AGE AND GROWTH OF THE WHITE SHRIMP *Litopenaeus schmitti* IN WESTERN VENEZUELA

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SUMMARY

Prior reports on the growth of Litopenaeus schmitti *showed differences in the values for the estimated parameters. These reports used length frequency distributions from Lake Maracaibo, where small specimens predominate, and omitted the fraction of large individuals that predominate in the Gulf of Venezuela. The present study reevaluated the growth of this species, considering the complete range of sizes present in both environments. A multinomial fit was used to differentiate modes, with a coefficient of variation of 3.5%. Calculation of the growth parameters used data on size increments between sizes at time intervals, adjusting the parameters using the von Bertalanffy growth formula through the least squares method. In females the growth was given by $L_t=21.7(1-e^{-0.95(t+0.050)})$, while in males it was given by $L_t=19.4(1-e^{-1.10(t+0.048)})$. A statistically significant difference in growth was observed between the two sexes (F-test=8.01, $p<0.05$).*

Introduction

The white shrimp *Litopenaeus schmitti* is the most abundant and economically valuable peneid in Venezuela (SARPA, 1996). This species forms the basis for the most important artisanal and industrial fisheries of the Venezuelan Atlantic, as well as for those in Lake Maracaibo and the Gulf of Venezuela, in the western part of the country (Figure 1; Novoa *et al*., 1998).

One of the distinctive characteristics of numerous peneids, including *L. schmitti*, is a life cycle that takes place in two different environments; a juvenile phase in coastal or estuarine zones where it supports artisanal fishery, and an adult phase in which a large size is attained after migration to deeper waters in the open sea, where it supports industrial fishery (Ewald 1964, 1965; Cadima *et al*., 1972; García and Le Reste, 1987). Thus, two fleets with different fishing power sequentially impact the same resource, and are usually analyzed as separate entities as regards the dynamics of the resource in each environment and the effects on each of the different fishing fleets. Considering the mutual effects that activity of one fleet has on the other, it is necessary to study the dynamics of the juvenile and adult populations jointly, as well as the interactions between the fishing fleets, evaluated as a unit.

The reports by Ewald (1964, 1965) are the first studies on the white shrimp in this area. These studies showed that the highest concentrations of juveniles occurred in Lake Maracaibo while those of adults were found in the Gulf of Venezuela (Figure 1). During 1964 and 1965 the total length of the white shrimp present in catches varied between 5.0 and 16.0cm in the Lake, while in the Gulf sizes ranged from 8.5 to 20.0cm. The life cycle of *L. schmitti* was described in these studies, suggesting that spawning occurred in the Gulf of Venezuela at water depths of 15 to 20m, with the most intense reproductive period in the second quarter of the year. It was also suggested that the shrimp migrated to the mangrove zone in Tablazo Bay, and toward Lake Maracaibo during the final larval stages, in search of estuarine areas favorable for their nutrition. Ewald (1965) suggested that growth was rapid in the Lake, as fast as 5.0cm per month, and that following a period of 6 to 9 months pre-adults began to move toward the Gulf, reaching sexual maturity at one year of life and spawning for the first time at the Calabozo Inlet (Figure 1). García and Ewald (1974) and García (1970, 1971) suggested that there were no sexually mature *L. schmitti* adults in Lake Maracaibo, confirming that spawning occurred in the Gulf of Venezuela and that 15 to 25 days following copulation, postlarvae 0.49 to 0.53cm in total length moved into the Lake. Godoy (1971) reported obtaining sexually mature females 13 to 22cm in length only in the Gulf of Venezuela, with a larger percentage of 16.5cm females having an adherent spermatophore during April-May and October-November at the Calabozo Inlet. Godoy (1971) did not find mature females in Lake Maracaibo, which suggested that these individuals became sexually mature when they reached the Gulf of Venezuela, with total lengths of 13 to 14cm.

