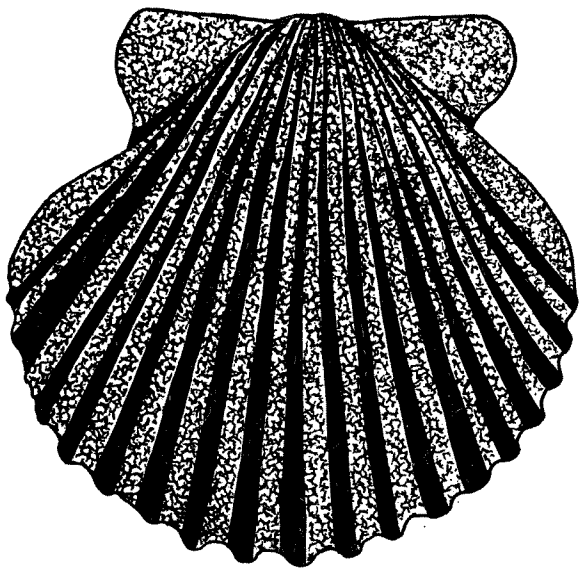
Province of British Columbia
Ministry of Environment
Marine Resources Branch

SCALLOPS: potential for mariculture in British Columbia



L.D. Hamilton

erratum: The following should be added to Suggested Reading -

Mottet, Madelon Green, 1979. A review of the fishery, biology and culture of scallops. State of Wash. Dept. of Fisheries, Tech. Report 39. 100pp.

Taguchi, K., 1977. A manual of scallop culture methodology and management f Overseas Fishery Co-operative Foundation. Fisheries and Marine Ser Translation Series #4198. 128pp.

SCALLOPS:

POTENTIAL FOR MARICULTURE IN BRITISH COLUMBIA

by

Linda D. Hamilton

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PREFACE

The Marine Resources Branch, Ministry of Environment, has initiated a program of resource planning and development to enhance the economic benefits derived from the marine biotic resources of British Columbia. One component of this program is a series of information reports and papers to inform interested individuals about the resources and their potential for commercial development.

This report provides an accumulation of basic information on the biology, fishery, culture, processing and markets for scallops. It is designed to assist an interested person to initiate more in-depth information gathering and to offer a general overview of the organisms, including their present and potential exploitation. Facts are often lacking due to a paucity of research or availability of published results and statistics. Therefore, opinions may be expressed which cannot be substantiated empirically. The reader should scrutinize these opinions carefully, only using them to assist in formulating his own perceptions and attitudes toward the prospective endeavour.

Detailed papers providing more rigorous analyses and evaluations will be provided when sufficient data are available. Meanwhile, this information report should provide a valuable source of preliminary knowledge.

James E. Fralick,
Head,
Finfish Section.

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INTRODUCTION

The shellfish industry in British Columbia is progressively evolving from wild stock harvest to mariculture. As demonstrated by the oyster industry, wild stock harvest has become increasingly expensive and the projected needs of the industry have begun to exceed the sustainable yield of the resource. Oyster farming is now an established industry in British Columbia and indications are that markets exist for other cultured shellfish as well.

This report is designed to provide preliminary information about scallop culture; describe the two native species of scallops that may be suitable for culture in British Columbia; and introduce scallop culture techniques already in use in other countries. A rigorous evaluation of culture techniques is not provided; however, a "Suggested Reading" list coupled with the References Cited should assist those interested in more in-depth information.

SCALLOPS

Several species of scallops have been recorded in British Columbia, but only two are large enough to be of commercial interest, the purple-hinge rock scallop, Hinnites multirugosus (Gale), and the weathervane, or giant scallop, Patinopecten caurinus (Gould). H. multirugosus cements one valve to a firm substrate, while P. caurinus is free living throughout its lifetime.

1. Fishery

a. Location of stocks

H. multirugosus occurs from low tide to depths of 130 m and ranges from Alaska to Baja, California. P. caurinus is found from 5-140 m and ranges from Alaska to Oregon.

