81/42

ABALONE CULTURE FEASIBILITY STUDIES

1. Macro algal feeding trials

Nursery feeding assessments were made during a 30 day trial in May and June 1982. A flow through nursery culture system was assembled and feeding trials with three macroalgal species: Macrocystis sp., Lessonia sp. and Ulva sp. have been completed Juvenile abalone at three size groups were monitored for growth.

Abalone were marked with dots of coloured nail polish, different colour combinations individually identified each abalone. Fresh algae was weighed, placed in abalone trays, removed after a week and reweighed.

Quantitative results were inconclusive due to difficulties in wet algae weight measurements. The wet weight error was probably greater than the small amounts eaten by the abalone. Qualitatively, however, juveniles appeared to prefer Ulva sp. at 2-5 mm and Macrocystis at >5 mm. Lessonia sp. was the least preferred at all sizes.

Results

Date	Tank No.	Mean Length (mm)	Growth Increment (mm)
7.4.82	A1 and 2	19.20	
	B1 and 2	15.07	
	C1 and 2	6.96	
7.5.82	A1 and 2	21.00	1.80
	B1 and 2	17.56	2.49
	C1 and 2	10.21	3.25

2. Container grow out culture trials

The objective is to evaluate biological and technical constraints to the culture of 50-80 mm abalone for direct marketing.

The project commenced on 20 September 1982, using wild stocks of juvenile blacklip abalone from Rocky Cape and cultured broods produced at the experimental abalone hatchery at Taroona.

Four deepwater sites have been used in the project to date and although abalone are tended every 2-4 weeks growth is monitored less frequently.

Initial trials were conducted at Lousy Bay near Dover but work was terminated due to theft of abalone and gear during December 1982. Sites were also established using existing long line facilities at Birchs Bay, Eaglehawk Bay and Port Esperance.

The abalone were fed *Macrocystis* sp. *ad libatum* and growth is shown in the graphs for three abalone length groups at each site.

The reults were generally poor with overall growth less than 50 μm per day. Individual results varied and some abalone at certain times showed good growth (ref. Birchs Bay, March-July). Of the three groups studied the <30 mm size group grew at the faster rate.

Two factors were believed to have markedly reduced growth rates namely location and abalone stocks used for the trials.

Locations were chosen on the basis of available and secure floatation systems (commercial longline farms) and generally were in areas devoid of natural abalone stocks. Throughout the duration of the trials it was noted that abalone behaviour was generally muted compared to that observed in animals in more optimal locations.

Secondly stocks were conveniently collected from wild settled abalone on Tasmania's North West Coast. Studies by P. Whyte of the University of Tasmania, have suggested that this area has high initial settlement rates of abalone but suffers from growth depression due to over competition for food.

Current trials in operation at a more remote but optimal site from abalone produced under the Industry-TFDA 1983 hatchery study have shown average growth rates of 120 μm per day over a 60 day period demonstrating the growth potential of this species.

3. Greenlip abalone, *Haliotis laevigata*

Five excursions were made to the Furneaux Island group at approximately six week intervals during the Autumn, Winter and Spring 1982 to assess the maturity of natural stocks of *H. laevigata* before inspection of divers catches were made. No abalone inspected were considered competent to be induced to spawn.

Unlike the blacklip abalone which has a protracted spawning season in the south of Tasmania it is considered the greenlip may have a shortened spawning period during summer. Further work is needed.

A successful method of transporting live greenlip abalone from the Furneaux group to Taroona Laboratory was developed.

Freshly caught greenlip were packed between layers of fresh damp seaweed in polystyrene coolers. A three inch layer of polystyrene packing beads on the bottom of the coolers absorbed excess moisture. A re-usable freezer above the upper layer of seaweed ensured a low temperature inside the cooler for the five hour trip to Taroona. Survival for the three experimental shipments was 100%.

4. Settlement and survival trials

Apparent low settlement rates, <1% prompted an investigation to determine the causative factors. From earlier studies in the U.S.A. it was considered that bacterial flora on the settlement surface was an important factor in determining settlement success (Elston and Lockwood, 1983; Sumner pers. comm.). In addition previous studies had failed to determine when the major mortality of newly settled larvae occurred. Larvae may have failed to settle on cultch, died on settlement or suffered mortality within a few days of settling. Previous sets were estimated within seven days of introduction of ready-to-set larvae.

To examine these factors two trials were conducted. Using standard techniques two batches of abalone larvae were reared in running sea water. Ready-to-set larvae, recognised by anatomical and behavioural characteristics, were introduced into settlement trays filled with 1 μm filtered sea water at 15°C. Larval densities were adjusted to provide for one larvae per 50 ml standing water volume and 9 cm^2 (abalone shell) cultch surface area. Tank surface areas were identical and were examined along with shells. After 48 hours tanks were irrigated with fresh 1 μm filtered sea water maintaining a flow rate equivalent to 30 tank volumes per day.

Trial 1.

The effect of an antibiotic on settlement was investigated. Paired sets of settlement tanks were daily treated with Neomycin Sulphate to produce a nominal concentration of 50 ppm. This antibiotic has been utilized in shellfish hatchery production (Pennec and Prieur, 1977).

Over a period of seven days, post introduction of larvae, tank surfaces and settlement shells were gently rinsed with sea water and washings collected on an 85 μm mesh diameter sieve. Debris was identified as: dead larvae (DL) - empty shells, no peristomal growth; live larvae (LL) - velar cilia intact; dead spat (DS) - peristomal growth present and live spat (LS). It was not possible to differentiate larvae that had settled (lost cilia) and died before any shell growth was apparent. These necessarily were included as dead larvae. All dead shells were discarded after counting and live larvae and spat resuspended in fresh sea water and returned.

In addition counts on all settlement surfaces were taken on days 1 and 7.

Treatment	Condition [1]	Antibiotic	Shell Cultch
A	Clean	-	-
B	Clean	+	-
C	Clean	+	+
D	Clean	-	+
E	Clean	-	+ [2]
F	Conditioned	-	-
G	"	+	-
H	"	+	+
I	"	-	+
J	"	-	+ [2]

[1] Conditioned: 7 days with running sea water prior to trial.

[2] Shells with elevated bacterial counts (provided by C. Garland).

Separate trials with the antibiotic produced shell surface densities of bacteria around 2×10^5 cells. cm^{-2} compared to normal levels of 5×10^6 and elevated levels 1×10^8 cells. cm^{-2} (C. Garland *pers. comm.*).

Results

No settlement was detected in treatments without shell cultch compared with a total of 491 live spat (17.8% of larvae) in other treatments (see Table 1). After 7 days only 1 live larvae remained (0.11%) in shell-less treatments and none in others. Cumulative percentages of dead shells showed that for treatments without shell cultch, antibiotic delayed onset of mortality although did not influence the final result. In other treatments the effect was similar irrespective of presence of antibiotic, viz. presence of shell cultch was sufficient to delay onset of mortality in larval abalone. However, in all cases this delay was less than 72 hours.

In treatments with shells peak settlement occurred within 48 hours of exposure of larvae to cultch with equally good results on antibiotic treated shells(H) and shells with an enhanced bacterial flora (E,J). However, by 7 days settlement had fallen to 4.5% giving a total count of live abalone of only 123. Numbers of live spat on shells in treatments E,J were higher at day 1 than for all other treatments (students 't' test, $P<0.01$).

TABLE 1: Summary of results of antibiotic treatments on settlement and survival of blacklip abalone larvae.

Treatment mean	Day	Debris*				Shell Set*				Cumulative
		DL	LL	DS	LS	DL	LL	DS	LS	% age dead
A,F	1	35.0	8.7	0	0	-	-	-	-	35.0
	7	46.7	0.4	0	0	-	-	-	-	46.7
B,G	1	39.1	21.7	0	0	-	-	-	-	39.1
	7	23.9	0	0	0	-	-	-	-	63.0
C,D,H,I	1	35.0	8.7	0	1.3	7.7	5.7	0	15.8	42.7
	7	26.5	0	0	0	7.6	0	0	3.8	69.2
E.J	1	36.5	7.8	0	1.3	7.7	0	0	22.9	44.2
	7	7.0	0	1.0	0	7.0	0	3.0	5.6	62.2

* Expressed as percentage of larvae introduced.

