |
| Year and place of construction .. | 1955, Japan | 1955, Japan |
| *Dimensions*: | | |
| Length .. | 34′- 4″ | 34′- 4″ |
| Breadth .. | 11′- 0″ | 11′- 0″ |
| Depth .. | 4′-11″ | 4′-11″ |
| Registered tonnage .. | 8·45 tons | 8·45 tons |
| *Particulars of Engine*: | | |
| Type .. | Marine diesel engine | Marine diesel engine |
| Make .. | Yanmar | Yanmar |
| B.H.P. .. | 42 | 42 |
| *Particulars of winch and warp*: | | |
| Type of winch .. | With wire drums | .. |
| Warp .. | 9 mm. diameter galvanised flexible steel wire | 19·05 mm. diameter manila rope |
| *Particulars of crew*: | | |
| Bosun .. | 1 | 1 |
| Mechanic .. | 1 | 1 |
| Lascars .. | 3 | 4 |

## IV. Particulars of Fishing Gear

The mechanized fishing vessels 'Tarpon' and 'Sagarkumari' used four-seaming, non-overhang otter trawl nets, the particulars of which are shown in Table II. The nets had legs, spreaders, bridles and sweeps.

**Table II**

*Showing particulars of the nets*

| Name of vessel | Type of net used | Mesh size (stretched) | Size of O.B. | | Length of | | Distance between *O.B.* and wings |
|---|---|---|---|---|---|---|---|
| | | | *Dim.* | *Wt.* | *H.R.* | *F.R.* | |
| Tarpon .. | Four-seaming Non-overhang trawl | Cod-end —1″ Rest —2″ | 58″× 26·5″ | 110 lb. | 51′ | 51·5′ | 37′ |
| Sagarkumari | Do. | Do. | 42″×25″ | 58·5 lb. | 40′ | 40·5′ | 43·5′ |

Note: *H.R.*—Head rope; *F.R.*—Foot rope; *Dim.*—Dimensions; *O.B.*—Otter Board; *Wt.*—Weight.

## V. Method of Operation

(i) *Deck arrangement.*—Since the vessel 'Sagarkumari' was without winch, certain arrangements were made to facilitate towing of the warp. Two iron chains 4–5′ (121–152·4 cm.) in length were fixed together to the rear of the fishhold towards stern-deck.

Manila ropes 0·75″ (19·05 mm.) diameter and one fathom in length were tied to the free ends of the chains. Two iron hooks were attached to these ropes by splicing their ends. To facilitate securing of warps on-board, each towline was spliced at a distance of 55 and 70 fathoms.

(ii) *Shooting.*—The shooting of the nets in both these vessels were carried out following the conventional way. After taking necessary soundings (for depth of water and nature of sea-bottom) of the fishing grounds on each day, the net was paid out in the order of cod-end, legs, bridles, sweeps, otter-boards and warp. Time required for shooting the warp in respect of each vessel was recorded and shown in Table III. The towing speed ranged between 2–2·5 knots per hour. It would be observed from Table

III that the time required for shooting the warp is more or less the same for both the vessels.

(iii) *Duration of drag.*—3–4 regular fishing hauls were made by these vessels on each day. The duration of each drag was between 60 and 90 minutes.

(iv) *Hauling.*—The hauling in of net in case of 'Tarpon' was effected by winch. The heaving operations were carried out by hand onboard 'Sagarkumari' after placing the engine in neutral position. The time required for heaving the warps recorded in respect of each vessel is shown in the last column in Table III.

TABLE III

*Showing the time required for shooting and hauling in the warps*

| Name of vessel | Depth in fathoms | Length of warp used in fathoms | Time required in minutes for | |
|---|---|---|---|---|
| | | | Shooting | Hauling |
| Tarpon .. | 5 –15 | 50–70 | 3·5–5 | 5–6 |
| Sagarkumari .. | 3·5–13 | 55–70 | 4–5 | 7–16 |

It would be obvious from Table III that the hand-operated trawl required more time for heaving the warps.

