Scientific Papers. Series D. Animal Science. Vol. LXI, Number 2, 2018
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

Rapana venosa - NEW EXPLOITABLE RESOURCE AT THE ROMANIAN BLACK SEA COAST

Cristian-Sorin DANILOV[1], George TIGANOV[1], Eugen ANTON[1], Magda-Ioana NENCIU[1], Victor Nicolae NITA[1], Victor CRISTEA[2]

[1]National Institute for Marine Research and Development "Grigore Antipa",
300 Mamaia Blvd., 900581, Constanta, Romania
[2]"Lower Danube" University of Galați, Faculty of Food Science and Engineering,
47 Domneasca Street, Galați, Romania

Corresponding author email: cdanilov@alpha.rmri.ro

Abstract

Starting with 2009, Romanian Black Sea fishery catches have recorded an increasing trend. Yet, this is not the consequence of a massive restoration of fish stocks or an increase of fishing effort, but the result of shifting the target species. The invasive gastropod Rapana venosa (Valenciennes, 1846) has raised the interest of economic operators due to its low exploitation costs compared to other valuable species (turbot, for instance). At the Romanian coast, fishing for R. venosa was first performed only using divers, because this is a method which provides high selectivity of the catches and protection of habitats. Starting with 2013, beam trawls were legalized and started to be used (Order no. 1696 of 11.07.2013, Order no. 400 of 2013). After the legalization of the beam trawl, the catch increased 2.27 times compared to 2012 (from 588 t in 2012 to 1,338 tonnes in 2013), the TAC being carried out at a rate of 23.5%. Many commercial companies in the field have shifted their business towards purchasing or manufacturing this type of gear, corresponding to their vessel capacity. From the selectivity point of view, the gear used for rapa whelk fishing (beam trawl) does not retain immature specimens of R. venosa and no juvenile fish belonging to certain demersal fish species (gobies, red mullet, whiting). Yet, there is some concern on the potential effects of beam trawl on the seabed, which should be investigated in the future. Also, as a consequence of exploitation, the drop of R. venosa populations was acknowledged, which requires future research meant to determine the actual stock size and total allowable catch (TAC), aiming at underpinning the rapa whelk fisheries on a scientific background and to reconcile these economically valuable activities for coastal communities with nature conservation.

Key words*: beam trawl, catches, invasive species, rapa whelk, resource.*

INTRODUCTION

The gastropod *Rapana venosa* originates in the Far East (Sea of Japan, South China Sea) and it is documented that it was first introduced in the Pontic basin around 1930-1940 (Grossu, 1986, 1993). It was first sighted and reported around the Novorossysky Port in 1947. Being a predator, with no natural enemies and competitors for food, *R. venosa* spread quickly eastwards, on the coasts of the Caucasus, and later to the south and west, decimating native oyster banks (*Ostrea edulis*, Linnaeus, 1758). In 1949, the rapa whelk was reported in Gudautsk, in 1954 in Yalta and Sevastopol, on the Crimean coasts (Golikov and Starobogatov, 1972), and in 1963 it was first sighted at the Romanian coast (Gomoiu, 1972; Skolka and Gomoiu, 2004) (Figure 1).

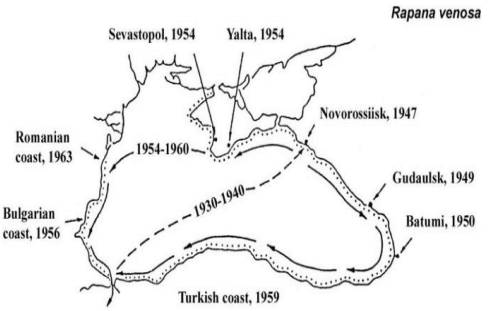

Figure 1. Expansion routes of *R. venosa* in the Black Sea (after Gomoiu and Skolka, 1996)

After its acclimation in the Pontic basin, *R. venosa* entered the Bosphorus Strait and spread into the Mediterranean Sea (Grossu, 1986; Goulletquer, 2002).