DISCUSSION AND CONCLUSIONS

Settlement only on the shells is indicative of a specific site selection requirement in the larval abalone. Morse *et al*. (1979) suggested that this was related to the presence of γ-aminobutyric acid in crustose red algae. Abalone shells used as cultch in this study were encrusted with related species *Lithophyllum* sp. However Akashige *et al.* 1981 dispute the effects of this amino acid and suggest other mechanisms of inducement for settlement of the abalone.

The increased settlements noted on shells with above normal bacterial densities suggests that there may be other biotic factors involved. Slightly higher rates of survival of settled abalone on these shells also suggests some continuing beneficial effect although it is likely by seven days that bacteria would have been reduced to similar densities in all treatments (C.D. Garland *pers. comm.*).

Unfortunately very variable rates of recovery of shells from the debris was a feature, 43.7% in treatments B,G on day 1 to a high of 77.2% in E,J renders further speculation meaningless. Shell damage to fragile larvae and daily handling may have further complicated interpretation of results although all treatments received the same degree of handling.

Irrespective of treatment however, settlement rapidly fell to low levels by seven days. Some nutritional deficiency is indicated at this juncture.

Trial 2.

In this trial abalone larval densities were distributed as for Trial 1. All treatments consisting of paired trays carried similar amounts of abalone shell cultch but were subject to different feeding regimes. Diatom cultures were added daily to respective treatments Chaetocerus calcitrans, Phaeodactylum tricornutum and Navicula minima at 36 x 10^6 cells day^{-1}. All tanks were cleaned daily and water exchange was identical to trial 1 but ceased for 1 hour after addition of diatoms.

Treatment	Condition
A	control
B	+ *C. calcitrans*
C	+ *P. tricornutum*
D	+ *N. minima*

Debris and settlement rates were collected as previously described but only categorised into dead and live individuals.

Results

Summarised results of trial 2 are presented in Table 2.

TABLE 2: Effect of treatment on abalone larval settlement and survival.

Treatment	Day	Debris		Shell Set		Cumulative
		Dead Shell	Live shell	Dead Shell	Live Shell	% age dead
A	1	40.4	9.3	6.2	10.1	53.6
	7*	15.7	0	0.7	4.7	69.0
B	1	5.8	2.1	1.2	32.3	7.0
	7	13.2	0	1.6	2.9	21.8
C	1	28.7	0.5	5.4	26.1	34.1
	7	4.2	0	5.0	1.5	43.3
D	1	16.4	10.0	0	53.0	16.4
	7	24.8	0	0	3.1	41.2

* Cumulative total days 2-7.

DISCUSSION - CONCLUSION

Again a relatively unsatisfactory settlement result was obtained, overall average 3.1%. Despite apparently different initial settlement rates end results were similar. None of the food treatments was successful in generating a better than average settlement. Difficulties in collecting and identifying debris were encountered in treatments B-D due to biofouling by added algae.

As for Trial 1 total rates of recovery were similar ranging from 41.4 to 79.4% of added larvae.

These diatoms have been used in other abalone rearing trials (Kikuchi, 1965 and Tong, 1982) but did not assist in this trial. Other factors including quality and quantity of bacterial flora and possibly site specific biotoxin presence require evaluation.

5. Pilot scale hatchery trials

During 1983 the technology developed as a result of the F.I.R.T.A. project was applied to a pilot scale hatchery to assess the commercial potential for large scale production of juvenile production of juvenile blacklip abalone. The project, jointly funded by industry and the T.F.D.A. commenced on 11 April at the Shellfish Culture Pty Ltd., hatchery, Bicheno.

Three spawnings were induced from three collections of brood stock. One was of major significance. Temperature and ultra violet irradiation of the adult receiving water induced spawnings.

Two batches were reared to settlement, larval survivals were 25% and 46% respectively. Larval survival and growth was monitored regularly. Approximately 17,000 fully metamorphosed larvae (appearance of the first respiratory pore) were obtained giving a post settlement survival rate of 43%.

These juveniles are currently being reared in sea cages at Nubeena. South East Tasmania and at the 21 February 1985, had a mean length of 1.73 cm.

REFERENCES

Akashige, S. Seki, T. Kan-no, H. and Nomura, T. 1981. Effects of γ-amino-butyric acid and certain neurotransmitters on the settlement and metamorphosis of the larvae of Haliotis discus hannai Ino (Gastropoda). Bull Tohoku Reg. Fish. Res. Lab. No. 43, 37-45.

Elston, R. and Lockwood, G. 1981. Pathogenesis of vibriosis in cultured juvenile red abalone, Haliotis rufescens (Swainson). J. Fish. Disease 6, 111-128.

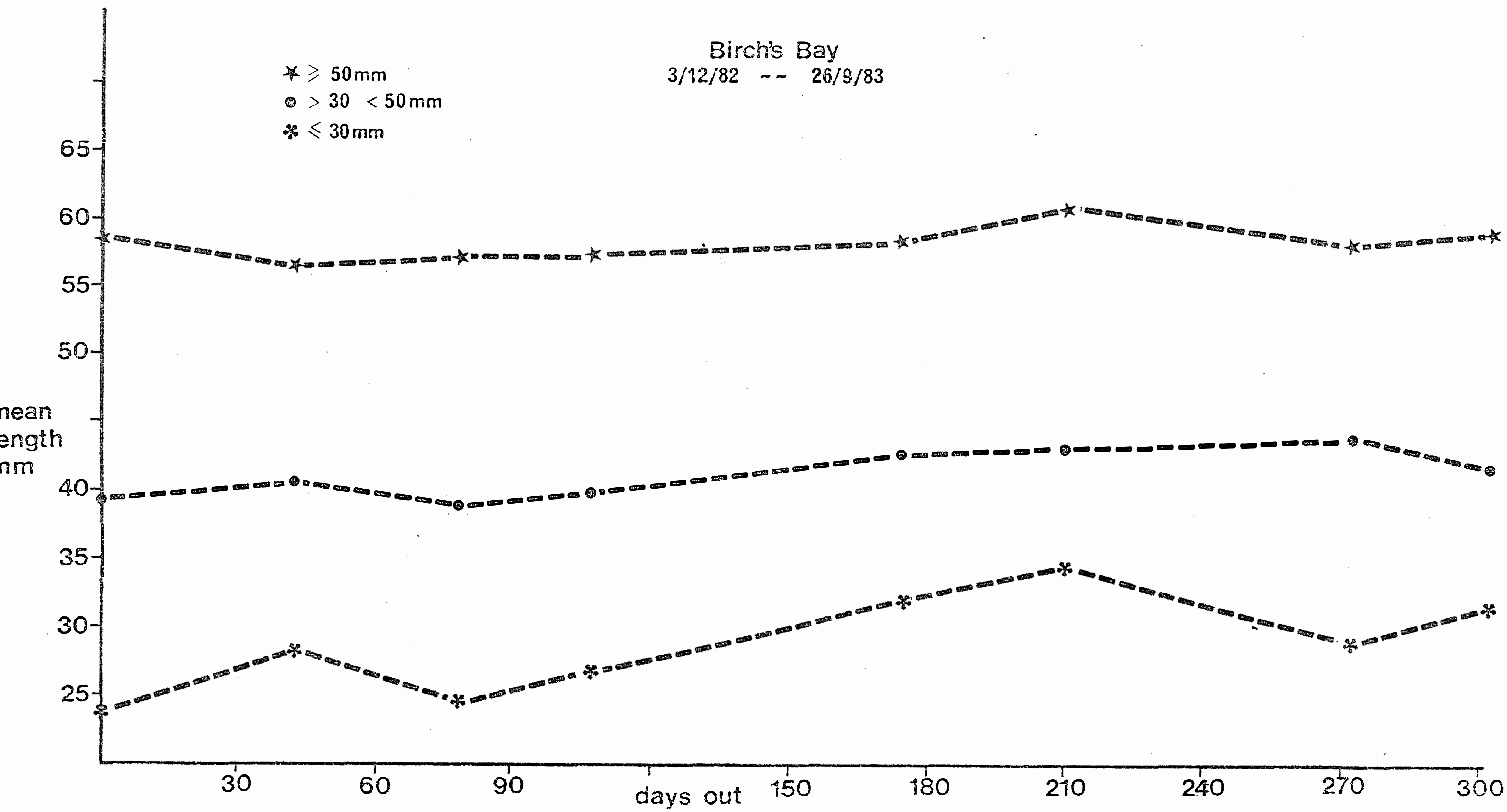
Kikuchi, S. 1965. Study on the culture of abalone, Haliotis discus hannai Ino. Peking Symp. Agricultural Sci. II, 861-878.