## VI. RESULTS

The quantity of fish landed by these vessels along with the other details are tabulated in Table IV.

TABLE IV

*Showing particulars of catch landed by these vessels*

| Name of vessel | Fishing trips | Fishing hauls | Duration of hauls | | Catch | | | Catch per hour | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hrs. | Mts. | Prawn (lb.) | Fish (lb). | Total (lb.) | Prawn (lb.) | Fish (lb.) | Total (lb.) |
| Tarpon .. | 71 | 335 | 330 | 33 | 29,805 | 60 844 | 90,649 | 90 | 184 | 274 |
| Sagarkumari .. | 71 | 347 | 369 | 47 | 25,384 | 26,209 | 51,593 | 69 | 71 | 140 |

The catch data reveal that the catch per hour of trawling is more in the case of mechanically operated trawl net. The catch per hour on the grounds operated works out to 90 lb. of prawns and 184 lb. of fishes in case of 'Tarpon' and 69 lb. of prawns and 71 lb. of fishes in case of 'Sagarkumari'.

## VII. Discussions

### 1. *Catch-per-unit volume of water filtered*

The quantity of fish caught by a trawl net has a direct bearing on the volume of water filtered by it during a certain period and the volume of water filtered by a net in turn depends on the vertical and horizontal mouth-opening of the net while in action. The volume of water filtered per hour by the nets operated was worked out by taking into consideration the opening of the net while being towed in water.

*Opening of the net in action.*—One of the major factors influencing the catch of a trawl is the vertical and horizontal area of the ground fished by the net. Takayama and Koyama (1959) and Okonski and Sadowski (1959) suggest that the vertical opening of the mouth of the trawl is important and depends mainly on the length of the 'headrope' and 'footrope'. Phillips (1959) states that the vertical plane is more essential than the horizontal for high swimming fish and "the height of the headline has a more direct bearing on the potential catching power than the spread caused by the trawl doors". Ben-yami (1959) describes the method of calculating the opening height and width of a trawl net and also suggests "pattern considered to be cheap, strong and efficient trawl net for the Mediterranean Sea where an increase in the fishing height may be of far greater importance". de Boer (1959) gives an account of the interesting results obtained by his under-water instruments, such as spread-meter and net-height meter, for recording the behaviour of trawl gear. Chikamosa Hamuro and Kenji Ishi (1959) used an automatic net-height meter to ascertain the height of the headline and wings of a trawl net in action. Scarfe (1959) recommends echo-sounding as a means of observing the performance of trawling gear and further states that the height of the opening, the position of danlenos and otter boards in regard to the net opening can be observed from echo-gram. The vertical and horizontal opening of the nets operated by 'Tarpon' and 'Sagarkumari' were worked out and the procedure followed in calculating the opening height and width of each net along with the other details are described under the appropriate paras.

(*a*) *Vertical opening of the net.*—The grounds where fishing was carried out by 'Tarpon' and 'Sagarkumari' were inhabited by prawns which adhere

to the sea-bottom during daytime and as such the vertical fishing height of the net was not of much importance. For want of modern equipments, the vertical elevation of net was estimated from the length of the headrope or size of the net.* The vertical height assessed in respect of nets operated by 'Tarpon' and 'Sagarkumari' are given below:

| Vessel | | Length of headrope | Estimated vertical height |
|---|---|---|---|
| Tarpon | .. | 51′ | 4·5′ |
| Sagarkumari | .. | 40′ | 3·6′ |

(*b*) *Horizontal opening of the net.*—The horizontal opening of the net in action was considered to be of great importance. The probable opening of each net, while being towed in water, was worked out from the actual measurements taken during the course of fishing. The method employed in calculating the approximate distance between the otter-boards was based on measuring the distance between the warps at two particular points on board the vessel during each day. This method, although not correct, suffices to procure the probable distance between two doors. The following equation was used in calculating the horizontal opening between otter-boards:

$$L : B = l : b.$$

Therefore,

$$B = \frac{b \times L}{l}.$$

where

$L$ denotes the length of warp used while trawling,

$B$ the horizontal distance between two doors,

$l$ the marked length of warp from the point $A$ where both the warps are secured together onboard, and

$b$ the horizontal distance between the ends of $l$.

