87/69

DEPARTMENT OF
SEA FISHERIES TASMANIA
23 OLD WHARF, HOBART 7000
G.P.O. BOX 619F 7001
TELEX: TASFA AA58352

OS-K 3643

PHONE: 306514
INQUIRIES: W. Zacharin
OUR FILE: 6/7/35
YOUR REF:

8 November, 1988

The Secretary,
Fishing Industry Research and Development Council,
Bureau of Rural Science, DPIE,
NFF House, Brisbane Ave,
Barton, ACT 2600.

Fishing Industry Research Trust Account 87/69

Dear Ms Stablum,

Enclosed please find the final report and financial statement of the twelve month funded project entitled "Development of Alternative Fishing Practices for the Harvesting of Wild and Reseeded scallops in Tasmania".

Investigations of new dredge designs as a result of this project will be of great benefit to the scallop industry in southern Australia. Already the sputnik type dredge that has been in use since the early 1960's is being phased out and the fishermen have begun to build their own prototypes based on the Japanese Keta-ami type dredge.

This project has been a worthwhile and successful exercise.

yours sincerely,

Paul A. Crew
DIRECTOR

DEPARTMENT OF
SEA FISHERIES TASMANIA
23 OLD WHARF, HOBART 7000
G.P.O. BOX 619F 7001
TELEX: TASFA AA58352

OS-K 3643

PHONE: 306113
INQUIRIES: A. Wright
OUR FILE: 6/7/35
YOUR REF:

Statement of Receipts and Expenditure for the period 1 July 1987 - 31 August 1988.

Firta 87/69
Fishing Practices for the Harvesting of Wild and Re-seeded Scallop Beds

| | | |
|---|---|---|
| Total Receipts | | $50,750 |
| Expenditure | | |
| Salaries | $17,618.43 | |
| Travelling | $ 3,997.36 | |
| Operating Expenses | $29,134.21 | |
| | | $50,750 |
| | Balance | NIL |

Commitments as at 31 August 1988 but paid at 31 October 1988.

| | |
|---|---|
| Travelling | $255 |
| Operating | $2,872.50 |

A.C. Wright, BBus AASA
SENIOR EXECUTIVE OFFICER

# FISHING INDUSTRY RESEARCH TRUST ACCOUNT
# FINAL REPORT

TITLE OF PROJECT : Development of Alternative Fishing Practices for the Harvesting of Wild and Reseeded Scallop Beds in Tasmania (87/69).

ORGANISATION : Tasmanian Department of Sea Fisheries.

PERSON(S) RESPONSIBLE : Mr. Paul Crew (Director)

CONTACT OFFICER : Mr. Will Zacharin

SUPPORT : 1987/88 $50,750

OBJECTIVES :

a. To determine the efficiency of Beam, Triple and Prawn trawling methods for the harvesting of scallops.

b. To investigate the difference in efficiency between the sputnik dredge and the Japanese Keta-ami dredge.

c. To investigate the difference in bottom damage between the sputnik and Keta-ami dredge.

d. To study dredge and trawl net behaviour using CSIRO underwater surveillance equipment.

## FINAL REPORT

Development of Alternative Fishing Practices for the Harvesting of Wild and Reseeded Scallop beds in Tasmania (87/69).

### Introduction

Scallops are harvested in southern Australia using toothed box dredges. These dredges range between 2.0 - 4.5 m in width and can weigh up to 900 kg. The prototype of these dredges was the Baird scallop dredge from the United Kingdom, introduced into Tasmania in the early 1960's. The heavier box dredges with pressure plates gained favour with the fishermen as they operated in deeper water and the self-tipping mechanism considerably reduced fishing time.

Fishing effort increased steadily through the 1970's as the fishermen moved offshore in search of new scallop grounds. In 1980 the vast Bank's Strait and Flinder's Island beds were found.

Fishing these high density beds the fishermen noticed considerable damage in the landed catch as the day progressed. This results from many vessels steaming back and forward over the same scallop grounds day in and day out until the bed becomes uneconomic to fish, or knowledge of another bed influences their departure.

During 1980 - 1984 catches were at their peak and little attention was taken of the incidental catch damage. When catches fell in 1985 and 1986, fishermen began to take more notice of the incidental damage. It was eating into their profit margin, which was in drastic decline. Not only had the dredges become wider and heavier over the last six years, but many of the vessels were no longer run as owner operator ventures. Instead vessels were run by hired skippers with little or no experience in scallop fishing and it's practices.

The Department of Sea Fisheries was approached by the Scallop Fishermen's Association in 1986 about the damage being caused to the scallop beds by the big heavy mud dredges. As a result of preliminary investigation into this problem it was decided that research must be undertaken into alternative fishing methods. FIRTA was approached in 1987 to provide funding for a twelve month study.

### Alternative Fishing Methods

Two different types of gear were investigated. Scallop trawl nets as used in the Queensland *Amusium* fishery, and "Keta-ami" dredges imported from Japan. Comparisons of efficiency were made between the trawl nets, toothed mud dredge and the Japanese dredges.

#### QUEENSLAND SIEBENHAUSEN SCALLOP TRAWL

An eight day familarization trip was undertaken to Queensland in September, 1987. The Fisheries Research Laboratory at Burnett Heads was used as a base. Mr. Mike Dredge, the Officer in Charge, explained the set-up of the scallop trawls and introduced us to local fishermen. One of the fishermen operating out of Yeppon had been a Tasmanian scallop fisherman before moving to Queensland and one field trip was conducted on his vessel. This proved to be an important exercise as the trawl nets efficiency was very dependant on the mode of operation and the correct deployment of the gear.

On return to Tasmania two Siebenhausen nets were rigged as a double trawl and trials were conducted on the remnants of the north coast and Flinder's Island scallop grounds. A major problem encountered early in the trials was the lack of scallops due to the collapse of the fishery in 1987.

Results

Results showed that Queensland scallop nets were able to catch scallops in southern Australia even though the terrain was very different and the swimming ability of *Pecten* is much weaker than the saucer scallops (*Amusium*) in Queensland (Table 1).

A problem in using the trawl nets is that a large proportion of the Tasmanian inshore scallop grounds are very rocky and tearing the nets is a common event. Also the fish by-catch could introduce difficulties in management of the south-east trawl fishery.

It is not recommended that trawl nets be introduced in the scallop fishery due to the above problems and the high cost of changing the gear.

JAPANESE KETA-AMI DREDGES

As part of the joint scallop reseeding programme being conducted by the Department of Sea Fisheries and the Overseas Fisheries Co-operation Foundation of Japan, two Japanese Keta-ami dredges were imported to Tasmania. Each originated from a different area of Japan, and have modifications characteristic of the bottom topography in that area. Dredge weight and robustness being a reflection of whether the area is mainly composed of sandy or muddy bottom.

The Japanese dredges consist of a 2 to 3 metre wide toothbar, having one or two rows of vertical teeth, each tooth being up to 60 cm in length. The scallops are trapped in a 3 to 3.5 m bag made from steel ring mesh on the bottom with a net mesh top (Figures 1 and 2).