Morse, D.E., Hooker, N., Duncan, H. and Jensen, L. 1979. γ-amino-butyric acid, a neurotransmitter induces planktonic abalone larvae to settle and begin metamorphosis. Science 204, 407-410.

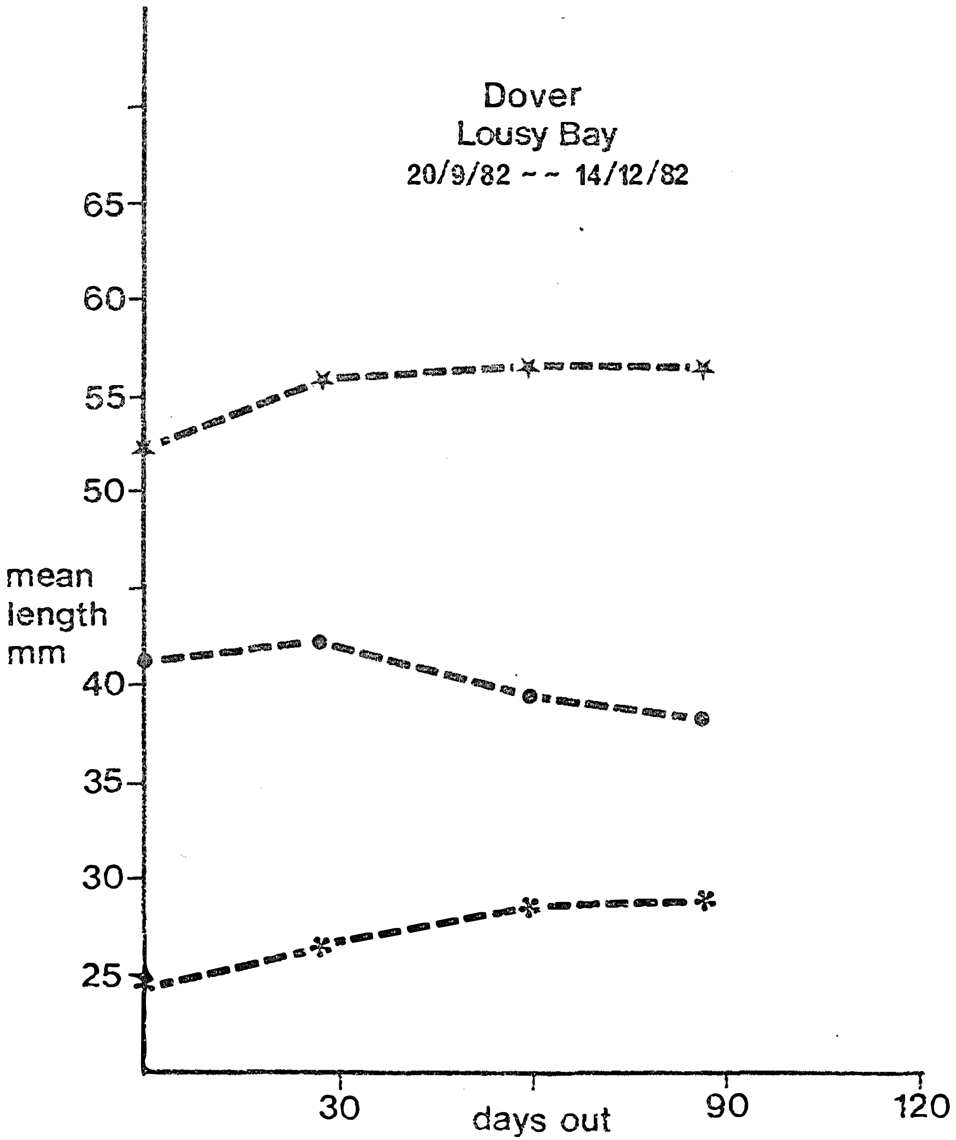
Pennec, Le M. et Prieur, D. 1977. Les antibiotics dans les elevages de larves de bivalves marines. Aquaculture 12, 15-30.

Tong, L.J. 1982. The potential for aquaculture of paua in New Zealand. Proc. Paua Fishery Workshop (Akroyd, Murray and Taylor ed.) Fisheries Research Div. Occas. Pub. No. 41, 36-40.

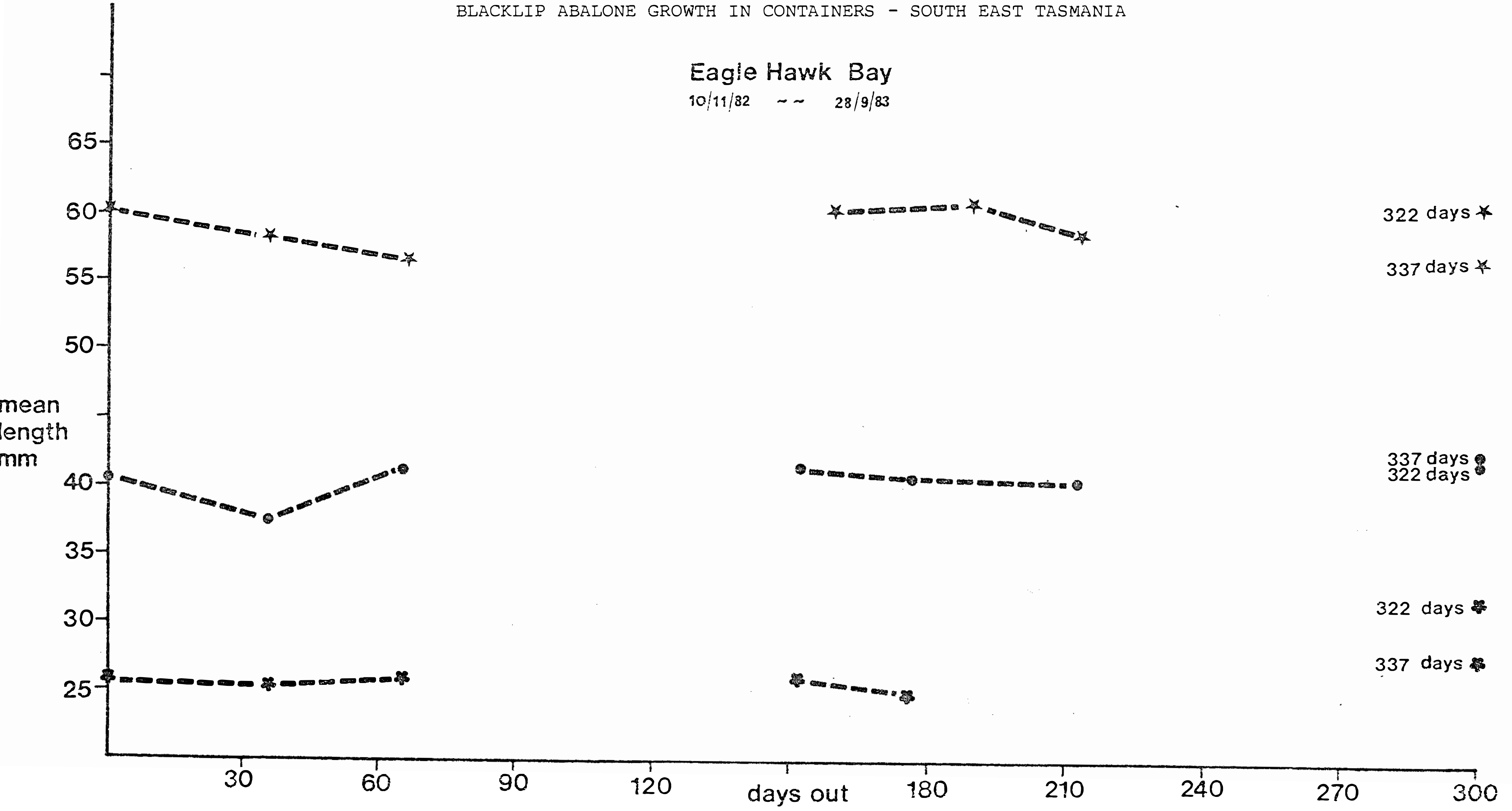
BLACKLIP ABALONE GROWTH IN CONTAINERS - SOUTH EAST TASMANIA



BLACKLIP ABALONE GROWTH IN CONTAINERS - SOUTH EAST TASMANIA



BLACKLIP ABALONE GROWTH IN CONTAINERS - SOUTH EAST TASMANIA



FIRTH 81/14C

SCALLOPS

1981/82 WORK

The 1981/82 programme proved extremely disappointing. Spat collectors could not be located before the major spatfall occurred, and 837 collectors yielded only 13 commercial (Pecten fumata) and 407 doughboy scallops (Mimachlamys asperrimus). The scallops were initially on-grown at Satellite Island (the southern end of D'Entrecasteaux Channel). Conditions proved far from ideal and mortalities were high and growth slow (Table 1). In January 1983, all scallops remaining were transferred to the Birchs Bay on-growing site.

