An Introductory Guide to Cultivation of the Queen Scallop

(Chlamys opercularis)

MAFF Commission
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J.D.Paul

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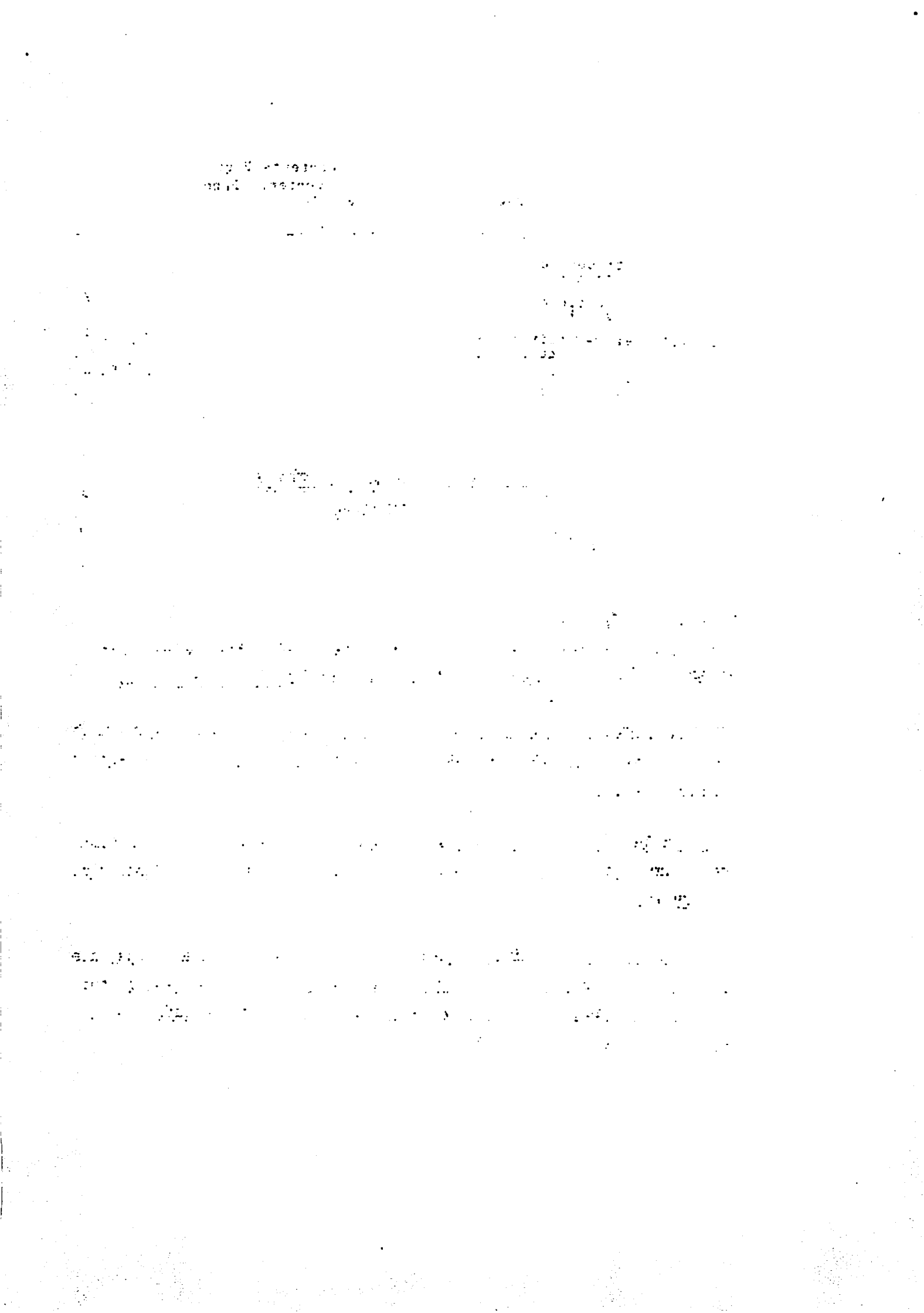


SEA FISH INDUSTRY AUTHORITY
Marine Farming Unit Ardtoe

Technical Report No. 325

J. D. Paul
February 1988

EXPERIMENTAL CULTIVATION OF MANILA CLAMS IN N.W. SCOTLAND

SUMMARY

This report covers details of the initial experiments carried out at Ardtoe on the cultivation of the Manila clam, Tapes semi-decussatus.

Various ongrowing methods involving the protection of seed clams with netting were tested at three sites with different substrate characteristics.

At least 3-4 years is required to reach a good commercial size of 40mm. The minimum commercial size is 35mm but the value of clams at this size is very low.

The clams grew and survived better in a coarse sand and shell substrate than in fine sand and mud. Clams were also held in hanging culture without substrate and initially these performed well but suffered high mortality when over 30mm shell length.

Survival increased with size of seed clams at laying, but could be extremely variable with returns ranging from 0 to 86% in different plots. Densities at seeding ranged from 200 to 800/m^2 with over 8kg/m^2 being harvested at the higher densities (70 - 86% survival).

It is estimated that from the current value of this species, a survival of 26 - 27% is required for an operation to break even. At the best test site, an overall survival at harvest of 48.9% was obtained, indicating the commercial possibilities of growing this species.

Contents Page

Introduction

The Seafish Industry Authority have conducted a research and development programme on the potential for farming scallops since the mid 1970's.

A good deal of technical and practical information has been collected and assessed during that time for both the great or King scallop (*Pecten maximus*) and the smaller queen scallop (*Chlamys opercularis*).

Much of the information is applicable to both species, but this report concentrates on the queen scallop and the princess scallop, the marketing term for small (40-50mm) cultivated queens where the whole animal is used, as with mussels or oysters.

The report is not intended to be a technical manual, giving definitive methods or answers, but a general guide to biological requirements, methods, equipment and problems which may be encountered.

The techniques of scallop cultivation as described in this report are based on the adaptation of Japanese equipment and experience, all the details covered could and should be subject to further development and modification depending on the farmers site, requirements and experience.

Further information can be obtained from the Marine Farming Unit, Ardtoe.

Species characteristics - some basic biology

The queen scallop is the species *Chlamys opercularis*, a smaller relative of the great or king scallop *Pecten maximus*. They are commercially exploited as a wild fishery by dredging and trawling. Scallops are filter feeders, pumping seawater across their gills for both oxygen and food, sifting out suitable sized particles and algal cells as food.

Queen scallops mature within their first year. They are hermaphrodite, with a 'roe' consisting of the red female and white male portions. The condition of the roe varies during the year, enlarging prior to spawning and may empty comletely at other times. The condition of the roe can be important commercially and a quick examination of it can give an indication as to whether spawning is imminent.

The spawning season varies between areas, but most often the roe is seen to empty in the autumn. However this apparant mass spawning does not seem to give rise to any larval settlement, which in general takes place in the spring/early summer after a less complete spawning. The free swimming larvae develop in the plankton for 3-4 weeks. During this time they are transported by the water currents and can travel large distances.

When the larvae reach a certain size (around $^{1}/_{4}$mm) they settle on a suitable surface, attaching to it by means of delicate byssus threads. It is at this stage they enter the farming cycle. Normally, the larvae would settle on animals or plants growing on the seabed. The farmer provides an artifical surface for the larvae to settle on and can therefore collect these spat.

Site selection

Unfortunately there are no distinct rules for site selection, chart studies and site visits are the obvious starting points, as well as obtaining local knowledge with regards to tides, exposure etc. There are a number of factors which need to be considered for each site studied. These affect either the requirements of the species being farmed or of the farmer.

1. Exposure: The gear to be used must be suited to the exposure of the site. Rafts and surface longlines cannot be used in exposed sites. Exposure can also restrict working time, but should not necessarily be avoided as unsuitable. Local knowledge is invaluable.

