https://doi.org/10.24199/j.mmv.1983.44.21 30 June 1983

SUMMARY OF FISHING GEAR AND METHODS EMPLOYED IN THE SQUID FISHERY OF JAPAN

By Michio Ogura

Department of Fishing Technology and Science, Tokyo University of Fisheries, 4-5-7, Konan, Minato, Tokyo 108, Japan

Abstract

The gear and methods that have been developed in Japan for catching squid, especially *T. pacificus*, are reviewed, with particular emphasis on lamps and illumination.

I. Fishing Gear

(1) *The Jigger* The common type of jigger used in Japan consists of numerous stainless steel hooks attached to the base of a plastic stem (Figure 1). About 30 jiggers are attached to an angling line at intervals of approximately 1 meter. Four lengths of stems, measuring 36, 42, 48 and 54 mm, are used. The 48 mm stem is employed mainly throughout the fishing season. There are certain fishermen, however, who change the size of their jiggers to match the seasonal changes in size and habit of the squids. The length of the hooks used ranges from 0.8-1.2 mm for the common squid (*Todarodes pacificus*) and from 1.2-1.4 mm for the red squid (*Ommastrephes bartrami*). These slightly elongated hooks are utilized in order to prevent excessive escapement. Generally red and green stemmed jiggers are used. In recent years, hollow vinyl stemmed jiggers have been used in conjunction with the common variety. In order to improve the jigging efficiency, one or two small battery-powered lights or 'cyalume lightsticks' are attached to the jigging line.

(2) *The Jigging Line* The jigging line consists of a main line attached to numerous jiggers connected to each other by leaders. The main line is of nylon monofilament or wire 1.35-1.67 mm in diameter, and the leaders are of nylon monofilament 0.74-0.90 mm in diameter. The leaders nearest the main line are slightly thicker than those towards the far end of the jigging line near the sinker.

(3) *The Sinker* The spindle-shaped, iron sinker is attached to the end of the jigging line. The 10-ton class of squid fishing vessels use a 750 g sinker, while the 99-ton class vessels use a 1 kg sinker.

II. Fishing equipment

(1) *The Automatic Squid Jigging Machine* The automatic jigging machine (Figure 2) has been widely used since about 1964. At present, most squid fishing vessels are equipped with these jigging machines. The machine is either electrically driven by the main engine (generator) or by a hydraulic system, and each machine controls one or two jigging lines. The vertical jigging motion of the jigging lines is achieved by the cam-shaped rotating drum; the speed of this motion is adjustable. When entanglement between neighbouring jigging lines occurs, the rotating drum can be stopped immediately or free-wheeled. Moreover, the lines can be adjusted to match fishing depths and the degree of jigging motion can be controlled. In recent years, vessels have been developed with a completely remote controlled system operated from the bridge.

(2) *Fishing lamps* Incandescent lamps (200 v, 3-4 kW) are used as the primary attracting light source in the squid fishery. The 99-ton class vessels, which are the mainstay of the squid fishing fleet, usually are equipped with 50 of these lamps (Figure 3) for a total illuminating power of 150 kW. In recent years, however, the smaller and more economical Halogen lamp has gained widespread popularity.

(3) *The Sea Anchor* Squid jigging is conducted with the boat stopped, so it is necessary to use a sea anchor (parachute anchor) (Figure 4) and spanker sail to maintain the vessels position against the wind and current. Spankers are most effective in smaller vessels, though the 99-ton class vessels also are equipped with them.