Trials did not begin until December, 1987 as the shipment of the dredges was postponed due to import regulations. The Japanese experts that were working in Tasmania as part of the Scallop Enhancement Project helped in the rigging of the dredge. Information supplied by the experts suggested that the best warp towing ratio was 4 or 5:1, speed less than 3.0 kn, and that incidental catch damage in Japan is approximately 2 %.

The dredges weighed less than 300 kg and this made for relatively easy deployment and handling. Dredges were deployed either from a strong boom with power lifting gear or from the rear of the vessel through a trawl block. The second method was the most favourable as most of the scallop vessels used did not have heavy duty booms with winches. The dredge was thrown over or released at a cruising speed of 5 to 6 knots until a fair amount of warp wire had been released. Once the depth to warp length was at the desired ratio, speed was reduced to 2.0 knots until the dredge contacted the bottom. If vibration of the warp wire indicated heavy contact with the bottom, speed was increased slightly. Speeds of over three knots at a warp ratio of 4:1 tended to lift the dredge from the bottom. This became obvious from the lack of vibration through the warp wire.

The dredge operates by the toothbar stirring the scallops on the bottom. Following the toothbar is a drop chain looped backwards from every third tooth. The area of chain fishing behind the toothbar could be increased or decreased by simply moving the connecting shackle up or down the holes on each tooth. In areas of rough bottom and areas with much rubbish, the lighter one fished with the drop chain the cleaner the total catch. So, it is very important to know : speed, warp ratio and bottom type.

Table 1 : Results from scallop fishing trials using Queensland Siebenhausen scallop nets.

| Shot No. | Duration (mins) | Warp Ratio | Speed (kn) | Depth (m) | Catch | By-catch |
|---|---|---|---|---|---|---|
| 1 | 10 | 4:1 | 2.0 | 38 | 40c | 2 flathead |
| 2 | 10 | 4:1 | 2.0 | 40 | 468c<br>2000d | gurnads<br>rays |
| 3 | 10 | 4:1 | 2.0 | 40 | 63c | 3 flathead |
| 4 | 15 | 4:1 | 2.0 | 40 | 254c | rays, flathead<br>gurnads |
| 5 | 15 | 3:1 | 2.5 | 34 | 107c | flounder,rays |
| 6 | 10 | 3.5:1 | 2.5 | 26 | 37c | 200rays<br>flounder<br>flatheads |
| 7 | 30 | 4:1 | 2.5 | 34 | 354c | 100rays<br>2 flathead |

c - commercial scallop *Pecten fumatus*
d - doughboy scallop *Chlamys asperrimus*

## Results

Initial trials were in an area of low scallop abundance, however, of the scallops caught incidental catch damage ranged from 5 - 32 % per drag (Table 2). Referring this result to the Japanese, their conclusion was that more fine tuning of the rig was necessary. This observation proved to be correct as in all the following cruises catch damage was less than 5 %.

Once confidence had been gained in it's operation the Keta-ami was pitted against the toothed box dredge in a number of comparative drags. Results of these drags showed that the Keta-ami dredge consistantly outfished the box dredge, some times as much as 7:1 by volume (Table 3).

## Port Phillip Bay Trials

On invitation from Dr. D. Gwyther at the Marine Science Laboratories, Queenscliffe the Keta-ami dredge was taken over to Port Phillip Bay to see how it performed in muddier substrates. Trials were conducted aboard the fishing research vessel SARDA with technical staff from the Marine Laboratories and representatives of the Port Phillip Bay Scallop Association. Drags were completed at various speeds, depths and warp ratio. Some comparative drags were done with commercial scallop vessels still fishing in the Bay.

The Keta-ami dredge used had a toothbar width of 6 feet, whereas the mud dredge used for the comparative drags had a width of 11 feet. Therefore, over a fixed distance the mud dredge was fishing a 54.5 % greater area. The catch in the mud dredge was

Table 2 : Initial trials using the Keta-ami dredge in Great Oyster Bay on the east coast of Tasmania. Catches were reasonable considering the low abundance in the area, but incidental damage exceeded that expected from the Japanese experience.

| Shot No. | Duration (mins) | Warp Ratio | Speed (kn) | Depth (m) | Catch | Damage no. | By-catch |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 5:1 | 3.0 | 45 | 1sc | 0 | sponge,shell |
| 2 | 5 | 5:1 | 3.0 | 43 | 20sc | 4 | sponge,weed |
| 3 | 5 | 5:1 | 3.0 | 42 | 21sc | 4 | clean shot |
| 4 | 5 | 5:1 | 3.0 | 43 | 17sc | 6 | clean shot |
| 5 | 10 | 5:1 | 3.0 | 42 | 53sc | 11 | clean shot |
| 6 | 10 | 5:1 | 3.0 | 43 | 56sc | 18 | clean shot |

sc - commercial scallop

Table 3 : Some comparative drags between the Japanese Keta-ami dredge and Toothed Mud dredge. Incidental damage to scallops using the Keta-ami dredge was under 2%, whereas using the mud dredge catch damage could be as high as 12%.

| Drag No. | Keta-ami No. Scallops | Keta-ami No. damaged | Mud dredge No. Scallops | Mud dredge No. Damaged |
|---|---|---|---|---|
| 1 | 188 | 3 | 16 | 2 |
| 2 | 597 | 2 | 59 | 4 |
| 3 | 1242 | 4 | 245 | 12 |
| 4 | 352 | 2 | 91 | 5 |
| 5 | 1076 | 11 | 237 | 8 |
| 6 | 664 | 6 | 80 | 3 |

significantly higher in one case, however, no count was made of the damaged scallops (Table 4).

This exercise was successful in introducing the Victorian fishermen to an alternative method less damaging to the scallops which is most important in Port Phillip Bay where most scallop beds appear to be bimodal, consisting of two age classes. Reducing mortality in the juvenile scallops may have a significant effect on the future viability of Port Phillip Bay.

The results show that the Keta-ami dredge is also proficient in catching scallops from muddy substrates. From all drags only negligible damage was observed in the landed catch. Comparative drags suggest that on muddy substrates the Keta-ami is as efficient as the mud dredge.

