

DISTRIBUTION, BIOLOGY, AND POPULATION DYNAMICS  
OF *ARISTAEOMORPHA FOLIACEA* (RISSO, 1827)  
(DECAPODA, NATANTIA, ARISTEIDAE)  
IN THE NORTH-WESTERN IONIAN SEA (MEDITERRANEAN SEA)

BY

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ABSTRACT

The distribution, biology, and population dynamics of *Aristaeomorpha foliacea* (Risso, 1827) have been investigated in the north-western Ionian Sea (middle-eastern Mediterranean). A total of 9,637 specimens, 5,570 females and 4,067 males, was collected during twelve trawl surveys carried out between 350 and 750 m of depth. *Aristaeomorpha foliacea* is found on muddy bottoms with the highest densities generally in the upper 600 m and in a zone where canyons cross the bottoms.

A spatio-temporal distribution correlated to bio-ecological aspects was shown in the population. An increase in males on the fishing bottoms was shown during winter when maturity of this sex begins and shortly after mating occurs in the population. During the winter-spring season the whole population migrates to the upper slope. After the mating peak, in summer, when spawning is at its maximum, the population is again displaced to the deeper grounds.

The ovary maturation period is between May and September and the largest specimens are the first to mate and reach sexual maturity. The size of "maximum reproductive potential" is 37.11 mm carapace length.

Recruitment occurs in spring and the stock is mostly represented by young individuals. Both female and male growth rates fit a Von Bertalanffy function. Both female and male stocks appear to be "mortality-dominated" ( $Z/k > 1$ ). Estimates of the exploitation ratio ( $E = F/Z$ ) are between 0.43 and 0.62 in females and between 0.46 and 0.65 in males.

RÉSUMÉ

La distribution, la biologie et la dynamique de population d'*Aristaeomorpha foliacea* (Risso, 1827) ont été étudiées dans le nord-ouest de la mer Ionienne. 9.637 spécimens, 5.570 femelles et 4.067 mâles, ont été recueillis au total au cours de douze chalutages entre 350 et 750 m de profondeur. *Aristaeomorpha foliacea* est trouvée sur des fonds de vase avec des densités maximales généralement dans les 600 m supérieurs, et dans une zone où les fonds sont traversés par des canyons. La population montrait une distribution spatio-temporelle corrélée avec des aspects bio-écologiques. Un accroissement du nombre des mâles apparaissait sur les fonds de pêche pendant l'hiver, au début de la maturité de ce sexe et peu après l'accouplement dans la population. Pendant

la saison hiver-printemps, la population entière migre vers la partie supérieure du plateau. Après le pic de la reproduction, en été, quand la ponte est à son maximum, la population se déplace de nouveau vers de plus grandes profondeurs.

La période de maturation ovarienne est entre mai et septembre et les plus grands individus sont les premiers à se reproduire et à atteindre la maturité sexuelle. La taille du "potentiel reproductif maximum" est de 37,11 mm de longueur de carapace.

Le recrutement survient au printemps et le stock est principalement représenté par des individus jeunes. Le taux de croissance des mâles et des femelles concorde avec la fonction de Von Bertalanffy. Les stocks mâles et femelles apparaissent comme "mortality-dominated" ( $Z/k > 1$ ). Les estimations du rapport d'exploitation ( $E = F/Z$ ) se situent entre 0,43 et 0,62 chez les femelles et entre 0,46 et 0,65 chez les mâles.

#### INTRODUCTION

The giant red shrimp *Aristaeomorpha foliacea* (Risso, 1827) is a species widespread in the eastern and western Atlantic, Indian Ocean and western Pacific, in the waters of Japan, Australia, New Zealand and in the Mediterranean Sea (Holthuis, 1980).

In this latter basin *Aristaeomorpha foliacea*, together with the blue and red shrimp *Aristeus antennatus* (Risso, 1816), represents the most important biological resource generally distributed at depths between 300 and 700 m over a large portion of the continental slope.

The knowledge of the distribution of these two shrimps in the Mediterranean indicates a longitudinal gradient of their abundance. In fact, in the western basin the blue and red shrimp greatly outnumber the giant red (Sardà, 1986) while the abundance of this latter species increases eastwards as far as the highest concentration found in the Sicilian Channel (Ragonese, 1993). Slightly beyond this area, in the Ionian Sea, *Aristaeomorpha foliacea* is again less abundant than *Aristeus antennatus* (see Matarrese et al., 1992; Tursi et al., 1993). Of the easternmost side of the Mediterranean no information is available on these shrimps.

