BIOLOGICAL AND "ECONOMIC" VIRTUAL POPULATION ANALYSIS OF THE RED SHRIMP (*ARISTAEOMORPHA FOLIACEA*) STOCK OF THE STRAIT OF SICILY.

Marco L. Bianchini[1], Sergio Ragonese[2]*

[1] Soc. Porto Romano & C.N.R., Roma, Italy - imarbot@mclink.it
[2] IRMA/CNR, Mazara del Vallo (TP), Italy

Abstract

The virtual population of the red shrimp (*Aristaeomorpha foliacea*) stock of the Strait of Sicily has been reconstructed, both in terms of biomass and of economic value, running the package VIT on experimental data "mimicking" the commercial catch. The most productive class is the 2-year old (55% in weight); about 2/3 of the loss is due to the fishing mortality; the turnover rate is 140-150% for the biomass, and 160% for the value. The actual critical age is around 1.4 years, while it is 2.5 years for the virgin stock. Results indicate a slight overexploitation, similar to that estimated for the companion shrimp *A. antennatus*, but a lower turnover rate.

Keywords : Decapoda, Fisheries, Population dynamics, Sicilian Channel

Aristaemorpha foliacea is a deep-water demerso-pelagic shrimp, distributed in the Mediterranean, Eastern Atlantic, Western and Central Pacific; in Sicily, annual landings exceed 1000 tons, worth over 10 million US$. A series of trawl experiments, carried out in 93-94 and aimed at selectivity studies, were used to reconstruct the life history of the stock [1].

The virtual population can be reconstructed by means of standard VPA or thru cohort analysis [2]; the first generally used for data structured in age-classes, the second for data both in age- or length-classes. Both approaches are implemented in the package VIT [3], which has been used in this study.

For VPA reconstruction, female shrimps (≈80,000 animals) were arranged by 1-mm carapace length classes. The input parameters [4] were L_∞= 70 mm, K= 0.6 /y, t0= 0, a= 0.0013, b= 2.642, M= 0.5, F_{term}= 0.5 (constant), proportion factor= 624 (to reach a catch of 1050 tons), maturation starting at 26 mm and always mature at 39 mm CL. In the analysis by ages, the terminal fishing mortality was adjusted to F_{term}= 0.04, and so was the maturation which is nil at age 1, 94% at age 2, and always present from age 3 on, up to the last class (age 8).

When the length-weight algorithm is replaced by a length-value (potential) relationship, the output may be considered as an "economic" virtual population [4]. For the "economic" VPA, the same above parameters were used, but with the following differences : a'= 0.00042, b'= 3.708, proportion factor= 772 (a multiplier used to reach a total value of the catch of 25 billion Italian liras).

The virtual population calculated from age-restructured data has a mean age of 0.8 y, and a mean CL of 23.6 mm, while the classes most represented (in weight) are those of age 2 and age 1 (521 tons and 198 tons, respectively); the average weight of the virtual population is 944 tons. The critical age is 1.0 y for the actual stock (corresponding to a critical length of 31.6 mm), and 2.54 y for the virgin stock (critical length 54.8 mm). On a total biomass balance of D= 1375 tons, the input is totally assigned to growth, while the output is 34.3% for the natural deaths, and 65.7% for the catch; the turnover is 145.6%. There is almost no difference in the two options, standard or pseudo-cohort analysis, since the two sets of results disagree for less than 0.5%, at least with the present data.

In contrast, the VPA performed on the length classes has a mean age of 1.02 y, a mean CL of 30.0 mm and mean fishing mortality of F= 0.46, while the classes most represented (in weight) are those between 31 and 49 mm CL; the average weight of the virtual population is 1066 tons. The critical age is 1.36 y for the actual stock (corresponding to 39.0 mm), while it remains at 2.54 y for the virgin stock (54.8 mm). On a total biomass balance (D) of 1583 tons, the input is split 1:20 between recruitment and growth, while the output is 1/3 for the natural deaths, and 2/3 for the catch. The turnover is 148.5%. A few compact elements of the VPA, useful for comparisons in time or space, are presented in Table I.