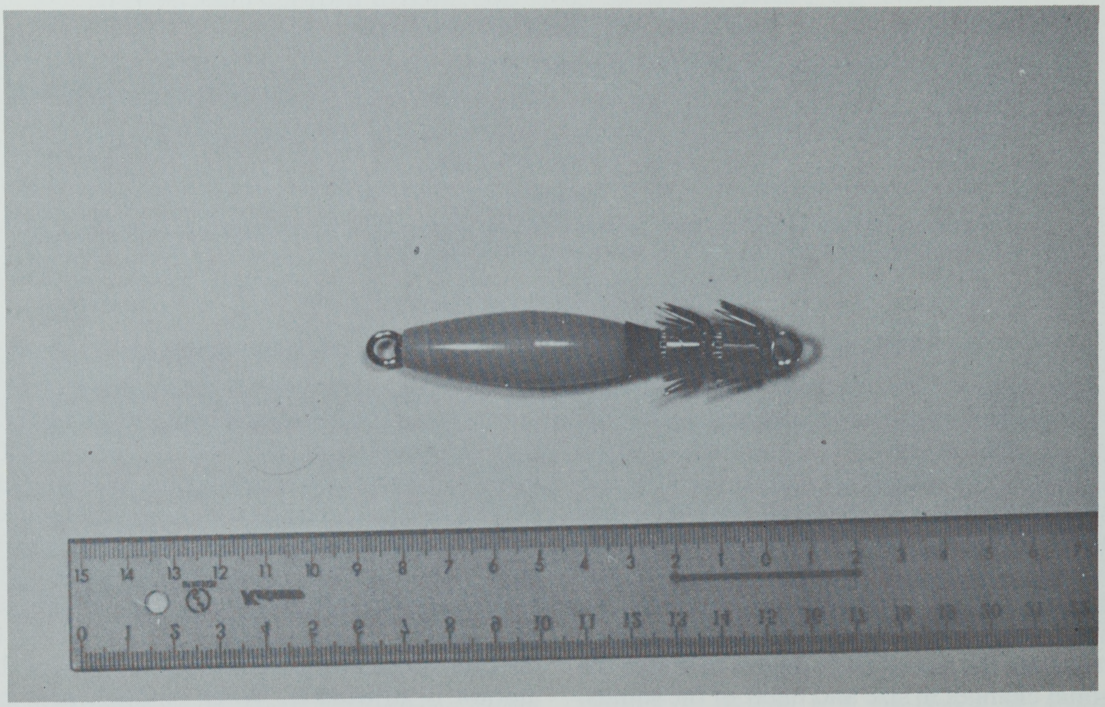
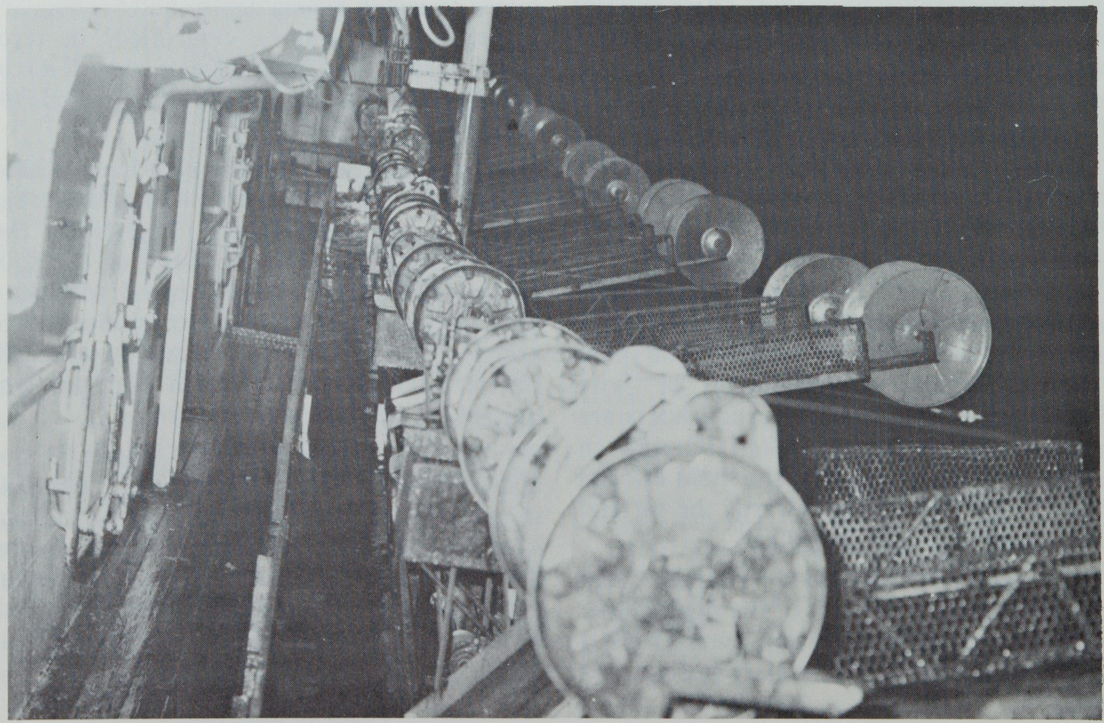


Figure 1. Common type of squid jigger.

Figure 2. Automatic squid jigging machines.