Although a large amount of information has been collected in the last two decades, contributing to the knowledge of the biology of both species, their spatio-temporal patterns are still not well understood.

Aspects of the life cycle and population dynamics also remain open questions for both species. Larvae and postlarvae distribution are still almost completely unknown; recruitment and growth patterns change over relatively short scales and uncertainty exists in the definition of life span. The main problems of the use of length-frequency data in population dynamics studies of shrimps are the representativeness of the samples and the degree of overlapping between the different size components. In areas with canyons length-based methods, such

as modal progression analysis, lead to misinterpretation of data and apparent "negative" growth can be explained as an effect of the size dependent migration into zones unsuitable for trawling (Sardà et al., 1994). Moreover, changes in recruitment pattern may have a marked influence on the estimate of population parameters.

In the north-western Ionian Sea, despite both *Aristaeomorpha foliacea* and *Aristeus antennatus* representing the target species of deep-water bottom trawling, the information on their bio-ecology is rather limited (Matarrese et al., 1992; Tursi et al., 1993; D'Onghia et al., 1994; Matarrese et al., 1994; Matarrese et al., 1995). This information is based on data collected at long time intervals between surveys (six months) and always during the same seasons (spring and autumn), so that aspects of population biology and dynamics of deep water shrimps were not completely covered.

Recently, research targeted on the distribution and population biology of these shrimp species in the north-western Ionian Sea has been funded by the European Commission. The aim of this paper is to provide a contribution to the knowledge on distribution, reproductive biology and population dynamics of *Aristaeomorpha foliacea* in this basin of middle-eastern Mediterranean Sea.

#### MATERIALS AND METHODS

The whole study area covers a surface of about 1,000 square miles (3,400 km<sup>2</sup>) between Cape S. Maria of Leuca (Lecce, Italy) and Cape Spartivento (Reggio Calabria, Italy) and depths from 350 to 750 m (fig. 1).

Twelve trawl surveys were carried out, at two month intervals, on the whole area between August 1993 and July 1995. A commercial 75 tons gross tonnage vessel, with 360 Hp engine, was chartered. It was equipped with a nylon otter-trawl net with 40 mm stretched mesh (20 mm side) in the cod-end. The horizontal and vertical net openings were measured for each depth by means of the SCANMAR sonar system (Fiorentini et al., 1994). They depended on various factors (depth, warp length, towing speed, etc.) and ranged from 21.71 to 25.09 m and from 0.8 to 0.73 m, respectively. The vessel speed, measured by using GPS, was maintained at 2.5–2.8 knots.

For each survey the hauls were randomly sampled within the study area (Fogarty, 1985). An average total of 17 hauls was carried out during each survey. The number of individuals for each haul carried in three investigated zones during the twelve surveys are reported in table I. The depth range surveyed was between 350 and 750 m. Fishing was restricted to day-light hours and the hauls lasted two hours each on average.

TABLE I  
Number of individuals *Aristaeomorpha foliacea* (Risso, 1827) caught in each haul in three areas in the north-western Ionian Sea

Hauls	Northern area										Central area									Southern area									
	1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7			
Survey	N of individuals																												
August '93	12	219	0	24	10	10					80	29	0	0	0	25	0	0	1				3	16	160	119	395	0	
November '93	11	0	6								0	8	173	0	20	0	0	0				793	95	3	13				
January '94	3	0	182								0	1	2	1	46	13	0	0				104	561	40	246				
March '94	18	34	100	5	0	119					76	96	0	5	25	1	0	3				0	0	0	0				
May '94	22	0	4	1	7	0	1	1	2		30	0	0	7								7	0	2	0	49			
July '94	0	0	65	2	23						1	7	0	0	1							0	16	0	1	7	120	0	
Aug.-Sept. '94	0	112	7	3	1						0	36	7	0	0	0						0	3	8	72	0	26	0	
Oct.-Nov. '94	0	364	14	26							0	274	1	0	520							0	364	14	26				
January '95	136	90	0	0	29	6					0	150	0	0	26	3	1	16	2			17	6	200	15	500			
March '95	219	17	0	188	0						2	0	0	0	2	2	6					46	28	0	20	0	0		
May '95	0	176	0	7	271	70	31				18	71	14	98								5	23	0	72	54	95		
July '95	0	0	4	20	25	55	60				60	0	0	4	0	16						80	0	0	666	0	17		