Recent studies on the growth of *L. schmitti* (Andrade, 1996; Andrade and Stotz, 1999) used data on length frequency distributions (lfd) from catches of the population fraction present in Lake Maracaibo, extrapolating the growth of the fraction of adults present in the Gulf of Venezuela. The results obtained by these authors indicated that the two sexes had different growth patterns, with L_∞= 18.0cm and K= 1.2year^{-1} for males, and L_∞= 21.5cm and K= 1.5year^{-1} for females; the range of sizes was from 6 to 21cm in total length. These results differed from those reported by Sangronis (2001) who estimated the growth parameters of *L. schmitti* to be L_∞= 13.1cm and K=

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RESUMEN

Trabajos previos sobre el crecimiento de Litopenaeus schmitti *mostraron diferencias en los valores de los parámetros estimados. Estos trabajos utilizaron como fuente de información distribuciones de frecuencias de longitudes en el Lago de Maracaibo, donde predominan tamaños pequeños, excluyendo la fracción de individuos presentes en el Golfo de Venezuela, donde predominan tamaños superiores. Este trabajo reevalúa el crecimiento de la especie considerando el rango completo de tallas presentes en ambos ambientes. Se utilizó un ajuste multinomial para distinguir modas con un coeficiente de variación de 3,5%. En el cálculo de los parámetros de crecimiento se utilizó datos de incrementos de tamaños entre tallas a intervalos de tiempo, ajustándose los parámetros por mínimos cuadrados usando la ecuación de crecimiento de von Bertalanffy. Para hembras el crecimiento estuvo dado por $L_t=21,7(1-e^{-0,95(t+0,050)})$ y para machos fue $L_t=19,4(1-e^{-1,10(t+0,048)})$. El crecimiento fue significativamente diferente entre los sexos (F-test=8,01, p<0,05).*

RESUMO

Trabalhos prévios sobre o crescimento de Litopenaeus schmitti *mostraram diferenças nos valores dos parâmetros estimados. Estes trabalhos utilizaram como fonte de informação distribuições de freqüências de longitudes no Lago de Maracaibo, de onde predominam tamanhos pequenos, excluindo a fração de indivíduos presentes no Golfo de Venezuela, de onde predominam tamanhos superiores. Este trabalho reavalia o crescimento da espécie considerando a faixa completa de tamanhos presentes em ambos ambientes. Se utilizou um ajuste multinomial para distinguir modas com um coeficiente de variação de 3,5%. No cálculo dos parâmetros de crescimento se utilizou dados de incrementos de tamanhos entre faixas a intervalos de tempo, ajustando-se os parâmetros por mínimos quadrados usando a equação de crescimento de von Bertalanffy. Para fêmeas o crescimento esteve dado por $L_t=21,7(1-e^{-0,95(t+0,050)})$ e para machos foi $L_t=19,4(1-e^{-1,10(t+0,048)})$. O crescimento foi significativamente diferente entre os sexos (F-test=8,01, p<0,05).*

1.7year^{-1} for males and L_∞= 14.2cm and K= 1.9year^{-1} for females, using the von Bertalanffy growth function. In this study the range of sizes subjected to analysis was from 1.3 to 14.0cm. It is probable that the origin of these differences was due to the range of sizes included in the analysis, which as indicated above are smaller in the Lake than in the Gulf.

A careful review of growth estimates for this shrimp is required given the importance of this resource for Venezuela and the need to have reliable biological parameters in order to evaluate correctly the biological, social, and economic impacts of alternative fishing regulations at artisanal and industrial levels. Thus, the objective of the present study was to determine the age and growth of the population of *L. schmitti* in western Venezuela, including information from both Lake Maracaibo and the Gulf of Venezuela.

Materials and Methods

The age and growth of *L. schmitti* were determined on the basis of the length frequency distributions (lfd's), which have been shown to be useful in crustacean studies. Data on total length (cm) were obtained monthly from commercial catches of white shrimp at the major landing ports in western Venezuela (Figure 1) including Curarire, La Rita, and El Moján in Lake Maracaibo, and Punto Fijo in the Gulf of Venezuela. The lfd's were analyzed for each port for two reasons: 1) movement of the juveniles from the Lake toward the Gulf may create fishing zones with different structures, such that the modal progression in a time interval may be altered if all the information is unified into a single sample, and 2) samples were not taken simultaneously at each port, and were out of phase up to three weeks. In this way, information on growth can be lost by grouping the samples. Data were collected from Apr 2001 to Jun 2003 in the Lake, and between Feb and Jul 2003 in the Gulf.