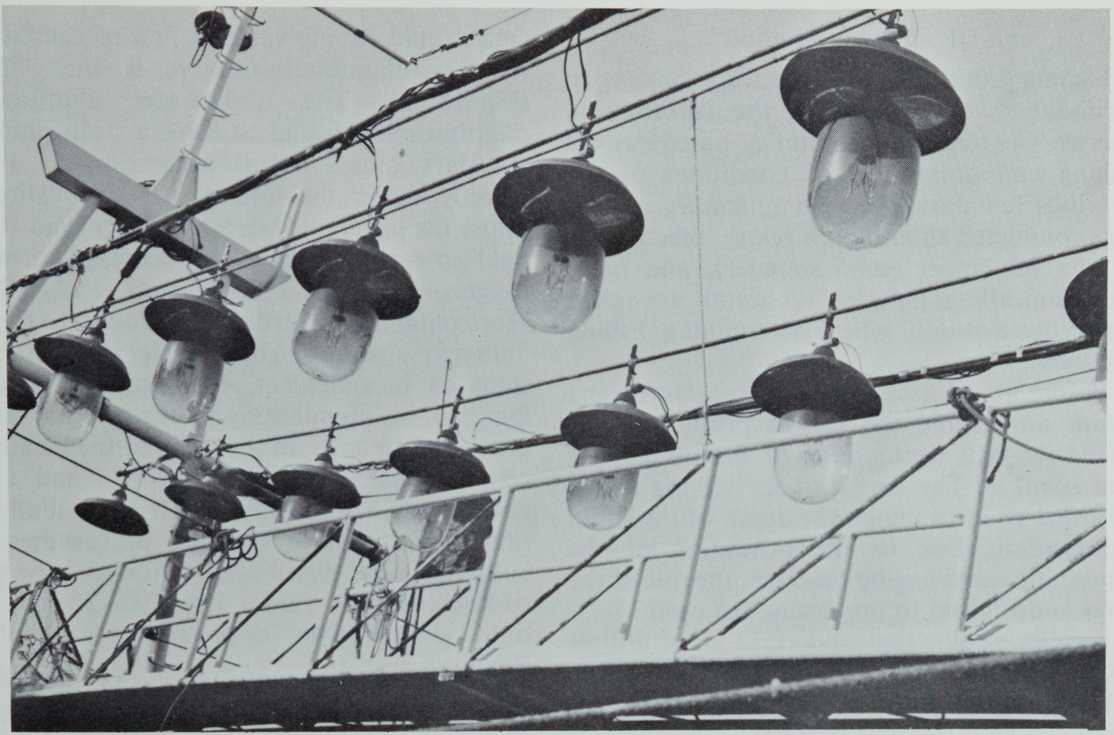


Figure 3. Fishing lamps (incandescent lamps: 200V, 3Kw).

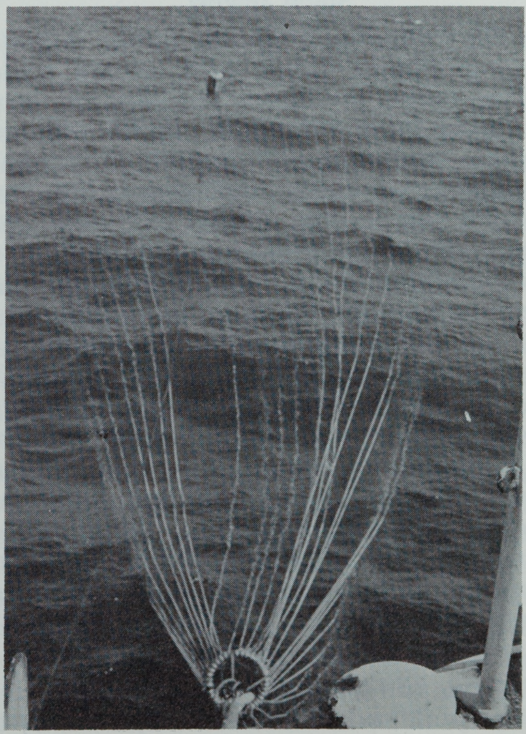


Figure 4. Sea-anchor (parachute anchor).

III. **Fishing Method**

Fishing grounds are determined according to information obtained from the Information Service Center, and location is based on the fishing and oceanographic conditions of the previous few days. Water temperature recordings conducted aboard each vessel, effective use of the fish finder (echo sounder), and radio communications between vessels all are taken into consideration when determining fishing grounds.

Before actual fishing commences, the fishing lamps are lit and the vessel's position established through deployment of the sea anchor and spanker. The length of the jigging line is adjusted so as to match the depth of the squid aggregation. Due to the utilization of the automatic squid jigging machine, the role of the crew is dedicated to processing the catch.

Smaller vessels that undertake short cruises store the squid in ice. The large vessels, with cruising capacities of between 20-30 days, are equipped with freezing facilities.