DREDGE BEHAVIOUR

To investigate the action of the Keta-ami dredge on the bottom the CSIRO provided their Osprey TVP underwater video system. The camera was first deployed on a large beam trawl apparatus in an attempt to view the dredge side-on. This was difficult to achieve as the warp wires could not be brought close enough together for a concise picture. However, the dredge unit and it's action on the bottom could be observed. If the boat speed is constant the toothbar remains in contact with the bottom at all times. Any change in the bottom, for example, rippling or sand pits, causes the

Table 4 : Scallop fishing trials using the Keta-ami dredge in Port Phillip Bay. Figures in brackets are comparative catches from commercial vessels over an adjacent area and similar estimated distance.

| Drag No. | Speed | Warp Ratio | Duration (mins) | Count Adult | Juvenile |
|---|---|---|---|---|---|
| 1 | 3.1 | 3:1 | 10 | 68+4 | |
| 2 | 3.1 | 3:1 | 10 | 49+1 | |
| 3 | 3.1 | 4:1 | 18 | 106+16 | (109) |
| 4 | 3.1 | 4:1 | 20 | 238+70 | (254+139) |
| 5 | 2.7 | 4:1 | 20 | 238+240 | |
| 6 | 3.2 | 5:1 | 20 | 213+108 | |
| 7 | 3.5 | 3:1 | 10 | 80+14 | |

dredge to lurch forwards, but the skids on the front of the toothbar prevent the angle of attack between the toothbar and the bottom increasing more than 110$^{o}$. Once the skids hit the bottom they bounce back-up and resume there normal position slightly off the bottom.

A second method was to mount the camera on the skids just infront of the toothbar. This gave a clear picture of the action of the teeth and the drop chain in picking up the scallops. The effects of increasing or decreasing speed on the dredge action could also be observed.

As the dredge descends, water moving through the catch bag stabilizes the gear and ensures that initial contact with the bottom is at the desired position and angle. Contact with the bottom is abrupt, the dredge resting on toothbar and skids until tension on the warp wire lifts the skids and the dredge moves forward. Within 30 seconds the warp tension has stabilized and the gear achieves optimum performance.

Increasing boat speed causes the dredge to fish lighter until speed approaches 3.5 knots where water moving through the catch bag causes the bag to bellow, and this lifts the toothbar off the bottom. Decreasing speed causes the dredge to fish harder and in areas of rough bottom the amount of rubbish increases considerably. The position of the drop chain on the front of the catch-bag can also determine the amount of rubbish in the catch.

To achieve optimal performance at a warp/depth ratio of 3:1 boat speed should not exceed 3.0 knots, and at a warp/depth ratio of 4:1 speed should not exceed 3.5 knots. It must be understood that warp/depth ratio and speed alter for dredges of different weight.

Film of the action of the mud dredge was also made available by the CSIRO. This graphically showed the ineffectiveness of the mud dredge, especially at speeds over 4 knots. Rough bottom causes the mud dredge to pitch and skew sideways, the toothbar not maintaining good contact with the bottom. This is the result of having a rigid catch-bag that will not allow the toothbar to act independently from the rest of the gear. Excessive speed shows the mud dredge pitching violently and in some cases forward lurching results in scallops being dumped back onto the bottom.

It is interesting to note that most commercial scallop fishermen tow their dredges at a speed of five knots or greater.

## BOTTOM DAMAGE

All scallop patches located for use in this study were not within safe diving depth so no examination of bottom damage or comparison between the two dredges was possible. However, gross examination of shallower bottom by diving after dredging indicated that the Keta-ami, as it is not as heavy as the mud dredge or prone to violent lurching, does not leave such a prominent track on the bottom. Little disruption to algal or sponge communities occurs. More extensive investigation on invertebrate communities and the effects of dredging would be desirable. Past studies Anon (1981) and Butcher (1981) suggest that the mud dredges have little harmful effect on the marine environment.

The Keta-ami being considerably lighter would be expected to have less effect on the bottom communities.

## CONCLUSION

Comparison of efficiency and incidental catch damage between the current toothed mud dredge and the Japanese Keta-ami dredges shows that the Keta-ami dredges are more efficient and less damaging. This is a consequence of the catch-bag being flexible, allowing the toothbar to maintain contact with the bottom at a constant angle of attack. In regard to deploying and retrieving the gear the mud dredge is much easier, however, with the increase in catch per drag using the Keta-ami dredge the increase in handling time is of no concern as catch per hour is greater.

Use of the Keta-ami dredge is limited in rough weather and may be less effective in deep water, but adding weight to the toothbar may alleviate the problem to a certain degree. Further research in dredge design is continuing with State funding in an effort to improve the Japanese design of southern Australian conditions.

It is the recommendation of this report that the Japanese Keta-ami type dredges or a hybrid are seriously considered as a alternative fishing method for introduction into the southern Australian scallop fisheries.

## REFERENCES

Anon. (1981): The Effects of scallop dredging on Port Phillip Bay ; A summary. *Mar. Sci. Lab.* Department of Lands, Parks and Wildlife, Victoria.

Butcher, T.B; Matthews, J; Glaister, J and G. Hamer (1981): Study suggests scallop dredges causing few problems in Jervis Bay. *Aust. Fish.* **40** (9), 9-12.

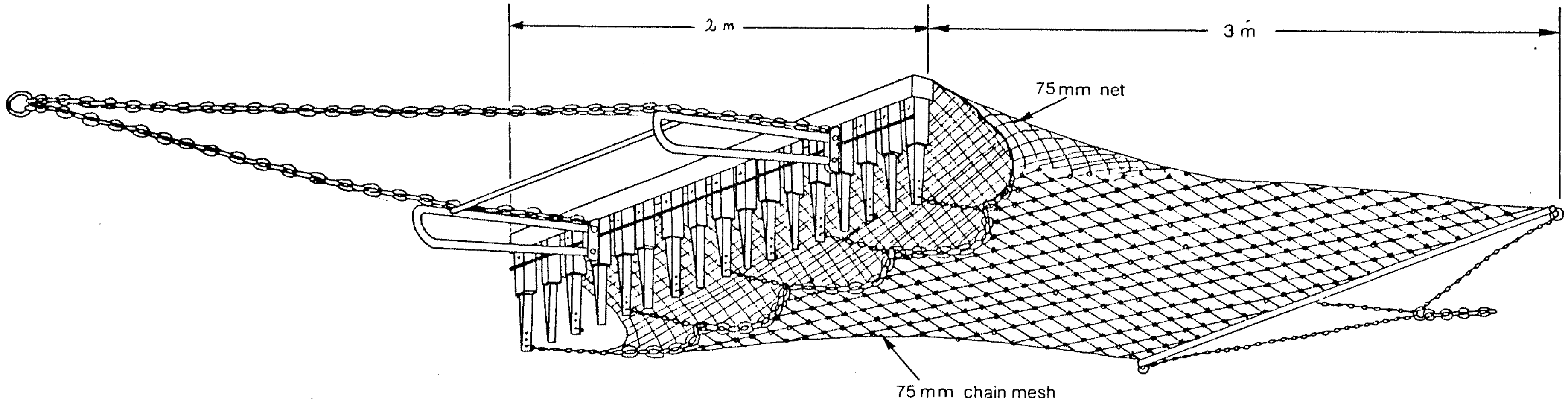



Figure 1 : Japanese Keta-ami scallop dredge. Toothbar width of 2.07 m, catchbag 3.0 m. This design has a single tooth row and performs well on both muddy and sandy substrates.

