NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N4499 **NAFO SCR Doc. 01/111**

SCIENTIFIC COUNCIL MEETING – SEPTEMBER 2001
(Deep-sea Fisheries Symposium – Poster)

Estimating Secondary Production in the Deep-water Shrimp *Aristeus antennatus* in the Catalano-Balearic Basin (Western Mediterranean).

by

M. Demestre and J. E. Cartes

Institut de Ciències del Mar. (C.S.I.C.). Passeig Marítim de la Barceloneta, 37-49
08003 BARCELONA E-mail: montse@icm.csic.es; jcartes@icm.csic.es

Abstract

The rose shrimp *Aristeus antennatus* (Decapoda: Aristeidae) is a dominant species in the mid-bathyal depths of the Catalan Sea (western Mediterranean) where it is the main target species in deep-sea fisheries and it is captured by trawlers at depths between 400 and 800 m depth. The bathymetric distribution of this species extends to 2 261 m in the Catalano-Balearic Basin. In the northwestern Mediterranean annual catches of *A. antennatus* have risen to 200-300 tons and it is a species of a high commercial value. In base (in place of ?? JG) of the growth parameters (*K*, L_∞ deduced from a Von Bertalanffy function) obtained for this species in the Catalan Sea off Blanes in 1988, we now estimate the P/B ratios and the secondary production of this population after applying the weight-specific growth rate (Method 3 A of Crisp, 1984) model to mensual series of size-frequency histograms. The results obtained will also be discussed in the context of the state of exploitation deduced for this species in previous studies.

Introduction

Preliminary results on the production and P/B ratios of the deep-sea shrimp *Aristeus antennatus* (Risso, 1816) are presented in this study.

Apart of its interest as fishery resource, *Aristeus antennatus* show a high ecological interest with some apparently contradictory features in its biology such as the possession of planktotrophic larvae (being the first instar the *nauplius* stage), and a recruitment of early juveniles restricted, in base to the available data, to depths below 1000 m in the Catalan Sea area which is progressively more important at higher depths. On the area of study (the catalano-Balearic Basin) *Aristeus antennatus* was distributed on the slope between 450 m (Abelló *et al*., 1989) to 2261 m depth (Cartes, 1992). The species also attain great depths in the Algerian Basin, to 1782 m in the SW of the Balearic Islands (Maynou and Cartes, 2000).

Material and Methods

We use a dataset of size-freqüencies of the red shrimp *Aristeus antennatus* based in two samplings performed in 1988. *A. antennatus* was sampled at two levels:

1. Middle slope (depth range between 450-800 m): Off Blanes in a monthly sampling performed with commercial trawlers.
2. Lower slope: (between 862-2261 m). Within the framework of the project Batimar, 3 cruises were performed at the end of June, July and October. This sampling was performed with the standardized deep-sea trawl OTSB-14 (Merrett and Marshall, 1981).

Aristeus antennatus have different size structure on the upper part of its distribution (to *ca*. 1000 m depth), where adult specimens, mainly females, dominate and below 1000 m where populations are mainly composed by males and juveniles (Fig. 1) Juveniles are progressively more important in the population with increasing depth (Sardà and Cartes, 1993; Fig. 1).

Two methods have been applied for production (and *P/B*) calculations:

1) the model by Crisp (1984), was applied to the population of the middle slope and to populations distributed below 1000 m. By this method, production is calculated via weight-specific growth rate:

$$P = \Sigma\, N_i \times w_i \times G_i \times Dt,$$

where N_i is the number of specimens in the *i*-th size class, w_i is the mean individual weight, G_i the weight-specific growth length of size class *i* and *Dt* is the sampling period. This model requires to know the growth population parameters deduced from Von Bertalanffy model. These parameters were obtained by Demestre and Lleonart (1993) for the middle slope population, while we calculated here growth parameters for the population sampled below 1000 m at 3 depth levels (1000-1400 m; 1500-1800 m and 1900-2200 m) between June to October.

2) At the interval 1500-2200, production, and *P/B* were calculated based in cohort-based (increment summation) methods. Natural mortalities for 3 cohorts were also obtained.

Results and Discussion

Recruitment basically occurred at great depths below 1400 m. and no cohorts of small juveniles (cephalotorax length CL < 20 mm) were recorded at the interval 1000-1400 m. Beyond 20 mm CL size classes overlapped between them and it was not possible to identify new cohorts.

Limits between cohorts 1,2, and 3 were established arbitrarily before the use of the Battacharya method. In general, similar cohorts were distinguished both arbitrarily and by Battacharya procedure (results not included). Growth, production and mortalities were calculated for these 3 established cohorts.