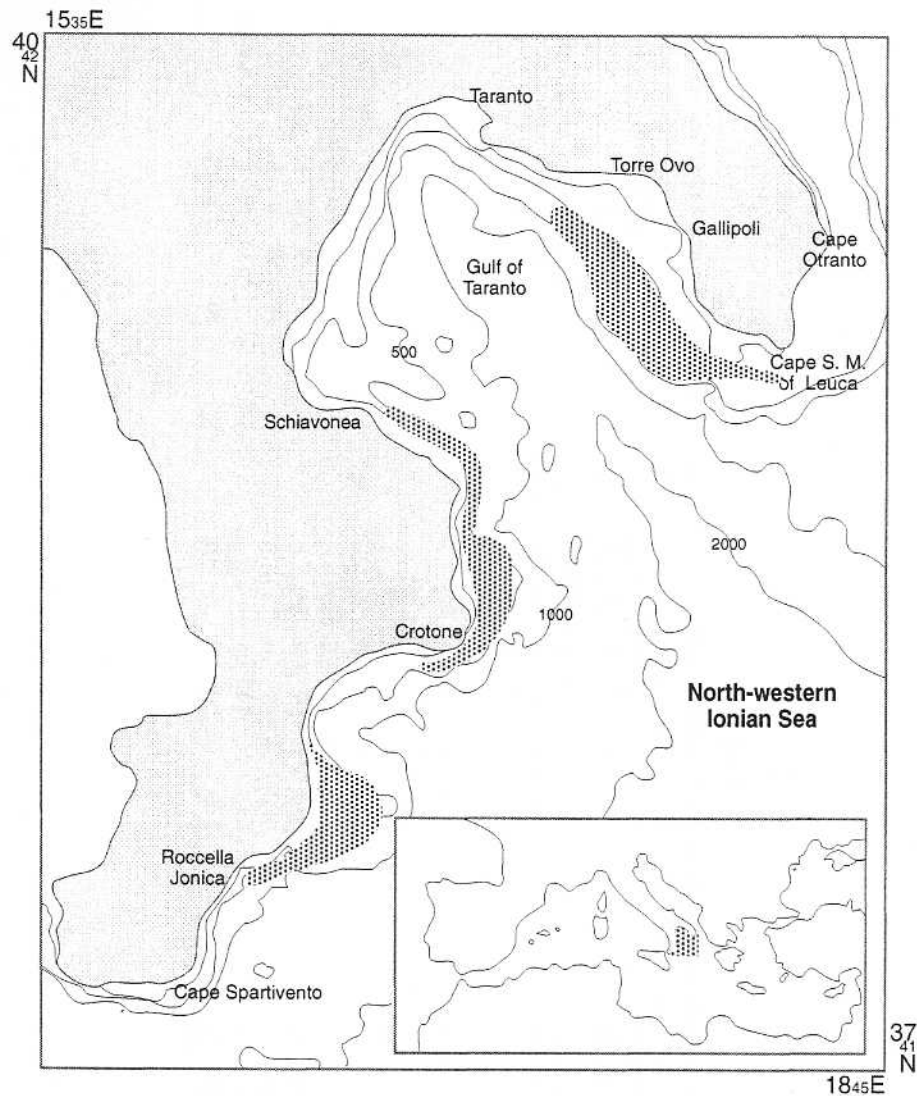


Fig. 1. Areas investigated in the north-western Ionian Sea from August 1993 to July 1995. Northern zone (Gallipoli fishery), central and southern zone (Crotona fishery).

The number of individuals of *Aristaeomorpha foliacea* for each haul swept area was regarded as a measure of density ( $N/km^2$ ). The "swept area" was estimated according to the wing spread of the net and the speed of the vessel (Pauly, 1983). The former changed with the length of wire which in turn depended on the depth of the haul (Fiorentini et al., 1994).

Density data were analyzed to evaluate eventual differences between surveys, depths and the three zones of the north-western Ionian Sea where shrimps are

