Preliminary Estimates of Growth Parameters for Three Commercial Bivalve Species of Peru (*Gari solida, Aulacomya ater* and *Semele solida*)

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Abstract

The parameters of the von Bertalanffy growth equation were estimated, mainly from size-frequency data, for three commercially exploited Peruvian bivalves, *Gari solida, Aulacomya ater* and *Semele solida*, collected by divers from "Bahia de Independencia", Pisco, Peru from November 1986 to September 1987 and from January to September 1990. Some related information on the three bivalves in question are also presented.

Introduction

The upwelling system off Peru is the most productive marine system in the world (Barber and Chávez 1986). Although it is the pelagic fisheries which have received most attention by fisheries scientists (Pauly et al. 1989), the invertebrate fishery has received much less attention, although it contributes a large fraction of the protein in the daily diet of the coastal population of Peru and has always been an important part of the Peruvian fishery sector as a whole (Arntz and Valdivia 1985).

The objective of this paper is to determine the growth parameters of three exploited bivalve species of Peru, with a view to their proper management.

Materials and Methods

From January to September 1990, monthly samples of *Gari solida* and *Semele solida* were collected at "La Pampa", Bahia de Independencia (14°15'S/76°10'W), approximately 250 km south of Lima. Samples were taken by scuba diving or commercial divers at a depth of about 10 m. Shell length (anterior-posterior axis) was recorded to the nearest millimeter. Published data on *Aulacomya ater* were taken from Tarazona et al. (1989). Sampling for these data was carried out from November 1986 to August 1987 in the same area and in a similar manner as for *G. solida* and *S. solida*.

From January to September 1990, growth experiments with *G. solida* and *S. solida* were performed. Individuals from La Pampa were tagged and placed in boxes filled with substratum also from La Pampa. The boxes were placed in an experimental area at a depth of 10 m, about 4 km away from La Pampa. Length was recorded at tagging and recapture. All growth parameter estimations were performed using routines incorporated in the Compleat ELEFAN Program, Ver. 1.10 (Gayanilo et al. 1988). In order to work with a time scale of one year, the sampling dates for *A. ater* collected in November and December 1986 were changed to 1987, under the assumption that growth did not change between years (this assumption is inherent in the ELEFAN I program, in any case).

The increment data obtained from the growth experiments were analyzed using the method of Gulland and Holt (1959), as incorporated in the Compleat ELEFAN package.

Results and Discussion

The best fitting growth curve for *A. ater*, estimated from the data in Table 1 by ELEFAN I (Fig. 1), had the following parameters: $L_\infty = 110$ mm, $K = 0.4$ year^{-1}, while the Wetherall (1986) plot gave $L_\infty = 90$ mm. However, sampling for these data was carried out in 1986 and 1987, only a few years after the severe El Niño of 1982-83. During this event, the *A. ater* population was almost entirely wiped out (Arntz and Valdivia 1985) and recolonization could still be observed in 1986. At this time, the population consisted only of small individuals of the first year class, making it very likely that the Wetherall plot underestimated L_∞. Davenport et al. (1984) studied *A. ater* in the Falkland Islands. According to their estimates, the asymptotic size of this species "appeared to be about 120 mm". This value supports the estimated value of L_∞ estimated by ELEFAN I.

The growth parameters for *G. solida* estimated from the data in Table 2 by ELEFAN I ($L_\infty = 86$ mm, $K = 0.7$ year^{-1}, with low fit of curve to data) and by the Gulland and Holt plot ($L_\infty = 80$ mm, $K = 0.83$ year^{-1}) are mutually compatible, considering that the mathematical model behind the von Bertalanffy equation implies that lower

Table 1. Length-frequency data on *Aulacomya ater*, La Pampa, Bahia de Independencia, Peru.

Ml/date	Feb	Mar	May	Jun	Aug	Oct	Nov	Dec
1.5	-	-	-	-	97.63	-	10.63	-
4.5	3.25	2.00	0.38	-	138.12	0.38	51.25	3.25
7.5	9.88	0.00	0.63	-	43.51	0.63	60.24	22.13
10.5	49.63	5.38	0.38	1.75	12.25	1.00	25.63	61.12
13.5	116.74	17.00	4.13	3.00	20.63	0.88	8.00	61.37
16.5	140.74	66.25	16.00	1.63	30.13	1.88	2.25	34.12
19.5	120.87	117.87	33.49	7.63	43.75	3.88	-	10.88
22.5	46.13	129.49	57.24	15.00	90.38	10.25	-	0.13
25.5	18.13	75.88	78.62	32.75	133.99	12.75	-	-
28.5	1.63	24.00	68.37	50.99	182.87	24.63	-	-
31.5	-	4.00	57.87	57.74	183.12	37.37	-	-
34.5	-	0.13	26.00	33.50	195.99	60.62	-	-
37.5	-	-	12.13	25.50	140.62	85.12	-	-
40.5	-	-	1.75	9.88	77.25	69.87	-	-
43.5	-	-	0.88	2.38	36.00	68.74	-	-
46.5	-	-	0.13	0.25	4.88	28.12	-	-
49.5	-	-	-	-	1.88	7.75	-	-
52.5	-	-	-	-	-	1.50	-	-
55.5	-	-	-	-	-	0.63	-	-
Sums	507	442	358	242	1433	416	158	193

