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Progress in Mass Culture of *Chlamys (Argopecten) purpurata* Lamarck (1819) with Notes on its Natural History

Avances en el cultivo masivo de *Chlamys (Argopecten) purpurata* (Lamarck 1819) y notas sobre su Historia Natural

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ABSTRACT

The scallop of the northern Chilean coast has an interesting potential for mass culture under managed conditions. It is near reproductive condition all year within its natural habitat and can be readily conditioned and spawned artificially. Established hatchery technology was effective in producing several broods of larvae, one of which produced set and rate of survival approaching commercial proportions. Representatives of an early brood reached commercial size of 8-9 cm length in one year using Japanese growout technology.

Key words: Scallop culture, *Chlamys (Argopecten) purpurata.*

RESUMEN

El ostión de la costa norte de Chile presenta interesantes perspectivas de cultivos masivos en condiciones controladas. Por una parte, su permanente estado reproductivo a través de todo el año facilitó su acondicionamiento y desove estimulado y, por otro, las técnicas establecidas en el desove y desarrollo también probaron ser efectivas y permitieron la producción de volúmenes importantes de agrupaciones larvales. Una de estas agrupaciones, luego de fijarse, demostró una sobrevivencia que se aproxima a los volúmenes comerciales y los ejemplares alcanzaron tallas de 8-9 cm de longitud en un año, mediante el uso, en el mar, de tecnologías japonesas.

Palabras claves: Cultivo de ostiones, *Chlamys (Argopecten) purpurata.*

INTRODUCTION

Chlamys (Argopecten) purpurata Lamarck, 1819 (Grau 1959), named as *Argopecten purpuratus* by Waller (1969), is the only scallop species inhabiting the northern coast of Chile, and is a highly valued seafood in this country. Because of the limited supply and constant demand for this scallop, it was of interest to study the feasibility of its mass culture using established bivalve culture techniques. Only a few data are available on the biology of this species, most of which have been found in unpublished progress reports. The aim of the present report is to summarize the few data so far available and to present the results of our progress in culture of this scallop from egg to commercial size.

Distribution

Chlamys purpurata has been reported from the South American west coast from 30° S to Peru (Grau 1959, Marincovich 1973). It is the only living remnant of a suite of five scallop species represented in Pliocene fossil beds of the Coquimbo region (Herm 1969). Owing to its requirement for semiprotected embayments with sedimentary substrates, populations are found discontinuously, since such embayments are uncommon along this coast. Scallop banks occur in embayments

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off the cities of Valparaíso, Coquimbo, Caldera, Antofagasta, Iquique and Arica. One of the authors (E.A.) has found this species in the Gulf of Arauco (37° S), representing the southernmost reporting of its range. The temperature in the middle of its distributional range varies slightly on a seasonal basis, from summer highs of about 18° C, to winter lows near 12° C, governed primarily by oceanic currents. According to population estimates made by SERPLAC (Región IV, unpub. data) individuals in known banks number in the few millions. As well known for the *Pectinidae*, population densities are subject to extreme annual variation. External pressure on population densities includes extraction by artesanal fishermen, sometimes carried out illegally during legal periods of protection of this species. Natural disasters may also affect population densities. A mass stranding of thousands of scallops occurred in Tongoy Bay in February, 1983, apparently due to the unusual wind and wave conditions experienced that year.

Chlamys purpurata is usually found between 15 and 30 m of depth, rarely going down to depths of 40 m. A survey in Tongoy Bay (30°15'S) revealed that scallops prefer coarse sand habitats with water currents of 2-4 cm sec^{-1}, forming under these conditions population densities between 0.2 - 2.4 individuals m^{-2} (SERPLAC, unpublished data). In Herradura Bay (30° S) the present authors have observed scallops on various types of sediments, ranging from muddy sand to coarse sand and cobble, at depths from 2 to 15 m. Individuals normally inhabit small depressions made by themselves in the substrate, where they attach themselves by byssal threads which they are capable of producing throughout their life span. Although there are no data available on longevity, this species is potentially long-lived, which may be concluded from the large individuals sometines obtained in Northern Chile (180 mm in length and 160 mm in height).

Commercial length of these scallops is 8-9 cm, which represents the major population mode in the natural banks in Northern Chile (SERPLAC, unpublished data). Scallops with a mean shell length of 9.5 cm possess adductor muscles with a mean weight of 11 g (90 muscles kg^{-1}; S. Akaboshi, unpublished). In Chile, adductor muscles are sold with gonads attached. The fact that the gonads are ripe throughout the year allows commercialization of the species regardless of season.

Reproduction

Chlamys purpurata is a functional hermaphrodite. The present authors have observed gonadal material in specimens as small as 13 mm in length. From this length onward, well developed gonads can be found the year round. Completely spawned individuals are seldom found in the field. Hogg (1977)[1] reported flaccid individuals in November 1976 and March 1977 (30° S), while the present authors observed such specimens in October 1980, and January, April, and July 1981 (30° S). S. Akaboshi (unpublished data) observed natural spawnings in Tongoy Bay in November, 1981 and April 1982.