IV. **Fishing Lamps and Light Attraction for Squid Jigging**

(1) *The Utilization of Fishing Lamps in Squid Jigging* Fishing lamps used aboard squid fishing vessels are mainly incandescent, consisting of 200 V-3 kW bulbs. In recent years, the use of mercury lamps has become widespread but this has not led to an improvement in the catching efficiency. Besides, the high cost of these lamps has contributed to a decline in their use. It was only after this that highly economical halogen lamps were developed, consisting of bulbs one-thirtieth the size of the incandescent bulbs. At present, the use of halogen lamps abroad large squid fishing vessels is steadily increasing. Aboard medium and small sized fishing vessels, too, halogen lamps now are used in conjunction with incandescent lamps. The use of metal-halide lamps has been considered recently, and experiments in their practical use are now being conducted.

(2) *The Underwater Distribution of Light for All Types of Fishing Lamps* The underwater intensity of an incandescent lamp used by a small squid fishing vessel is first measured and its equal-illumination curve is then drawn (Figure 5). The underwater illumination distribution is found to have a steep gradient for dark areas, but is approximately 1 lux directly under the hull of the ship. Directly under the jiggers, for depths greater than 10 m, light intensity is found to decrease within a range of less than 1 lux (Ogura *et al.*, 1973). Horizontal light distribution is found to form a 'butterfly' shape. The underwater light distributions of incandescent, halogen and mercury lamps of an illuminating power of 3 kW each, are found to have, in the cases of the incandescent and halogen lamps for 10, 5 and 1 lux respectively, with highly similar equal-illumination curves; but in the case of the mercury lamps the light distribution is found to be very widespread—for values less than 20 lux, the light distribution approximately doubles (Figure 6 a-c).

(3) *The Effects of Arrangement and Height in Fishing Lamps* Squid generally are observed to gather within shaded areas formed by the shadow of the vessel. The fishing jiggers pass over rollers positioned on the gunwales and through the common boundary area of the dark and lighted areas. Consequently, the relationship between the position of the rollers and the arrangement and the height of the lamps above the deck is important (Ogura, 1973).

A number of experiments have been conducted in order to determine the relationship between the catch and light penetration of fishing lamps. Results show that jiggers suspended in bright areas experience extremely low catches, whereas jiggers suspended through the border between dark and lighted areas yield particularly good catches (Kawamura, 1970). Squid fishing vessels are numerous with either a single or double row of lamps running from stem to stern. Research on changes in the arrangement of the lamps and the corresponding effects on catches shows that a double row of lamps produces better catches than a single row (Karube & Takahashi, 1977).

(4) *The Effects of the Illuminating Power of Fishing Lamps on Catches* The relationship between the illuminating power of fishing lamps

