THE CONTROLLED BREEDING AND REPRODUCTION OF THE *PALAEMON ELEGANS* ROCK SHRIMP RATKE 1837 ON THE ROMANIAN LITTORAL

Tania ZAHARIA[1], *Dragos MICU*[1], *Sanziana MICU*[2]
[1] National Institute for Marine Research and Development "Grigore Antipa", Constanta
[2] "Alexandru Ioan Cuza" University, Iasi

Abstract

During the past years, in many countries of the world, shrimp consumption has registered a significant increase due to their nutritional value. Out of the 320 shrimp species, about 100 are suitable for human consumption, controlled and artificial breeding. As far as the year 1997 is concerned (cf. FAO Statistics), 941 thousand tons of shrimps were obtained (with a value of 6,074 mil. USD $). Based on the general criteria of interest for captivity growing, two of the 12 species present in the Black Sea are of interest for breeding in captivity, namely *Palaemon adspersus* (grass shrimp) and *Palaemon elegans* (rock shrimp). As for the Romanian littoral, they are consumed by the local population and they are not objects of industrial fishing. Lately, many investors have shown their interest in the exploitation of the natural shrimp stocks of the Romanian littoral. In these circumstances, the practicing of mariculture would diminish the anthropogenic pressure on the natural stocks produced through fishing, and would ensure the continuity of the market supplying.

The main objective of our research was to carry out reproduction and breeding experiments of the two above mentioned species, aiming to establish the methods and technologies for practicing mariculture on the Romanian littoral. The *P. elegans'* spawners were captured from nature and were put under captivity growing conditions, in May 2004, in concrete basins of 75 cm capacity, supplied with marine water and under pressure air. In July, after the specimens had been spawned and following the metamorphosis period, the larvae were raised and wintered in captivity, with food distribution (until September 2005). The obtained results, expressed in growing and survival parameters, are encouraging and will represent the basic elements in establishing the breeding and reproduction technology of these valuable species.

Key words: reproduction, breeding, rock shrimp, Romanian littoral

Introduction

Among crustaceans, the decapods have attracted attention especially due to the practical aspects, being searched for their high nutritive value. Out of the 49 species of decapods living in the entire Black Sea basin, 32 were identified on the Romanian littoral. In the sea economy, the decapods are playing an important role, as they constitute food for many commercial fish species, dolphins and sea birds, as well as for human consumption; their planktonic larvae are food for planktonophagous fish species. 20 of the 49 decapod species were found in the intestines of 35 fish species (Bacescu, 1967, Gomoiu&Skolka, 1998). So, the decapods contribute actively not only to the enriching of the benthic nutritive base, mainly on the continental shelf of the sea, but also to the planktonic one, through their larvae.

Among decapods, two shrimp species play an important role in exploitation - *Palaemon adspersus* and *Palaemon elegans*; although small-sized species (5-6 cm length), they are consumed by people, especially from the coastal settlements, constituting ideal candidates for mariculture practicing. Through their breeding, high productions are to be obtained, with comparable prices with those achieved in the industrial fishing of the species. Obtaining biologic material through mariculture will mitigate the pressure on natural stocks, exerted through industrial fishing, a high quality material being delivered on market as well.

The present paper deals with the results of experiments developed between 2004 and 2005, aiming to assess the reproduction and growing possibilities in controlled conditions of the *P. elegans* Rock Shrimp.

Materials and methods

The experiments were carried out in the NIMRD experimental base (outdoor concrete basins, supplied with marine water and air under pressure), and in laboratories, using different experimental capacities, as follows:

- 9 outdoor concrete basins (5 x 10 x 1.5 m), supplied with water and air under pressure (Photo 1);

Photo 1 – Outdoor basins (NIMRD original photo)

- laboratory for algae cultivation: 6 fiberglass tanks of 120 l, different glass capacities for intermediary cultures; the laboratory is equipped with a supplying source for marine water, a filtration device, an installation for water aeration with under pressure air (Photos 1 and 2);

Photo 2: Filtration marine water device Photo 3: Microphitae algae culture (NIMRD original photos)

- laboratory for invertebrate growing: 14 PVC tanks and 8 Zug Weiss supplied with marine water and under pressure air, and lightened with neon tubes (Photos 4 and 5).