Histological studies have shown that a significant percentage of individuals contain mature gametes throughout the year. Evacuated regions of the gonads are continuously replaced with new waves of gametic development (Brown and Guerra 1980)[2]. Rapid recovery of gonads after release of gametes was recorded for local specimens (30° S), with replacement of gametes as rapid as one month after evacuation (Brown and Guerra 1980)[2]. The same authors concluded that maturation of the gonad was directly dependent on food availability.

Little is known about dispersion patterns, planktonic life history, and favored setting substrates. Hogg (1977)[1] reported scallop set in the algae *Rhodymenia* sp. in Herradura Bay. Divers of the Coquimbo laboratory have rarely seen aggregations of very small scallops during many years of field work. The present authors have isolated a few small juveniles from outcrops of *Bugula* spp. in Herradura and Tongoy Bays; spat have been captured in Japanese

1 HOGG D (1977) Natural history of the Northern Chilean scallop. Progress. Report. Universidad del Norte, Coquimbo, Chile.

2 BROWN D & R GUERRA (1980) Recuperación gonadal en "ostión" *Chlamys (Argopecten) purpurata* (Lamarck, 1819) luego de evacuación de gametos. Archivos de Biología y Medicina Experimental (Chile) 13: 363. (Resumen).

"onion bag" collectors suspended in Tongoy Bay at depths between 3 and 20 m (S. Akaboshi, unpublished data).

Hogg (1977)[1] produced larvae of 230 μm after a period of 40 days in culture at 14-16°C, with the larvae never reaching metamorphosis. Padilla (1979) was able to condition and spawn adults in the laboratory, inducing spawning by rapid lowering of water temperature. Padilla (1979) cultured larvae for 36 days at 18°C, and observed a high rate of mortality; only 40 of 400,000 larvae reached the postlarval stage.

The present report presents data derived from five cultures (**I-V**) carried out from late 1981 through 1982. Four of these cultures produced postlarval scallops which were reared to larger sizes with variable success. Supplementary data from incomplete cultures or related experiments have been included where relevant.

MATERIALS AND METHODS

Brood Stock and Spawning

Adult scallops with turgid, well colored gonads were available at all times of the year in the waters of Herradura Bay adjacent to the Coquimbo laboratory. Visual criteria were insufficient to judge if any given specimen was ready to release gametes or not and it was found that although some specimens could be spawned immediately when brought from the Bay, the majority required a few days of conditioning in running seawater. This was effected by maintenance of 10-15 specimens per m^2 tank space in a flow of 5-10 l min^{-1} of Bay surface water, seasonally varying between 13° and 20°C. Attempts to recondition spent scallops were made by dosing inflowing seawater dropwise with dense cultures of mixed microalgae produced in outdoor tanks.

Although *C. purpurata* responded positively to a variety of spawning stimuli, the present data are based only on spawnings induced by exposing conditioned scallops to high concentrations of cultured microalgae (Breese and Robinson 1981). Routinely, 5-10 specimens were taken from conditioning tanks, cleaned of surface encrustation, and placed in seawater containing 1-2 million cells/ml^{-1} of either *Pavlova lutheri* (MONO) or *Pseudoisochrysis sp.* (VA - 12). Seawater for collection of gametes, rearing of larvae, and maintenance of postlarvae was pre-filtered to 10 μm through sand and then synthetic fiber bag filters (GAF Corp.) and finally filtered to 1 μm using AMF Corp. "CUNO" cartridge filters. The water was then passed through a REFCO Co. model RL-10 UV water treatment unit. At spawning, scallops were rinsed in clean seawater and deposited individually in plastic buckets containing 2-3 liters seawater. Spawning behavior was monitored and gametes were collected separately so as to avoid premature mixing of sperm and eggs. Fertilization and larval rearing were carried out using established methods (Costello et al. 1973, Breese and Malouf 1975). Eggs collected from individual specimens were placed in 10 l of seawater and fertilized by addition of a dense sperm suspension, to give a final concentration of approximately 5 - 10 sperm per egg, verified by microscopy. After one hour, the fertilized eggs were placed directly into culture water in epoxy coated fibreglass or plywood tanks of 100 or 200 l capacity. Seawater was heated when required using a NESLAB Co. model SWHX heat exchanger, and temperature of culture was maintained to within ± 2°C using space heating.