Table 1: Scallop growth and survival at Satellite Island.

Date	Doughboys			Commercials		
	Mean Length (mm)	Number	% Survival	Mean Length (mm)	Number	% Survival
24th March, 1982	23.2	407	-	32.9	13	-
21st April, 1982	27.8	389	95.6	38.2	13	100.0
7th June, 1982	30.9	381	93.6	39.1	12	92.3
30th June, 1982	31.3	363	89.2	38.1	12	92.3
28th July, 1982	32.3	359	88.2	38.0	8	61.5
16th September, 1982	30.8	335	82.3	-	7	53.8
28th October, 1982	33.4	327	80.3	40.0	7	53.8
21st December, 1982	33.7	247	60.7	39.1	7	53.8
27th January, 1983	36.1	208	51.1	42.3	-	-
26th May, 1983	46.4	90	22.1	-	-	-

1982/83 WORK

A more intensive second year programme was initiated, and divided into three areas: Larval sampling, spat settlement and survival, and on-growing of juveniles.

Larval sampling programme

The initial aim of the project was to develop a programme to predict the date and location of maximum scallop larvae settlement. The Japanese have developed such a programme for Mutsu Bay. Monitoring the concentrations of scallop larvae in the water columm enables collectors to be placed so as to maximise spatfall (Ito et al. 1975).

Five sample stations in Great Oyster Bay and Mercury Passage Figs 1&2) were established and sampled regularly over an eleven week period beginning in early August 1982. On Onga MA6 pump (Capacity = 300 l/min mounted on the deck of a seven metre Sharkcat, and driven by a Honda generator, was used to pump water from various depths. The water was brought to the surface through a 25 mm diameter reinforced nylex hose weighted by a length of galvanised pipe above the intake. At each sampling 1,000 l of seawater was filtered through a series of sieves ranging from 63 to 250 microns, and the samples preserved and returned to the laboratory for identification (Figs. 3 & 4).

Larval identification was aided by the use of preserved cultured scallop larvae from a previous FIRTA supported programme 1974/75, (Dix & Sjardin 1975), and extensive bibliographic details of other scallop larvae (Chanley & Andrews 1971; Comely 1972; Loosanoff, Davis & Chanley 1966). Nevertheless, identification of small scallop larvae (70-95 microns) proved difficult because of their similarity to the early larval stages of many other winter spawning shellfish. In 72 samples taken regularly from the sampling stations only three commercial scallop larvae were identified

The concentration of adult scallops in Great Oyster Bay and Mercury Passage, is very low (estimated at 1/100 m^2 J.G.K. Harris pers. comm.) and is not sufficient to support a commercial fishery. In addition dredge samples of adult scallops taken during the survey period indicated erratic spawning of the stocks. Both factors are almost certainly responsible for the extremely low density of scallop larvae observed in the samples taken. It was therefore impossible to develop an accurate spat prediction programme under these circumstances.

Despite the low numbers of scallop larvae encountered the method proved very effective in sampling larval shellfish in the water column. Thousands of bivalve larvae at all developmental stages and from a variety of species (probably greater than 12) were collected in excellent condition.

Collector placement

Spat collectors (a tangle of old monofilament shark net in netlon bags (Fig. 5)) were suspended from sub-surface longlines (Fig. 6). The longlines were placed at a number of locations around the east and south-east coasts of Tasmania. An additional longline was placed off Soldiers Point in D'Entrecasteaux Channel, south of Hobart (Fig. 1 & 2).

Longlines, such as those at Buxton Point and in D'Entrecasteaux Channel, were placed in close proximity to known scallop beds. Other longlines were located according to knowledge of local currents and their influence on drifting shellfish larvae.

Two individually weighted droppers connected by a sub-surface tie line were located between two major commercial scallop beds off the east coast of Flinders Island (Fig. 1). Each line, approximately 45 m in length with 84 collectors, was weighted by an 80 kg concrete block, and marked with a dahn pole and surface buoys. A similar dropper placed at the northern end of a small commercial scallop bed in Marion Bay, south-east Tasmania was not recovered.

The collectors were attached to the lines within a two week period from late August to early September 1982. This was predicted to be close to the time of maximum settlement using information from previous studies, knowledge of the maturing condition of adult scallops in the area, and the time taken for developing larvae to metamorphose to the spat stage of the life cycle (Dix & Sjardin 1975). Collectors were placed to cover virtually all of the water column.

Spat settlement and survival

Collectors placed at Darlington were monitored regularly and used as a model for the other areas. Settlement of commercial scallops was first noted on 5th October, 1982, 28 days after collector placement. Based on subsequent work on growth rates, the scallops were probably spawned in mid-late August and settled in mid-late September.

All three scallop species (the commercial, *P. fumata*; the doughboy *M. asperrimus*; and the queen, *Equichlamys bifrons*) were found during the course of the study. Table 2 gives details of collector catches and catch rates for each sample date, and for each location.

Table 2: Scallop catch data

Site	Date Collected	Number of Collectors	Scallop Species: Commercial Number	Commercial Catch/ Collector	Doughboy Number	Queen Number
Darlington	1.11.82	19	1981	104.3	0	0
"	7.12.82	24	1227	51.1	PNR	0
"	14.12.82 } 15.12.82 }	227	6437	28.4	389	0
"	18. 2.82	238	1779	7.5	857	0
"	16. 3.83	21	107	5.1	83	0
"	19. 5.83	45	150	3.3	96	0
Johnsons Point	17. 2.83	215	2925	13.6	165	0
Buxton Point	16. 2.83	308	3	<0.1	8	0
Soldiers Point	14. 2.83	74	10	0.1	2350	37
" "	27. 4.83	84	8	0.1	3291	144
Flinders Island *	16. 3.83	127	Est 30000	Est 235	1760/ collector	0

PNR - present but not recorded.

* - figures are estimated catch rates (see text).

Previous work had shown that scallop spat detach themselves at a size of 5-7 mm and fall to the bottom to begin the final phase of the life cycle. As the stretched mesh diameter of the collectors was 8 mm, it was considered that a percentage of the settled spat could be lost. To verify this three large bags (mesh diameter 4 mm) were placed over three different collectors to retain detached spat.

Results from use of the small mesh retainer bags around conventional bags verified the self detaching hypothesis. Some 45% of the total catch was located outside the netlon collectors; these scallops were also significantly smaller than those retained within the collector.

The target species for the project was the commercial scallop, and with this in mind catch results were encouraging at both Darlington, Johnsons Point and Flinders Island. The lower February catch rate for Darlington can be explained by the loss of detached scallops combined with heavy losses due to leatherjacket predation. Large detached scallops (>8 mm) accumulated in the bottom corners of collectors, and at sizes less than about 20 mm were easy prey for the leatherjacket populations that frequented the longlines. The most common species of leatherjackets observed were the brown striped, *Meuschenia australis*, the toothbrush, *Penicipelta vittiger*, and the bridled, *Acantherluteres spilomelanurus*.

Based on November catch rates the maximum catch of scallops taken at Darlington was approximately 70,000. A similar catch rate at Johnsons Point would have meant a maximum catch of 35,000.

Scallop catches in the Flinders Island collectors were particularly noteworthy. A total of 127 of the original 168 collectors were recovered, and 48 of these were totally intact, the remainder were torn or damaged during recovery. The intact collectors yielded 69 commercial scallops per collector (range 1-344), and 568 doughboys per collector (range 1-2,440). However the total catch of both species of scallops was far greater than this.