No surveys have been conducted to determine the precise location of H. multirugosus beds off the British Columbia coast. Five surveys have been conducted to determine the location and size of beds of free living scallops such as P. caurinus. These surveys were conducted between 1934 and 1967 and are summarized by Bernard (1969). The cumulative coverage of all five surveys can be seen in Figure 1. Results of these surveys indicate sparse scallop populations (Bourne, 1969). Scallops have only been landed consistently in two areas: Dixon Entrance and the Gulf Islands area (Bourne, 1969).

b. Biology

The rock scallop, H. multirugosus, may attain a shell length of 25 cm and is found firmly cemented to rocks. This species is dioecious (sexes are separate) and, in California, is found to be gravid twice each year (Leighton and Phleger, 1977). The time of spawning may vary due to location. In California Leighton and Phleger (1977) found that rock scallops located within a bay spawn in the spring and fall, while those located offshore spawn

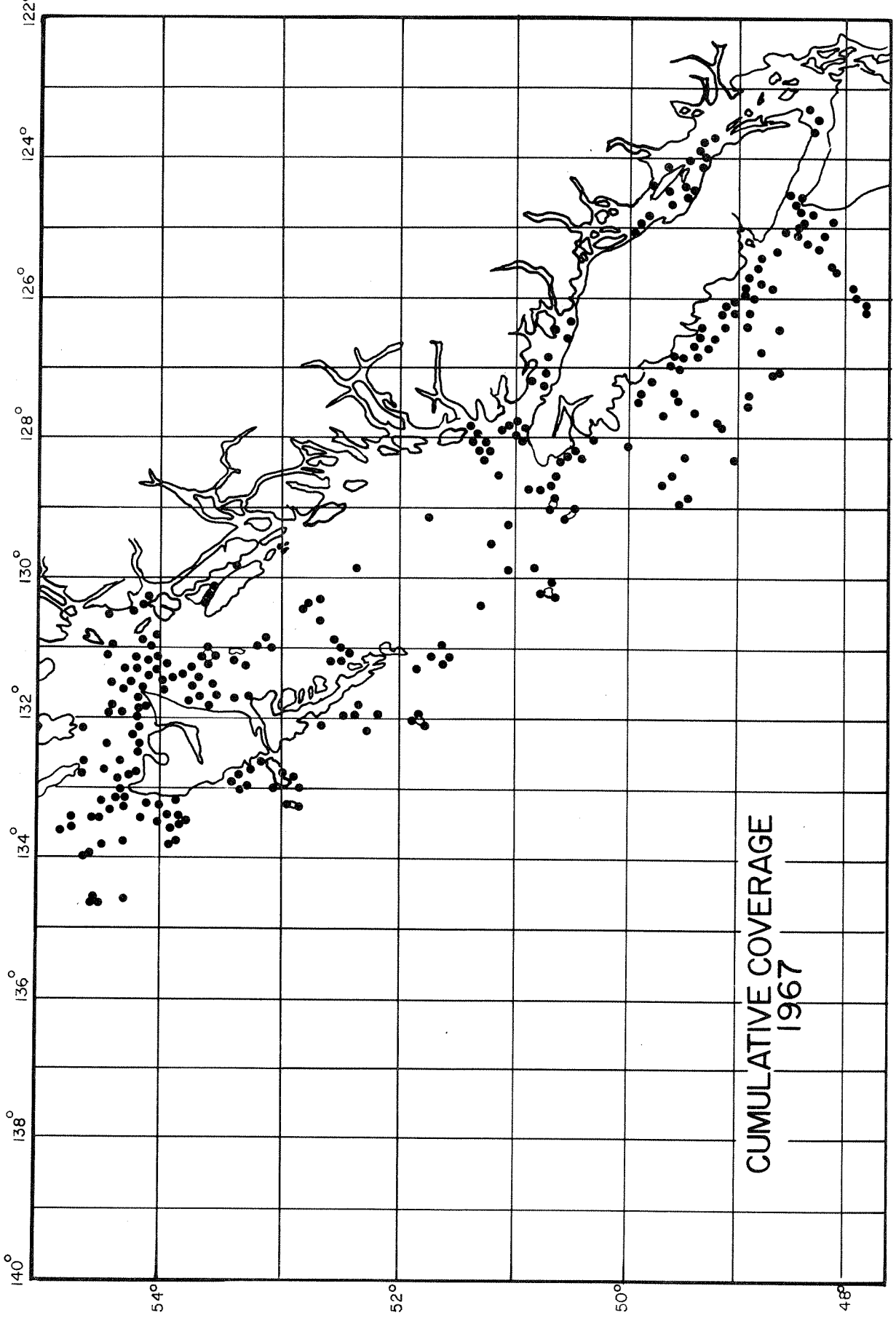


Figure 1. Cumulative coverage of hauls made with various types of bottom drags to assess the bottom fauna along the coast of British Columbia. Figure taken from Manuscript Report No. 975.