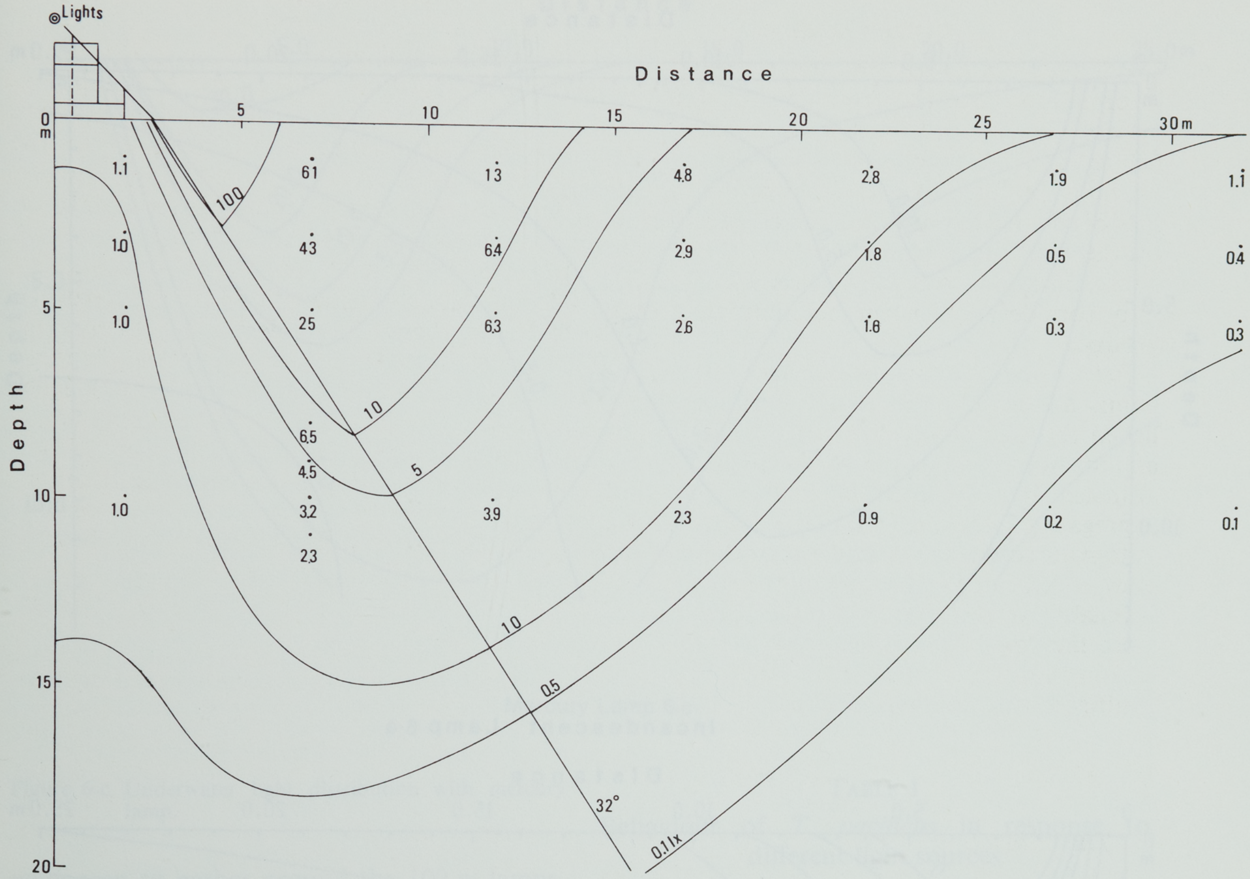
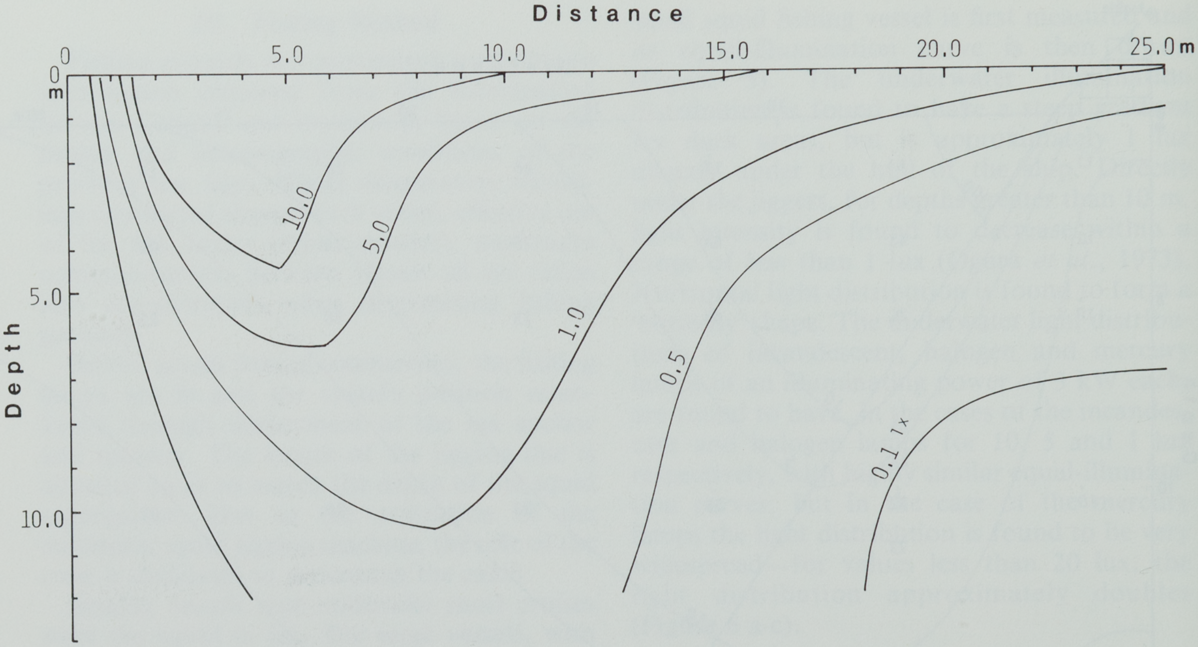


Figure 5. Vertical distribution of underwater illumination with 9 bulbs of 1-2 Kw incandescent lamp in one row along the centre of the boat (5 ton).