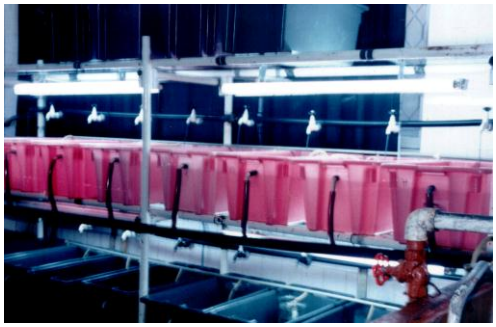


Photo 4 - PVC tanks Photo 5 – Zug Weiss for *Artemia* nauplii
(NIMRD original photos)

The biologic material consisted in:

- strains of alochtonous and autochthonous microphytes (*Tetraselmis suecica, Nannoclhloris oculata* f. *atomus, Isochrysis* sp. (clone Tahiti), *Pavlova lathery, Chaetoceros calcitrans* f. *pumillum, Chaetoceros* sp.);
- larvae (*nauplii* and *metanauplii*) of *Artemia,* obtained from cysts (originated from Salt Lake, USA);
- *P. elegans* adults and juveniles, collected from the natural environment and/or from own experiments, through controlled breeding and growing;

The work methods used were the ones generally used in aquaculture, namely "clear water" or "green water", after case.

For the physico-chemical parameters, the determinations were carried out following the standard methods, the samples being processed in a RENAR accredited laboratory.

Results and discussions

Short description of *P. elegans* Ratke 1837 – Rock shrimp

At the first reproduction, the females have 3-3.5 cm length; the longest one having a length of 5.8 cm. The living animal is beautifully colored, with brown stripes on the transparent body, blue nuances, a light blue making visible the pereiopods articulations. The eyes are black, the peduncle is green-bluish when it is alive, and red-brown when the material is stored (Photo 6).

Photo 6 – Rock shrimp *P. elegans* Ratke 1837

P.elegans is the ordinary shrimp found on the entire Romanian littoral, on the sandy bottoms covered with algae (Bacescu, 1967). Generally euryhalinic and eurybiontic species, it reaches dense populations even on the breakwater of Sulina, after years running with short-duration high floods. Usually, the species stays in the sunlight, climbing on the sidewalls of rocks, being easier to be caught in the dredge. The fact that most individuals were caught in the nocturne dredge proves that the species has a nictemeral activity. It is a rocky species. During the storms it can migrate offshore or hide under rocks, so fewer *P.elegans* individuals are thrown on the beaches than other crustacean species. The species tolerates winter better then *P.adspersus*, disappearing only under 0-1^{o}C.

Not even high turbidity influences this species. It lives in agglomerations, densities of 200-300 ind./mp being signaled on the rocky walls, especially vertically.

This species has a carnivorous regime, even predatory, being a large consumer of animal scraps. Generally, it rarely leaves the sea floor, entering the nocturnal plankton.

It reproduces from late May up to September. The eggs have a green-yellowish color.

Being considered as an independent species, or sub-species (after some authors), the sea shrimp is known only in the lusitanic sector of Atlantic Ocean, the Mediterranean Sea, the Adriatic and the Black Sea.

Reproduction and breeding of authohtonous Peneids

P. elegans' spawners were caught from the natural environment in late May, both in 2004 and 2005. The biometric aspects of the selected female and male lots (n=40) are shown in Table 2 and 3, and those regarding the reproduction in the 2004 phase.