Sexual differentiation in growth pattern exists in many species of peneid shrimp (García and Le Reste, 1987), and therefore sexes were analyzed separately. Monthly lfd´s were constructed in 1cm classes, as this scale was the most useful for the detection of modes according to preliminary analyses of the information.

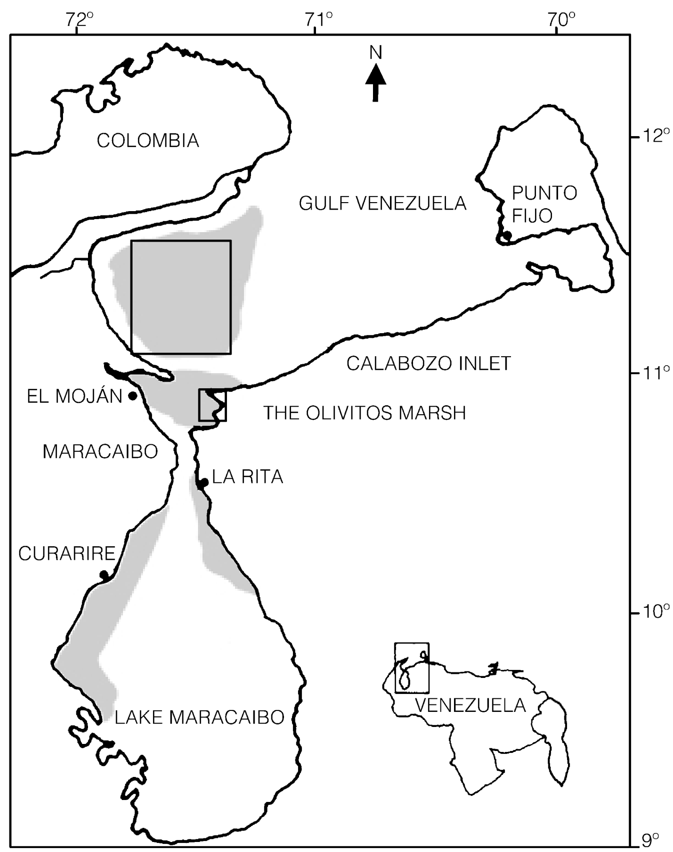

Figure 1. Main landing ports (●) and fishing areas (shadowed) for *L. schmitti* in western Venezuela.

The multinomial distribution (Haddon, 2001) was employed in order to separate the modes for each cohort present in the lfd's,

$$P(x_i | n,p_1,p_2,...,p_k) = n!\prod_{i=1}^{k}\frac{p_i^{x_i}}{x_i!} \quad (1)$$

where x_i: number of times an event of type i occurs in n trials, n: size of the samples or number of trials, and p_i: separate probabilities for each one of the k types of possible events. The expectancy of occurrence of each type of event is $E(x_i)=np_i$, where n is the size of the sample and p_i the probability of an event of type i.

Although other types of distributions may be employed (*eg*. the gamma distribution), the normal distribution (Zar, 1984) was used to describe the distribution of sizes for each cohort as

$$P_{L_k} = \frac{1}{\sigma_n\sqrt{2\pi}} e^{\frac{-(L_k-\mu_n)^2}{2\sigma_n}} \quad (2)$$

where L_k: length observed for each of the k categories and n age classes, μ_n and σ_n: mean and standard deviation of the distribution. The probability estimated for the multinomial is given by Haddon (2001) as

$$LL(L|\mu_n,\sigma_n) = -\sum_{i=1}^{k} L_i \cdot Ln(\hat{p}_i) = -\sum_{i=1}^{k} L_i \cdot Ln\left(\frac{\hat{L}_i}{\sum \hat{L}_i}\right) \quad (3)$$

where μ_n and σ_n: means and deviations, respectively, of the n cohorts in the frequency distribution where there exist k classes of length; L_i and $\hat{L}_i$: frequencies observed and expected, respectively, for class i; $\hat{p}_i$: expected proportion of length class i from the combined normal distributions. To find the optimal combination for the n distributions, the differences between the observed and expected frequencies were minimized using the method of least squares.