Source: Bernard, F.R., 1969.

in the summer and winter. Gametes are extruded into the water during spawning where the larvae remain through all of the larval stages. Larvae metamorphose into bysal-thread forming juveniles at about 30 days, depending upon the temperature, and then cement to a substrate at about six months. Samples of juvenile H. multirugosus collected in a California bay in mid-May ranged from 2-7 mm, while those collected in September ranged from 2-25 mm (Leighton and Phleger, 1977). Growth rates are dependent upon water temperatures as well as the abundance of food (plankton).

The weathervane scallop, P. caurinus, is found on sand, gravel and occasionally mud bottoms. This species is free living. Although able to "swim" by flapping its valves and propelling itself with jets of water, the species is primarily benthic. Weathervanes are also dioecious, with spawning occurring once annually, usually during early June. Fertilization occurs when the gametes are extruded into the water column, where the larvae remain for approximately 30 days before settling. Settling is dependent on water temperature. Weathervane scallops grow faster and to a larger size in the Strait of Georgia than the outer Washington coast (Haynes and Hitz, 1971). Maximum sizes of 200 mm for the Strait of Georgia and 106 mm for the outer Washington coast have been recorded. Hydrographic conditions differ between these two areas. The Strait of Georgia has relatively warm (8 to more than 10° C annually), turbulent waters with rich concentrations of phytoplankton, especially from May to October. On the outer Washington coast, at 50-60 fathoms where the scallops are found, the water is cold (6.5-9.0° C annually), stable, and the primary plankton layer is above the scallop beds for much of the year (Haynes and Hitz, 1971).

The shell of the weathervane scallop is sometimes heavily infested with a boring annelid (worm), which causes the scallop to divert energy to shell repair, possibly resulting in reduced growth (Haynes and Hitz, 1971). Principal predators of the weathervane and rock scallops are sea stars, crabs and some fishes.

c. Fishing methods

Free living, bottom dwelling scallops such as P. caurinus can be fished by bottom drags, dredges and trawls. However, the rock scallop, H. multirugosus, due to its attachment to firm substrates, is usually collected by divers.

d. Industry characteristics

There is presently no scallop industry in British Columbia, and Bourne (1969) suggests that a commercial fishery is not likely to develop due to: 1) sparse commercial size populations; 2) low recruitment to the adult populations; and 3) a limited amount of good dragging bottom along the British Columbia coast.

e. Economics

As there is no commercial scallop fishery in British Columbia, there is little economic information available. A few boats have attempted a commercial fishery in the Gulf Islands area but ceased activity due to insufficient volumes in the catches.

Restaurants and fish markets in British Columbia obtain frozen scallops from east coast processors because neither fresh nor local scallops are available for purchase.

2. Mariculture

The establishment of a viable commercial scallop fishery is unlikely. However, in light of the fact that scallop mariculture in other countries is a well established commercial enterprise, it seems possible that a mariculture industry may be established in British Columbia. The information presented in this section is a summary of mariculture techniques employed in other countries, which may have potential application in the development of scallop culture in British Columbia.

a. Site requirements and locations

There are at present no commercial scallop culture operations in British Columbia, but based on culture operations in other countries, certain general requirements can be stated. They include water temperatures of between 8-18° C, adequate tidal flushing and abundant food supply. Easy access to the site and proximity to processing plants and markets would also be beneficial. Off-bottom culture techniques (eg. raft, longline), similar to those used by British Columbia oyster growers, would likely be used for scallop culture; therefore, protection from violent wave action would be necessary.

b. Culture and enhancement methods

Spawning of H. multirugosus has been induced in the laboratory by increasing the water temperature about 5° C above ambient, and/or by adding suspension of testes material to tanks holding both males and females (Leighton and Phleger, 1977). Spawning has also been stimulated by using seawater irradiated by ultraviolet light (Uki and Kikuchi, 1974). Frequently, however, these methods prove unsuccessful - probably due to gametogenic immaturity.