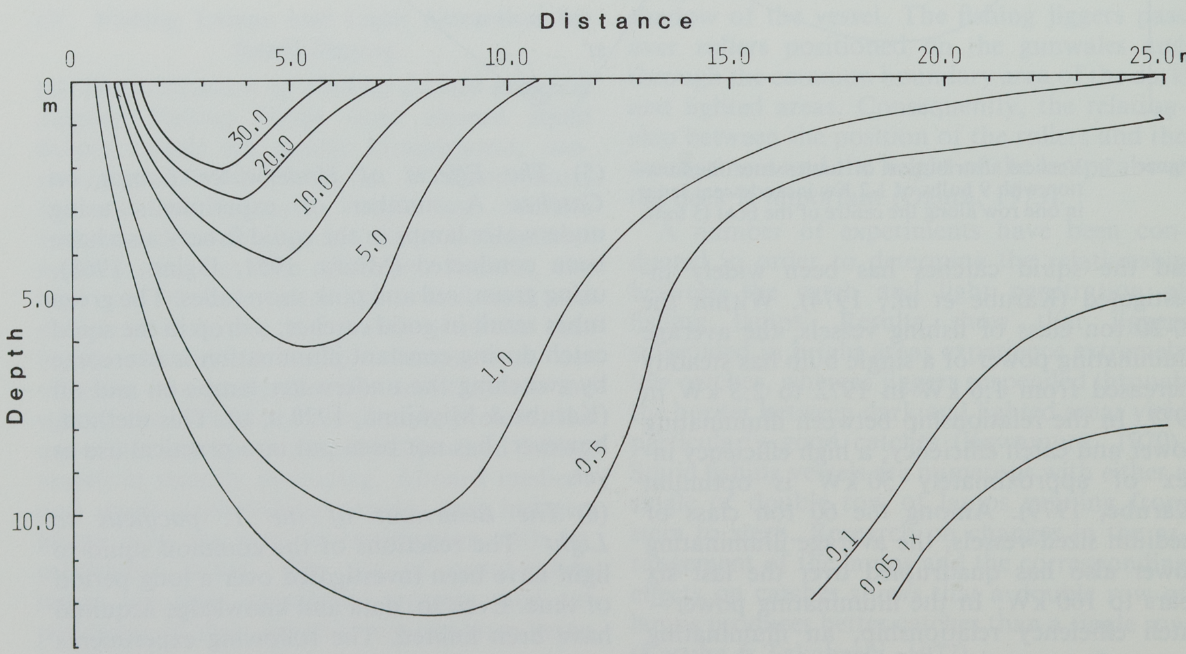
and the squid catches has been widely investigated (Karube *et al.*, 1974). Within the 10-20 ton class of fishing vessels, the average illuminating power of a single bulb has steadily increased from 1.6 kW in 1972 to 2.3 kW in 1977. In the relationship between illuminating power and catch efficiency, a high efficiency index of approximately 50 kW is optimum (Karube, 1979). Among the 60 ton class of medium sized vessels, the average illuminating power also has quadrupled over the last six years to 160 kW. In the illuminating power—catch efficiency relationship, an illuminating power of greater than 100 kW produces no increase in the efficiency index (Figure 7) (Ogura *et al.* 1979). Accordingly, there are clear limits to the illuminating power-catch relationship.

(5) *The Effects of Underwater Lamps on Catches* A number of experiments using underwater lamps in the squid fishery also have been conducted (Miura, 1951; Ogino, 1968), using green, red and pink neon tubes. The green tubes result in good catches; a drop in the squid catch during constant illumination is overcome by switching the underwater lamps on and off (Karube & Miyajima, 1978 a, b). This method, however, has not been put into practical use as yet.