2. Salinity: Scallops, unlike oysters and mussels cannot withstand prolonged exposure to low salinities. It is therefore advisable to avoid areas with high freshwater runoff or to ensure that there is sufficient depth to allow the stock to be placed below the influence of freshwater.

3. Depth: Influenced also by 1 & 2. There must be sufficient depth for the type of equipment to be used. A shallow exposed site would be unsuitable whereas a deep exposed site may be acceptable as the gear can be sunk below the influence of wave action. There must always be sufficient depth so that ongrowing equipment never touches the seabed.

4. Access/shore base: If possible choose an area which has good access and the possibility of development a shore base. - Long journeys increase costs.

Legal requirements

To set up a fish farm, sea bed rights need to be obtained from the Crown Estate Commissioners (see address list). A lease gives the right to occupy the sea bed involved and security of tenure for the farm.

It is also necessary to obtain the consent of the Department of Transport and to register with the Department of Agriculture and Fisheries for Scotland under the terms of the Diseases of Fish Act 1983. Permission should also be obtained from the local coastguard and Port/harbour Authority in whose area the fish farm site is located.

Pilot Studies

It is always advisable to carry out small scale pilot projects before investing in a full scale operation. For scallops in particular the site chosen should be assessed on two separate aspects.

1. Spat collection. Initial studies to establish the suitability of the area for spat collection: to make the decision to collect your own, or, if a poor area for settlement, to collect or buy in spat from other areas.

2. Ongrowing. Is the productivity of an area enough to give good growth? Are there problems with fouling organisms/siltation?

The Techniques

1. The longline system

Longlines are amongst the most commonly used systems in shellfish cultivation. Rafts can be used but are expensive in terms of capital outlay and are only suitable for sheltered areas. Surface longlines, as used for mussels by many farms are also suitable for sheltered areas. The longlines described here are sub-surface lines which can be used in quite exposed sites. Basically there are no hard and fast rules for construction, the ones described here have been used by the Marine Farming Unit for many years, with no major problems.

Fig.1 illustrates a generalised longline which can be used for both spat collection and ongrowing. The depth of the actual line is a requirement of the exposure and depth available at the site. The line should be at sufficient depth from the surface to avoid much of the wave action yet there must be sufficient depth beneath the collectors/ongrowing equipment so they do not touch the seabed at low tide.

To work longlines, the operator must have a sufficiently stable boat to safely hold the weight of a line and its ongrowing equipment. It is also an advantage to have a boat with sufficient deck space for working and transporting stock and equipment in reasonable quantities.

2. Star wheel rollers

It is an advantage in longline working to equip the boat with a pair of 'star wheel' rollers mounted on the gunwhale. These allow the boat to move along the longline without

interference from the nets or buoys. These can be made quite simply by welding spokes onto a 4-5" diameter trawl block pulley.

3. Anchors

Over the years we have tried many designs of anchors and have found one of the best to be a Japanese design - home made out of mild steel (Fig.2).

Maintenance

Maintaining a longline system consists of regular checking of the moorings and ropes etc. for any signs of wear and chaffing.

The general operation requires the addition and removal of buoyancy (we use 8" floats) to the longline as needed. It cannot be stressed too much that the nets must not be allowed to touch the seabed otherwise stock will be rapidly destroyed by predators.

During the summer, when growth of the stock and fouling organisms is at its most rapid, floats will probably need adding each week. The easiest indication that more bouyancy is required is when the surface floats appear 'heavy'.

Spat collection

This is the basis of the operation, although spat can be purchased from other areas/farms (contact MFU for details).

The basis of spat collection is to provide a suitable surface for scallop larvae to settle on and attach by byssus threads at the time of their metamorphosis from a swimming larva to a settled, recognisable scallop spat. Over the years, the best and cheapest type of spat collector has been found to be a simple mesh bag (onion bags) filled with scrap monofilament nylon mesh.

It should be noted that under the Inshore Fishing (Prohibition of carriage of monofilament gill nets) (Scotland) Order 1986 it is illegal to carry gill nets on British fishing boats in Scottish waters.

Other meshes are suitable, but the best types are those which have an inherent stiffness which holds the bag open. Old trawl nets or soft multifilament nets are not really suitable as these tend to bunch at the bottom of the bag.

The timing of placement of collectors in the sea is critical for their success. If set too early they rapidly become fouled or silted and unnattractive to the larvae. Over the years, the MFU have collected sufficient data to establish that the peak of settlement usually occurs over a 5 week period between the end of June and the end of July. Consequently it is advisable to put out sufficient collectors in batches at invervals over this period to be sure of one batch getting the peak. Collectors are the cheapest part of the operation and consequently it is not

worth skimping on them in order to save a little, at the risk of missing the settlement.

Settlement will vary in time and quantity from area to area. It is not possible to predict good or bad areas. An area with or without a population of scallops does not mean you will or won't obtain spat settlement. The only way to assess a site for spat collection is to try it. The simplest way to do this is to put out single lines of collectors in various sites over the collection period, say, 10 bags/line at 3-4 places each week over July. This will give a good assessment for the next year's collection.

The best depth for collection of spat appears to be in mid-water irrespective of the overall depth. All the studies have shown a reduction in spat near the surface and near the seabed.

After placing the collectors it is best to leave them alone. Spat will not be visible on the bags until September at the earliest.

Spat sorting normally starts at the end of October by which time most of the spat will have reached a size of around 10mm. Don't start sorting the collectors until the spat are big enough for the mesh of your ongrowing equipment. - An obvious statement perhaps but one which needs reinforcing.

When big enough the spat can be removed from the bags by simply washing them vigourously in tubs of water. This is sufficient to break the byssus threads. The spat can then be washed and graded to the size of your mesh.

It is best not to leave the collectors too long because predators (crabs and starfish) also settle in collectors over the

summer and can cause considerable damage.

All predators must be carefully removed at this sorting/grading stage. These include starfish, small edible crabs and swimming crabs (small porcelain crabs and spider crabs are harmless - if in doubt remove them all).

It is not possible to give figures for numbers of spat which will be obtained per bag. This will vary from site to site and year to year but a good number would be 500-1000 though numbers up to 8,000 per bag have been obtained.

Fig. 3 shows the approximate cost of collecting spat depending on the numbers collected in a given area. These are calculated based on 2,000 collectors at the peak time of collection and are for general guidance only.

Ongrowing

Queen scallops are an excellent species for ongrowing. They have the advantage that they spread themselves out over the three dimensions of the ongrowing nets and, unlike many other species, do not have a tendancy to die at the slightest opportunity.

The MFU have used mainly Japanese ongrowing equipment - i.e. lantern nets and pearl nets. Alternatives are available and there is no reason why growers could not make their own systems.

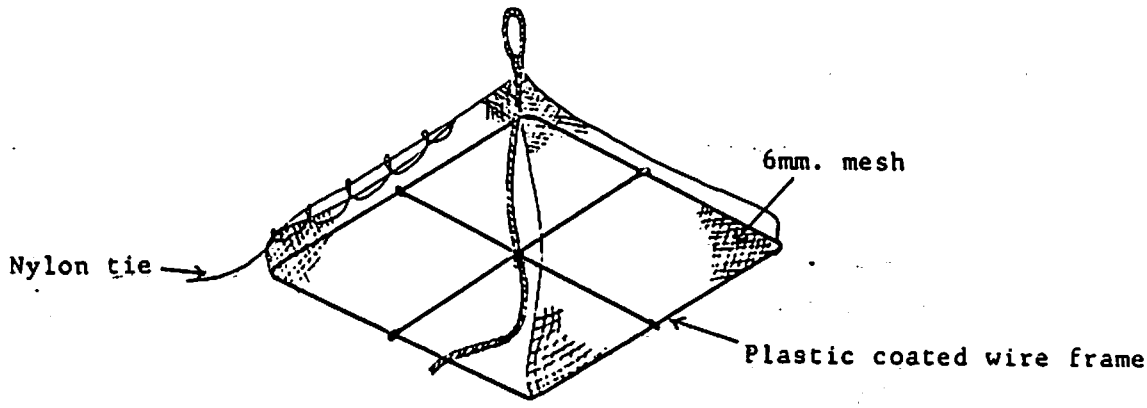
It is possible to grow princess scallops to a commercial size of around 45mm without changing nets. For queen scallops around 2 years is required and net changes are advisable.