Many scallops were lost during recovery. Following retrieval of the droppers, the collectors were held in the well of the commercial scallop boat "Petuna" but because of bad weather were not landed for a further ten days. During this period many thousands of scallops detached from the collectors, fell through the mesh and collected in the well of the boat (Neville Rockliff, skipper F.V. "Petuna", pers. comm.). A small percentage (2-5%) of the loose shell in the well of the boat was removed in an attempt to estimate the total catch. A conservative estimate of the original commercial scallop catch rate is 235 per collector, and for doughboys the estimate is 1760 per collector.

The original catch, however, may have been greater still, if loss of spat occurred at the 5-7 mm stage as at Darlington. The scallops from the Flinders dropper averaged 14 mm at recovery (98% greater than 7 mm) thus losses are already likely to have occurred, and at a 40% reduction rate catches are likely to have been double those estimated above.

Poor results at Buxton Point are due to vandalism of the longline, and detachment of the droppers.

Doughboy scallops are the dominant species in D'Entrecasteaux Channel, and predictably they also dominated settlement in the collectors. The catch rate of 36 per collector was low when compared with that for Flinders Island. It was thought that the predominant water movement pattern swept the drifting larvae away from the general area of the collectors.

Second Settlement

A second settlement of all three species was observed late in summer (Table 3). The commercial scallop settlement was observed at Darlington, with settlements of doughboy and queen scallops on the Soldiers Point line.

Based on the growth rate for first set commercial scallops, the second set scallops were probably spawned in late November and settled in mid-late December 1982. The catch rate for the second settlement was 1.3 per collector with a maximum of 32.

As the doughboy and queen scallops were a secondary part of the project, accurate spawning and settlement dates are unavailable.

Table 3: Size comparison of first and second set scallops.

Scallop Species	Commercial		Doughboy		Queen	
Settlement	1st Set	2nd Set	1st Set	2nd Set	1st Set	2nd Se
Date Observed	18 February 1983		27 April 1983		27 April 1983	
Average Size (mm)	26.5	5.4	14.6	4.3	11.8	3.9
Number (n)	381	73	190	109	104	40
Size Range (mm)	14-39	1.8 - 9.1	9 - 23	2.4 - 7.2	7.8 - 18.0	2.7 - 7

Scallop Growth within Collectors

Once the settlement of scallop spat on the Darlington collectors had been verified, regular samples were taken to assess spat growth within the collectors. Spat size at settlement (220-240 microns) has been documented by Dix and Sjardin (1975). When first observed in the collectors spat averaged 0.4 mm, and had reached 41.9 mm when the last samples were removed on 19th May (Fig. 7).

The final set of collectors were removed nearly 250 days after settlement. At this point in time the bags were heavily fouled and a complex animal community dominated by ascidians had colonised the collectors. Water movement through the collectors was poor, and many of the scallops still retained within the collectors were dead (64 out of 199 or 32%). The growth rate of the surviving scallops was excellent.

On-growing of Juveniles

Sites, Grading and Growth

Spat were on-grown in Japanese pearl nets (pyramidal nets, mesh size 6-7 mm, 35 x 35 x 15 cm) and lantern cages (cylinders with six levels, diameter 50 cm, mesh size 16 or 32 mm). Darlington was chosen as the major site for on-growing in pearl nets. In early December 1982 6,139 small scallops (average size 9.4 mm) were removed from Darlington collectors, placed in the pearl nets and returned to the longline. Numbers per pearl net varied between 250 - 300 (3:1 ratio of open space: scallop area; area of pearl net 1,225 cm^2, area of scallop approximately 1 cm^2). Growth in the pearl nets is illustrated in Fig. 8.

In February/March 1983 scallops were removed from nearly all remaining collectors, the scallops from the pearl nets graded, samples measured and placed in lantern cages and then distributed to the major sites for on-growing. Numbers per layer of each 16 mm lantern were 70 or 80 depending on size (same principle applied to pearl nets used to calculate densities). As scallops grew they were transferred to 32 mm lanterns at 35 or 45 per layer.

Sites chosen for on-growing were the deepwater site at Darlington on the east coast, and two inshore sites at Birchs Bay in D'Entrecasteaux Channel and Eaglehawk Bay on the Tasman Peninsula (Fig. 1). The inshore sites were commercial mussel and oyster farm leases, and the lantern cages were attached to buoyed, surface longlines.

Table 4 below lists the numbers of scallops by species being on-grown at each of the three sites.

Table 4. Scallop distribution at on-growing sites

Site	Scallop Species		
	Commercial	Doughboy	Queen
Darlington	4,823	-	-
Birchs Bay	2,705	664	35
Eaglehawk Bay	3,464	640	105
TOTAL:	10,992	1,304	140

Early figures on growth rates at Darlington have been very encouraging with rates of 1.5 - 2mm per week being recorded for some cages (Fig. 8). Growth at the other sites has not been as good, averaging a little less than 1 mm per week.

Survival

Survival of the commercial scallops at all three sites has been extremely good. At Darlington survival for the period 18th February - 19th May, 1983, was 98.9%. Survival for similar time periods at Birchs Bay and Eaglehawk Bay has been 94% and 91% respectively.

The problem of biological fouling has already appeared at the two inshore sites. Oysters, mussels, mock oysters, tubeworms and hydroids have all been observed, with tubeworms being particularly prevalent. Algal fouling of the lantern cages is evident at both these sites but, as yet, is not a major problem. In contrast the deepwater site at Darlington has proved virtually free of all forms of fouling to date.

Growth, survival and observations relative to the success of commercial scallop culture for each on-growing site will be monitored until June 1984, as part of the 1983/84 FIRTA grant.

Gluing Trials

The capital cost of Japanese lantern cages at current prices, may mean that commercial scallop farmers would be unable to compete with scallops landed from the natural fishery. Dix (1981) mentioned the possibility of attaching vertically orientated scallops by adhesive to suspended tapes. If proved effective this method could considerably reduce costs, and would also reduce the need for handling live scallops.

With the above in mind trials were initiated to assess the suitability of different types of glue for attaching scallops to tapes for on-growing. Twelve different glues and cements were trialed on two tape surfaces - vinyl and polypropylene. The requirements were for a glue that set rapidly on a damp surface, hardened under water, was relatively cheap and had a reasonably long working life, e.g. 30 - 60 minutes. The only glues that formed a strong bond were Araldite and Loctite Superglue. However, both glues are relatively expensive and have a limited working life. Commercially available glue guns and hot melt glues were all found to be unsuitable.

The potential importance of a successful trial in reducing costs of culture cannot be overstated. Gluing trials will, therefore, continue to be pursued on an ad hoc basis for the remainder of the project. It is noted that the doughboy scallop M. asperrimus produces significant quantities of its own natural glue. It may be that further investigation of this natural product could lead to the artificial synthesis of a suitable glue.

On-growing Site Assessment - Use of Doty Block

Doty blocks proved invaluable in giving an indication of relative water movement inside and outside collectors, pearl nets and lantern cages. For this reason they proved invaluable as an aid to the assessment of site suitability for on-growing (Doty 1971, Dawes et al. 1974, Santelices 1977).

The blocks are Plaster of Paris moulds of known weight. Several blocks were placed at each site, both inside and outside the on-growing cages for a period of 24 hours. The amount of dissolution in the field was assessed by comparing initial and final dry weights. Control blocks were placed in still seawater from the site being tested. Percentage weight loss (diffusion factor) provided a quantitative assessment of water movement various locations within one site.

Further trials are continuing, but preliminary results suggest the blocks will be very effective as general aquaculture site indicators. More specifically they will provide quantitative indications of water movement, and assist assessment of productive versus unproductive areas.

COST ANALYSIS OF COMMERCIAL SCALLOP CULTURE

At the conclusion of the study a complete cost break-down of all aspects of the project will enable an assessment of the commercial feasibility of scallop culture. With this in mind details have been recorded outlining the time taken for planning and construction, the specifications of materials used and the cost of all materials.

DISPLAY BOARDS

The success of the project was in part due to the co-operation of commercial fishermen from throughout Tasmania. At the conclusion of the major spat collection two display boards illustrating aspects of the project were constructed and are now displayed in Fisheries offices in Hobart and Swansea, and at the Research Laboratory, Taroona. The boards have created great interest amongst fishermen, and information exchange and transfer of technology has been greatly assisted by their preparation and distribution.