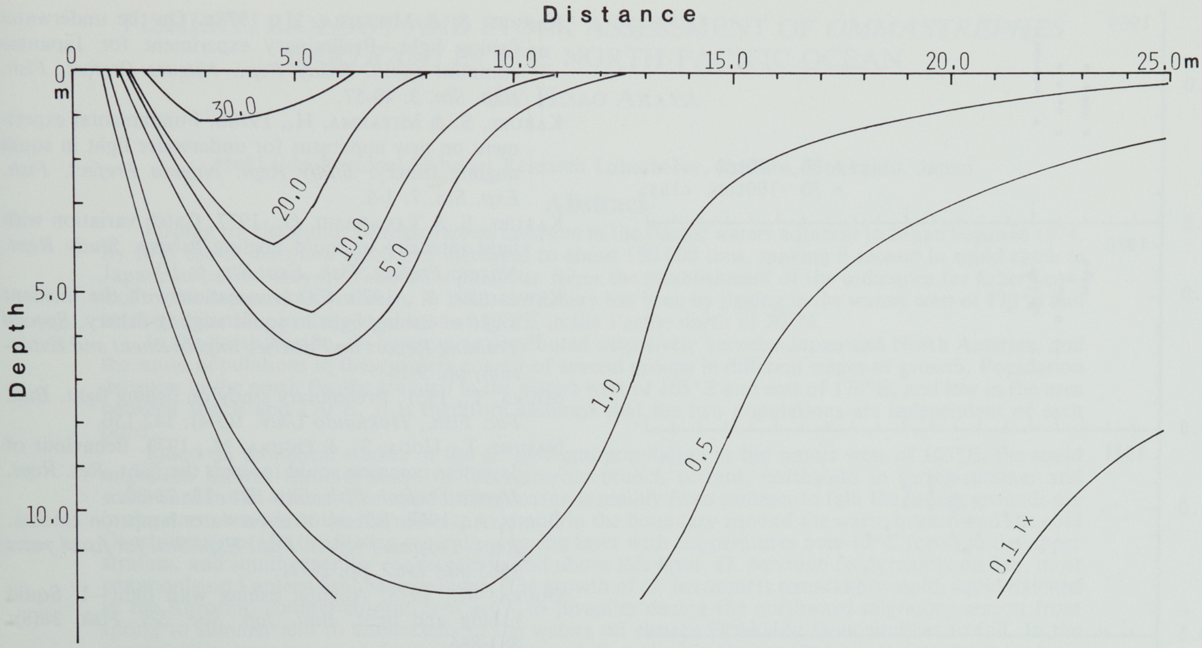
(6) *The Behaviour of the T. pacificus to Light* The reactions of the common squid to light have been investigated over a long period of time. Even so, data and knowledge acquired have been limited. The following experiments concerning the reactions of the common squid to light have been conducted by the author. In the case of incandescent lamps with differing illuminating powers of 500 w and 100 w, squid



Incandescent Lamp 6-a



Halogen Lamp 6-b



Mercury Lamp 6-c

Figure 6-c. Underwater light distribution with mercury lamp.

were seen to gather around the 100 w lamps, whereas they tended to scatter away from the 500 w lamp. For differing voltages of 100 v and 130 v, the squid prefer the higher voltage. In the case of the mercury lamps, during the time taken to achieve maximum luminosity the squid frequently are observed to dart to the darkest area, which is located at the opposite side of the light source. In the case of green fluorescent lamps, the squid concentrate directly below the light sources; but in comparison with the incandescent lamps the squid seem to disperse slightly (Table 1) (Nasumi *et al.*, 1973; Ogura & Nasumi, 1975).

Figure 6-a. Underwater light distribution with incandescent lamp.

Figure 6-b. Underwater light distribution with halogen lamp.

TABLE 1

Behaviour of *T. pacificus* in response to different light sources

Light source	Distance from light source	Size of squid school
Incandescent		
100V 100W	2.33^{m}	2.51$^{m^2}$
130V 100W	3.48	3.32
100V 500W	2.99	3.98
Halogen		
Transp. 40W	1.98	3.39
White 40W	2.65	4.31
Fluorescent		
20W	2.10	2.20

References

KARUBE, S., 1979. Fishing efficiency in small-typed squid angling boat, in relation to its historical development in Niigata prefecture. *Study Rept. Niigata Prefect. Fish. Exp. Stn.* 8: 1-11.

KARUBE, S., ISHIKAWA, Y., & HONMA, K., 1974. Present status on small-type squid angling boat in Niigata prefecture. *Study Rept. Niigata Prefect. Fish. Exp. Stn.* 3: 29-43.