Larval Rearing

Upon development of straight hinge larvae, feeding was begun starting with daily addition of 20,000 cells of MONO or VA - 12 ml^{-1} of culture water. Food ration was increased periodically to meet the needs of the larvae as determined by their growth rate and clearance of the algae from the water. Advanced larvae received up to 70,000 cells ml^{-1} once in the morning and once in the evening. Algae were cultured using the methods detailed by Breese and Malouf (1975), modified within the limitations of our facilities. Progress in larval growth was monitored daily using a Zeiss adjustable ocular micrometer. During and after metamorphosis, food additions were further increased, and in some instances "cultured water" similar to that produced by Castagna (1975) was used to supplement our algae production which often fell below the demands of the spat. Spat placed in out-

door tables received a flow of sand filtered seawater at 5 - 10 l min^{-1}.

Larval densities varied between cultures, initially ranging from 50 to 100 larvae ml^{-1}. Densities were reduced to 1 to 5 larvae ml^{-1} nearing metamorphosis by dilution, or by screening them off on appropriate nylon screen (Nytex Co.) so as to discard slow growing or deformed larvae. About one third of the water volume was changed daily, and every third day the larvae were screened off and rinsed in clean water while culture tanks were cleaned. In cases where bacterial infection was suspected, chloramphenicol was added to the culture water at a dosage level of 25 mg l^{-1}.

Metamorphosis and setting were allowed to proceed in the culture tanks, and postlarvae were removed from tank surfaces using a soft paintbrush and collected by siphoning; transfers were made as rapidly as possible, because the spat re-attached quickly.

Intermediate Rearing and Growout

Culture I: Postlarvae were maintained in the laboratory until reaching 0.85 mm and were then set on scallop shell and maintained in running seawater with no supplementary feeding. At about 4 mm they were transferred to trays which were screened top and bottom with 1 mm mesh Nytex and hung in Herradura Bay at a depth of 3 m. At a size of 5-6 mm in shell length, they were transferred to Japanese pearl nets (Ise Shyokai Co., 35 x 35 cm base; 4 mm mesh).

Culture II: Postlarvae were transferred to running seawater tables at a density of 50 cm^{-2} where observations were made on behavior and early growth with some intermittent supplemental feeding. Subgroups of these were transferred to the Bay on different occasions in 1 mm screened trays. These scallops were graduated to pearl nets as they reached the 5 mm size and were suspended in the Bay.

Culture III: About 1 million spat were set in pearl nets loosely packed with plastic mesh screening (Netlon) commonly used in Japanesse spat collectors. Spat at about 0.8 mm were transferred from laboratory rearing tanks and repeatedly poured over (submerged) pearl nets until they attached to the Netlon. About one million spat were distributed as evenly as possible among 50 pearl nets. A group of pearl nets loosely packed with the locally common rhodophycean alga *Gracilaria* sp., was set with spat in the same manner. A further group of 8000 of these spat reared in the laboratory to 3 mm were placed in the Bay in a tray system. The pearl nets were hung from a longline arranged just below the bay surface to 5 meters depth near the laboratory pier, and the tray cultures were suspended from the pier at 3 meters depth. Progress of the spat in the pearl nets was routinely checked, and after about two months the pearl nets were brought to the laboratory for harvesting of juvenile scallops. Juveniles were returned to the Bay in various growout systems which are currently being monitored.

Culture V: About 200,000 spat successfully raised to the 2.5 mm size, were placed in the Bay in tray system in order to duplicate tray results obtained with Culture III. These died unexpectedly in a few days possibly as the result of blasting and dredging in the Bay at a distance of about 500 m.

RESULTS

Brood Stock and Spawning

Adults of this species proved to be hardy in the laboratory and could be kept for months in seawater tables with no apparent ill effects. Supplementary feeding with mixed algae cultures aided maturation of the gonads in spent scallops and produced rapid shell growth. In a midwinter test at 13°C, ten spent scallops replaced gonadal material and were spawned again in four weeks. Little gonadal recovery and shell growth occurred in a control group which was not fed. Under summer conditions at 18-20°C recovery occurred in about the same time.

Scallops spawned within 1 - 2 h using the high algal density method. In some cases where scallops failed to spawn, they filtered the water free of algae during the first half hour of treatment. Conversely, failure to clear the water could be taken as a good indication that spawning would occur.

Release of gametes was usually, though not always protandrous. Sperm were released with little shell movement over periods ranging from 20 min to one hour.

Following a resting period of 5 - 10 min, eggs were released over a 10 - 20 min period accompanied by forceful closure of the valves. Scallops of 9 - 12 cm in length released 7 - 9 million eggs each per spawning. Spawned individuals were observed among a group of small cultured scallops (5 months of age) which had been brought in from the Bay for measurement. Of a group of 10 of these, five individuals ranging in length from 21 to 27 mm could be induced to spawn, releasing 4 to 30 x 10^4 eggs each.

In two cultures which failed to produce complete larval development (undocumented in this report), eggs averaged 60 and 62 μm. These eggs were significantly smaller ($P = 0.05$) than those which were produced in successful cultures (Table 1).