Table 2 – The biometric aspects regarding the selected *P.elegans* male lot (n=40)

Parameters	Total length (mm)	Cephalotorax length (mm)	Weight (g)
Mean	30.8	13.25	0.27905
Minimum	25	10	0.165
Maximum	37	17	0.405

Table 3 – The biometric aspects regarding the selected *P.elegans* female lot (n=200)

Parameters	Total length (mm)	Cephalotorax length (mm)	Weight with eggs (g)	No. of eggs
Mean	43.35	20.07	0.98768	585
Minimum	30	11	0.495	196
Maximum	58	25	2.25	1500

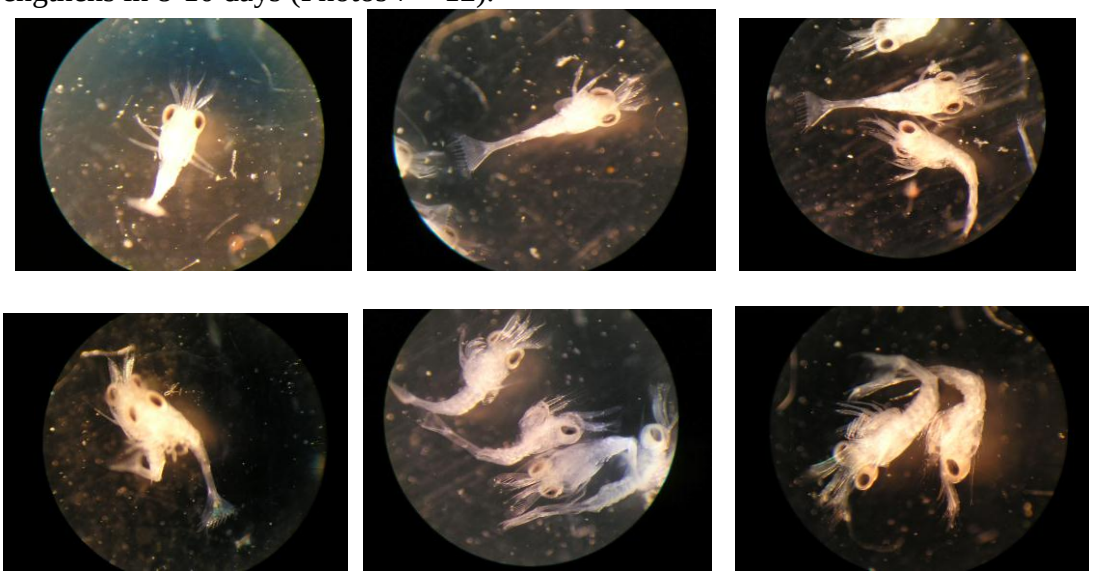
The pronounced sexual dimorphism is to be remarked, the females being longer then the males, some specimens reaching almost 6 cm.

The number of eggs/female, an extremely important parameter in controlled reproduction, was around 590 eggs/female (ranging from 198 to 1,500 eggs/female). The females caught in May carried eggs under the cephalotorax; they laid the eggs in late

June – early July. 83 egg-bearing females were used in reproduction, about 48,000 larvae being obtained.

The larval development takes place in complicated metamorphosis, generally passing through seven stages: *nauplius, metanauplis, protozoea, zoea, mysis* and *decapodit*.

The decapods pass through a series of sloughs, corresponding to the different larvae stages. The adults are continually growing, losing periodically their old external skeleton. The slough process is one of the most important physiological processes of the decapods life. The whole process lasts for about two weeks, and the external skeleton strengthens in 8-10 days (Photos 7 – 12).



Photos 7-12 – Larval stages of rock shrimp metamorphosis

(NIMRD original photos)

The females were separated by the males and isolated in a little net cage with mesh size of 2 mm, placed in an outdoor concrete basin (Photo 13). The females were fed daily, supplied *ad-libitum*, the food consisting in small-sized marine fish mixed with fish flour.

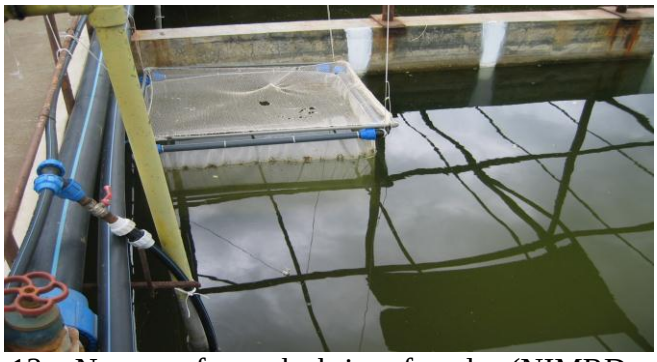


Photo 13 – Net cage for rock shrimp females (NIMRD original photo)

After the females laid down the eggs, the larvae passed in basin through the mesh net, and the females they were removed from the basin in order to prevent the cannibalism phenomenon.