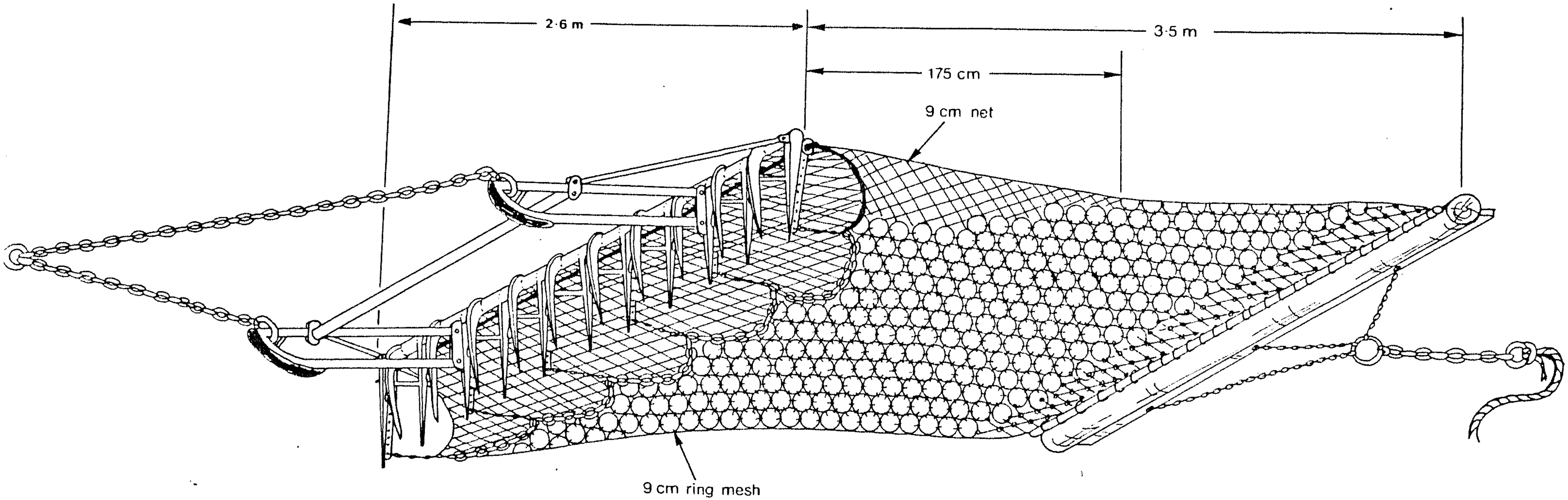



Figure 2 : Japanese Keta-ami scallop dredge. Toothbar width of 2.60 m, catchbag 3.5 m. This design has a double tooth row and performs well on sandy substrates. The rational in having two tooth rows is unclear.

# There is a better way

*In 1987 DSF scallop specialist Will Zacharin received a twelve month FIRTA grant to study alternative methods for catching wild and re-seeded scallops. Preliminary results are most encouaging.*

**Scallop nets**

Two twelve fathom Siebenhausen scallop nets were deployed in Bass Strait as a double rig using small wooden and steel framed trawl doors with a single sled similar to the gear used in the Queensland scallop fishery.

Total spread of the double rig varied between 26 and 32 metres at a towing speed of two knots.

Catches depended on the detection of commercial scallop beds, which currently are difficult to locate in Bass Strait due to a lack of recruitment. The largest haul caught 468 commercial scallops (Pecten fumatus), together with thousands of doughboy scallops (Chlamys asperrimus). These doughboys are too small to be commercially viable, and from long term observations do not grow to a suitable size for harvesting in Bass Strait.

From all trawls conducted less than one percent of scallops appeared damaged or smashed. Typical fish by-catch consisted of Flathead, Flounder, Stingrays, Gurnads, Porcupine fish and Octopus. Benthic organisms common were sponges, bryozoans, hermit crabs and other molluscs.

To avoid collecting too much benthic "rubbish" the nets needed continual fine tuning. Chain droppers that connect the chain to the ground line are frequently parted when fishing rough ground, and occasionally the head and ground lines become twisted when deploying and retrieving the nets.

These trials have demonstrated that scallop trawl nets will catch scallops of the genus *Pecten* in southern Australian waters effectively, and with considerably less incidental damage than exhibited by the toothed mud dredge.

**Japanese Keta-ami Dredges**

Two types of Keta-ami dredge were investigated, each built and originating from a different province in Japan. The smaller of the two has so far proved to be the most successful.

Each dredge consists of a toothbar with arm extensions, along which a chain is attached for towing. The arms have another function in preventing the toothbar from digging too deep, and controlling the toothbar angle of attack.

Scallops are trapped in a floppy bag, the bottom of which is constructed of chain-mail (width 7.5 cm); the top of mesh netting (width 7.5 cm). The catch bag is three metres long and two metres wide. At the end is a single wooden pole on which the chain and mesh is connected using rope.

The Keta-ami was deployed from a trawl block located one metre out from the side of the vessel and a few metres in from the stern. A warp to depth ratio of 3:1 gave the greatest and cleanest catches over adjacent areas. Towing speeds of three knots should not be exceeded. Maximum speed of three knots was better in areas with large amounts of sponge and doughboys.

Care must be taken when retrieving the gear. Once up on the trawl block the toothbar is manoeuvred aboard and the catch bag inverted. In rough weather avoiding the toothbar when swinging it in can be hazardous. A great improvement to the design would be twin bars at the end of the catch bag that clipped together so the contents could be easily dumped within having to invert the dredge.

The Keta-ami dredge consistantly out-fished the mud dredge 5:1 by volume. Less than two percent shell damage was observed in all the Keta-ami shots, while the mud dredge had up to twelve percent damage in larger shots.

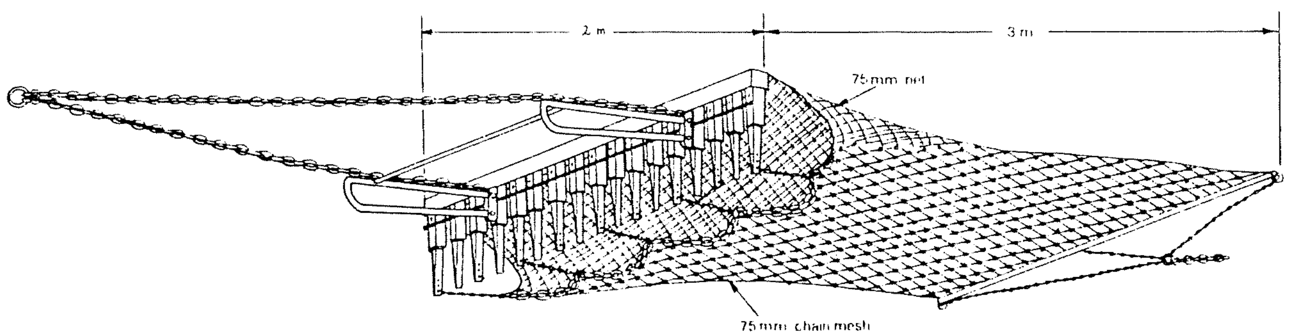
Towing either dredges over three knots reduced efficiency, especially with the Ket-ami dredge which could 'fly' and leave the bottom altogether. Excessive spead also increased shell damage by the mud dredge.