Larval Rearing

The majority of eggs showed evidence of fertilization within one hour, as noted by extrusion of polar bodies, with cleavage beginning within one hour after fertilization. Straight hinge veligers were produced in 24 - 48 h depending on temperature (Table 1). Maximum temperature for

TABLE 1

Summarized data from five cultures of *Chlamys (Argopecten) purpurata.*

Datos resumidos de cinco cultivos larvales de *Chlamys (Argopecten) purpurata*

Culture no.	Date of Initiation	T (°C)	Egg size (μm)	AGES AND SIZES OF LARVAE					
				Straight hinge		Eyed larvae		At metamorphosis	
				(h)	(μm)	(d)	(μm)	(d)**	(μm)
I	7 Sep 81	19	—	48	102 ± 2	14	208	15	241
II	26 Jan 82	23-25	—	24	—	9	220	10	224
III	18 May 82	21-22	64 ± 1	36	104 ± 2	10	214	12	231
IV*	12 Aug 82	18-20	64 ± 2	48	92 ± 3	–	–	–	–
V	29 Sept 82	20-22	65 ± 2	24	94 ± 4	12	216	14	231

* Lost mid culture due to infection.
** First observed.

culture appeared to be 25°C; two culture attempts at 26 - 28°C failed for no other apparent reason than excessive temperature. Larvae grew at rates between 11 and 16 μm day^{-1} (Fig. 1, 2). Weakly defined umbones began to appear at about 140 μm length, with eyespot and foot developing at somewhat over 200 μm length. As larvae approached the 200 μm size they settled from the water column, and swam along the bottoms of the tanks. Some larvae metamorphosed as small as 224 μm length, though the majority metamorphosed at about 240 μm. The velum was lost in parts, with flagellar tufts being lost in groups of 2, 4, 6 or more, with a basal portion attached (Fig. 3). At metamorphosis larvae could be observed with the mantle cavity full of these velar fragments which retained motility in the culture for hours after release and gave the appearance of outsized free living flagellates. The remnant of the velum (Fig. 4) was resorbed in a few hours as metamorphosis progressed. Disparity in larval size resulted in a prolonged period of metamorphosis lasting 4 - 5 days as larvae reached setting size. Under optimal conditions a high percentage of larvae metamorphosed with low mortality. For example, in Culture II (Table 2), 3 million postlarvae were produced without mass mortality at metamorphosis. However, in Culture II large numbers of larvae remained small, failed to continue development, and died apparently due to infection. Successful sets were produced with 5 larvae ml^{-1}, although at this density there was high risk of bacterial infection. In Culture V, one of three replicate tanks containing 3 larvae ml^{-1} was lost due to bacterial infection while two adjacent tanks treated with chloramphenicol proceeded through metamorphosis with small losses.

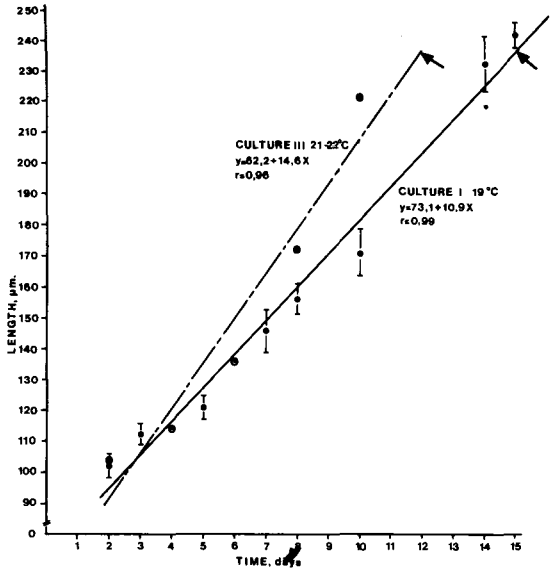

Fig. 1: Growth rates of two larval cultures of *C. purpurata* at different temperatures. Curves represent calculated regression lines given by the equations included. Each data point is a mean value representing measurement of 20 larvae. Where not included, standard deviation was less than ± 3 µm. Arrow indicates initiation of setting.

Crecimiento de dos cultivos de larvas de *C. purpurata*, a diferentes temperaturas. Cada punto representa el promedio de 20 mediciones con su correspondiente desviación estándar, excepto cuando ésta fue inferior a 3 µm. Las flechas indican la iniciación de la etapa de fijación larval.