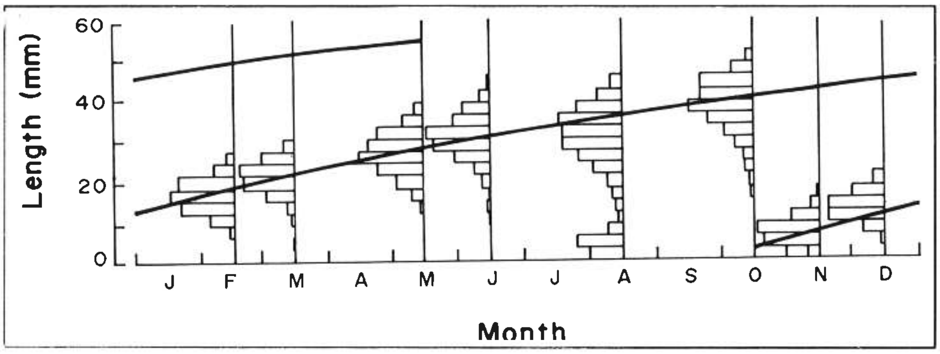

Fig. 1. Length-frequency data and superimposed growth curve of *Aulacomya ater* in Bahia de Independencia, Peru (see Table 3 for growth parameter estimates).

Table 2. Length-frequency data on *Gari solida*, La Pampa, Bahia de Independencia, Peru.

ML\DATE	1/3	2/18	3/5	4/4	5/19	6/21	7/5	8/5	8/26	9/29
22	-	-	-	-	-	1.17	2.00	3.53	0.67	-
26	-	-	-	-	-	1.00	5.84	12.41	2.17	0.50
30	-	-	-	-	-	0.17	6.18	25.97	2.67	2.68
34	-	-	-	0.17	-	2.34	2.67	31.00	1.00	4.02
38	-	-	0.17	1.17	-	4.34	2.83	17.25	0.50	4.01
42	-	-	1.67	0.83	1.01	4.34	12.50	4.69	0.00	1.34
46	0.17	-	1.67	2.66	1.01	7.34	25.52	4.02	0.00	1.17
50	1.84	1.17	0.66	6.67	0.34	11.85	21.02	3.69	0.17	2.01
54	3.84	2.34	0.66	7.00	1.34	17.36	18.52	5.70	5.33	5.35
58	7.67	3.34	1.84	8.17	3.17	28.38	38.70	6.71	8.16	12.03
62	23.66	5.35	9.34	11.51	13.65	49.24	64.87	6.04	12.50	16.88
66	39.16	15.54	18.99	17.34	38.66	89.81	73.05	9.38	13.50	18.71
70	34.50	27.22	24.00	26.99	65.16	149.74	70.71	18.11	9.83	22.57
74	18.17	37.06	20.33	40.33	48.16	166.27	57.04	31.17	7.83	35.92
78	8.16	37.90	17.50	34.32	22.16	138.22	38.36	27.48	7.16	36.59
82	2.33	26.87	12.66	21.66	10.83	88.97	17.35	17.10	2.34	31.92
86	0.50	7.18	6.17	15.17	5.17	44.24	10.67	8.71	1.84	28.25
90	-	3.01	3.84	8.34	3.67	14.36	2.50	3.02	0.83	12.20
94	-	2.01	0.50	3.17	0.67	4.68	0.67	1.01	0.50	4.01
98	-	1.01	-	0.50	-	2.18	-	1.01	-	1.84
Sums	140	170	120	206	215	826	471	238	77	242

Table 3. Summary of growth parameter estimates in three Peruvian bivalve species (see text).

Species	L_∞ (mm)	K ($year^{-1}$)	ϕ'[a]	C	WP[b]	Method
Aulacomya	110	0.40	3.68	0.2	0.5	ELEFAN I
ater	90	-	-	-	-	Wetherall
Gari	86	0.70	3.71	0.2	0.6	ELEFAN I
solida	86	0.73	3.73	-	-	Munro
	80	0.83	3.73	-	-	Gulland and Holt
	102	(0.50)[c]	-	-	-	Wetherall
Semele	67	0.77	3.54	-	-	Gulland and Holt
solida	85	(0.48)[b]	-	-	-	Wetherall

[a]$\phi' = \log_{10}K + 2\log_{10}L_\infty$ (Pauly and Munro 1984).
[b]Note that values of WP = 0.5-0.6 identify June-July (southern winter) as periods of reduced growth.
[c]Using the mean value of ϕ' = 3.72 estimated from ELEFAN I, and the Munro and Wetherall methods.
[d]Using the value of ϕ' = 3.54 estimated via the Gulland and Holt plot.

values of L_∞ are always associated with higher values of K and conversely (Pauly and Munro 1984; Vakily 1990). Growth parameters estimated from tagging data with the method of Munro (1982), as implemented in the Compleat ELEFAN package for a fixed value of L_∞ (= 86 mm) resulted in K=0.73 $year^{-1}$. On the other hand, the L_∞ value estimated by the Wetherall plot was 102 mm. Samples collected by the authors and by fishermen show length above 90 mm rather frequently, tending to confirm a value of $L_\infty \approx 100$. Vakily (1990) has shown that the ϕ' concept is very appropriate for growth comparisons in bivalves, a feature also suggested by *G. solida* in Table 3, whose values of ϕ' are very similar. Using L_∞ = 102 and the mean ϕ' value of 3.72 (Table 3) leads to K = 0.5 $year^{-1}$, a value probably more appropriate than those estimated by ELEFAN I and the Gulland and Holt plot.

S. solida is not very common in Bahia de Independencia although it is exploited commercially in Chile. For these reasons it was not possible to obtain size-frequency samples large enough for the estimation of growth parameters using ELEFAN I. These were therefore determined through tagging experiments and compared with those obtained through the method of Wetherall (1986). Here, the value of L_∞ = 85 mm estimated by the latter method appears more likely than the value of L_∞ = 67 mm obtained through the Gulland and Holt plot. Using ϕ' to estimate K from L_∞ = 85 mm and ϕ' = 3.54 leads to K = 0.48 $year^{-1}$ (Table 3).

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