Here $L$ in operation is known and if we can measure $l$ on both the warps correctly, then $b$ can be easily measured as illustrated in Fig. 3.

* Based on a personal communication from Dr. H. Miyamoto.

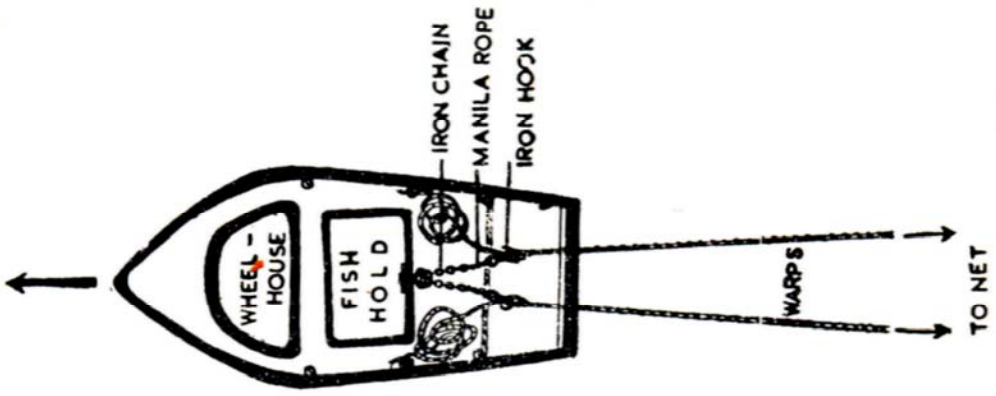


FIG. 2

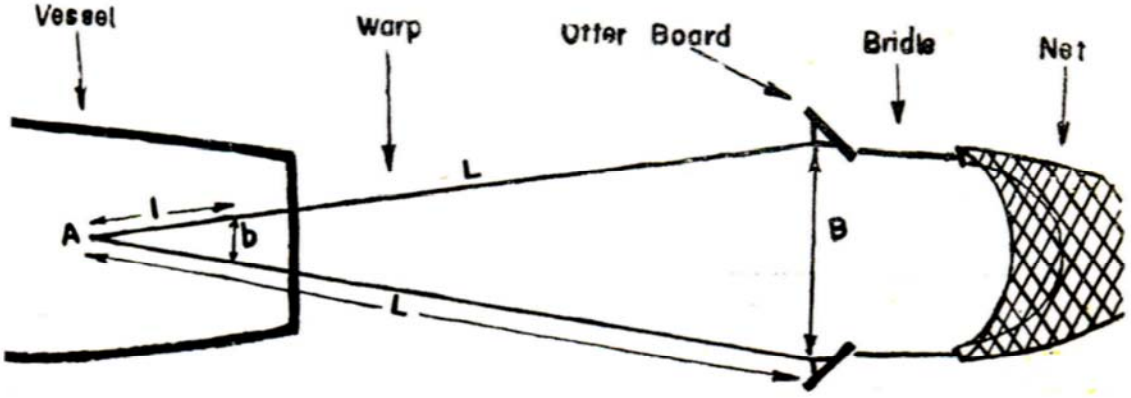


FIG. 3

FIGS. 2–3. Fig. 2. Showing deck arrangement on board 'Sagarkumari'. Fig. 3. Showing procedure followed in measuring the horizontal spread.