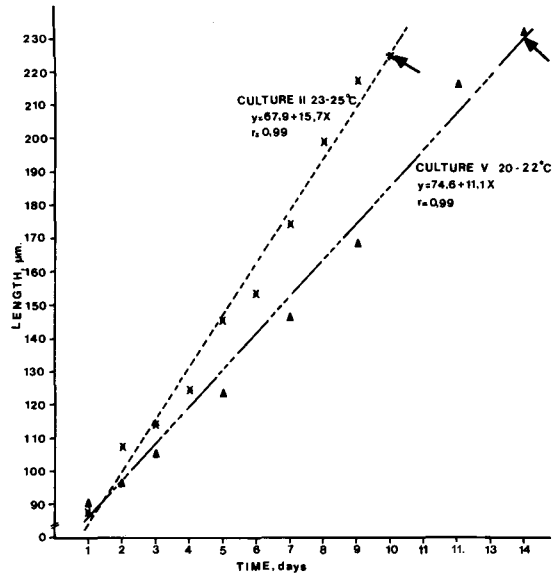

Fig. 2: Growth rates of two larval cultures of *C. purpurata* at different temperatures. Curves represent calculated regression lines given by the equations included. Each data point is a mean value representing measurement of 20 larvae. Standard deviations were less than ± 3 µm. Arrow indicates initiation of setting.

Crecimiento de dos cultivos de larvas de *C. purpurata*, a diferentes temperaturas. Cada punto representa el promedio de 20 mediciones, sin incluir la desviación estándar (± 3 µm). Las flechas indican la iniciación de la etapa de fijación larval.

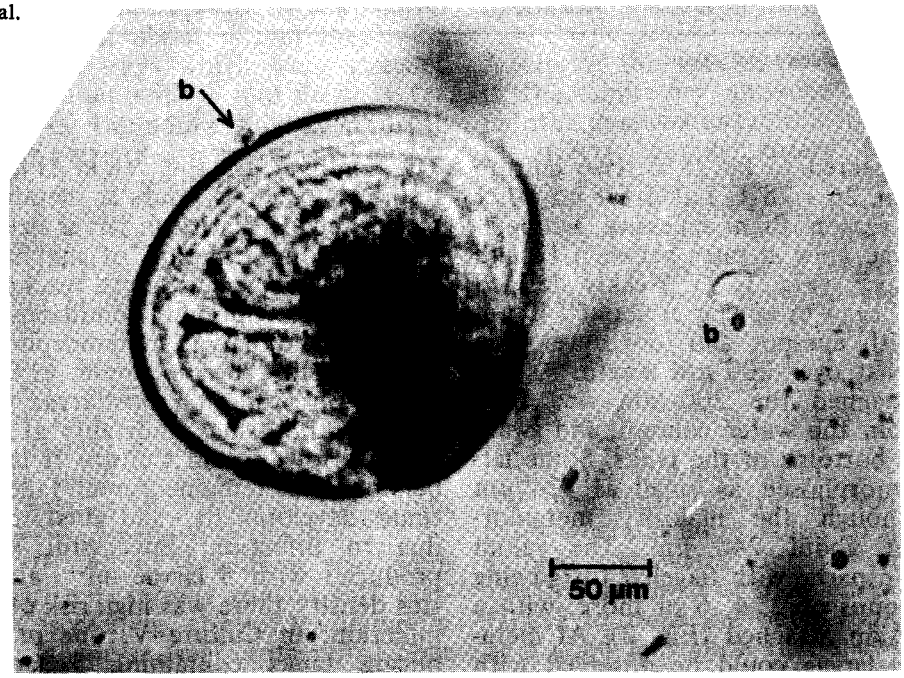

Fig. 3: Larva of *C. purpurata* in metamorphosis, showing escape (loss) of velar flagellae attached to basal body (b).

Larva de *C. purpurata* en metamorfosis, mostrando la pérdida de flagelos velares unidos al cuerpo basal (b).

Postlarvae preferred to set on horizontal surfaces. Although capable of active movement by using foot and byssal attachment, once set they moved only in readjustment to crowding or toxic materials (e. g. a copper nail), spacing themselves uniformly. Observation in aquaria containing naturally derived algae growth offered as substrate, suggested that the spat remained fixed where deposited, and did not actively climb *Enteromorpha* sp. or *Polysiphonia* sp. Spat on Netlon bags tended to drop to the bottoms of aquaria when held for several weeks in flowing water. Postlarval growth ranged from 33 to 65 μm day^{-1} (Fig. 5), with plicate stage beginning at about 1 mm. Ctenolium, ocelli, tentacles, and shell coloration began to appear at 1.0 to 1.5 mm in length.

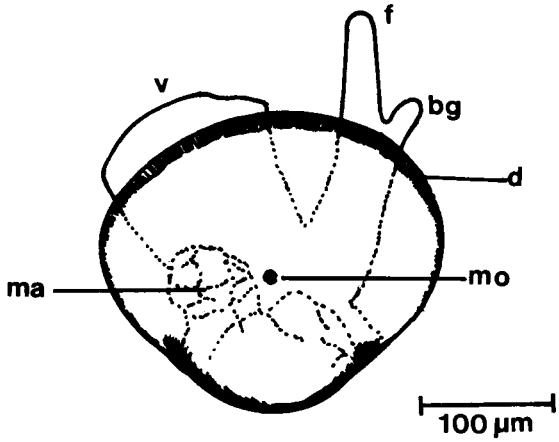

Fig. 4: Diagrammatic representation of larva of *C. purpurata* after loss of velar flagellae leaving base of the velum (v). Legend: f = foot, b = byssal gland, ma = position of adductor muscle, mo = eyespot, d = early dissoconch.