Growth of cohorts (Fig. 2). At 1400-1800 m interval, size of the smallest cohort (cohort 1) increased from a modal size of 13 mm CL (end June) to 15 mm CL (end July). Cohort 2 increased from CL 16 mm (end June) to CL 18 mm (end July) with density of size-class 16 increasing from end June to mid July. Finally, cohort 3 grew from CL 18 mm (end June) to CL 20 mm (end July).

At 1800-2200 m, where no mid July samples were available, cohort 1 increased in size from CL 13 mm (end June) to CL 16 mm (end July), and cohort 2 grew from 15-16 mm (end June) to 18 mm CL (end July). Cohort 3 was missing from this level probably due to migratory movements up to the slope with increasing size.

Assuming this scheme, the growth of *Aristeus antennatus* at June-July was linear with cohort increasing in size *ca*. 2 mm by month. Smaller juveniles than 17 mm CL are rarely captured on the upper-middle slope (to 1000 m) in a previous seasonal study performed in the same area (codends used of *ca*. 6 mm)(see Sardà and Cartes, 1997).

No recruitment of small juveniles of CL < 18 mm occurred in October. Demestre (1990) reported mature (mating) females between May-October in *Aristeus antennatus* in this same area, with peaks of reproductors in July-September. In view to the planktotrophic nature of firsts larvae (*nauplius*) of *Aristeus antennatus* it seems unlikely that the recruitment here reported at 1400-2200 m be a consequence of larvae hatched the same year 1988, but more likely *ca*. one year earlier. The smallest individual of *A. antennatus* collected with bottom trawls had a CL of 7 mm and it was captured in December (Sardà and Cartes, 1997). These specimen were captured with suprabenthic sledges, a sampling gear designed to catch vagile fauna living near the bottom (Cartes et al., 1994; Fig. 3).

Growth parameters of *Aristeus antennatus* living below 1000 m depth are in Table 1. In general, the growth coefficient *K* was higher (between 0.32-0.38) than those obtained at the middle slope where the smallest size classes were absent (see Demestre and Lleonart. 1993).

Production. P of cohorts 1,2, and 3 (Table 2) at 1500-1800 m oscillated between 1.22 gWW/ha (cohort 1) to 3.39 gWW/ha (cohort 3), with (mensual) P/Bs between 0.255 to 0.287. At 1900-2200 m, P oscillated between 2.53 gWW/ha (cohort 1) to 4.511 gWW/ha (cohort 2), with (mensual) P/Bs between 0.417 to 0.461. Comparing these results to those deduced in base of the Crisp 3A model the cumulative P by cohorts 1,2 and 3 at 1500-1800 m and 1900-2200 m was below the P deduced for the whole population using the growth instantaneous mo del (see Table 3). Thus, at 1500-1800 m ΣP of these 3 cohorts (7.885 gWW/ha/mo) represented 30.1% of the whole P. At 1900-2200 m $\Sigma P_{cohorts}$ was 7.041 gWW/ha/mo, 41.4% of the whole production.

P/B of cohorts at the lower slope ranged between 0.26-0.29 at 1500-1800 m (Table 3), higher to that estimated for all the population (0.16). P/B of 1900-2200 m cohorts were between 0.42-0.46, also higher to that of total population (0.13).

The P/B calculated for populations living at the upper-middle slope were 0.38 for females and 0.58 for males, on average higher to those obtained for deeper-smaller populations

Mortalities (M). M by month/cohort results was: At 1500-1800 m, cohort 1 (0.016), cohort 2 (0.019), cohort 3 (0.106), and at 1900-2200 m, cohort 2 (0.127). However, these results can be discussed with caution due to the apparent migration of small sizes up to the slope with increasing size and also because they are not annual, but tri-mensual, mortalities. The low M here obtained comparing to the coefficients obtained by Demestre and Lleonart (0.5 to 0.8) seems, however, consistent with extensive feeding studies performed simultaneously in the same area on potential predators of *A. antennatus*. *Aristeus antennatus* is uncommon as prey in stomach contents of deep fishes and large invertebrates (e.g. other decapods). The most important contribution to the diet of any fish was that found in the bony fish *Alepocephalus rostratus* accumulating only a low 0.06 %IRI (Carrasson, 1994; own unp. data).

Acknowledgements

Our thanks to Mr. J.M. Anguita for his assistance preparing the poster.

References

Cartes, J.E., Sorbe, J.C., (1999). Estimating secondary production in bathyal suprabenthic peracarid crustaceans from the Catalan Sea slope (western Mediterranean; 391-1255 m). *J. exp. Mar. Biol. Ecol.*, 239, 195-210.

Crisp, D.J. (1984) *Energy Flow Measurements*. In: Holme, N.A., McIntyre, A.D., (Eds.) Methods for the study of marine benthos. IPB Handbook nº 16. Blackwell Scientific Publications. pp. 197-279.