Pearl nets

Cost approx. 80p each

Dimensions 35 x 35cm.

Capacity - spat 100 - 150/net



Tie together in strings
as required

These are imported from Japan (minimum order required) and can be obtained in various mesh sizes. They have a simple construction based on a plastic coated wire frame. They are easy but fiddly to use.

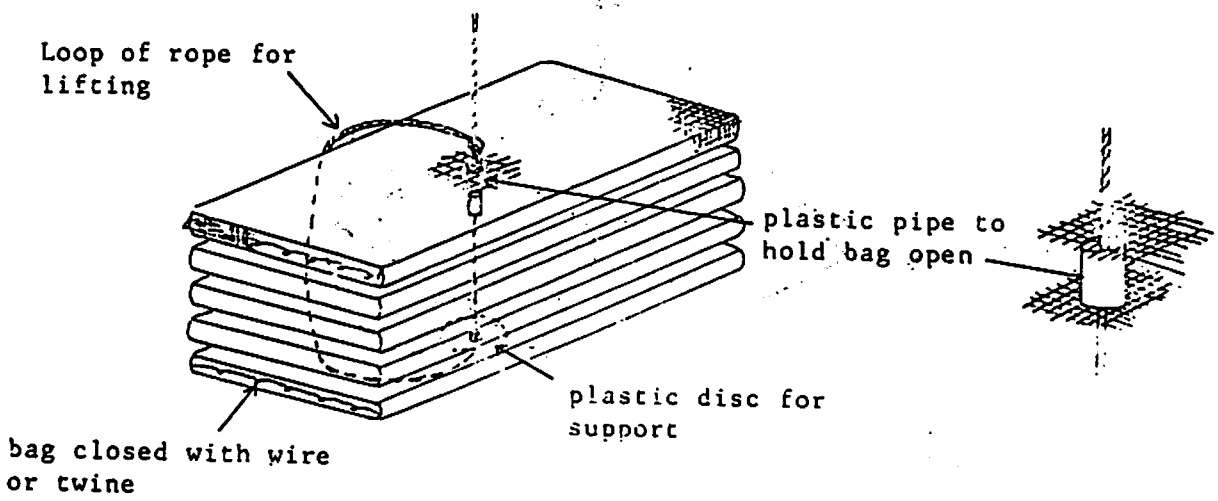
Oyster bags - as developed by Westend Shellfish

Cost: approx. £1.31 - £1.40

Dimensions: 1m x $^{1}/_{2}$m

Capacity - spat 300

- queens 150



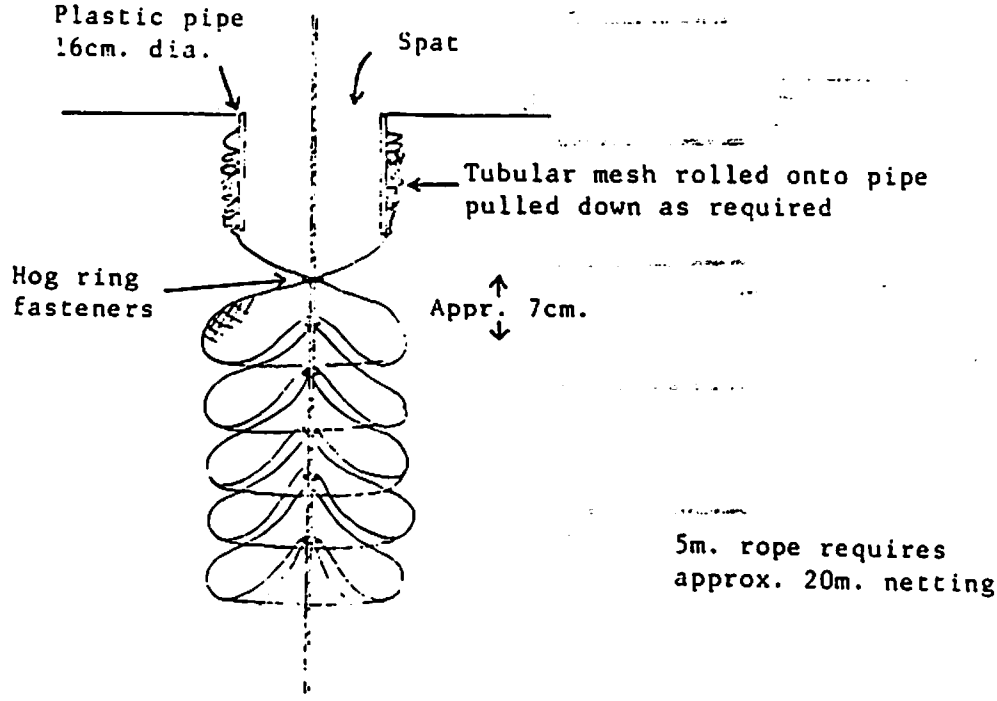
These are plastic mesh bags (rigid side type) with various mesh sizes and can be strung on a central rope using pieces of plastic pipe to hold the bags open. For ease of handling it may be worth while to cut the bags in half i.e. $^{1}/_{2}$m $^{1}/_{2}$m bag.

Mussel stocking mesh - as developed by Salen Shellfish

Cost: approx. 10p/m

Capacity: - 10-15 spat/pocket

This method uses tubular plastic mesh formed into pockets and fastened to a central rope using a hog ring.

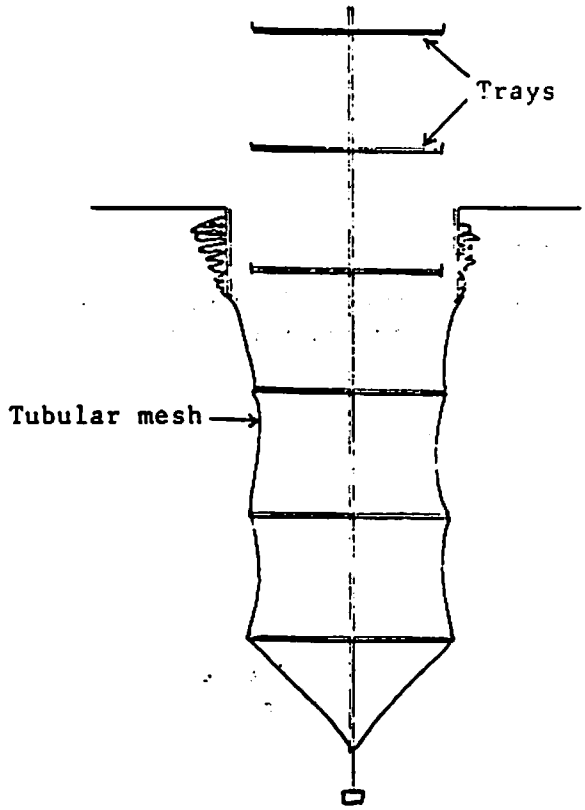


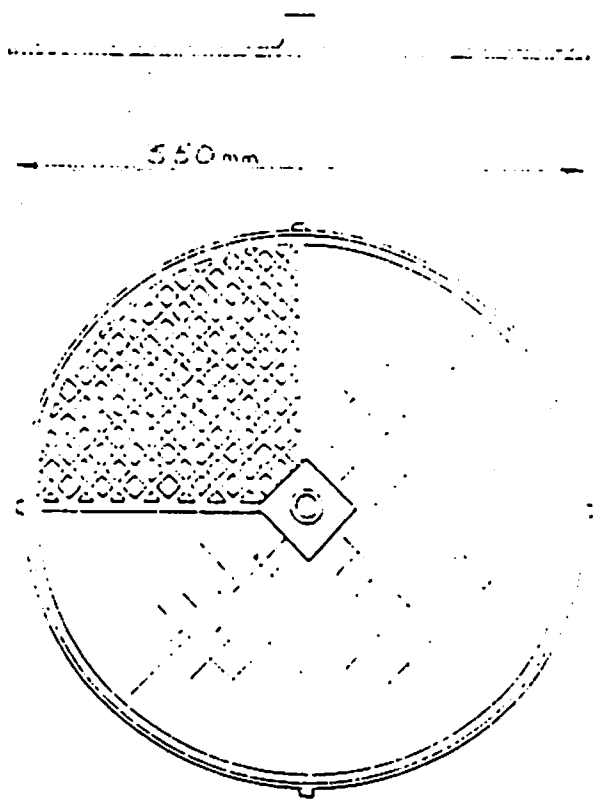
The hog ring fastener can be applied either manually or an air driven gun. The netting is not reused, but could be stripped off for use in spat collectors.