**Conclusions**

Both the trawl nets and the Japanese dredges perform far better then the toothed mud dredge. Efficiency is greater and damage is greatly reduced.

In keeping with all other scallop fisheries, the large, heavy toothed dredges are unlikely to be used again in Tasmania. Industry will have to move towards smaller, lighter dredges that follow sea bed contours and inflict minimal damage.

Keta-ami Dredge



# New scallop dredge shows promise

By Sue Hobbs

A "GENTLE" scallop dredge being trialled at Queenscliff could breathe some life back into Port Phillip Bay's depressed scallop fishing industry.

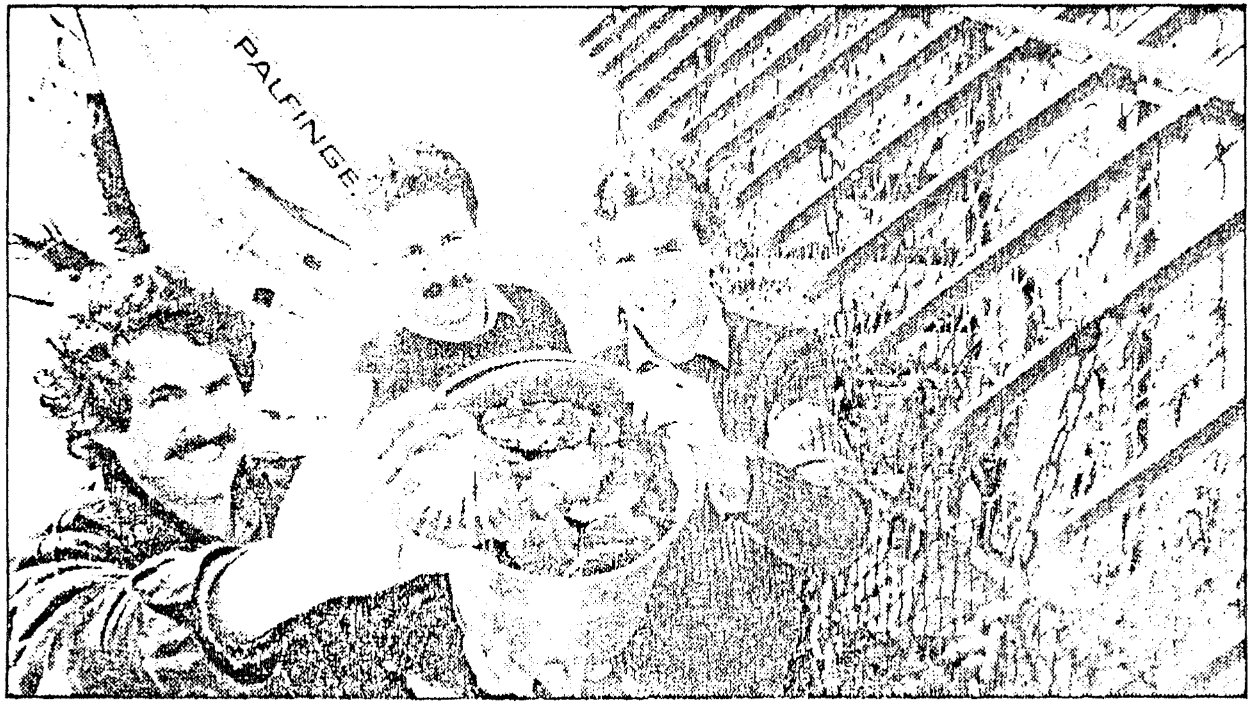
Researchers from the Marine Science Laboratories began testing the dredge yesterday and believe it could prove more efficient and cause less damage to the seabed and young scallops than the metal cage dredge.

Queenscliff scallop fishermen watched the Japanese-style dredge in action yesterday and gave it a tentative thumbs-up.

Called a Keta-ami, it has been a traditional tool of Japanese fishing fleets for years, and uses a metal rake to scoop scallops off the seabed into an attached net.

The netting makes it much lighter than the metal cage which has been used by local fishermen since the early 1960s.

The lightweight dredge has been tested in Tasmanian waters under a three-year scallop enhancement research project between the State's Department of Sea Fisheries and Japan's Overseas Fishery Co-operation Foundation.




• Queenscliff scalloper, Mr Michael Aleslos, checks yesterday's catch from the Keta-aml with Tasmanlan fisheries officer, Mr Will Zacharin, and MSL soclal blologlst, Mr David Gwyther.

MSL scallop biologist, Mr David Gwyther, said bay fishermen would have to adjust their boats to use the Keta-ami which is more awkward to empty than the self-tipping cage.

But it would take months of trials to determine the worth of introducing the new dredge there.

Mr Gwyther said that in poor seasons such as the present one fishermen had to spend more hours dredging the bay to obtain the daily quota of scallops.

This disturbed the seabed considerably and could damage juvenile scallops.

Because scallop yield had been so low in recent years, fishermen and scientists are keen to investigate any new measures to boost fish numbers.

After yesterday's demonstration, fisherman, Mr Peter Friend, said it was an "extremely gentle method of catching scallops — and very efficient".

Mr Michael Alesios, also of Queenscliff, agreed.

"I think it's a goer," Mr Alesios said. "It's different to the other one; it's not as heavy and it wouldn't do the damage that the other dredge would."

"And it seems to be catching just as much as the conventional dredge."

**• The bay's ailing 1988 season will come to a premature end this week. See page 11.**

Proceedings of the National Scallop Workshop Hobart 11-15 July, 1988 (in press)

## ALTERNATIVE DREDGE DESIGNS AND THEIR EFFICIENCY

Will Zacharin
Department of Sea Fisheries
Crayfish Point, Taroona
Tasmania.

**ABSTRACT**

*Scallop dredge designs differ markedly around the world. The Europeans have been experimenting for over forty years with gear in an effort to increase efficiency and reduce incidental damage to the catch. Fishermen in southern Australia still use a toothed box dredge being a variation on the Baird dredge. Efficiency is rated at less than 10 % much lower than dredges in use in Europe and America. Preliminary investigations of efficiency using Japanese Keta-ami dredges in Australia have been encouraging.*

### INTRODUCTION

Many different scallop dredge designs have been experimented with and adopted by scallop fisheries worldwide. This paper reviews the literature on scallop dredge design and efficiency testing from the present scallop fisheries and reports on the preliminary results of the recent 12 month FIRTA project entitled "Development of Alternative fishing practices for the harvesting of wild and re-seeded scallop beds in Tasmania" (87/69).

In southern Australia scallops are still harvested using the modified Baird or toothed mud dredge. Little research has been conducted on gear technology in this fishery since the introduction of the Baird type dredge back in the 1960's. Even at the time of it's introduction fishermen were concerned at the damage being done to the scallop beds when incidental damage to the catch greatly increased. However, the toothed mud dredge gained wide favour as it could be operated in deeper water. One could suggest that without it's introduction, expansion of the scallop fishery out into Bass Strait may have been retarded. Therefore the box dredge was probably beneficial in promoting expansion of the fishery, but was detrimental from a biological perspective.