Demestre, M. and J. Lleonart (1993) Population dynamics of *Aristeus anetnnatus* (Decapoda. Dendrobranchiata) in the northwestern Mediterranean. *Sci. Mar.* 57(3): 183-189.

Table 1. Growth parameters for *Aristeus antennatus* deduced from Von Bertalanffy growth model. *** from Demestre and Lleonart (1993)

	K	***Li***(mm)
	27/06 to 28/10	
500-800 m**	0.3	76
1000-1400 m	0.35	71
1500-1800 m	0.32	70
1900-2200 m	0.38	73

Table 2. Production (P) and P/B ratios of the 3 cohorts of *Aristeus antennatus* identified on the lower slope of the Catalano-Balearic Basin (mensual values).

	P(gWW/ha)	**P/B**	**P**(gWW/ha)	**P/B**	**P**(gWW/ha)	**P/B**
	27/06 to 28/07					
	cohort 1		*cohort 2*		*cohort 3*	
1500-1800 m	1.22	0.29	3.28	0.27	3.39	0.26
1900-2200 m	2.53	0.46	4.51	0.42		

Table 3. Production (P) and P/B ratios for *Aristeus antennatus* at the lower slope of the Catalano-Balearic Basin.

	P(gWW/ha)	**P/B**	**P**(gWW/ha)	**P/B**
	27/06 to 28/07		27/06 to 28/10	
1000-1400 m			185.16	0.45
1500-1800 m	26.16	0.16	123.82	0.72
1900-2200 m	16.99	0.13		

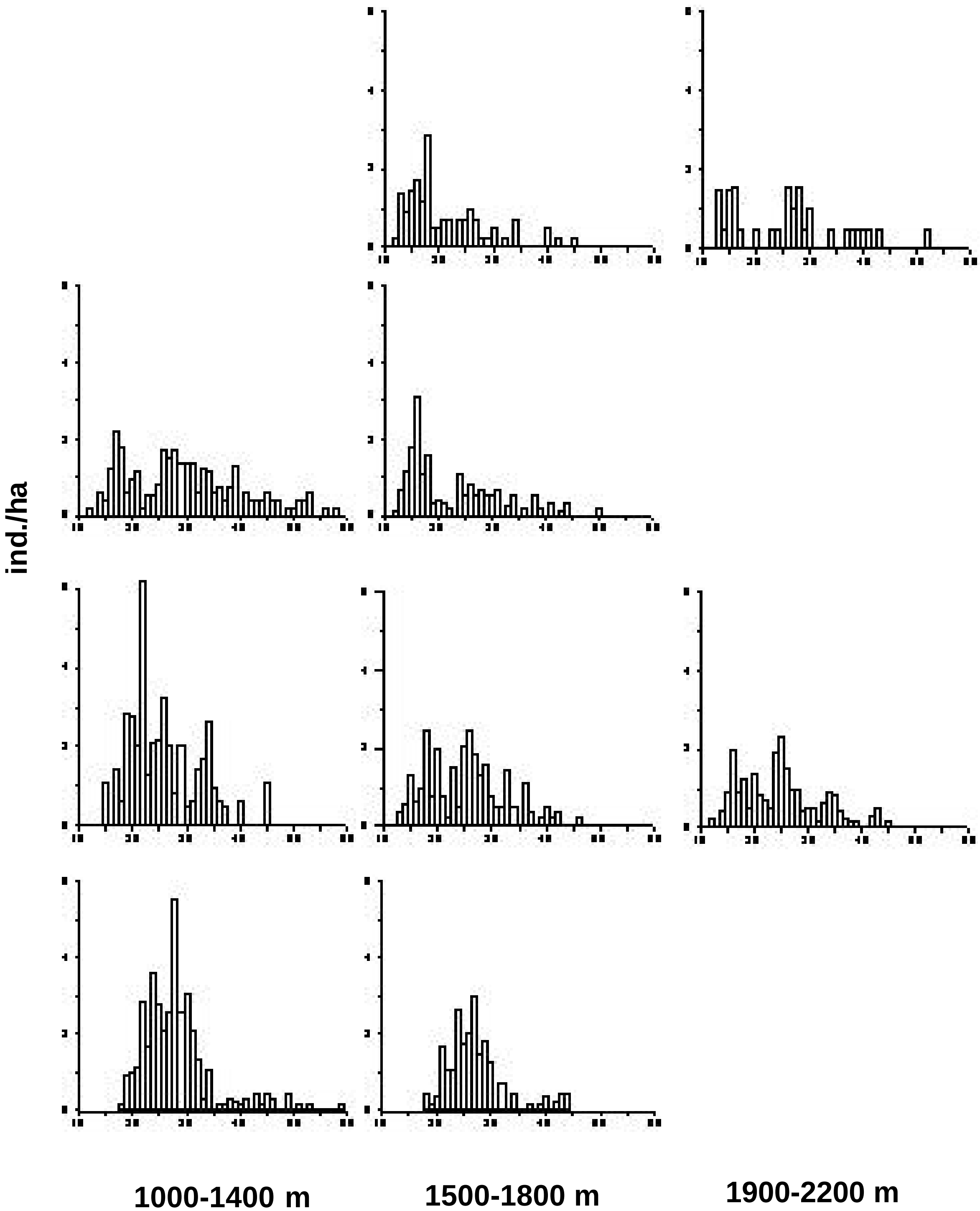

Fig. 1. Size structure of *Aristeus antennatus* on the upper part of its distribution (to *ca*. 1000 m depth).