'Salen Shellfish' trays

Cost: approx. 30p each

Capacity: 12" dia. 100-150 spat



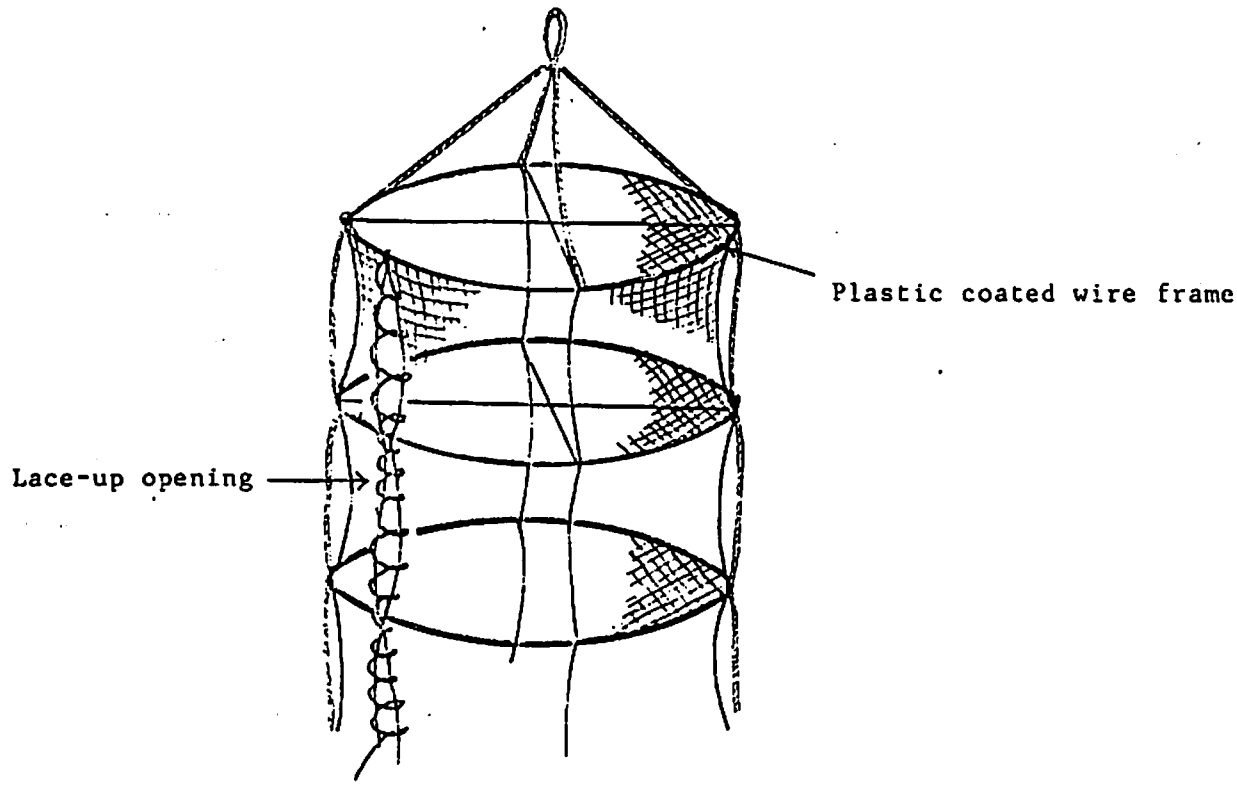


These can be used either inserted in an onion bag or rigged on a line as a lantern net.

Lantern nets - for larger animals, mesh size 12-21mm 5-10 layers diameter 50cm.

Cost: approx. £16

Capacity: Up to 100/layer



These are the standard Japanese systems for ongrowing to commercial size. They are, however, expensive, but are easy to use and collapse down to take up little space for storage.

One of the most critical factors for ongrowing shellfish is their density - As density increases, growth decreases up to a point. In farming, it is a compromise between reducing densities to obtain the best growth and the economics of requiring more ongrowing units. The best density for each area may vary, but as a guideline, the following densities are recommended for pearl nets and lantern nets based on the findings at Ardtoe.

				Shell height
June/July	spat settlement			
Oct./Nov.	spat sorting.	pearl nets	120 - 150/level	15mm
		mussel mesh	10 - 15/pocket	
		oyster bags(full)	300/bag	
April/May	princess scallops	- net change optional or as for queens		30-35mm
	queen scallops	- lantern nets	60/level	
		trays	30/level	
		oyster bags	100/level	
2nd Year		Lantern nets	50/level	
	Autumn			60+

Princess scallops, if left in one system should be expected to reach their minimum commercial size of 40mm by August of the following year (Fig.4) and can be harvested right through to the following February-March by which time they will be becoming too large (i.e. greater than 50mm) for the specification of this product. This season for the correct size can be extended by keeping some of the stock at increasingly high densities to restrict the growth.

For growing through to queen scallops with a minimum size of around 60mm, a series of net changes is necessary as they become fouled and the stock grows. It is advisable to change nets after the first winter and spring so the stock has the advantage of clean nets for their first summer's growth. Again, densities need to be adjusted accordingly. A second change may be required in the autumn if fouling is very severe. Queens should reach a commercial size in the autumn, 2 years after their initial sorting following a further net change in their 2nd spring.

It is probably best to sell before the 3rd year of growth as high natural mortality will probably be found from the spring onwards. These losses would probably counter the increase in yield obtained and therefore the extra time in cultivation may not be profitable.

Fig. 6 shows approximate meat yields of adductor muscle and gonad. Commercially, meat yield is usually expressed as numbers of meats to the pound. Approximate expected meat yields are given in Fig 7 for queen scallops, i.e. adductor muscle only (roe off) and adductor muscle and gonad (roe on).

Marketing

The success of a scallop cultivation operation will to some extent depend on the successful marketing of the product.

Farming does, however give a number of immediate benefits for marketing - these must be emphasised.

1. The product is high quality - particularly in terms of yield, freshness and purity - cultured scallops have never been on the seabed and so are grit free.

2. Product specification can be established and maintained by planned harvesting.

3. Cultured scallops are available when the farmer/buyer wished to sell/buy, not simply when catches are landed. Therefore, competition with wild stock can be avoided and optimum prices obtained - also giving continuity of supply.

Princess scallops and queen scallops must be looked at separately.

a) Princess scallops

This is essentially a new product, with all the problems that entails - such as education, market acceptance etc. Growers must be aware that large markets have yet to be established. People already involved in the scallop business are not used to a whole animal, gills and all, and tend to resist the fact that these small animals can be eaten in this way.

Education and samples cooked correctly are essential.

Less resistance is obtained from the rest of the trade who are used to cooking and eating other types of shellfish which are consumed whole e.g. mussels, oysters and clams. Here princess scallops have been accepted readily although guidelines must be

given on how long to keep them and how to cook them. Currently a price of around 65p/dozen for small quantities delivered to local hotels etc. should act as a basic guideline. The price for princess scallops should not be compared with the price for processed scallop meat as these are two distinct products.

b) Queen scallops

The traditional market for queen scallops is to processors who shuck out the scallops to give either roe-off white meat for the USA market or roe-on meat for Europe.