To ensure normal development of H. multirugosus eggs, females are isolated at the onset of spawning in freshly filtered and UV sterilized seawater (Leighton and Phleger, 1977). Fertilization is controlled by adding one millilitre of sperm suspension to one litre of seawater containing approximately 10^5 eggs. Fertilized eggs are pipetted from the bottom of the spawning containers, suspended in clean seawater and allowed to settle. Several repetitions involving decantation, resuspension and settling are sufficient to rinse the eggs. Incubation of the eggs (5,000/litre) is carried out in polyethylene pails (10 litre) at a temperature of 14-16° C. Antibiotics (Streptomycin sulfate and Penicillin G. Potassium, 10-50 ppm) are added to retard bacterial growth and water is renewed each day

until hatching. Swimming stages receive water changes every other day by gently collecting the larvae on fine plankton netting (64 µm) and keeping the netting immersed in filtered seawater. Mortality is highest in the early life stages, particularly at the time of attachment.

Early development of larval H. multirugosus held at different incubation temperatures in a thermal gradient apparatus is depicted in Figure 2. Note that after three days at temperatures above 18° C, larval development rate declined. Table 1 shows the rate of growth of the rock scallop dispersed in suspended rack culture.

To our knowledge, there are no published accounts of the artificial propagation of P. caurinus; however, a similar species, P. yessoensis, is widely cultured in Japan. The method of spawning induction is by thermal stimulation, as in H. multirugosus, and treatment of the spawning individuals and resulting larvae is almost identical to that described above for the rock scallop (Sanders, 1973).

Although the Japanese have scallop hatcheries, natural spat (settling larvae) collection is the preferred method. A brief outline of the Japanese scallop culture technique is given below. For greater detail of these methods, see Introduction to scallop farming, Aomori Prefecture (1975) and Culture of the scallop Patinopecten yessoensis (Jay) in Japan, Saunders (1973).

"Seed collectors" are used to catch the settling larvae in the water column. Collectors are bags or baskets, usually made of plastic web (4 mm mesh; Figure 3a, b and c; Figure 4a) filled with collecting material, such as discarded gill nets. Spat initially attach to the collecting material, but when they reach a shell length of 6-10 mm, they drop off and are caught in the mesh of the bags. Juvenile scallops are then transferred to cages with a mesh of 5-9 mm (Figure 3b, c and f) and reared to a size of 3 cm. This period is called intermediate culture which is followed by hanging culture (Figure 4b), where the scallops

Figure 2. Early development of larval Hinnites held at different incubation temperatures in a thermal gradient apparatus. After three days larvae at temperatures above 18° C declined. At each observation time, larvae were recorded as having attained early, mid-, or late development with respect to each of the stages indicated on the ordinate.

Source: Phleger, C.F., et.al., 1977.

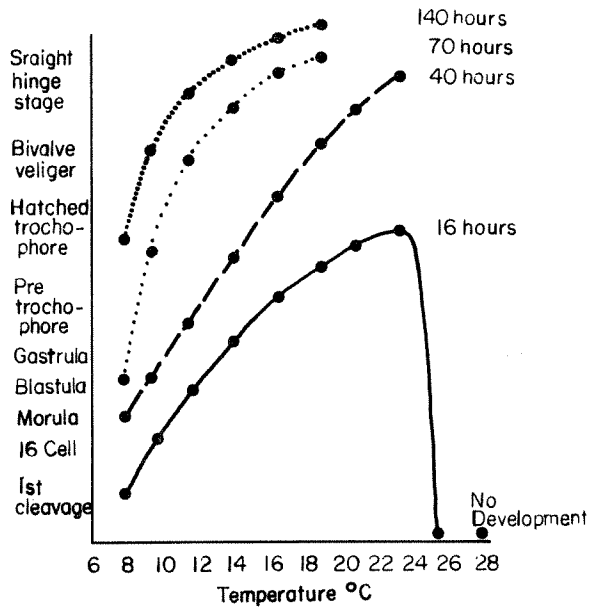


Table 1. Growth of Hinnites dispersed in suspended rack culture in Mission Bay, California.

Group	(n)	Size October 10, 1975*		Size October 9, 1976		Group Mean Increase
		Group mean	Range	Group mean	Range	
I	(8)	19.9 mm	15.5-23.8 mm	66.4 mm	54.0-75.0 mm	46.5 mm
II	(18)	31.2	25.6-34.4	70.8	56.5-83.5	39.5
III	(7)	42.8	38.4-45.3	81.2	68.0-85.3	32.9

* Shell outline was highly variable. Accordingly, an average shell diameter was recorded for each individual: (height + width)/2

Source: Phleger, C.F., et.al., 1977.