Hereinafter cohorts are referred to as modes, because in a normal distribution the mean for each cohort is equivalent to the mode or median.

It is assumed that the standard deviation of the mean length increased as new age groups were detected (Sullivan *et al.*, 1990) and that the coefficient of variation has a fixed value of 3.5%, as obtained from a prior analysis of the data. The IS index of age class separation was used for separation of the different cohorts (Sparre and Venema, 1995), as

$$IS = \frac{Lt_2 - Lt_1}{\left(\frac{s_2 + s_1}{2}\right)} \geq 2 \quad (4)$$

where Lt_1, Lt_2 and s_1, s_2: mean lengths and standard deviations, respectively, at times t_1 and t_2. If IS<2, then it is not feasible to separate the normal components of the frequencies observed (Sparre and Venema, 1995).

Once the means and standard deviations are calculated for the lfd's of all months, the von Bertalanffy growth formula is fit,

$$Lt = L_\infty (1-e^{-K(t-t_0)}) \quad (5)$$

where L_∞: asymptotic length, K: curvature parameter, t_0: theoretical age at length zero and t: age. This von Bertalanffy model is a useful expression of growth for peneid shrimp species (Silliman, 1969; Parrack, 1979; García y Le Reste, 1987).

The parameters of equation (5) were fit through least squares employing as objective function (Gallucci *et al.*, 1996)

$$\Delta L = L_{t+\Delta t} - L_t = (L_\infty - L_t)(1-e^{-K\Delta t}) \quad (6)$$

where ΔL: difference observed in length for a given cohort in time interval Δt. Since there is a subjective component in the identification of two distributions estimated over different times as pertaining to the same cohort, only the modes between contiguous months were included, as the probability of committing an error in identification of the cohort was judged to be minor. Thus, if one mode was not evident in the sample of the following month, this datum was not considered, even if it was evident in the second following month.

ΔL was calculated without considering the year in which the sample was taken, in order to favor obtaining a greater contrast of information on sizes and to include the entire range of sizes present in the catches. The basic assumption here was that the pattern of growth was the same, regardless of the year. Thus, the integration of the data for each site ends with the incorporation of all the supposed increases in one plot. Also, for 2001 and 2002, information on size composition of the catches was not available from the industrial fishery in the Gulf, which would have otherwise facilitated the analysis.

In order to evaluate the reliability of the parameters estimated for *L. schmitti*, they were compared with those of related species, following the criteria of Pauly and Munro (1984) and Pauly (1991), who reported that a species-specific relation exists, at the genus level, between $\log(L_\infty)$ and log(K) such that the relation between these parameters remained constant, independently of their values, and

$$\phi' = \log(K) + 2\log(L_\infty) \quad (7)$$

This permits to estimate the pertinence of the values of the growth parameters L_∞ and K, since ϕ' does not change independently of these values. In such a way, an evaluation can be made as to whether the estimates of the two parameters are valid or incorrect, as they become more distant from the value of ϕ' reported for species of the same genus (Sparre and Venema, 1995), allowing for the establishment of interspecific comparisons (Pauly, 1991).

An analysis of the residual sum of squares (ARSS) was used to compare the growth curves by sex (Chen *et al.*, 1992). This procedure entails comparing the summed residual of squares (RSS) and the respective degrees of freedom (DF) for each growth curve against the RSS and DF of a curve of general fit for both (grouped) sexes. The F-statistic was calculated after Chen *et al.* (1992) as

$$F = \frac{\frac{RSS_p - RSS_s}{3(J-1)}}{\frac{RSS_s}{N-3J}} \quad (8)$$

where RSS_p: RSS of the growth curve common to both sexes, RSS_s: RSS of each growth curve by sex, N: size of the grouped sample, and J: number of curves compared. The difference between sexes was evaluated by comparing the value of F calculated by equation (8) and the critical value of F, with [3×(J-1)] and [(N-3×J] DF for the numerator and denominator, respectively.