Each board measures 90 x 60 cm, and has sections on larval sampling and identification, spat settlement and collection, and on-growing. A further feature of the display is a set of colour prints depicting some of the underwater observations. A set of these prints is included as part of the final report.

APPLICATIONS OF CURRENT WORK

Techniques and gear developed for the scallop project have several applications for future work. Sub-surface longlines have proved highly effective in extremely rough sea conditions. Proper setting of the lines makes them extremely stable even in areas of heavy surge and strong tidal currents. They can also be used in areas frequented by large numbers of small vessels. Set two to three metres below the surface and marked by a surface buoy and dahn pole, they provide little or no hazard to navigation.

The success of the collectors in providing an artificial substrate for the spat to settle on has already proved beneficial. Doughboy scallop larvae, produced in a preliminary trial for a joint T.F.D.A. -

W.A. Fisheries and Wildlife Pearl Oyster Culture Project (FIRTA 1982/83), were set on these collectors held in a 5,000 l larvae bin at the Taroona laboratory. Ten collectors yielded an average catch of 5,000 spat per collector. This has led to a successful T.F.D.A. - FIRTA grant to investigate the feasibility of production of commercial scallops at the Shellfish Culture oyster hatchery at Bicheno.

If this technique proves successful and economical the production of large numbers of juvenile scallops for reseeding depleted commercial stocks, and subsequent sea ranching of these areas becomes a possibility. High natural settlements, such as that obtained on the Flinders Island dropper, may also lead to restocking of inshore fisheries.

The settlement on the Flinders Island dropper has demonstrated a natural spawning in the area for 1982. More intensive collections using strategically located droppers could provide an early estimate of the success of future spawnings. Follow up surveys either by dredging or diving, could then provide estimates of recruitment to the population (McShane 1982, 1983). Predictability of future yields from commercial beds and more efficient management techniques to help protect developing juvenile beds will only benefit the industry.

A 1983/84 FIRTA grant (Port Phillip Bay Scallop Research) is already planning trials using the above technique. Discussions have already been held with scientific personnel engaged in that project, and exchange of advances in techniques and results achieved will continue in the coming year.

Finally, the development of Doty blocks as an aid to mariculture site evaluation has already proved successful. Further trials are needed to refine the system, but the blocks will almost certainly assist any prospective fish or shellfish farmer in site assessment.

PROJECT SUMMARY

The project saw a successful catch of scallop spat in the spring of 1982. It is estimated that more than 100,000 commercial scallop larvae settled on East Coast collectors. Regular sampling provided information on settlement rates and growth and survival of spat.

Some 11,000 commercial scallops are being on-grown at three sites, and preliminary indications are that both growth and survival are higher than recorded in previous work.

An attempt to develop a spat prediction programme was unsuccessful because of low numbers of adult scallops in Great Oyster Bay, and erratic spawning of those scallops present.

Work continuing includes regular monitoring of growth and survival in lantern cages, development of on-growing systems more suited to the commercial scallop (all work to date has been based on Japanese systems applicable to their native scallop) and further development of techniques already successfully applied during the course of the scallop project.

References

Chanley, P. and Andrews, J.D. 1971. Aids for identification of bivalve larvae of Virginia. Malacologia 11: 45-119.

Comely, C.A. 1972. Larval culture of the commercial scallop. Pecten maximus (L). J. Cons. Int. Explor. Mer. 34: 365-378.

Dawes, C.J., Mathieson, A.C., and Cheney, D.P. 1974. Ecological studies of floridian Euchema (Rhodophyta, Gigartinales) I. Seasonal growth and reproduction. Bull. Mar. Sci. 24: 235-273.

Dix, T.G. 1981. Preliminary experiments in commercial scallop (Pecten meridionalis) culture in Tasmania. Tas. Fish. Res. 23: 18-24.

Dix, T.G. and Sjardin, M.J. 1975. Larvae of the commercial scallop (Pecten meridionalis) from Tasmania, Australia. Aust. J. Mar. Freshwater Res. 26: 109-112.

Doty, M.S. 1971. Measurement of water movement in reference to benthic algal growth. Botanica Marina 14: 32-35.

Ito, S., Kanno, H., and Takahashi, K. 1975. Some problems on culture of the scallop in Mutsu Bay. Bull. Mar. Biol. Stat. Asamushi 15(2) 89-100.

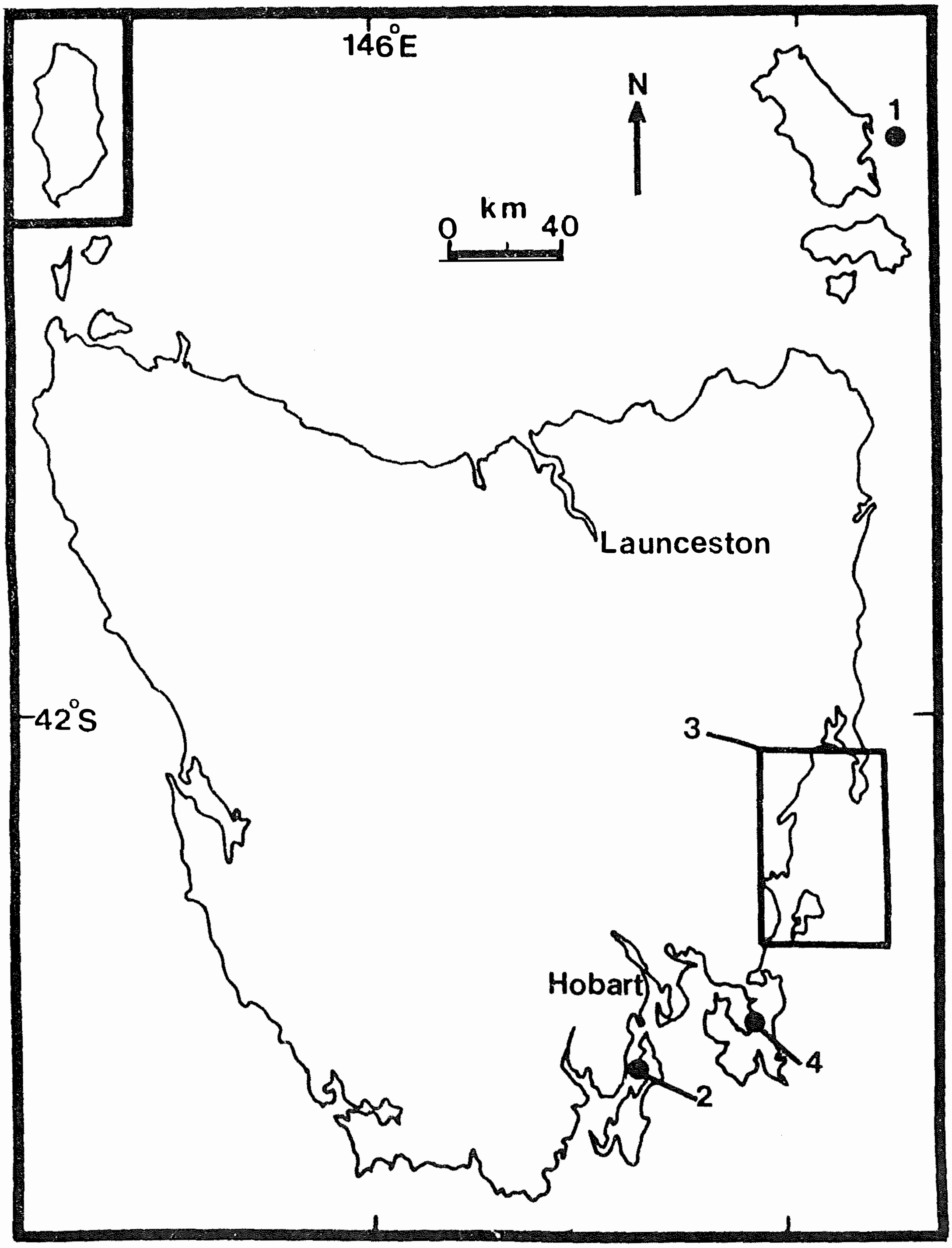
Loosanoff, V.L., Davis, H.C. and Chanley, P.E. 1966. Dimensions and shapes of larvae of some marine bivalve molluscs. Malacol. Int. J. Malacol. 4: 351-435.

Santelices, B. 1977. Water movement and seasonal algal growth in Hawaii. Mar. Biol. 43: 225-235.