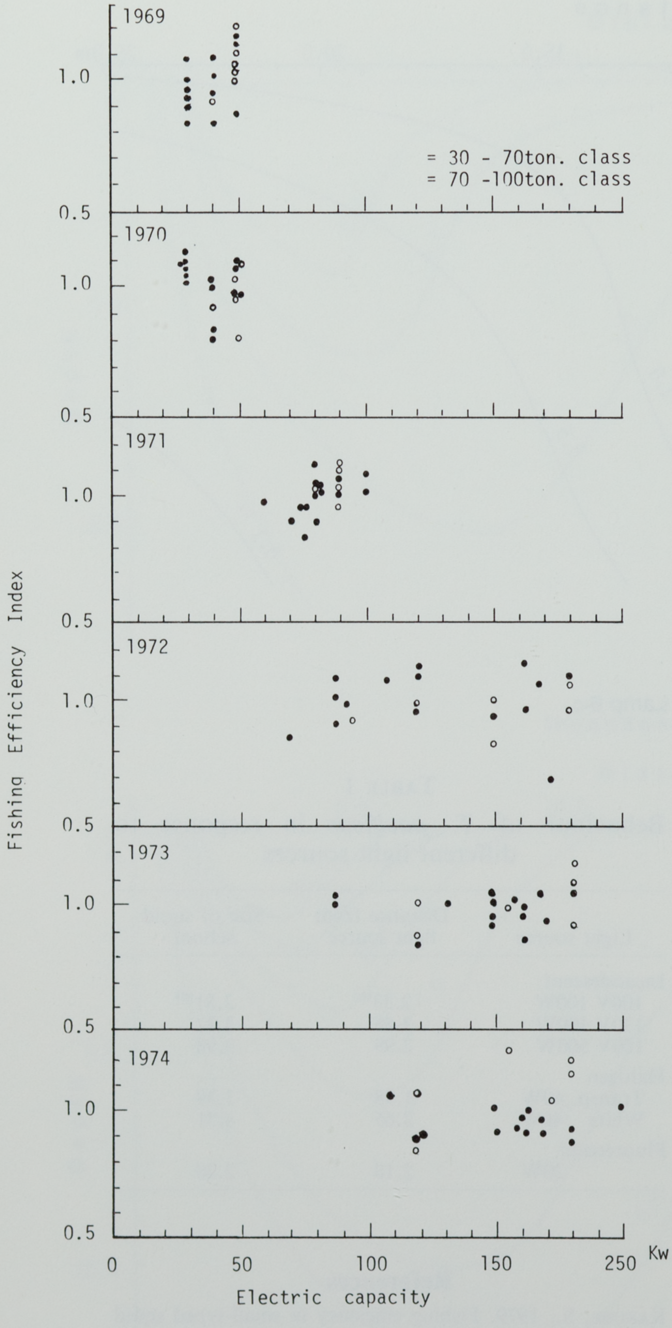


Figure 7. The relationship between the electric capacity of generator and the fishing efficiency index.

KARUBE, S. & MIYAJIMA, H., 1978a. On the underwater fishing light—Preliminary experiment for Japanese common squid. *Study Rept. Niigata Prefect. Fish. Exp. Stn.* 5: 49-57.

KARUBE, S. & MIYAJIMA, H., 1978b. Fundamental experiment on new apparatus for underwater light in squid angling fishery. *Study Rept. Niigata Prefect. Fish. Exp. Stn.* 7: 1-6.

KARUBE, S. & TAKAHASHI, O., 1977. Catch variation with light intensity in squid angling fishery. *Study Rept. Niigata Prefect. Fish. Exp. Stn.* 6: 1-8.

KAWAMURA, K., 1970. Catch variation with the incident angle of fishing light in squid angling fishery. *Special Training Report on Fisheries Improvement and Extension*, pp. 9-14.

MIURA, T., 1951. Preliminary study on fishing light. *Bull. Fac. Fish., Hokkaido Univ.* 1(3-4): 142-150.

NASUMI, T., UODA, S., & OGURA, M., 1973. Behaviour of Japanese common squid towards the light. *Res. Rept. Hyogo Prefect. Fish. Exp. Stn.* 13: 23-30.

OGINO, A., 1968. Effects of underwater lamps on catches. *Rept. Toyama Prefect. Fish. Exp. Stn. for fiscal years 1965 and 1967*, pp. 28-31.

OGURA, M., 1973. Angling fishing with light—I. Squid fishing and light. *Bull. Jap. Soc. Sci. Fish.* 38(8): 881-886.

OGURA, M., HIRAYAMA, N., & YANAGAWA, S., 1979. Study on optimum intensity of fishing light in squid angling fishery—I. Fishing efficiency in relation to yearly change of light intensity. *Summary book, spring meeting, Jap. Soc. Sci. Fish.*, pp. 5.

OGURA, M. & NASUMI, T., 1975. Study on squid angling fishery—III. On the behaviour of Japanese common squid towards the light. *Summary book, spring meeting, Jap. Soc. Sci. Fish.*, pp. 16.

OGURA, M., YANAGAWA, S., & NASUMI, T., 1973. Underwater distribution of light intensity with fishing light in squid angling fishery. *Summary book, autumn meeting, Jap. Soc. Sci. Fish.*, pp. 5.