Figure 3. Equipment used for culture of scallops. Baskets of types a, b, and c are used for spat collecting; of types b, c and f for intermediate culture; and of types b, d, f and g for adult culture (g is designed for attachment of the rock scallop Hinnites multirugosus.) The method of ear hanging is shown in e.

Source: Sanders, M.J. (1973).

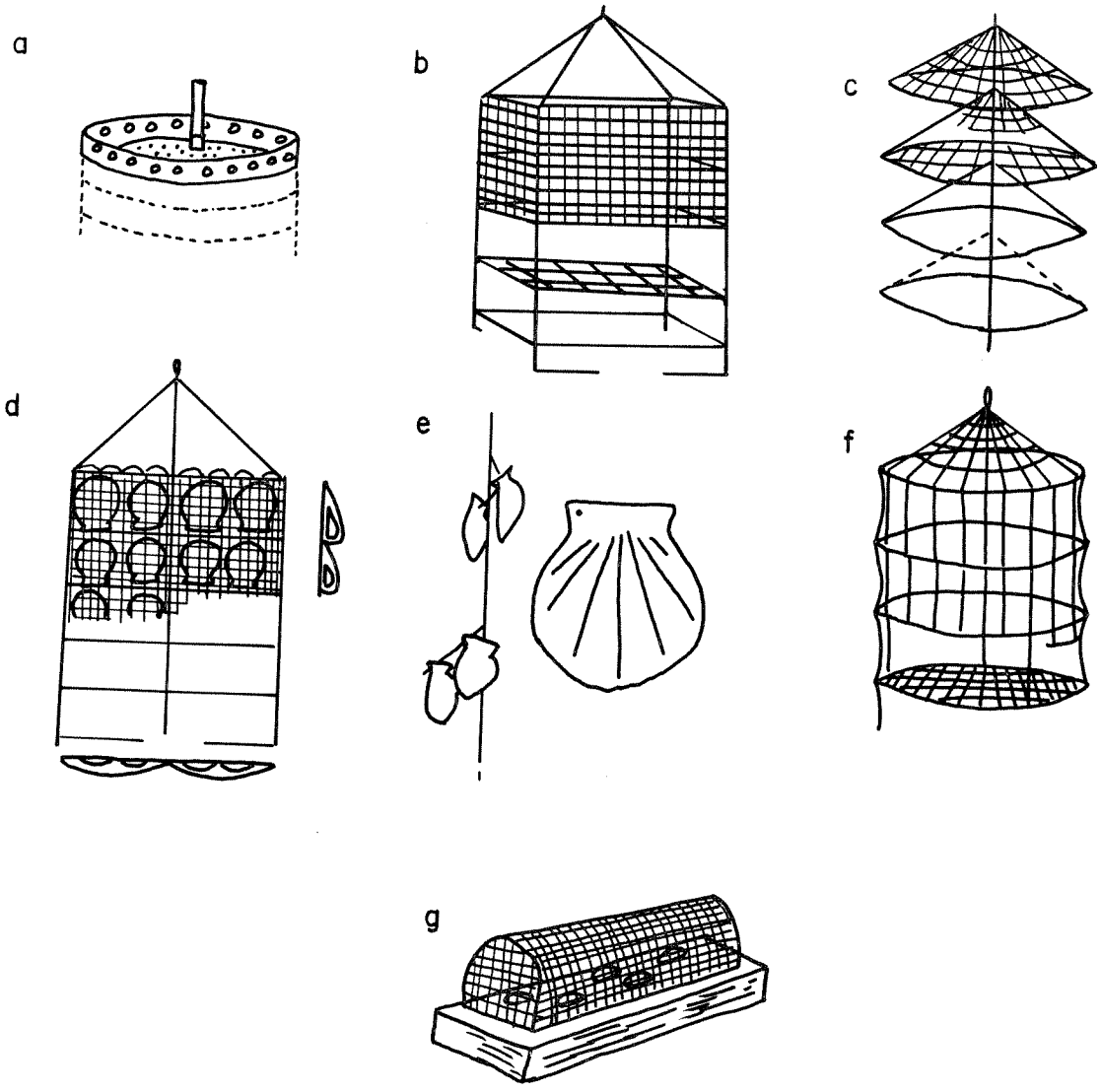
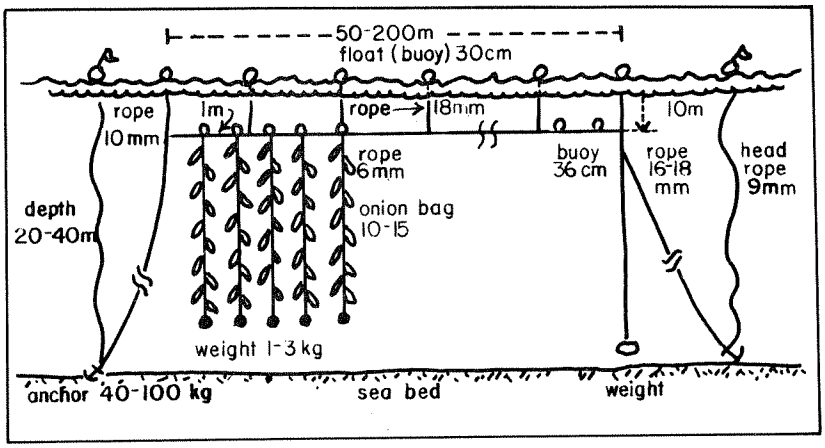