Results

The size ranges recorded in the present study were between 7 and 17.5cm in length for Lake Maracaibo individuals and between 13 and 23.5cm for those from the Gulf of Venezuela. A total of 144 cohorts (80 for females and 64 for males) which complied with the rule of being from contiguous months were obtained from the four landing ports (Tables I and II). The IS between modes was >2 in all cases, which satisfied the requirement for a minimum distance between the distributions. For females in the Lake, mean values (modes) for the different cohorts identified ranged between 8.0 and 15.0cm, while in the Gulf the maximum mode was 18.8cm. For males, modes ranged between 8.0 and 13.9cm in the Lake, and in the Gulf the maximum was 19.0cm. The highest mode values for both male and female were found in the Gulf, and the lowest ones were found in the Lake.

In both sexes the relation between size and monthly increase in length was inverse ($p<0.05$) although with high variability (Figure 2a, b). For females the growth equation obtained

TABLE I
STATISTICS FOR FEMALE COHORTS IDENTIFIED AT MARACAIBO LAKE AND GULF OF VENEZUELA

Port	Year	Month	Mode	S.D.	N
Curarire	2001	Apr	13.40	0.47	2034
		May	10.81	0.38	23
			12.53	0.44	121
		Jun	9.58	0.34	338
			11.93	0.42	1875
			13.37	0.47	717
		Jul	10.29	0.36	1171
			12.54	0.44	255
			14.58	0.51	1019
		Sep	11.86	0.42	305
			13.06	0.46	218
		Nov	10.66	0.37	671
			12.71	0.44	439
	2002	Jan	8.13	0.28	108
			8.75	0.31	1494
		Feb	8.35	0.29	386
			9.34	0.33	2468
		Mar	8.46	0.30	1469
			13.62	0.48	810
			14.93	0.52	726
		Apr	9.41	0.33	9300
			14.10	0.49	1260
		Jun	14.58	0.51	810
		Jul	10.72	0.38	40
			12.30	0.43	78
		Oct	11.87	0.42	43
	2003	Mar	8.52	0.30	3766
			10.46	0.37	11721
			13.35	0.47	1152
		Apr	12.59	0.44	361
		May	11.48	0.40	627
			13.33	0.47	1111
El Moján	2001	May	10.65	0.37	678
			12.72	0.45	1279
		Jul	10.52	0.37	195
		Sep	11.73	0.41	503
			13.51	0.47	1926
		Oct	12.90	0.45	844
	2002	Jan	8.00	0.28	73
			11.28	0.39	1735
			13.84	0.48	1191
		Feb	9.01	0.32	3460
			10.32	0.36	2876
			12.63	0.44	1598
		Mar	10.10	0.35	234
		Apr	11.90	0.42	102
		May	12.80	0.45	537
		Sep	13.79	0.48	258
		Oct	14.31	0.50	1047
		Nov	12.90	0.45	186
	2003	Mar	14.34	0.50	54
		Apr	11.27	0.39	366
		May	12.22	0.43	189
La Rita	2001	May	13.53	0.47	608
		Jul	11.23	0.39	387
		Aug	12.67	0.44	86
		Sep	14.97	0.52	99
	2002	Jan	9.22	0.32	328
			11.75	0.41	2820
			12.60	0.44	1400
			14.50	0.51	1310
		Feb	9.22	0.32	2033
			13.94	0.49	1990
		Mar	9.13	0.32	1363
		Apr	8.42	0.29	2128
			9.53	0.33	6180
		Oct	12.71	0.44	1505
		Nov	12.48	0.44	45
	2003	Mar	8.58	0.30	314
			9.63	0.34	421
			11.14	0.39	422
			13.60	0.48	231
		Apr	10.53	0.37	775
			12.74	0.45	129
			14.18	0.50	233
		May	11.00	0.39	700
Gulf	2003	Apr	14.40	0.50	15
			15.47	0.54	8
		May	16.55	0.58	57
		Jun	18.83	0.66	45

S.D.: standard deviation; N: number of individuals in the cohort.