Most of the world scallop fisheries in Scotland, England, France and Canada use dredges that are much smaller in size, weigh considerably less, and collect the catch using a floppy chain or net mesh bag of varying length and mesh diameter. These dredge designs are the result of development over many years by fisheries researchers and industry in searching for more efficient and less damaging fishing practices. In Australia we have been content to use what ever is available and little funding has been made available for technological research. It has primarily been left to industry which was quite content to keep using the toothed box dredge with automotive self-tipping gear (Figure 1).

Scottish Dredge Design and Efficiency Tests

Scallop dredge designs in the United Kingdom have undergone continued testing over the past 40 years, but until Baird began observing and estimating the efficiency of English scallop dredges in the 1950's little had changed in dredge design. Baird estimated that the dredges were only catching 5 to 20 % of the scallops in their path. He subsequently designed the "Baird" dredge with it's characteristically pronounced pressure plate on the front of the toothbar. This improved the efficiency of the dredges to between 24 and 33 % on sandy bottom (Chapman et al, 1977). However, the Baird dredge lost favour in the early 1970's and later dredges were built without pressure plates (Franklin *et al*, 1980).

Chapman *et al* (1977) conducted efficiency trials on the Scottish standard fixed bar dredge and a new spring loaded toothed bar which was introduced into the scallop fishery in favour of the Baird dredge. Taking the dredge size selectivity into account their results showed that efficiency of capture varied from 14 to 27% using the different gears. Overall the fixed toothbar dredge caused less damage and was more efficient. However, all the trials were conducted over sandy bottom, whereas the spring loaded dredge is popular with fishermen as most fishing is in areas of rough bottom and the spring loaded dredge does not collect as much rubbish. This effectively decreases sorting time and therefore fishing time.

Research into efficiency was continued by Strange (1978, 1979) using a lighter fixed toothbar dredge. He attached a trash vent to some dredges in an effort to reduce the incidental rubbish collected. Results showed that the standard dredge with fixed toothbar outfished dredges with spring loaded toothbars or dredges with trash vents. Strange also recognised the importance of keeping the toothbar angle of attack constant.

The most recent work on dredge efficiency by Howell (1983) using the Scottish dredge with spring loaded toothbar has shown that smaller but more numerous dredges are better able to conform to the contours of the bottom and fish more efficiently than wider dredges with fixed toothbars (Figure 2).

Canadian Dredge Designs

Caddy (1971,1973) studied the effects of two types of dredges on a scallop ground from an underwater submersible. One was a 2.4 m offshore dredge, weighing 0.6 tonnes with a bag knit from 76mm steel rings. The second consisted of a gang of three 0.8 m wide Alberton inshore dredges considered by fishermen to catch less rubbish on rougher ground. Caddy estimated that the efficiency of the offshore dredge was approximately 15% and that incidental mortality to uncaught scallops was in the range of 15-20%.

French Dredge Designs

The French use two distinct types of dredges. The most common is called a Regular or inshore dredge. This has a rectangular frame used to keep open a catch bag having a metal ring base and net top. The other, called an Offshore dredge, is distinguished by having a sloping pressure plate above the toothbar. Width two metres, weight about 200 kg. Dupouy (1982) observed that the dredge with a pressure plate was slightly superior than the one without, attaining an efficiency rating of 35%. Comparing this figure with the Scottish and Canadian dredges shows that the Saint Brieuc offshore dredge is the most efficient yet reported (Table 1).

Australian Mud Dredge

With the downturn in the scallop catches in 1985 the incidental damage to the catch became more controversial and the Tasmanian scallop industry approached the Department of Sea Fisheries to carry out trials on alternative fishing methods. The result of this request was the recent FIRTA funded project (87/69).

Preliminary results from CSIRO's efficiency tests indicate that the toothed mud dredge has an efficiency rating of approximately 9.9% (P. Young - pers. comm.). Underwater observations using video show that having a wide rigid frame does not allow the toothbar to keep in contact with the bottom, even at slow speeds. Unless the toothbar angle of attack is constant, efficiency decreases and scallop damage increases.

FIRTA Project

Two alternative methods were investigated - Queensland trawl nets and Japanese Keta-ami dredges (*pronounced Keta-army*). Queensland Siebenhausen scallop nets were obtained and fishing was conducted using a double rig comprised of two twelve

Table 1 : Comparative table of dredge efficiency for various dredge designs and scallop species.

| Type of Dredge | Weight (kg) | Country | Species | Efficiency (%) | Reference |
|---|---|---|---|---|---|
| Rake dredge | 90 | Scotland | *Pecten maximus* | 20 | Baird (1955, 1959) |
| Spring dredge | 110 | Scotland | *Pecten maximus* | 13 | Chapman *et al* (1977) |
| Baird Offshore dredge | | Scotland | *Pecten maximus* | 30 | Rolfe (1969) |
| Digby bar dredge | 300 | Canada | *Placopecten magellanicus* | 5 to 12 | Dickie (1955) |
| New Bedford chain dredge | 350 | Canada | *Placopecten magellanicus* | 8 to 10 | Caddy (1968) |
| Toothed drag | 200 | France | *Pecten maximus* | 30 | Dupouy (1978) |
| Saint Brieuc offshore dredge | 200 | France | *Pecten maximus* | 35 | Dupouy (1978) |
| Toothed mud dredge | 750 | Australia | *Pecten fumatus* | 9.9 | Young *et al* (pers. com.) |

* table taken from Dupouy, H. (1983)

fathom nets. Shots were for a maximum fifteen minutes duration, the most successful shot yielding over 400 scallops. Difficulty in shooting this gear over much of the scallop grounds soon became apparent as rocky outcrops were a major hazard. However, the trials proved that scallops could be caught in commercial quantities using trawl gear. This was the only trawl gear investigated during the study.

Japanese Dredges

With the commencement of the joint scallop enhancement project in Great Oyster Bay between the Tasmanian Department of Sea Fisheries and the Overseas Fisheries Cooperation Foundation (OFCF) of Japan, two different types of Japanese scallop dredges were transported to Tasmania. The dredges, called Keta-ami dredges, differ in their robustness, this being a reflection of the bottom topography in the area in Japan from where they originated. The general design consists of a horizontal tooth bar supported on teeth being anywhere from 50 to 60 cm in length. Trailing behind the toothbar is a catch bag having a chain mail bottom and mesh netting top. The sides taper towards the rear of the catch bag similar to the wings in a small trawl net. A tickler chain is connected to the forward edge of the catch bag and this has two functions: in keeping the bag open, and with speed or warp adjustment, determines the composition of the catch (Figure 3).