Figure 4. a. Layout of the long-line used for large-scale scallop spat collection in Matsu Bay, Japan.
b. The long-line layout commonly used for intermediate and hanging culture with pearl nets (left) and lantern cage.
c. Top and side view of an improved long-line design also being used for scallops in Japan.
Source: Taguchi, K. 1976.

a



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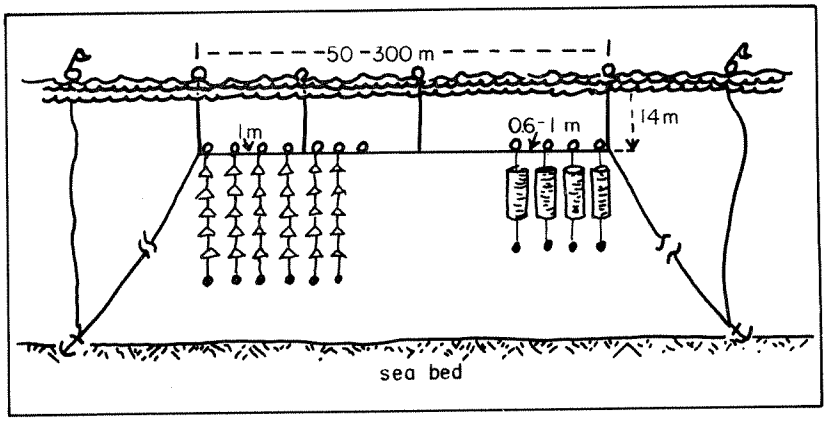

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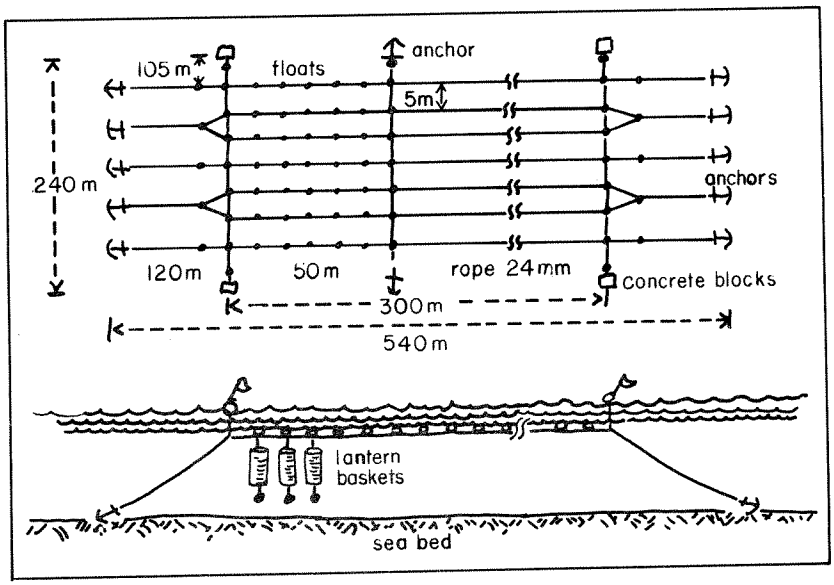

are transferred to another type of cage (2-3 cm mesh; Figure 3b, d, f and g) and reared to market size. The Japanese have found that juvenile scallops in the intermediate culture stage must be kept at a uniform size within a given cage, as smaller juveniles will not grow if mixed with larger ones (Aomori Prefecture, 1975).