TABLE II
STATISTICS FOR MALE COHORTS IDENTIFIED AT MARACAIBO LAKE AND GULF OF VENEZUELA

Port	Year	Month	Mode	S.D.	N
Curarire	2001	May	12.49	0.44	52
		Jun	9.64	0.34	134
			13.75	0.48	690
		Jul	10.69	0.37	100
			12.34	0.43	207
		Sep	11.68	0.41	88
		Oct	12.09	0.42	918
		Nov	8.12	0.28	74
	2002	Jan	8.04	0.28	346
			12.77	0.45	1419
		Feb	8.11	0.28	195
			9.63	0.34	1200
			13.62	0.48	1540
		Mar	9.16	0.32	1039
			13.20	0.46	300
		Apr	9.14	0.32	2071
			13.45	0.47	770
		Jun	13.46	0.47	1275
		Aug	11.48	0.40	82
			13.23	0.46	175
		Oct	11.51	0.40	13
	2003	Mar	10.29	0.36	6738
			12.98	0.45	1009
		May	13.43	0.47	1064
El Moján	2001	May	11.51	0.40	2106
		Jun	10.65	0.37	168
			12.40	0.43	326
		Sep	11.55	0.40	762
			13.56	0.47	717
		Oct	11.00	0.39	133
			12.84	0.45	732
			13.72	0.48	1058
	2002	Jan	12.60	0.44	294
		Feb	8.06	0.28	385
			9.78	0.34	2800
			12.46	0.44	617
		Apr	8.63	0.30	443
		May	11.60	0.41	137
		Sep	13.37	0.47	175
		Oct	13.54	0.47	770
		Nov	12.63	0.44	500
	2003	Mar	10.79	0.38	195
		Apr	10.81	0.38	146
		May	12.35	0.43	151
La Rita	2001	May	13.92	0.49	413
		Jul	13.60	0.48	215
	2002	Jan	11.63	0.41	526
		Feb	9.69	0.34	3250
			12.67	0.44	2410
		Mar	10.52	0.37	4978
		Apr	8.20	0.29	924
			9.19	0.32	959
			13.83	0.48	710
		Jun	12.20	0.43	245
			13.13	0.46	1152
	2003	Mar	8.70	0.30	179
			10.45	0.37	381
		Apr	11.51	0.40	28
			13.12	0.46	141
		May	12.69	0.44	97
Gulf	2003	Feb	19.00	0.67	8
		Apr	15.10	0.53	11
		May	14.81	0.52	61
			16.08	0.56	37

S.D.: standard deviation; N: number of individuals in the cohort.

was $L_t=21.7(1-e^{-0.95(t+0.050)})$ while for males it was $L_t=19.4(1-e^{-1.10(t+0.048)})$. Figure 3 shows the fit for male and female when all lfd's, from both Lake and Gulf were pooled together. The pattern of growth calculated was statistically different for the two sexes (F test=8.01, $p<0.05$).

The value of ϕ' was similar between sexes, obtaining 2.65 for females and 2.62 for males. When compared with the ϕ' values for other species of the same genus obtained from the literature a large dispersion is found (Table III).