During the entire duration of the experiments, the physical-chemical parameters evolution of the water was put under observation (Table 4).

Table 4 – The variation of physical-chemical parameters of the water of *P.elegans* breeding (limit values: minimum-maximum)

Code	T°C	Salinity	pH	O2 cm^3/l	Organic matter mgO2/l	PO4 µM/l	SiO4 µM/l	NO3 µM/l	NO2 µM/l	NH4 µM/l
Source	14,0 24,0	11,14-15.23	8,1-8.2	3,71-5,39	2,12 - 2.94	0,06-0,60	14,5-18,1	5,50-15,3	0,39-0.53	2,50-7,38
Indoor basin	15,5-23,0	11,14-15.72	8.1-8.2	4.96-6.13	1,96-2,78	0,04-1.24	12,6-16,3	7,00-17,61	0,41-0,81	4,42-11,94
Outdoor basin	14,2 28,3	14,25-16,02	8,3-8,4	5,77-6,84	6,37-7,02	0,30-0,74	3,1-6,6	1,22-3,10	0,38-0,23	2,05-2,54
C1 PVC indoor tank	15,7-22,7	10,89-15,97	8,1-8,2	3,76-5,85	1,47-3,59	0,08-0,98	13,6-17,0	6,79-20,03	0,24-1,03	4,54-13,04
C2 PVC indoor tank	15,7-22,7	10,77-16,09	8,0-8,1	4,23-6,27	1,63-3,10	0,06-0,98	10,1-17,0	6,57-20,18	0,45-0,59	4,06-9,04
C3 PVC Indoor tank	15,7-22,7	10,53-15,07	7,9-8,2	3,78-6,34	1,63-2,78	0,12-0,84	7,5-17,0	6,20-18,03	0,40-0,63	4,26-8,90

The shrimp breeding*:* after the testing, in 2004, of small volume experimental capacities (maximum 70 l), experiments were made in outdoor concrete basins of 75 mc, where the wintering took place. In 2005, the experiments were developed in two concrete basins, one with juveniles obtained in 2005, and other one with adults obtained in 2004. In the latter basin, the natural reproduction took place, consequently 57% adults (2004 reproduction, mean total length 31.47 mm, August 2005), 43% juveniles (natural reproduction 2005, mean total length 18.07, August 2005) were found at the periodical sampling. The total production obtained in the basin, in early September 2005, was of 2.264 Kg, about 452 Kg/Ha (Table 5).

Table 5 – The experimental variants of *P.elegans* breeding

Code	Period	Age classes	Initial density	Flow l/min.	Initial weight g/ind.	Observations
Outdoor basin-juveniles	May-September 2005	juveniles	500	Intermittent supplying	egg/ 0.118	Reproduction May 2005
Outdoor basin-adults	May 2004-Sept.2005	Juveniles and adults	250	Intermittent supplying	egg/ 0.449	Reproduction May 2004 and May 2005

The *P. elegans* population dynamics from the outdoor basin – adults, in June 2004 – August 2005 period, is shown in Table 6 and Picture 1.

Table 6 - The *P. elegans* population dynamics from the outdoor basin, in June 2004 – July 2005 period

No. of egg-bearing females June 2004	Total no. of juveniles August 2004	Total no. of adults Oct. 2004	Total no. (adults and juveniles 2005 August 2005
60 ♀♀=35.000 eggs	25.000	15.660	22.900**:** 6.400 adults 16.500 juveniles 2005 Production: 4 800 g / basin (96 g/m^2 or 64 g/m^3) (458 ex/ m^2 or 305 ex/ m^3)