A major contribution to the rapid expansion of this gastropod in the Black Sea was held by the fact that it virtually exterminated oyster and mussel banks from the areas initially covered by these bivalves and, developing huge populations, it was necessary for it to seek other areas with unaltered food resources.
As such, during the 1950s, *R. venosa* recorded an exponential development, the population effecttives reaching considerable values. Subsequenly, as a follow-up of decreasing food resources, the rapa whelk population effectives dropped significantly.
The species tolerates well a wide range of temperatures, salinities and oxygen concentrations (Zolotarev, 1996; Mann and Harding 2003).
The rapa whelk has separate sexes. Its spawn has the appearance of white filaments, minimum 7 mm and maximum 30 mm high (Harding et al., 2007). It breeds yearly and starts laying the eggs at an 18^0C water temperature. Spawning continues for 11-15 weeks. The average female lays between 150-200 eggs/week (Harding et al., 2008).
After hatching, veliger larvae remain in the water column for 14-80 days, before fixating on the seabed, thus insuring a great dispersion potential for this species. A study performed by Harding (2006) showed that larvae fixate at a shell length of 1.2 mm, after a planktonic larval period which ranges between 24-42 days.
The great plasticity of the planktonic period increases the survival and dispersion probability. Larvae tolerate a wide range of salinities, up to 10‰, the survival threshold being 7‰ six days after hatching (Mann and Harding, 2000).
Imposex individuals (a pathologic state which causes the development of male gonads in females) have been reported in the rapa whelk (Mann et al. 2006).
This paper is an outline of the current state of the invasive *R. venosa* fisheries at the Romanian Black Sea coast.
The state-of-the-art knowledge on *R. venosa*'s biology is due to the research of Romanian and Russian experts during 1960-1990. However, during the past 20 years, various changes in the environmental conditions and the exploitation manner of this gastropod have occurred. The species was studied at the Romanian coast by Gomoiu (1972), in collaboration with other researchers.
Some studies on the rapa whelk stock dynamics in relation to the recent commercial exploitation have been performed at the Romanian Black Sea coast.
The biology, ecology and state of alien species in the Black Sea have been studied, starting with the early 20^{th} century, by several authors: Antipa (1941), Bacescu and Carausu (1964), Golikov and Starobogatov (1972), Gomoiu (1972), Grossu, (1986), Teaca et al. (2006), Zaitsev and Ozturk (2001) etc.
The knowledge of the breeding, growth, development and distribution conditions of this species in territorial waters can be useful in elaborating the harvesting and stock management measures (Tiganov et al., 2017).
Currently, due to its gastronomic properties, it has become object of industrial scale exploitations in Romania, as well. Only a small share of this biological resource remains in the domestic market, the rest being exported.
In recent years, the drop of *R. venosa* stocks has steepened in Black Sea countries, as a consequence of commercial exploitation of the species (food source, also known for aphrodisiac properties) and export of large amounts to Far East countries (Turkey exports yearly 800 tons to Japanese markets).

MATERIALS AND METHODS

This paper is based on the results obtained by research performed during 2009-2016 with industrial fishing vessels, equipped with beam trawl fishing gear (Figure 2), as well as with boats for specialized manual harvesting (with divers) (Figure 3).

Figure 2. Beam trawl fishing (Photo: Danilov)

Figure 3. Manual harvesting by diver (Photo: Danilov)

A total of 10 surveys with vessels (152 hauls, 76 trawling hours) and 10 hand harvesting surveys with divers were performed (around 50 hours).

The work areas were the following (Figure 4):

- Northern sector - between Cape Midia and Chituc, on the 18-25 m isolines;
- Southern sector - between Mangalia - Vama Veche, at 3-12 m depths.

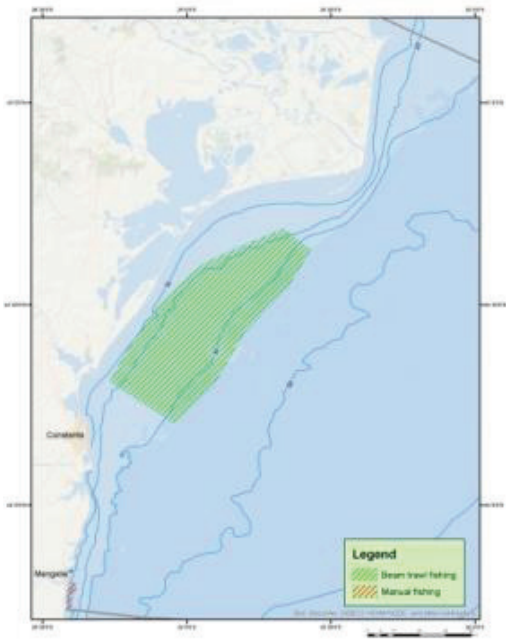

Figure 4. Map of *R. venosa* fishing areas

RESULTS AND DISCUSSIONS

During 2009-2012, rapa whelk fishing was made only by hand, by divers, being the only harvesting technique allowed by legislation. Starting with 2013, beam trawls were legalized and started to be used (Order no. 1696 of 11.07.2013, Order no. 400 of 2013, setting-up the fishing prohibition periods and areas, as well aquatic resources protection zones in 2013).

Catches have increased from one year to the other, from approximately 1.7 t (2009) up to 6,504 t (2016) (Figure 6).

Once the beam trawl use has become legal, many commercial companies in the field have shifted their business towards purchasing or manufacturing this type of gear, corresponding to their vessel capacity.

As such, the number of vessels equipped with this type of gear has increased yearly, and many of them have two beam trawls towed simultaneously (Figure 5).