From the growth parameters obtained, it was deter-

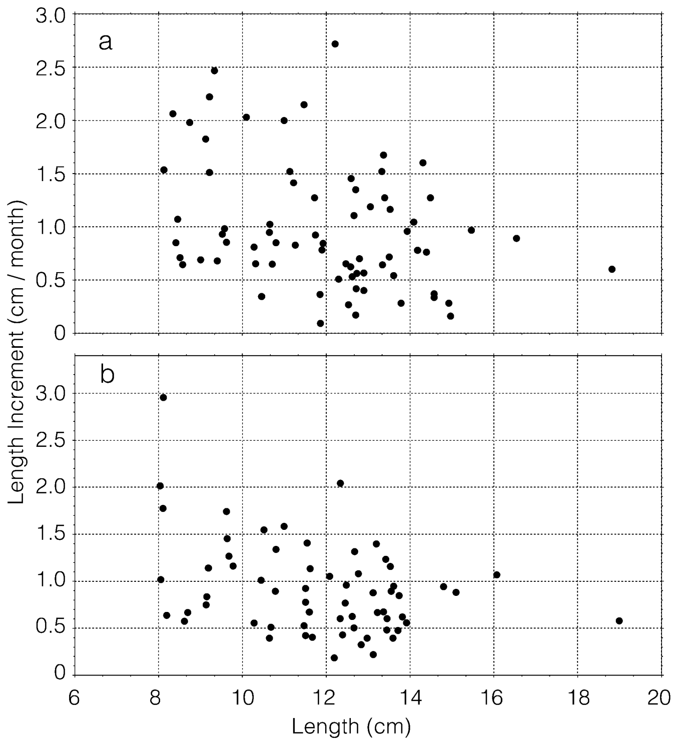

Figure 2. Monthly length increase as a function of initial size in females (a) and males (b) of *L. schmitti.*

mined that in Lake Maracaibo the first class present would include individuals having a mean length of 7cm and an age of 3 to 4 months. Similarly, the greatest frequency of sizes was between 12 and 13cm, representing an age of 7 to 8 months. The presence of the shrimp decreased in the Lake as their size reached 15cm in length at an age of about 1 year, while in the Gulf the frequency of individuals of this size increased. The youngest class of shrimp present in the Gulf had an average length of 14cm, and was about 1 year of age, while the oldest class had a mean length of 21cm, and was about 2 years of age.

Discussion

The white shrimp *L. schmitti* was found to have different growth rates by sex. Analysis of the growth curves showed higher values for K and lower values for L_∞ in males as compared to females, which is consistent with the larger sizes found for females in the catches, especially above 16cm in total length, as shown by this and other studies (Tables I and II; Parrack, 1979; D'Incao, 1984; Sumiomo, 1988; García and Le Reste, 1987; Matthews, 1989; Rodríguez and López, 1989; Castro and Arreguín-Sánchez, 1991; Palacios *et al.*, 1993). The estimation of growth parameters for *L. schmitti* differed from those obtained by Andrade (1996), Andrade and Stotz (1999), and Sangronis (2001a, b). These differences could originate in part from the methods used, as in the three cited references the methodology was based on lfd's of shrimp caught by the artisanal fleet of the Maracaibo Lake, and data were analyzed using ELEFAN algorithms (Gayanilo *et al.*, 1988). Thus, the larger sized individuals were underrepresented since they are more frequent in the Gulf (Ewald, 1964, 1965; García, 1970, 1971; García and Ewald, 1974; Godoy, 1971; García and Le Reste, 1987). It is known that superposition of cohorts is produced toward larger sizes, generally impeding precise determination of the number of modes present in these portions of the lfd´s. These modes contain a large amount of information since they indicate a decrease in the rate of growth as they approach L_∞. A greater representation in the lfd's of individuals of smaller sizes where growth is more rapid may lead to overestimation of the value of K, or, in the absence of data on the larger sizes it may lead to an overestimation of L_∞ (Wolfgang Stotz, personal communication). Since the ELEFAN procedure is sensitive in the detection of modes, particularly with the larger sizes, a degree of uncertainty is possible in the estimations of K or L_∞, or both, in proportion to under-representation of the larger sizes in the samples.

In the method used in the present study, the modes were determined by using a statistical criterion that included a multinomial distribution of parameters μ_n and σ_n, which represented the means and deviations of n cohorts in each lfd's, with k length classes. In this way it was possible to recognize all the modes present, including those of the largest individuals, closest to L_∞. Thus, the estimates of growth parameters using this method may have a higher degree of reliability than previous methods, and when introduced into models of stock evaluation may give more accurate results. However, it should be indicated that the objective of this study was to evaluate the growth rate of *L. schmitti*, emphasizing the statistical criterion for separation of the modes, and was not designed as a comparison between methods of growth evaluation.