Two alternative methods of hanging culture are: 1) drilling a hole in one ear of the shell and suspending the scallop directly from the long-line (Figure 3e); or 2) gluing the scallops back to back onto plastic tape, which is suspended in the water column. An alternative long-line method is depicted in Figure 4c.

The rock scallop, H. multirugosus, is presently being reared in California in cages designed to suit this species' behaviour of attaching to the substrate (Figure 3g; Leighton and Phleger, 1977). This is a research project designed to develop culture techniques, and a commercial venture has not begun. One aquaculture operation in British Columbia is collecting what is believed to be H. multirugosus spat on oyster trays, and attempting to rear this species to marketable size.

c. Mariculture feasibility

Scallop culture is a viable industry in other countries, but its feasibility in British Columbia is unknown and subject to many unanswered questions. Firstly, a reliable source of spat must be secured. This may be through the identification of natural seed producing areas and subsequently developing spat collection techniques suitable to our coastal conditions; through the use of artificial hatchery methods; or through scallop spat imports. Other countries have found natural spat collection is the more economical source of supply (Sanders, 1973). Secondly, much of the biology of H. multirugosus and P. caurinus is unknown. Thirdly, successful application of Japanese culture technology to our species must be made. Fourthly, mortality

rates and production cycles must be determined. Finally, the economics of a culture operation, which has in other countries proven to be very labour intensive, must be investigated. Answers to these questions will form the basis for determining the feasibility of scallop culture in British Columbia.

3. Processing

a. Present products in British Columbia

A survey of several local stores and restaurants indicates that scallops are only available as frozen product (from the east coast of Canada).

b. Potential products

In eastern Canada, scallops are sold fresh, frozen, canned, breaded and partly fried (Bourne, 1964). In Ireland, England, France and Australia the roe (gonad) is marketed, and in some places the mantles are used (Bourne, 1964). However, none of the local stores which were surveyed expressed an interest in these latter products; hence, considerable promotion would presumably be required in order to create a market for scallop roe and mantle.

c. Methods of processing

Shucking scallops and removing viscera is done by hand; however, mechanical shucking techniques are being developed. The capacity of a worker shucking by hand is 50-60 kg (weight including shell) per hour. The percentage of soft parts in the total weight varies according to the time of harvesting, due to changes in gonad weight. It may be anywhere from 25-50%; however, the percentage of muscle remains constant at about 14% (Taguchi, 1976).

4. Markets

a. Potential markets for British Columbia products

Present markets for east coast scallops are, presumably, potential markets for British Columbia scallops. This is particularly true for the west coast domestic market.

Export markets already established by the east coast Canadian scallop fishery are listed in Table 2, along with the quantity and wholesale value of scallop products exported in 1980.

Table 2. Quantity and wholesale value of scallops exported from Canada in 1980. [Dash (-) means less than one tonne].
Source: Statistics Canada.

	Country	Quantity (tonnes)	Value ($'000)
Fresh and Chilled	Japan	-	1
	United States	389	4,111
Frozen	Australia	52	440
	Barbados	1	14
	Bermuda	7	75
	Denmark	1	10
	France	102	1,069
	Hong Kong	2	16
	Malasia	-	4
	New Zealand	2	17
	St. Pierre Micheleau	2	16
	Sweden	14	133
	Switzerland	5	45
	West Germany	5	70
	United States	6,922	72,463

The cumulative quantity and landed value of scallops caught by the Atlantic provinces (N.S., N.B., P.E.I., Que., Nfld.) in 1979 and 1980 are given in Table 3. There are no figures available as to the quantity of scallop meat imported, inter-provincially, to British Columbia from the Atlantic provinces.

Table 3. Quantity (round weight) and landed value of scallops caught by the Atlantic provinces in 1979 and 1980, January-December.
Source: Government of Canada, Fisheries and Oceans.

	1980 (Preliminary Figures)	1979
Quantity (tonnes)	68,393	89,488
Value ($'000)	66,147	74,451

SUMMARY

It cannot be stated with certainty, that a market, whether domestic or export, exists for cultured scallops from British Columbia. This will only be determined after intensive examination of the present and potential supply from wild stocks, the demand from the consumer, and the economic feasibility of a culture operation. However, the technology for such a venture is available and need only be modified to suit the unique characteristics of the British Columbia coast.

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