Prices for meat have risen steadily and are currently at around £2 - £2.50 per lb. of meat (Jan.1987) depending to some extent on the meat yield expressed as number of meats to the lb. Farmers should be able to produce scallops at 70-100 meats/lb. after 2-2 1/2 years. (Fig.7). The price for queen scallop meat can however fluctuate tremendously depending on not only the success of the UK wild fishery landings, but also on international fisheries such as Peru, Norway and Japan (cultivation) who may flood the U.S. market at certain times.

The growers must be aware of market changes and it may be to their advantage to form marketing co-operatives to process their own 'farmed' product and market it as such, with a standard of quality and reliability, avoiding competition with the wild fishery.

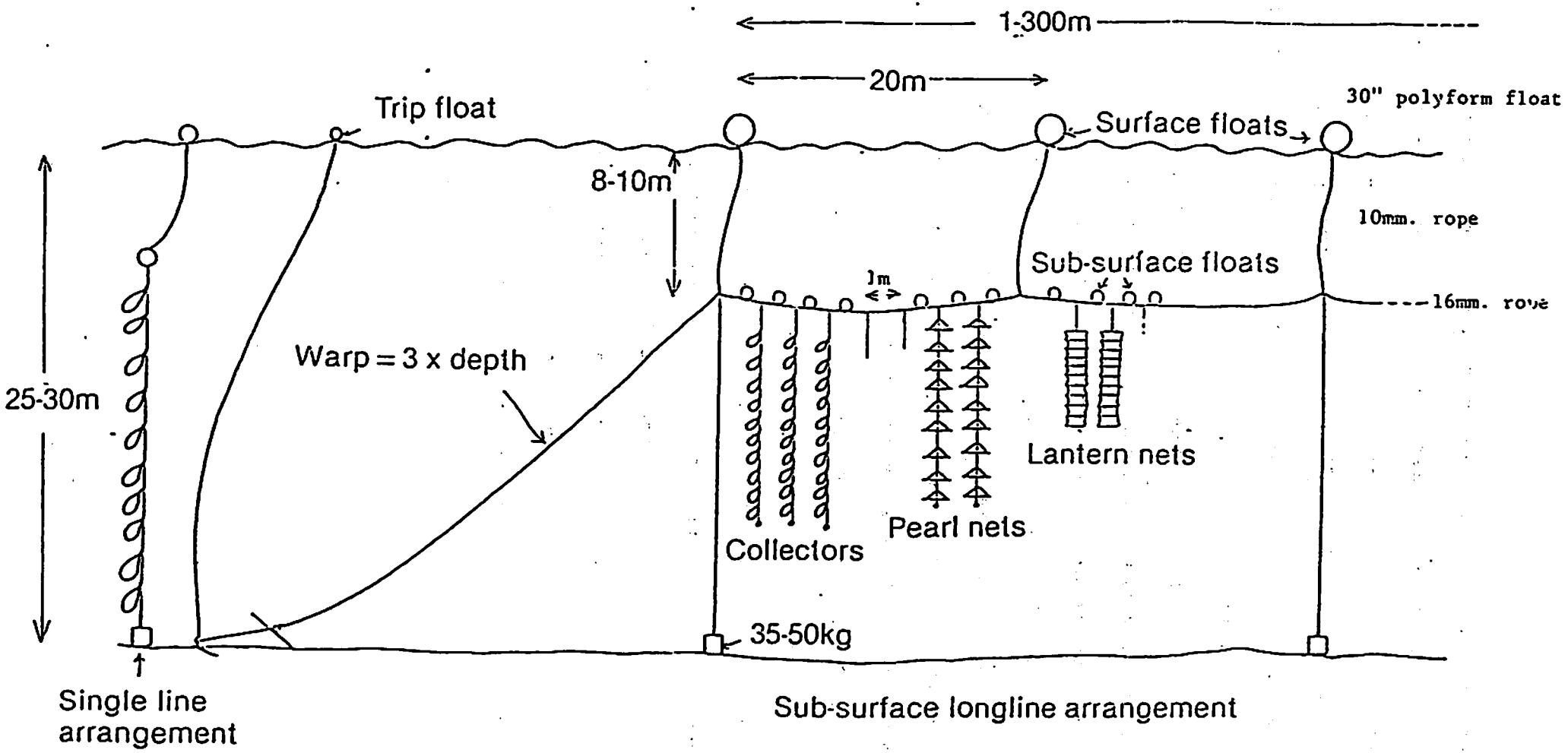
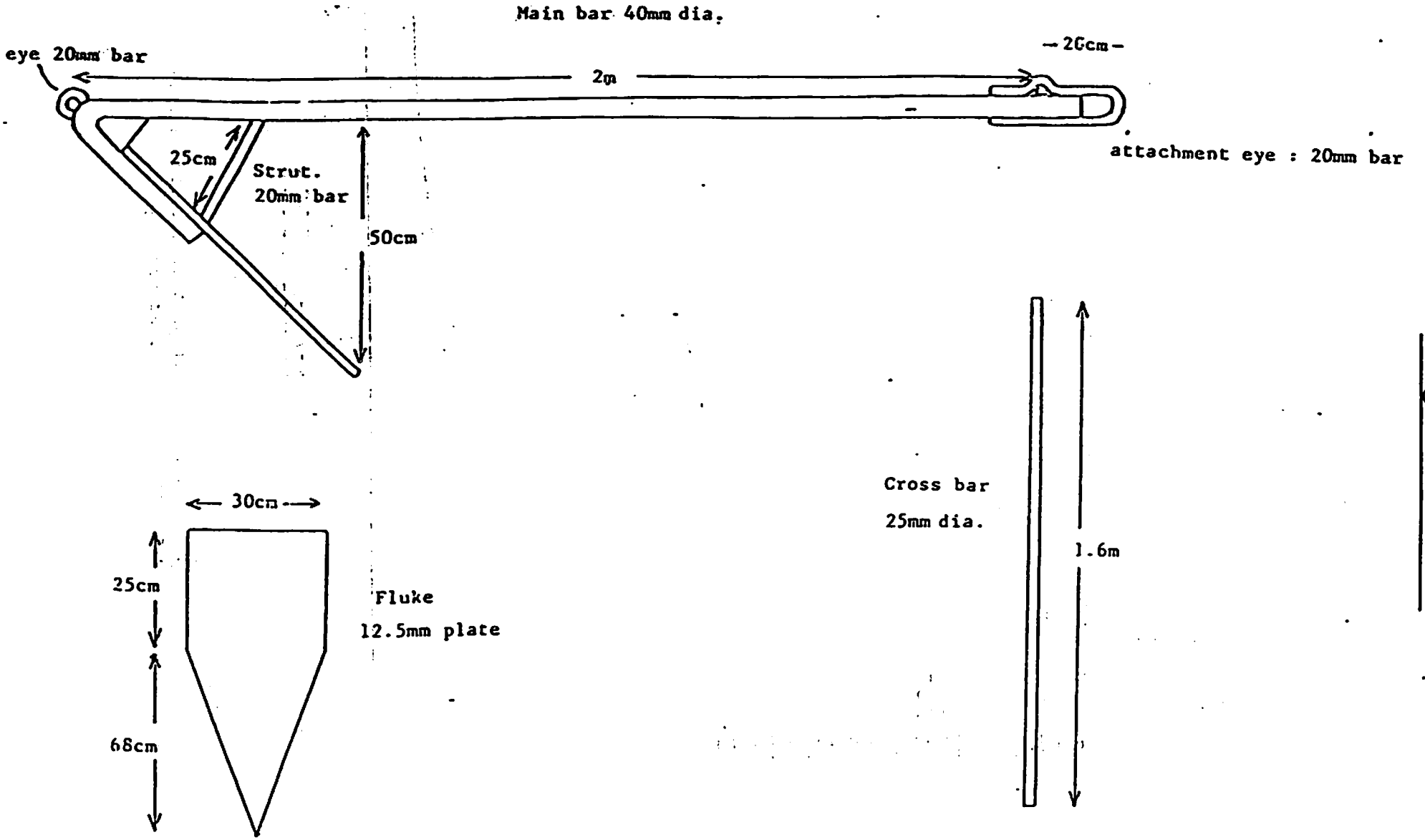


Fig.1. Diagram of a scallop cultivation longline system and single line spat collector system.