In relation to the value of the growth constant ϕ', the results obtained differed from previous studies for the genus *Litopenaeus* (Table III), being comparable only to the values reported for *L. schmitti* males (Andrade, 1996; Andrade and Stotz, 1999). According to the ϕ' method, when there are different growth parameters for a given species (or genus), these estimates should lead to similar ϕ' values. If it does not occur it is possible that some of the estimations are incorrect (Sparre and Venema, 1995). Table III shows a large variation in ϕ' values. This inconsistency indicates that some parameters listed in Table III may have been incorrectly estimated and makes it necessary to reexamine the usefulness of this parameter for these species.

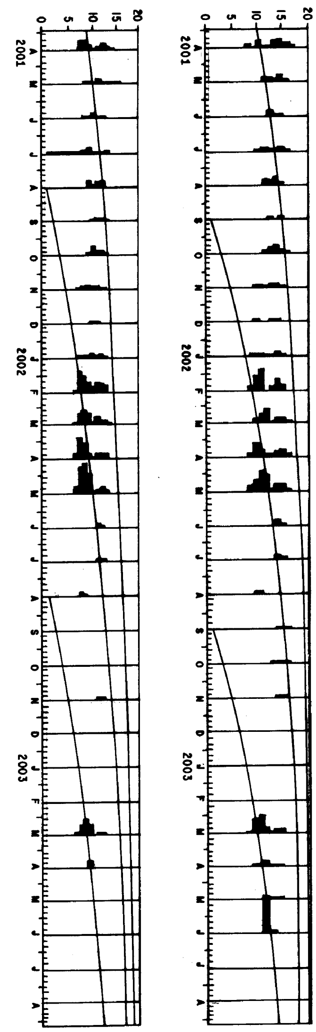

Figure 3. Growth curves fitted for *L. schmitti* males (left) and females (right). All lfd's (both from Lake Maracaibo and Gulf of Venezuela) were pooled together.

Older individuals (>18cm) were present in the Gulf. For females this size corresponds to 1.85 years, while for males it corresponds to 2.08 years. In the Lake, the maximum mode for females was 15cm

TABLE III
GROWTH PARAMETERS FOR SOME SPECIES OF *Litopenaeus* GENUS

Species	Sex	L_∞ (cm)	K($year^{-1}$)	t_0(years)	φ'	Reference
L. schmitti	M	19.4	1.24	-0.0430	2.62	This paper
	F	21.7	0.95	-0.0500	2.65	
L. schmitti	M	18.0	1.2	-0.0101	2.59	Andrade and Stotz (1999)
	F	21.5	1.5	-0.0162	2.84	
	B	21.4	1.5	-0.0205	2.84	
L. schmitti	M	13.1	1.7		2.46	Sangronis (2001)
	F	14.2	1.9		2.58	
L. setiferus	B	22.7	2.8	0.0110	3.17	Castro *et al.* (1986)
	B	22.1	2.8	0.6550	3.13	
	B	21.6	3.3	0.8530	3.19	
	B	22.1	3.4	0.4910	3.22	
	B	20.6	2.5	0.3300	3.03	
L. setiferus	M	21.0	2.7	0.3273	3.08	Schultz-Ruiz and Chávez (1976)
	F	22.3	2.2	0.2545	3.04	
	B	21.6	2.5	0.8088	3.06	
L. stylirostris	M	20.0	1.6	-0.108	2.81	Palacios *et al.* (1993)
	F	20.5	1.8	-0.096	2.88	
L. vannamei	M	18.8	5.16	-0.2050	2.70	Chávez (1973)
	F	21.3	5.16	-0.1700	2.75	
	B	20.0	3.24	-0.2927	2.32	
L. occidentalis	M	13.3	3.2	-0.0563	2.76	Rodrígez and López (1989)
	F	14.8	3.2	-0.0544	2.85	

F: females, M: males, B: grouped sexes.

(1.19 year) and 13.9cm for males (0.97 years). This could be interpreted as an indirect evidence for migration of youngest individuals from the Lake to the Gulf, where they complete their life cycle.

The commercial catches in Lake Maracaibo were made up primarily of individuals having a rapid rate of growth and 7 to 8 months of age, while adult individuals were predominant in the Gulf of Venezuela, having low growth rates and being about two years of age, characteristic of a species with a short life span.

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