McShane, P.E. 1982. A comparison of dredge and dive surveys of scallop populations in Port Phillip Bay, Victoria. Marine Science Laboratory, Queenscliff, Technical Report No. 10.

McShane, P.E. 1983. Port Phillip Bay scallop population assessment - January 1983. Marine Science Laboratory, Queenscliff, Technical Report No. 26.

Fig. 1. Location of major study site and on-growing locations in eastern and south-eastern Tasmania. (1) Flinders Island, (2) Soldiers Point - Birches Bay, (3) Great Oyster Bay - Mercury Passage, (4) Eaglehawk Bay.



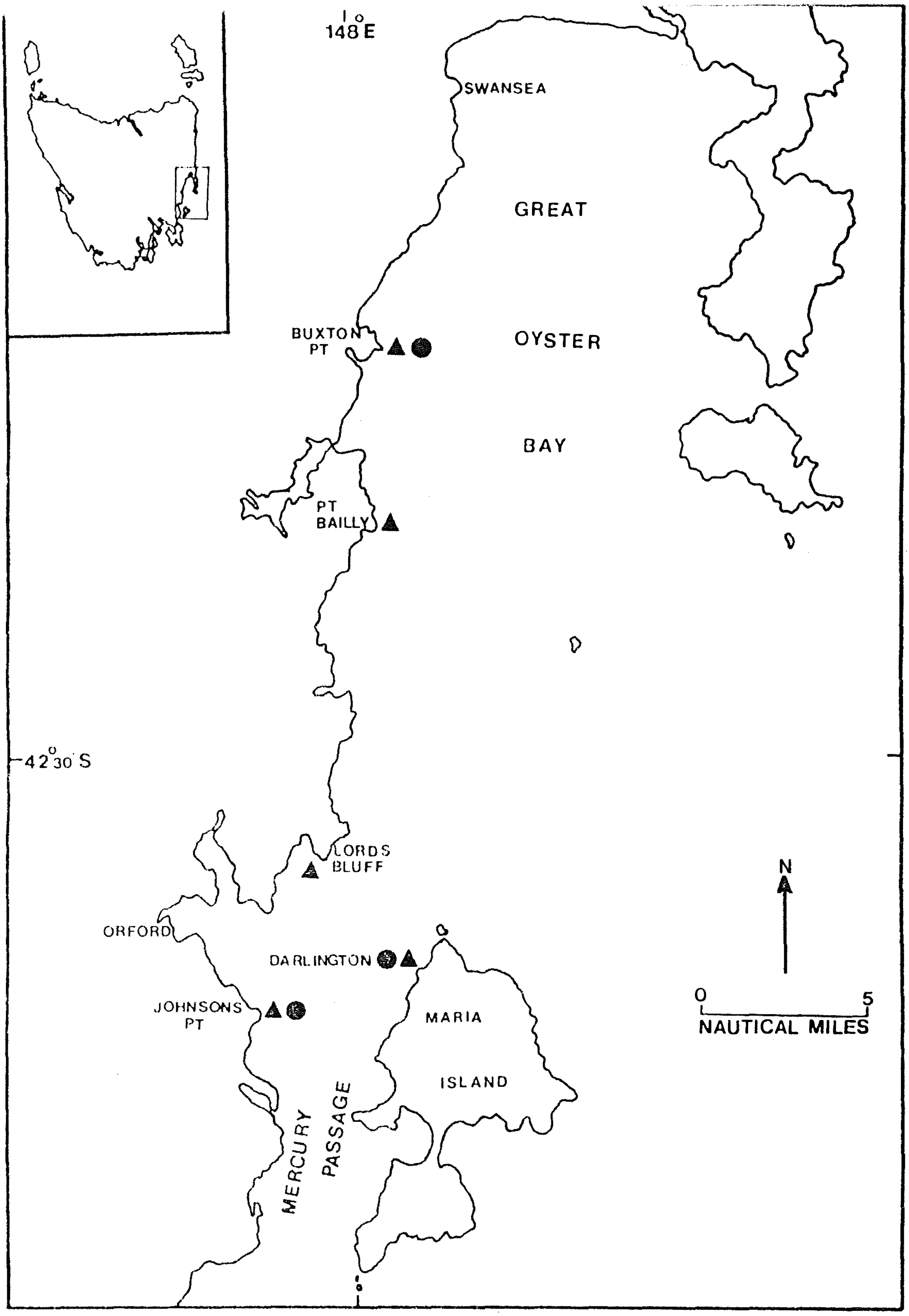


Fig 2. Location of longlines (●) and larvae sampling stations (▲) on Tasmanian East Coast.