Long-line anchor

Fig.2. Detail of Longline anchor design

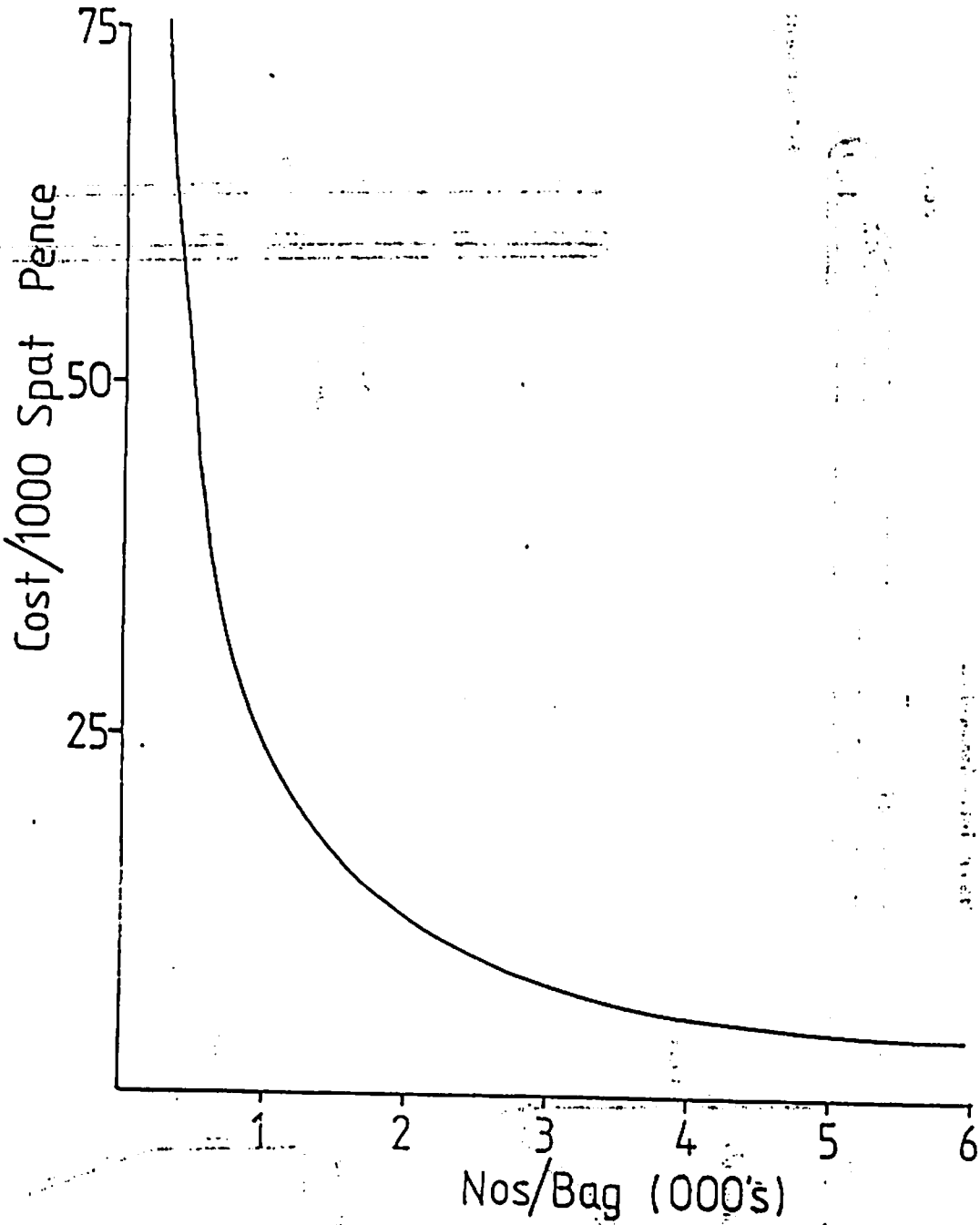


Fig.3. Approximate costs of spat collection in relation to the numbers collected per bag.