Results of trials using these Keta-ami dredges are most encouraging. Not only is the comparative efficiency of the Keta-ami greater than the mud dredge but the incidental damage is minimal. The most successful comparative ten minute drag showed the Keta-ami dredge catching 1242 scallops to the mud dredge's 245 scallops. This represents a catch difference of approximately 5:1. In every comparative drag undertaken the Keta-ami consistantly outfished the mud dredge and incidental damage observed in the Keta-ami catches was also greatly reduced (Table 2).

One advantage the mud dredge has over the Keta-ami is it's ability to be deployed and retrieved using automotive self-tipping gear. This reduces fishing time considerably and fishermen do not have to handle heavy gear, which could be dangerous in rough seas. However, although handling time is increased using the Keta-ami the corresponding increase by volume in catch per drag still results in the Keta-ami dredge catching more scallops per hour dredging.

Recently there has been great concern among scallop researchers that dredge damage to juvenile scallops is having a significant effect on recruitment. Reducing this damage is one problem that could be overcome by using more efficient and less damaging gear such as the Japanese Keta-ami dredges.

Table 2 : Some comparative drags between the Japanese Keta-ami dredge and Toothed Mud dredge. Incidental damage to scallops using the Keta-ami dredge was under 2%, whereas using the mud dredge catch damage could be as high as 12%.

| Drag | Keta-ami | | Mud dredge | |
|---|---|---|---|---|
| No. | No. Scallops | No. damaged | No. Scallops | No. Damaged |
| 1 | 188 | 3 | 16 | 2 |
| 2 | 597 | 2 | 59 | 4 |
| 3 | 1242 | 4 | 245 | 12 |
| 4 | 352 | 2 | 91 | 5 |
| 5 | 1076 | 11 | 237 | 8 |
| 6 | 664 | 6 | 80 | 3 |

## CONCLUSION .

The toothed box dredge is no longer used in most of the world's scallop fisheries. Research has shown that rigid dredges cannot adequately follow the contours of the seabed. This results in low catch efficiencies and damage to the remaining scallops on the bed.

Designs have sifted towards dredges with flexible catch bags made from heavy netting or steel ring mesh. These have a greater catch efficiency rating and cause minimal incidental damage to the scallops.

Japanese dredges tested in southern Australian waters were observed to be more efficient than the toothed mud dredge in operation at present. Incidental damage to the catch is also greatly reduced. It is hoped in the near future that the toothed mud dredge will be banned and a Japanese Keta-ami type dredge, modified for Australian conditions, will be it's replacement.

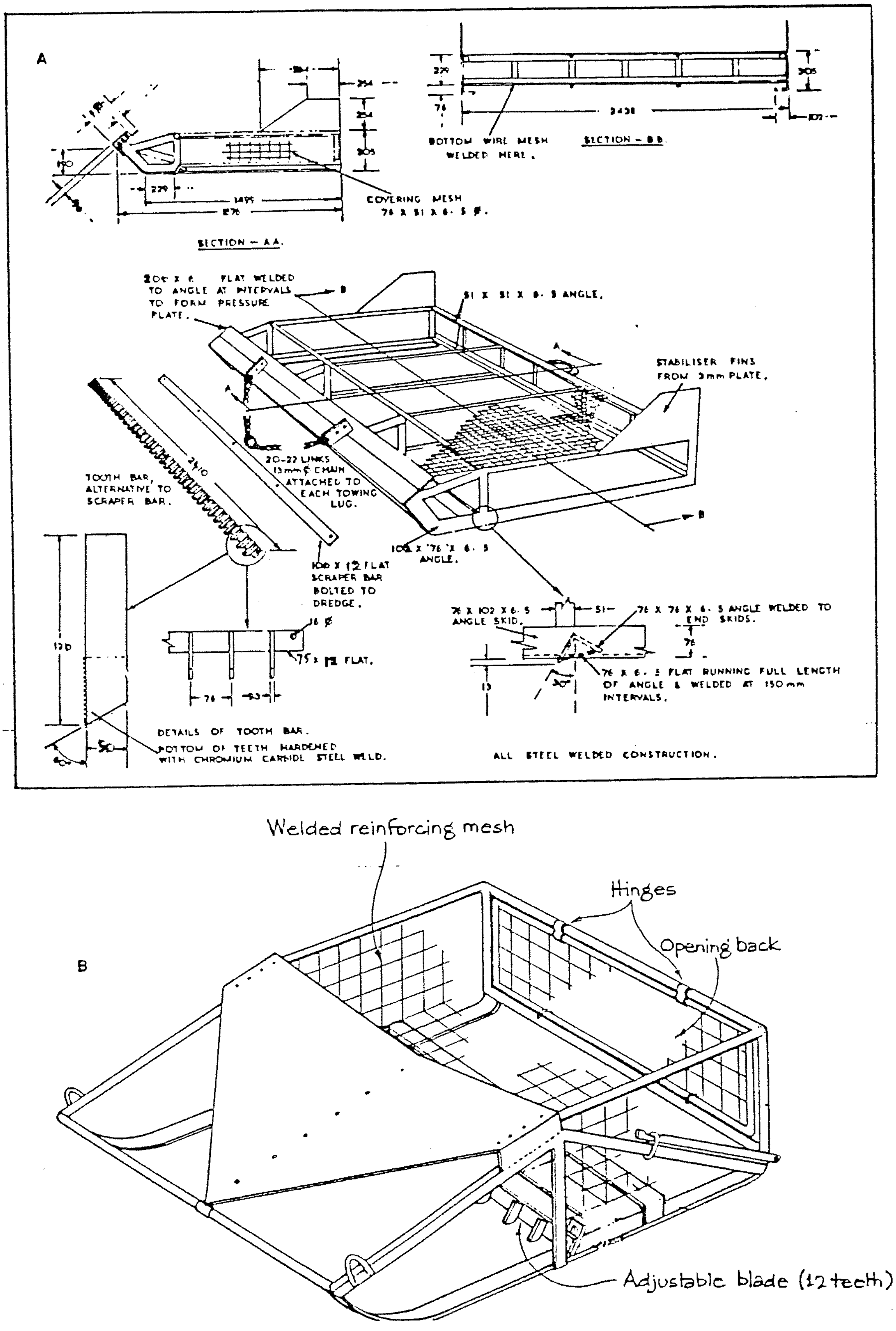



Figure 1 : A - Victorian toothed mud dredge as drawn by Hughes (1972). B - modified Baird dredge in use in Tasmania in the 1960's.