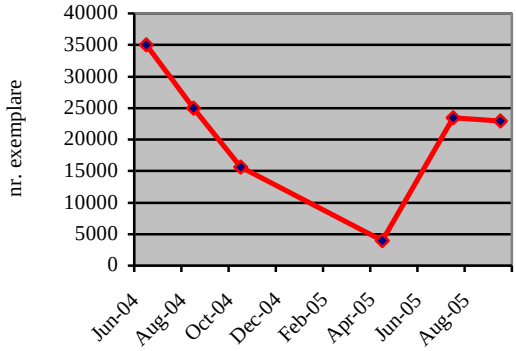


Fig. 1 – Dynamics of shrimp populations from the experimental basin

Photo 14 – *P. elegans* obtained controlled breeding (NIMRD original photo)

A severe depletion of the individuals number during wintering was noticed; and the increase, after the 2005 breeding season (the population almost doubled). Thus, it is difficult to establish the survival rate for the entire breeding period. It must be mentioned that the temperatures remained very low for long time during the 2004-2005 winter, leading to the freezing of the water from the basin; in order to provide the necessary solved oxygen, ice holes were practiced. We consider that an increased survival percentage can be assured if the wintering water basin will have minimum depth of 3 m, sheltering areas and a continuous current of marine water.

At temperatures between 4^{o} and 15 ^{0} C, the shrimps were fed *ad libitum* with wet food (paste of marine small fish mixed with vitaminized fish flour), and with granulated food under these temperatures. The granules small leaf-like Nutrafin (made in Taiwan), composed of fish, plankton, shrimps, soya, aquatic plants, fish liver as well as vitamins (A, E, B, B1, B2, B6, B12, C and folic acid), and minimum 46% protein, were very well accepted In order to improve the feeding regime, both the juveniles and adults received *nauplii* and *metanauplii* of *Artemia.* The growing rhythm was constant during the warm season, a stagnation being registered during the winter, due to the lower temperatures (Fig. 2).

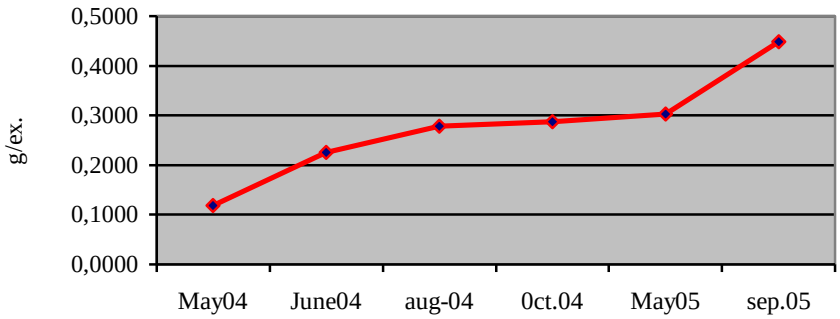


Fig. 2 – Growth rhythm of shrimps in the experimental basin

Conclusions

In accordance with the assessment criteria of the species suitable for mariculture and taking into consideration our results followed the experiments and observations, we can appreciate that:

- The species is able to resist to the region climate, being an autochthonous species;
- The growth rate is high enough; the species is not demanding at feeding; the breeding is cheap, even at an intensive scale;
- The species is able to reproduce in controlled conditions, in order to provide viable juveniles to be used in breeding;
- The candidate accepts and consumes artificial food, which is abundant and cheap;
- The species is accepted by the consumers; it is consumed currently on the Romanian littoral;

- The species tolerates high densities; it is a gregarious and social species;
- The species is resistant to sickness and tolerates repeated handlings.

Note

The research was developed within the Project " The establishment of the measures/possibilities and conservation /rehabilitation ways of the marine natural bivalve populations and crustaceans, through mariculture" (NUCLEU Project: PN 03-14 03 02).

References

1. BACESCU M., 1967 – Fauna RSR Crustacea, Decapoda, vol. IV, fasc.9, Ed. Academiei: 97-113
2. BURA. M., 2002 – Special Aquaculture, Frigs, Crustaceans and Molluscs, Orizonturi Universitare, Timisoara, 363 p.
3. GOMOIU M.-T., SKOLKA M., 1998 – Evaluation of Marine and Coastal biological Diversity at the Romanian Littoral – a Workbook for the Black Sea Ecological Diversity – Annals of the "Ovidius" University Constanta, Biology – Ecology series, vol.II, year II, supplement, 167 p.