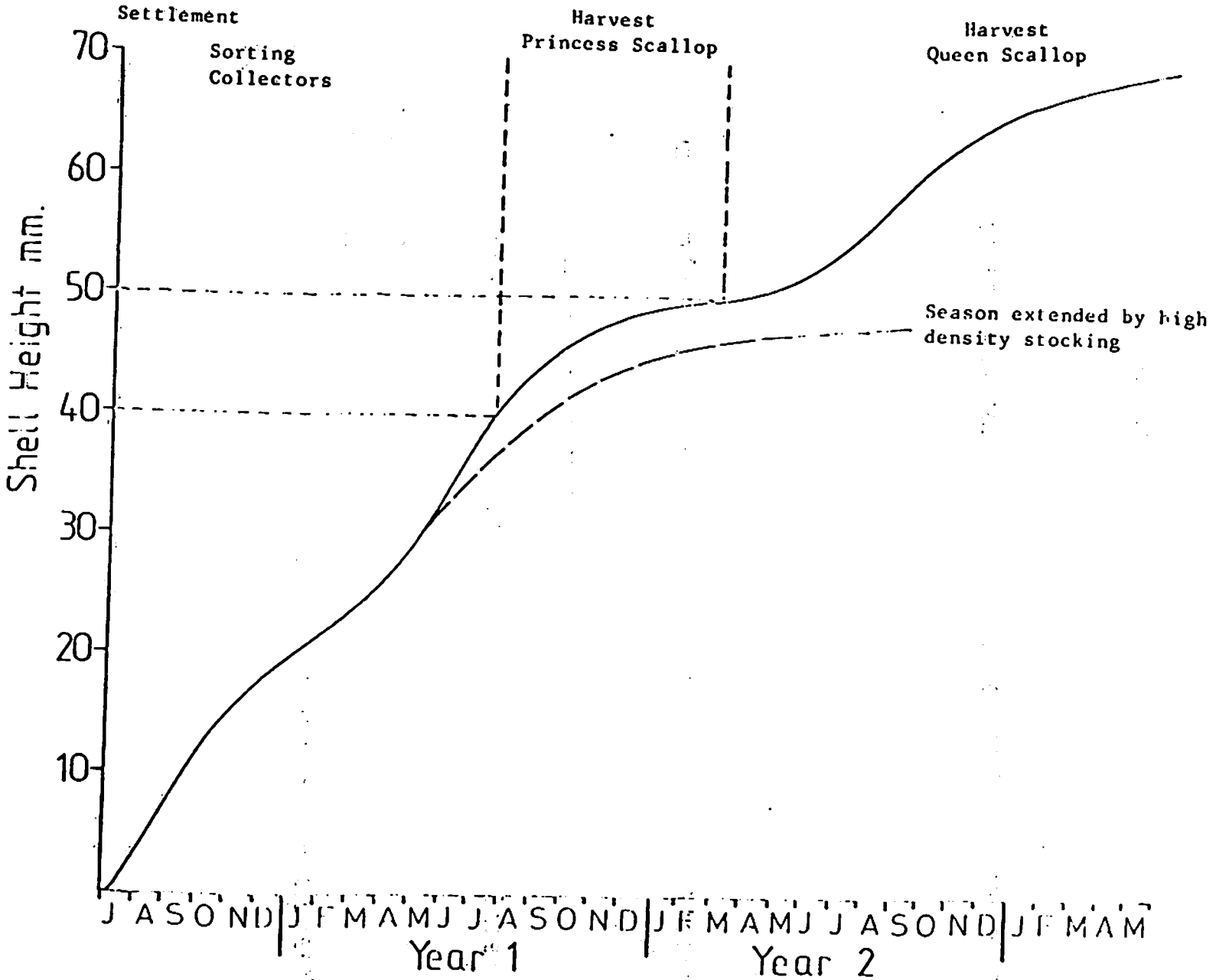
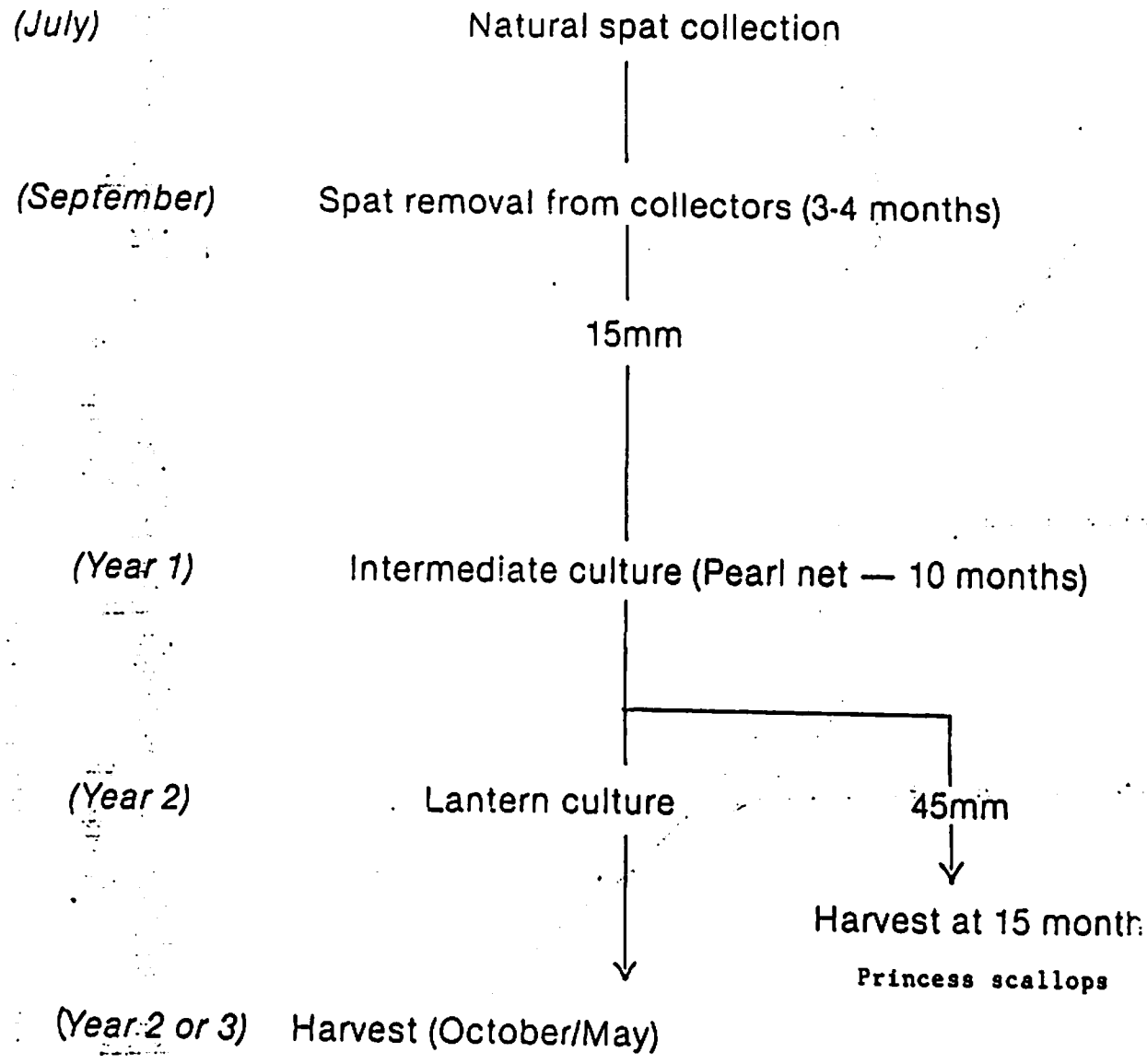


Fig.4. General expected growth curve for cultivated queen scallops. For guidance only