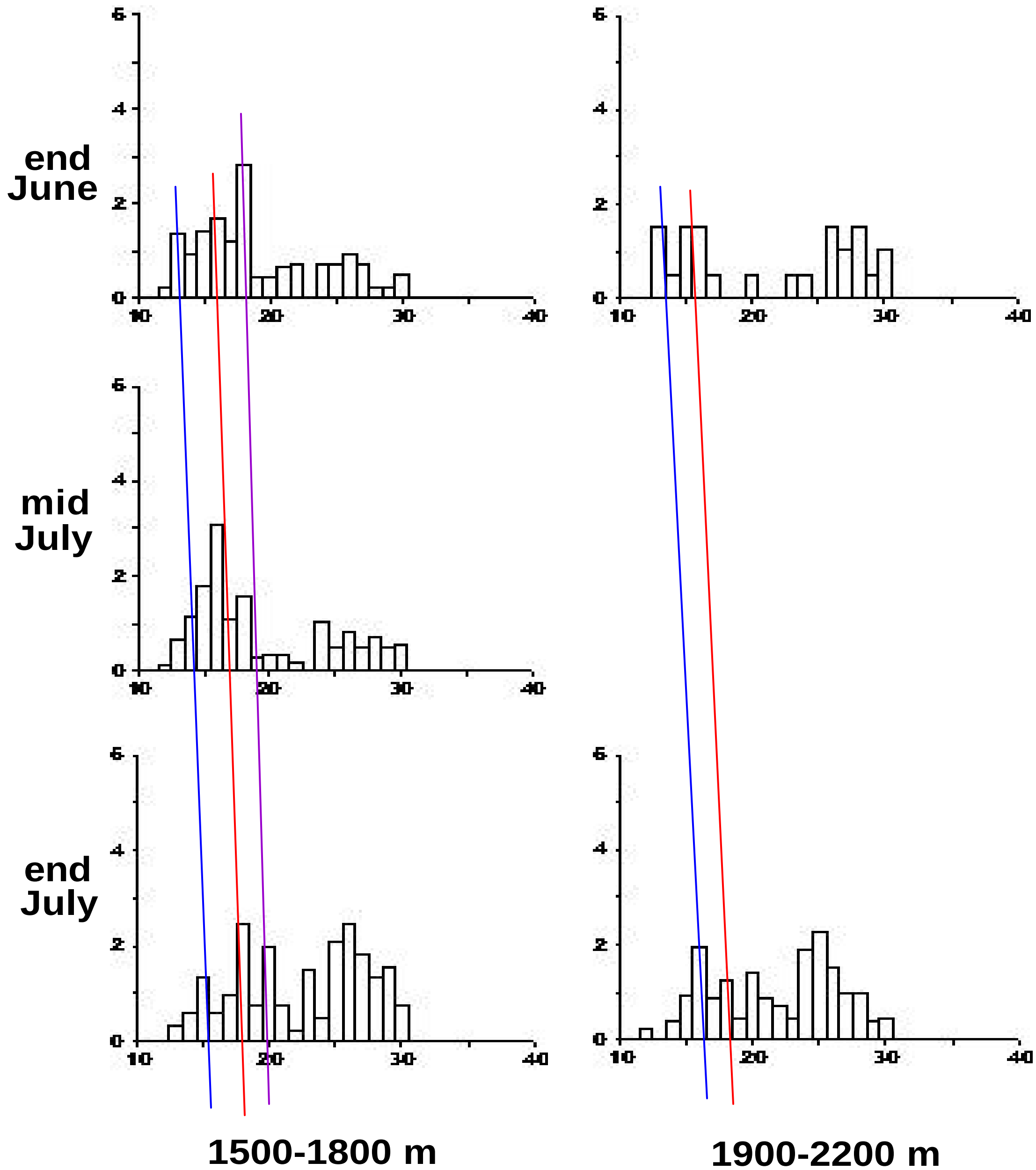

Fig. 2. Growth of cohorts between end June to October in *Aristeus antennatus* collected below 1000 m depth.

Fig. 3. The Macer-GIROQ sledge used to sample small juveniles of megabenthic species (e.g. *Aristeus antennatus*) in the deep Catalan Sea