The results obtained after calculating the horizontal distance between two doors reveals as follows:

| Vessel | Approximate distance between two doors |
|---|---|
| Tarpon .. | 58·14′ |
| Sagarkumari .. | 37·89′ |

The horizontal opening thus procured is not the actual mouth-opening of the net while fishing but the distance between two otter-boards. However, this distance helps in calculating the actual opening of the net or distance between the two wings. Presuming that the headrope with legs, bridles and sweeps maintains a catenary curve while being pulled along the sea-bottom and since the distance between the doors and wings is known, the horizontal distance between the two wings can be easily measured. The following procedure was followed in measuring the horizontal opening of the net under laboratory conditions.

Two nails were fixed on the wall at a distance already obtained (the distance between two doors). An iron chain (thin) having length equivalent to the total length of headrope, legs, bridles and sweeps (of either side) was hung, by its free ends on to these nails. The chain thus hung maintains a catenary curve. The distance between door and wing was marked on either side of this chain from its free ends or from the nails. The horizontal distance between these two marks was measured indicating the expected horizontal mouth-opening of the net or the distance between the two wings. Particulars of the above measurements obtained in respect of each vessel are tabulated in Table V.

TABLE V

*Showing horizontal distance between doors and wings of each net*

| Vessel | Horizontal distance in feet between | |
|---|---|---|
| | Doors | Wings |
| Tarpon .. | 58 | 38 |
| Sagarkumari .. | 38 | 24 |

After ascertaining the horizontal and vertical opening of the net and average towing speed of the vessel per hour while trawling, the volume of water filtered per hour by each net was calculated from the following formula:

$$V = B \times H \times S,$$

where

$V$ denotes the volume of water filtered,

$B$ and $H$ the horizontal and vertical openings respectively, and

$S$ the distance for which the net was towed during one hour.

The volume of water filtered by the nets operated by 'Tarpon' and 'Sagarkumari' are recorded in Table VI.

TABLE VI

*Showing the volume of water filtered by each net and the catch per unit volume of water filtered*

| Vessel | Average trawling speed | Vertical fishing height | Horizontal fishing height | Volume of water filtered per hour (c.ft.) | Catch-per-unit volume (1,00,000 c.ft.) | |
|---|---|---|---|---|---|---|
| | | | | | Prawns | Fish |
| Tarpon .. | 2·0 | 4·5′ | 38′ | 20,52,000 | 44 | 99 |
| Sagarkumari | 2·5 | 3·6′ | 24′ | 12,96,000 | 63 | 55 |

Presuming 1,00,000 c.ft. of filtered water as a unit for both these nets, the quantity of prawns and fish caught by filtering $10^5$ c.ft. of water by the vessel 'Tarpon' and 'Sagarkumari' comes to 44 lb., 90 lb. and 53 lb. and 55 lb. respectively (Table VI). Therefore, the quantity of fish caught per unit of filtered water is more in case of winch-operated trawl whereas the quantity of prawns is more or less the same in case of both the nets. The difference in catch so far as fish and prawns are concerned indicates that *bigger net increases the vertical fishing height of a net whereas the smaller net catches more from the horizontal plane (nearer to the bottom).*

2. *Catch per unit area covered*

The catch of fish and prawns caught per unit area covered by the nets operated by these vessels and tabulated in Table VII was worked out by taking into consideration the towing speed and horizontal opening of the net in action.