Fig.5. FLOW PROCESS CHART — QUEEN SCALLOP



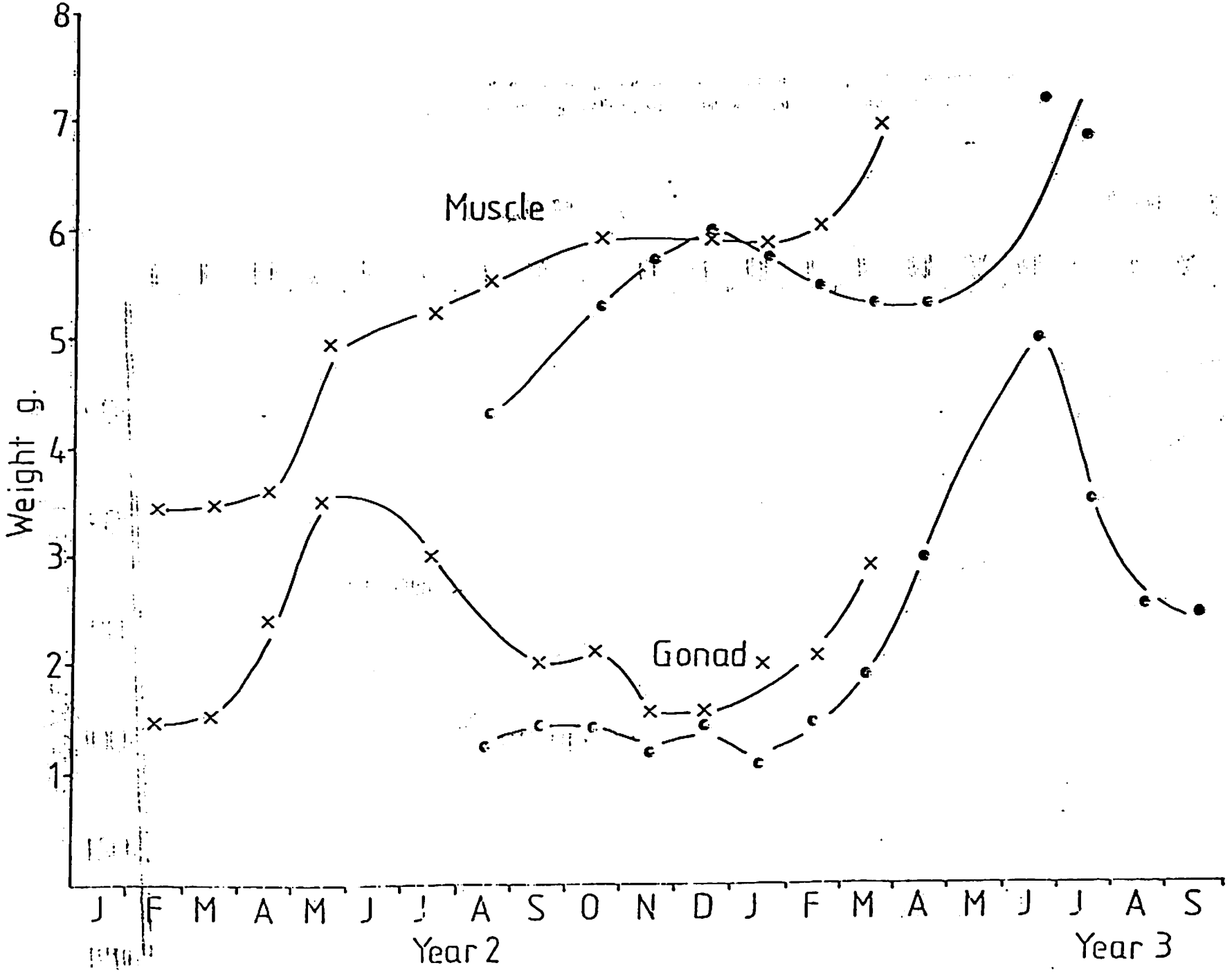


Fig.6. Yield of adductor muscle and gonad. Results from two separate year groups

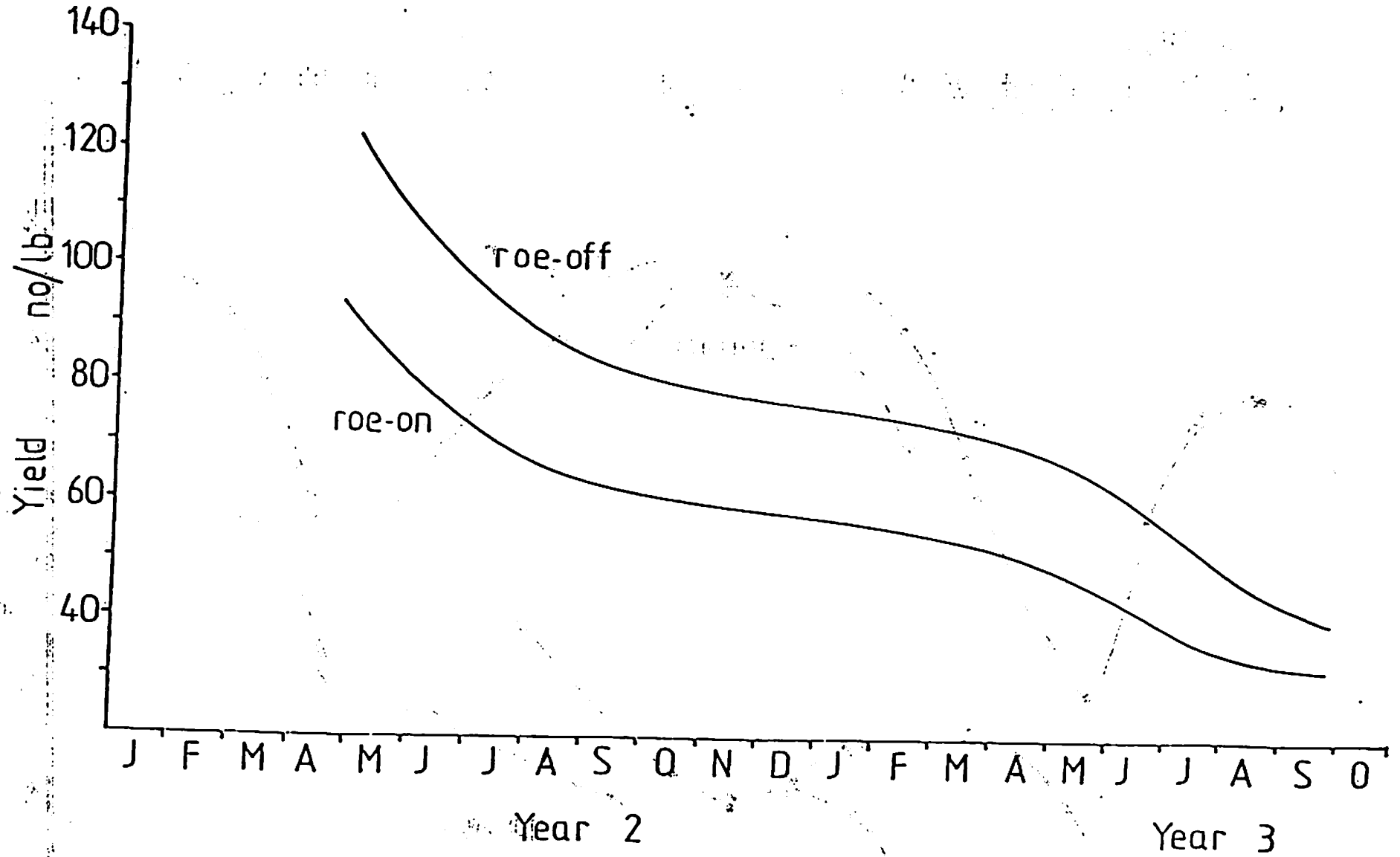


Fig.7. General expected meat yield in meats/lb. for roe-on and roe-off processing. For guidance only.

Industrial Injection Moulders Ltd., Milton Industrial Estate, Lesmahagow, Scotland ML11 0JN.	8" 'Inshore' floats
Taiyo (UK) Ltd., Northgate House, 20-24 Moorgate, London EC2 6JD	Lantern nets pearl nets
Kimura Shoten Ltd., No. 3-37, 1-Chome, Sakaigawa Nishi-Ku, Osaka, Japan.	Lantern nets pearl nets
Hakutaka Screw Co. Ltd., 7-21, 1-Chome, Mikage-nakemachi Higashinada-ku Kobe 658, Japan	Lantern nets, pearl nets
Styropack 2-4 Whitefield Drive, Heathfield Industrial Estate, Ayr.	Polystyrene boxes
Plasboard Plastics Ltd., Unit 8, Broomfield Industrial Est., Montrose DD10 8SY	Boxes.
Knowle nets 20 East Road, Bridport, Dorset DT6 4NX	Plastic mesh for making lanterns/ pearl nets

Suppliers List

This is a general list of suppliers. It is not complete nor necessarily the only or cheapest available. It is always worth obtaining a number of quotes for equipment.

Kerrypack Ltd., Longbrook House, Ashton Vale Road, Bristol B53 2HA.	Onion bags, Stocking mesh & packing net
W & J Knox Ltd. Kilbirnie, Ayrshire KA25 7DY	Nets, onion bags, stocking mesh, oyster bags, plastic mesh
Berisfords Ltd., P.O. Box 2, Congleton, Cheshire CW12 1EF	Onion bags, mesh
Alex Reid Co. Ltd., 421 Hillington Road, Glasgow G52 5BL	tags/fastenings
Aquatic Services (International) Whiteridge, Heath Lane East Boldre., Hants.	Netlon oyster bags
Tinsley Wire Sheffield, P.O. Box 119, Shepcote Lane, Sheffield.	Plastic coated wire
Young Black Industrial Stapling, 25 B Techno Trading Estate, Bramble Road, Swindon SN2 6EZ	Hog rings
British Industrial Fastenings, BIF House, Gatehouse Road, Aylesbury, Bucks. HP19 3DS	Hog rings
Morep Ltd., Luddenden Chambers New Road, Luddenden, Halifax, W. Yorks.	Ropes/floats etc.
Hugh Norman Ltd., Unit, 1., Castle Road Industrial Est. Ellon, Aberdeenshire AB4 9RF	Ropes/floats etc. Lantern nets
Bridport Gundry Marine, The Court, Bridport, Dorset DT6 3QU	Ropes/floats etc.
Salen Shellfish, Salen, Acharacle, Argyll.	Shellfish trays, longline floats and other equipment. Scallop processing

ADDRESS LIST

Crown Estate Commissioners,
10 Charlotte Square,
Edinburgh EH2 4DR.

Department of Agriculture & Fisheries for Scotland,
Chesser House,
500 Gorgie Road,
Edinburgh EH11 3AW

Department of Agriculture & Fisheries for Scotland,
Marine Laboratory,
P.O. Box 101,
Victoria Road,
Aberdeen AB9 8DB.

Department of Transport,
Marine Division,
Surley House,
90-93 High Holburn,
London WC1V 6LP

Highlands & Islands Development Board,
Bridge House,
27 Bank Street,
Inverness IV1 1QR

Scottish Shellfish Growers Association,
(Secretary) Janet Church
Tigh na Speir,
Connel,
Argyll PA37 1PH

Shellfish Association of Great Britain,
Fishmongers Hall,
London Bridge,
London EC4R 9EL

Scottish Development Agency,
120 Bothwell Street,
Glasgow G2 7JP

Highland Regional Council,
Development Department,
Regional Buildings,
Glenurquhart Road,
Inverness IV3 5NX