Table I - "Compact" results of the VPA of *Aristaeomorpha foliacea*; data classified by CL size or restructured by age.
R/B_{mean}, ratio of recruits to mean standing biomass; B_{max}/B_{mean}, ratio of critical class to mean standing biomass; D/B_{mean}, turnover, i.e. ratio of annual biomass balance to mean standing biomass; B_{max}/D, ratio of critical class to annual biomass balance.

	R/B_{mean}	B_{max}/B_{mean}	D/B_{mean}	B_{max}/D
from age (%)	0	54.1	145.6	37.2
from length (%)	7.0	69.7	148.5	46.9

The "economic" virtual population calculated from age-restructured data has an average value of 19.5 billion liras. On a total value balance of D= 31.3 billion liras, the input is totally assigned to growth, while the output is 31.3% for the natural deaths, and 68.7% for the catch; the turnover is 160.0%. In contrast, the average value of the virtual population is 22.0 billion liras when calculated for length-structured data. The critical age for value is 1.41 y for the actual stock (corresponding to 40.0 mm), and 2.54 y for the virgin stock (54.8 mm). On a total value balance of D= 36.0 billion liras, the input is split 1:99 between recruitment and growth, while the output is 30.5% for the natural deaths, and 69.5% for the catch. The turnover is 163.9%. A few compact elements of the economic VPA are presented in Table II.

Table II - "Compact" results of the economic VPA of *Aristaeomorpha foliacea*.
data by CL size or restructured by age. $\$R/\$_{mean}$, recruits to mean standing value; $\$_{max}/\$_{mean}$, critical class to mean standing value; $\$D/\$_{mean}$, turnover; $\$_{max}/\$D$, critical class to annual value balance.

	$\$R/\$_{mean}$	$\$_{max}/\$_{mean}$	$\$D/\$_{mean}$	$\$_{max}/\$D$
value (age)	0	56.2	160.0	35.1
value (length)	1.9	68.4	163.9	41.8

The VPA is based on the assumption that the length-frequency data that are used are representative of the commercial landings; thus, results should be taken with precaution, since the data set comes from experimental hauls, and is therefore only an approximation of the population structure of the actual landings, and since the steady-state assumptions might not be fulfilled; in any case, real commercial data are not available at present for this population. In spite of these limitations, present results indicate a status of slight overexploitation, similarly to that estimated using an analogous methodology for the companion shrimp *A. antennatus* [5], but with a lower turnover rate.

Bibliographic references

1 - Ragonese S., M.L. Bianchini, L. Di Stefano, S. Campagnuolo, F. Bertolino. 1994. The selectivity and assessment of the coefficient of retention of the trawl nets used for red shrimp fishing (*Aristaeomorpha foliacea* and *Aristeus antennatus*) in the Sicilian Channel. *Final report to the European Union*, DG XIV: pp. 300.
2 - Sparre P., E. Ursin, S.C. Venema. 1989. Introduction to tropical fish stock assessment. *FAO Fish. Tech. Pap.*, 306 : 429 pp.
3 - Lleonart J., J. Salat. 1997. VIT : software for fisheries analysis - User's manual. *FAO Comput. Inf. Ser. (Fish.)*, 11 : pp. 105.
4 - Bianchini M.L. 1999. The deep-water red shrimp, *Aristaeomorpha foliacea*, of the Sicilian Channel : biology and exploitation. Univ. of Washington *Ph.D. dissertation* : pp. 482 + 17.
5 - Garcia-Rodriguez M., A. Esteban. 1999. On the biology and fishery of *Aristeus antennatus* in the Ibiza Channel (Balearic Islands, Spain). *Scientia Marina*, 63(1) : 27-37.