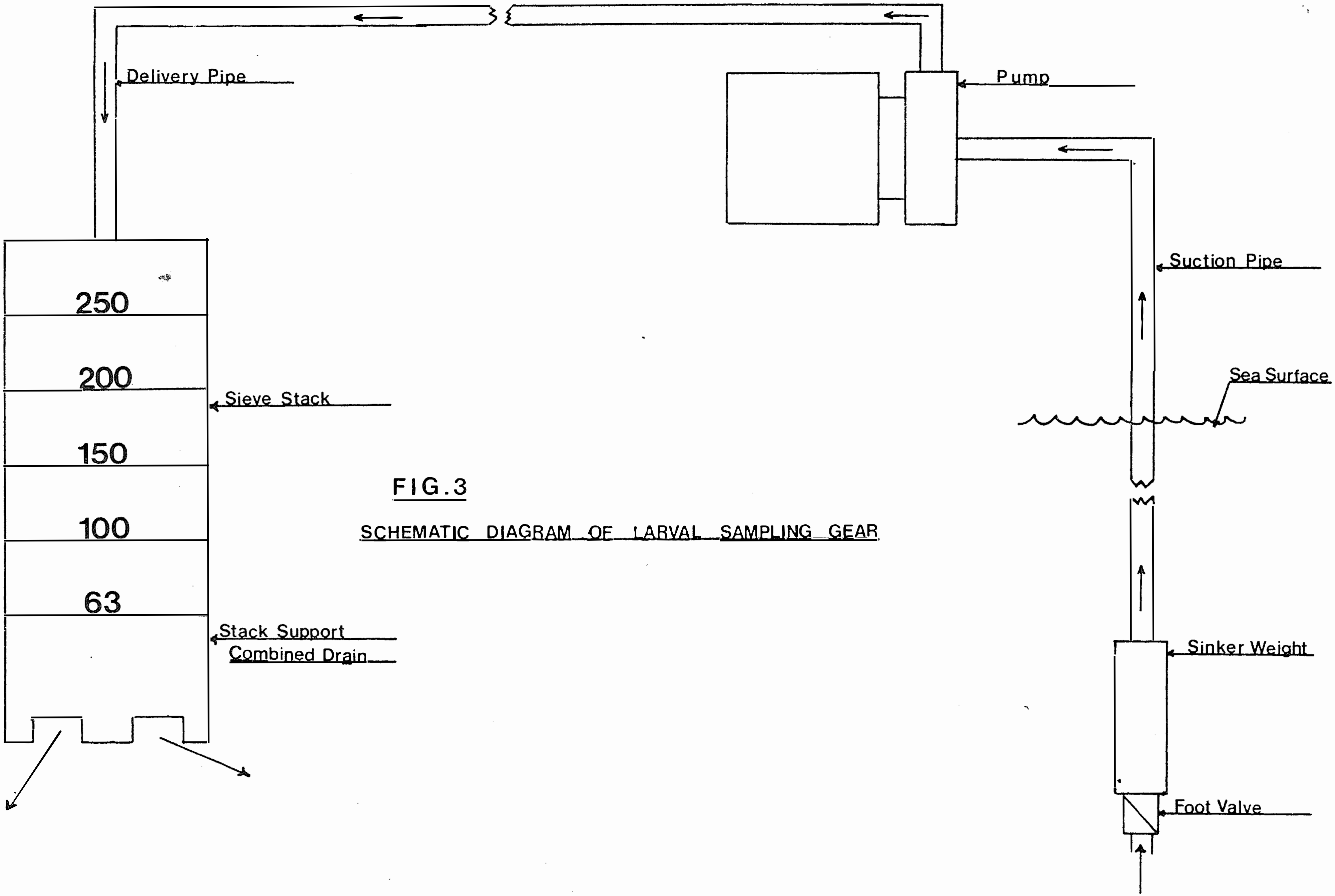


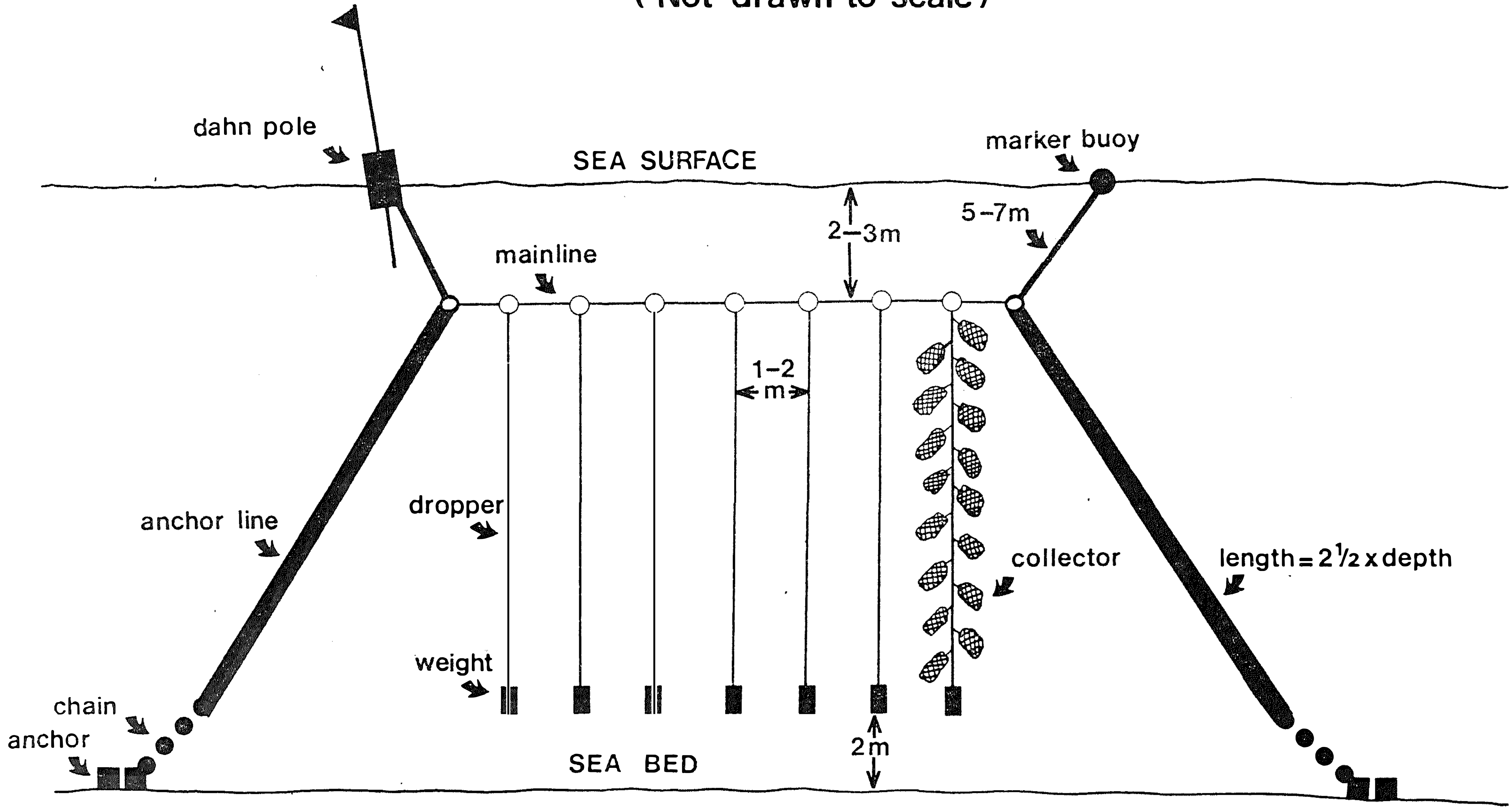
FIG.3

SCHEMATIC DIAGRAM OF LARVAL SAMPLING GEAR

FIG.6

SUB–SURFACE LONGLINE DESIGN

(Not drawn to scale)



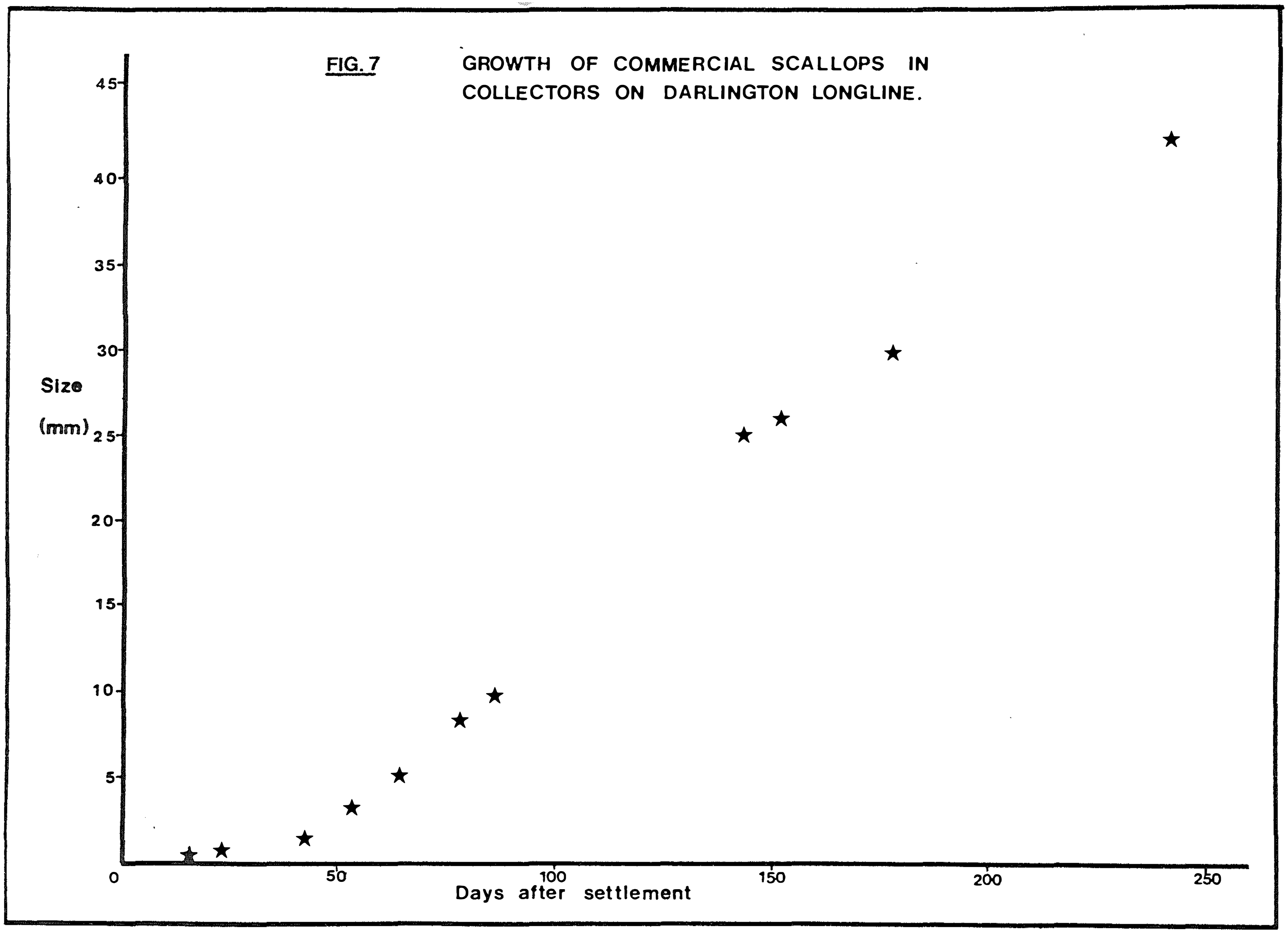


FIG. 7
GROWTH OF COMMERCIAL SCALLOPS IN COLLECTORS ON DARLINGTON LONGLINE.
Size (mm)
45
40
35
30
25
20
15
10
5
0
50
100
150
200
250
Days after settlement

FIG. 8 GROWTH OF COMMERCIAL SCALLOPS AT ON-GROWING SITES IN SOUTHEAST TASMANIA