TABLE VII

*Showing catch in lb. per 100 sq.ft. of area of the sea floor*

| Vessel | Catch in lb. per hour | | Towing speed in knots per hour | Horizontal opening in ft. | Total area covered per hour in sq.ft. | Catch in lb. per 100 sq.ft. | |
|---|---|---|---|---|---|---|---|
| | Prawn | Fish | | | | Prawn | Fish |
| Tarpon .. | 29,805 | 60,844 | 2·0 | 38 | 4,56,000 | 6·53 | 13·34 |
| Sagarkumari | 25,384 | 26,209 | 2·5 | 24 | 3,60,000 | 7·05 | 7·28 |

It would be evident from Table VII that there is not much difference in the quantity of prawns landed by each vessel. *The catch data further reveals that the prawns were distributed evenly along the sea bed and as such the vertical opening or fishing height of the net is not important while trawling for shrimps.*

Comparing the catch of fish landed by each vessel, it is clear that the catch per 100 sq.ft. of area scooped by the nets operated by 'Tarpon' and 'Sagarkumari' comes to 13·34 lb. and 7·28 lb. respectively. *The difference between the fish catch further indicates that the fishes dwell not only along the sea-floor but also swim above it and as such the vertical fishing height of the net is of greater importance while trawling for fishes.*

3. *Relation between hauling time and catch*

Time required for heaving the warps during each haul and the quantity of fish caught by the net during each drag were recorded and mentioned under appropriate paras earlier. The quantity of fish caught per haul and time required for hauling-in the warps is illustrated in Fig. 5.

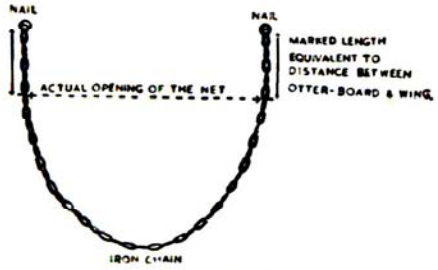


FIG. 4

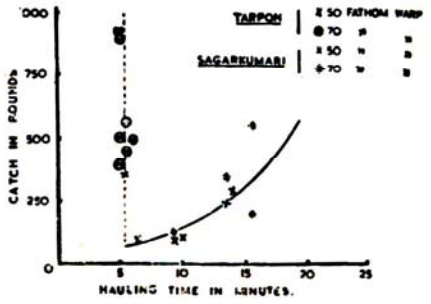


FIG. 5

FIGS. 4–5. Fig. 4 Showing arrangements made for calculating the actual opening of a trawl net. Fig. 5. Showing the relation between the quantity of fish caught and the time required for taking the warps onboard in respect of 'Tarpon' and 'Sagarkumari'.

The above graph indicates that the time required for heaving the warps by hand depends entirely on the quantity of fish enmeshed in the codend region (provided there is not much difference in the length of warp used while trawling), whereas it remains constant throughout in case of trawls operated by mechanical means.

## VIII. RECAPITULATION OF ADVANTAGES OF MECHANICALLY OPERATED TRAWL NET

Based on the results of observations made during the course of studies, the following have been noted to be the decided advantages of the mechanically operated modern gear:

(i) The number of crew engaged while fishing is less in case of nets operated by winch.

(ii) The hand-operated vessel could not operate a bigger net than the one operated by her as more hands are necessary for hauling-in a bigger net.

(iii) Though the time required for shooting the net is same in case of 'Tarpon' and 'Sagarkumari', the hauling-in of warps by hand required more time. Moreover, the vessel 'Sagarkumari' had to be stopped from going ahead while heaving the net which resulted in escape of some of the fishes from the net.

(iv) The number and duration of hauls were more in case of 'Sagarkumari' as prolonged trawling results in additional labour and time for taking the increased catches onboard.

(v) While comparing the opening of the nets, it can be deduced that the opening is more in case of fully mechanized craft. One of the factors responsible for getting less spread in the net operated by 'Sagarkumari' is the size of the warp (0·75" Manila rope) which offers more water resistance while being towed.

(vi) Comparing the catch efficiency per unit effort, it can be concluded that the catch is more in case of 'Tarpon'. The catch per hour comes to 274 lb. and 140 lb. in respect of winch and hand-operated trawl net.

Both the methods of operation are being practised in India and the present author is however of the opinion that, if trawling is to be conducted commercially, powered operations would increase efficiency.

## IX. Acknowledgements

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