Esquema de una larva de *C. purpurata* luego de perder los flagelos velares, mostrando la base del velo (v), el pie (f), la glándula del biso (b), la mancha ocular (mo) y la posición del músculo aductor (ma).

Intermediate Rearing and Growout

Spat grew slowly when kept in flowing seawater at ambient temperature without algal supplements (Fig. 5, Culture I). Most of the spat from Culture II were lost due to infection under these conditions. Juveniles whose growth was stunted by long term maintenance in the laboratory seawater tables regained normal growth when placed in the Bay.

Culture III set on Netlon or *Gracilaria* sp. produced highly variable yields, ranging from 5 to 5000 juveniles per net. Of the 1 million spat placed in the Bay by this method, only 26,000 were recovered for growout. Periodic checks prior to harvesting showed that most of the spat had fallen out of the collectors in a few days after the beginning of the culture. Many of these were recovered as juveniles growing on the top surfaces of pearl nets hanging lower in the strings.

The best results in management of these spat were obtained by rearing them to 3 mm in the laboratory and then placing

TABLE 2

Summarized data relating to early development of *C. (A.) purpurata* for cultures listed in Table 1.

Datos resumidos en relación al desarrollo inicial de *C. (A.) purpurata* de cultivos presentados en la Tabla 1.

Culture	I	II	III	V
N° of eggs	nd	24×10^6	61×10^6	23×10^6
Survival at Straight hinge, %	nd	89	19.6	27
Larvae loss due to:	M	S	S	MS
N° of larvae premetamorphosis	1.6×10^5	7×10^6	nd	nd
N° of postlarvae	5400	3×10^6	$2\text{-}3 \times 10^6$	2×10^5
Spat loss due to:	M	1	2	3
N° to 20 mm or more:	40	600	26,000	

M = mass mortality
S = screening selection
1 = infection at 2 mm
2 = falling from spat collectors
3 = blasting, see text
nd = no data

Note: Culture IV lost in early stages.

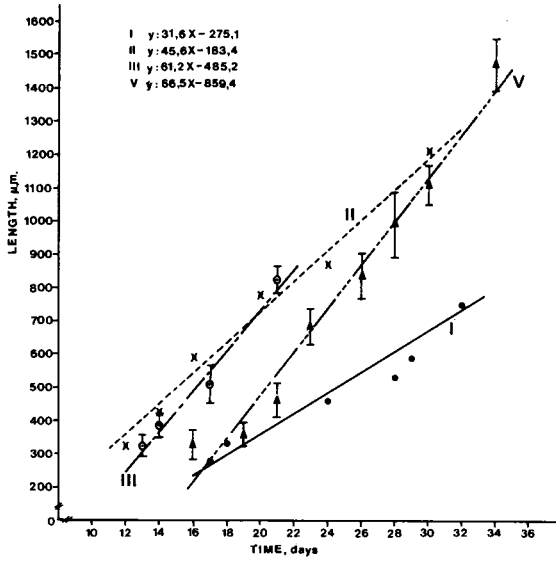

Fig. 5: Calculated regression lines describing the growth of four cultures of postlarval *C. purpurata.* Culture I was maintained in flowing seawater and not fed. Culture II same as I but fed intermittently. Culture III and V were reared in the laboratory with cultured microalgae. All data points are mean values based on measurement of 20 larvae; all r values ≥ 0.95. Where not indicated, standard deviation less than $\pm$ 10 μm.

Crecimiento de cuatro cultivos de postlarvas de *C. purpurata* ajustado por rectas de regresión. El Cultivo I se mantuvo en un flujo de agua de mar, sin alimentación, el Cultivo II se alimentó en forma discontinua, los Cultivos II y V fueron criados en laboratorio y alimentados con microalgas cultivadas. Todos los puntos representan promedios de 20 mediciones con la correspondiente desviación estándar, excepto en aquellas mediciones en que ésta es menor que $\pm$ 10 μm.

them in the Bay in tray systems. In Culture III, of the 8000 spat placed in the Bay in this manner, about 6000 were recovered after two months, averaging 8.6 mm in length.

Comparative growth data from three scallop cultures are listed in Table 3. This table shows that spat placed in the Bay at the small size of 0.8 mm grew less than those placed in the Bay when of larger size. Those placed in the Bay at the 4.3 mm size showed no better growth than those placed in the Bay at 1.6 mm.