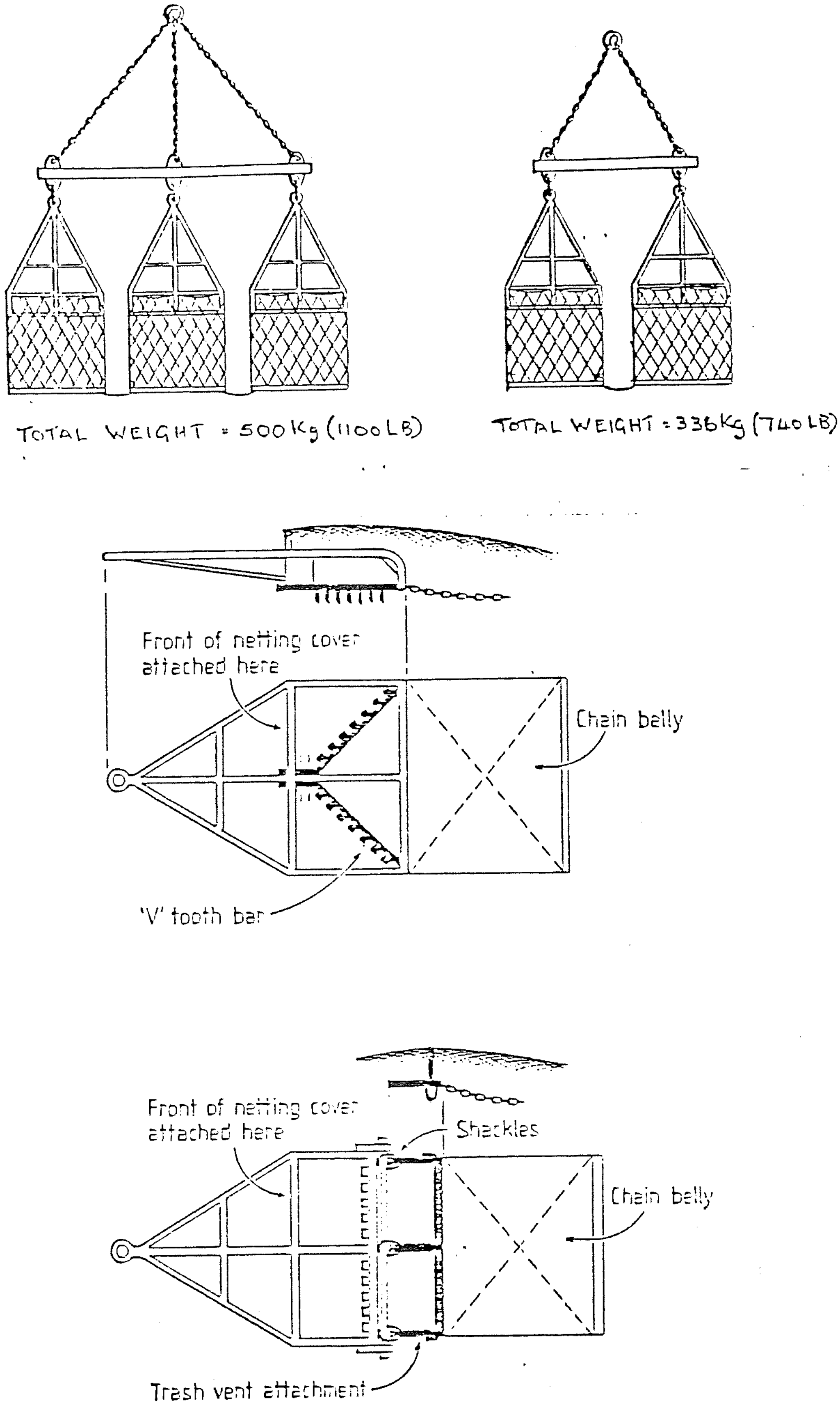
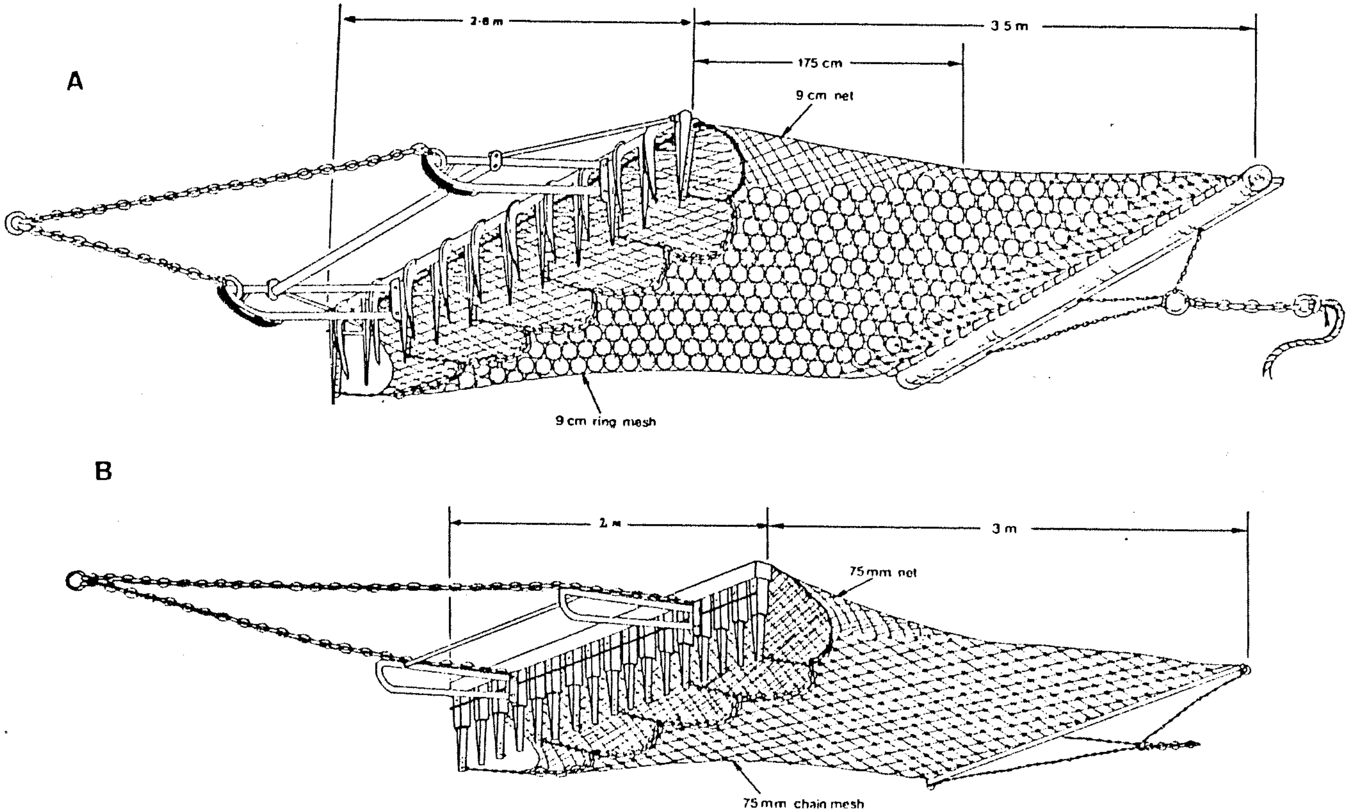



Figure 2 : Scottish dredge designs and deployment apparatus as shown by Strange (1978,1979).




<u>Figure 3 :</u> Japanese Keta-ami type dredges.  Type B has proved to be the most successful in southern Australian waters.

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