Statistical data shown in Table 4 include length, growth rate, and survival of a sample of scallops from a larger group which was cultured to commercial size. Theoretical values for growth, following the Von Bertalanffy model were calculated for this sample using the Walford-Ford method (Ricker 1975); the theoretical curve and its equation are presented in Fig. 6. The data points suggest correlation between slow growth in mid-winter (June-July) and rapid growth in the spring season of high productivity (September-November). Calculation from the growth equation indicates the age of a 180 mm scallop (mentioned in the introductory section) to be about 3 years. Using our data and the calculation of Taylor (1958), the probable maximum age of this species may be about 7 years.

TABLE 3

Relative growth of three cultures of *Chlamys purpurata* in Herradura Bay.

Crecimientos relativos en tres cultivos de *C. (A.) purpurata* en Bahía La Herradura

	CULTURE Nº		
	I	II	III
Days held in lab	128*	38**	15**
Size placed in Bay (mm)	4.3	1.6	0.8
Number of specimens measured (n)	40	100	100
Days in Bay		Mean Size (mm)	
25	–	4.4	2.3
50	–	–	7
75	22	20	–
100	–	28.4	11.5
125	32	39	28
150	42	48	–
175	lost	50	36

* Not fed cultured algae.
** Fed cultured algae.

TABLE 4

Size, monthly absolute growth rate, survival rate and water temperature experienced by a group of *C. purpurata* produced in the laboratory, and then suspended in Herradura Bay in a pearl net (calculation after Ricker, 1975).

Tamaño, crecimiento absoluto mensual, tasa de sobrevivencia y temperatura experimentada por un grupo de *C. (A). purpurata* producido en el laboratorio y suspendido en Bahía Herradura (cálculos según Ricker, 1975).

Date	T (°C)	Number (N)	Mean Length (mm ± SD)	Monthly Absolute growth rate (mm)	Monthly Survival rate (S)
4 IV**	15.90	36	3.80 ± 0.73	–	–
11 V	15.27	33	9.80 ± 1.20	6.00	0.92
8 VI	15.11	29	17.50 ± 1.90	7.70	0.88
7 VII	13.70	29	27.00 ± 2.62	9.50	1.00
10 VIII	13.20	29	39.30 ± 4.60	12.30	1.00
9 IX	14.20	29	46.00 ± 6.36	6.70	1.00
15 X	16.25	27	60.30 ± 3.55	14.30	0.93
16 XI	15.60	27	67.93 ± 3.38	7.63	1.00
22 XII	18.15	25	74.90 ± 5.14	6.97	0.92
25 II***	20.00	18	83.80 ± 7.81	8.90	0.72
23 III	17.80	14	88.70 ± 7.38	4.90	0.78
26 IV	16.30	11	96.91 ± 6.61	8.21	0.79
26 V	16.45	9	102.00 ± 3.89	5.09	0.82
28 VI	14.60	9	106.22 ± 2.11	4.22	1.00

Survival rate S=Ntx/Nto (Ricker 1975).

** 1982
*** 1983.

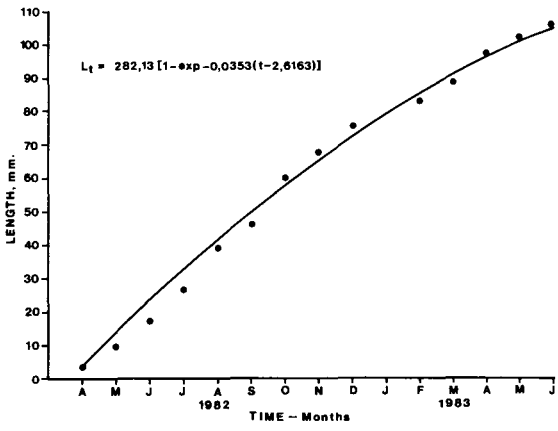

Fig. 6: Von Bertalanffy growth curve of a sample of *C. purpurata* from those reaching commercial size. Calculated by the method of Ricker (1975). Observed data points included for reference only (see Table 4 statistics).

Crecimiento, en el mar, de una muestra de 36 ejemplares de *C. purpurata* según el modelo de Von Bertalanffy ajustados por el Método de Walford (para análisis estadísticos, ver Tabla 4).

DISCUSSION

The scallop of northern Chile is an interesting candidate for mariculture. This species is long lived, stays in reproductive (and thus market) condition the year round, appears to be amenable to hatchery mass production, and grows rapidly to commercial size. These useful characteristics, expressed in an environment of moderate, relatively stable temperature and abundant food supply are the product of the favorable genetic potential of *C. purpurata.* A possible reason explaining why natural populations are not as extensive as those of species which are commercialized in other countries is the lack of suitable physical habitat on the steep rugged coastline typical of northern Chile. Reproduction of this species, which can occur at any time of the year, is induced by subtle, as yet unquantified, transient environmental factors. For example, the present authors noted in a preliminary experiment that spawning could be induced

by a 4°C temperature rise above ambient temperature, as well as by a corresponding drop in temperature of 4°C. Furthermore, scallops could be spawned with no temperature change when exposed to UV treated water. This is the first Pectinid species to our knowledge which has been routinely spawned using food suspensions of high microalgal density, as reported by Breese and Robinson (1981). This phenomenon was fortuitiously discovered in early stages of this research while feeding scallops in conditioning tables at constant temperature. A relatively low concentration of the microalgae induced spawning, suggesting that natural blooms of algae might trigger spawning at sea.

Larval culture proceeded routinely along lines established by other workers (see literature listed by Broome 1976, Mottet 1979). Small variation in egg size was apparently important to larval development and growth. The high mortality in the experiment described by Padilla (1979) may have been related to the small egg size of 60 μm diameter, a size which the present experiments have revealed to be inadequate for successful larval development. Larval growth was generally dependent on temperature, with the highest growth rate (16 μm day^{-1}) obtained in the upper range of temperature tolerance. With strict adherence to correct hatchery procedure (Breese and Malouf 1975), there was low mortality at metamorphosis and little need for antibiotics.

Only a few spat of *C. purpurata* remained attached to collector material of Japanesse origin (Netlon), which is successfully used in Japan for capture and intermediate culture of *Patinopecten yessoensis* Jay 1856 (Mottet 1979). Present results suggest that tray systems should be selected for future study of intermediate culture of *C. purpurata.* Growth to commercial size of 9 cm in one year is high when compared to natural growth rates of other species of scallops (Mottet 1979), although other species have shown proportionally accelerated growth rates in culture systems (Rhodes and Widman 1980). The growth rate of laboratory produced *C. purpurata* did not differ from the growth rate of the same species when captured in the field and reared by the same methods (S. Akaboshi, unpublished data). Survival rates to commercial size (approx. 50%, Table 4) appear low, and will probably be improved through further research and testing of growout methods, currently in progress.

Exogenous problems encountered in growout included biofouling and predation. Intense biofouling occurs in Herradura Bay (Viviani and DiSalvo 1980). Barnacles fouled the shells of juvenile scallops, mechanically interfering with their growth. Fouling by spionid polychaetes (*Polydora* sp.) caused dense sedimentation inside pearl nets and damage to scallop shells by boring. Circulation within pearl nets and trays was impeded by thick growth of *Bugula* spp. and algae on net surfaces.

Predation occurred at all stages of culture in the field, beginning with very small crabs apparently arriving as larvae with the plankton and developing in the pearl nets where they began life by feeding on scallop spat. This predation was minimal in the more finely screened tray systems. Larger crabs damaged pearl nets in advanced cultures in cases where they were able to mount the longline. When placed on the Bay bottom in an open corral an entire group of 1000 young scallops (with an average shell length of 30 mm) was consumed in less than three days by the local *Cancer setosus* (Molina 1782).

This research has been the first attempt to test feasibility of growing this scallop in mass culture, and the first time data has been presented on the entire growth cycle from egg to commercial size. Research now in progress is expected to fill in more detail concerning the culture of *C. purpurata.* Currently, 9000 juveniles originating in the laboratory, have been consigned to local fishermen for growout, using Japanese technology under the direction of S. Akaboshi. This venture is expected to elucidate practical problems involved with establishment of this type of culture in Chile, as well as aiding in its promotion at the local level.

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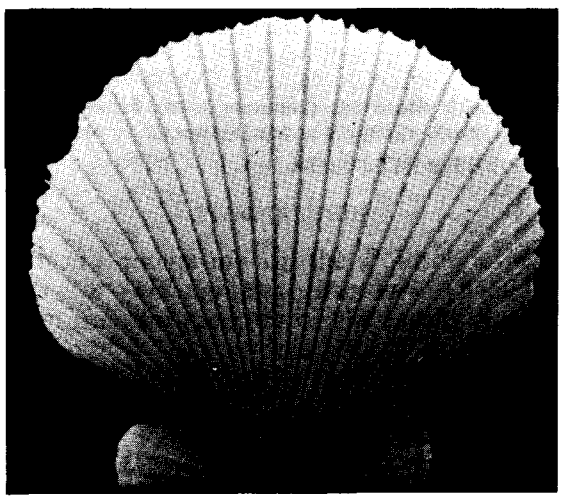

NOTE ADDED IN PROOF

In December 1983 a single specimen of *C. (A.) purpurata* was obtained in Coquimbo by the authors from local fishermen who said they had unintentionally hooked it at approximately 300 meters depth while fishing offshore with longlines. This is the deepest recorded occurrence of this species to the knowledge of the authors. The specimen was unpigmented (white), 62 mm in length, and showed mature gonad, although this was about one tenth the size of the gonad found in similarly sized shallow water specimens.