During the analyzed time frame (2016), 6,435 *R. venosa* individuals were measured.

The length ranged between 4 and 10 cm, individuals with 6-8 cm were dominant. Individual weight ranged between 20 and 177 g, with a mean weight of 76.87 g and mean length 7.38 cm (Figure 7).

The length-weight relationship was calculated according to the equation $W(i) = q.L^b(i)$, where:

W(i) - body weight **i;**
L (i) - total height **i**;
q and **b** - parameters

The correlation between height - weight resulted in a $R^2 = 0.704$ coefficient, which indicated a good correlation of biometric parameters and the studied sample was homogeneous (Figure 8).

Figure 5. Various fishing vessels equipped with beam trawl (Photo: Danilov)

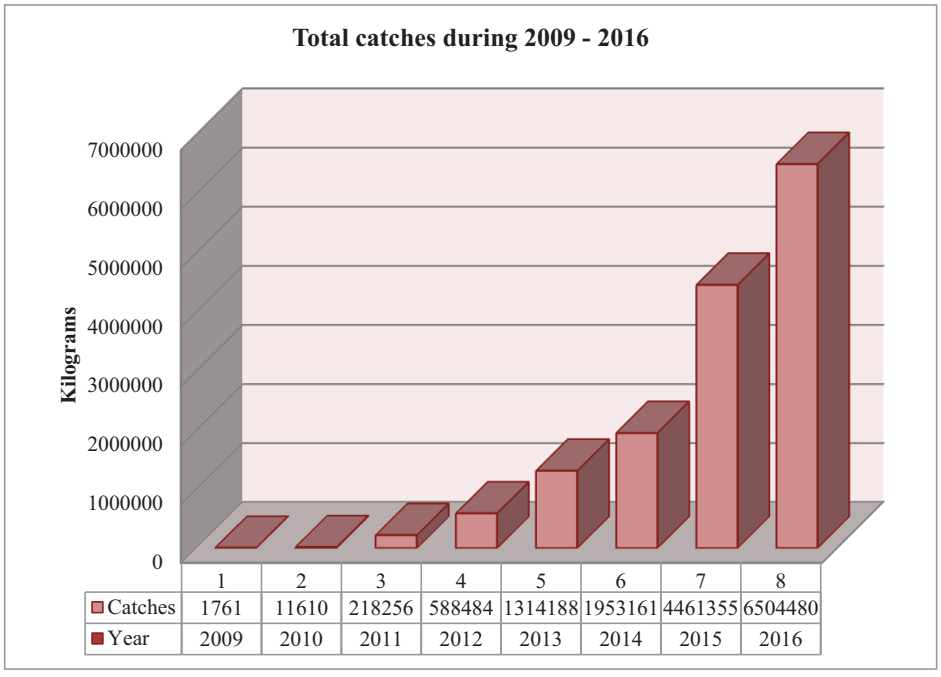

Figure 6. Total *R. venosa* catches during 2009 - 2016

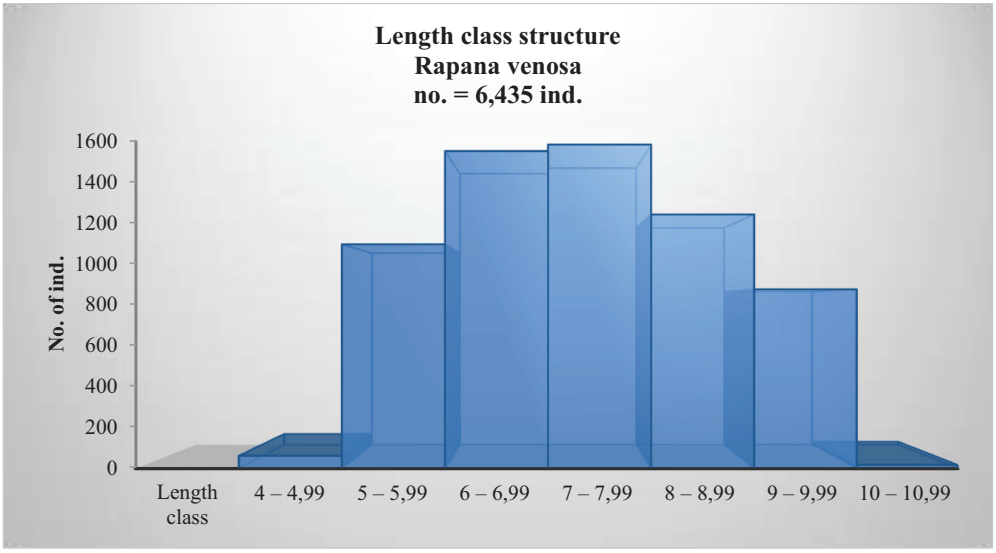

Figure 6. Length class structure of *R. Venosa* in 2016

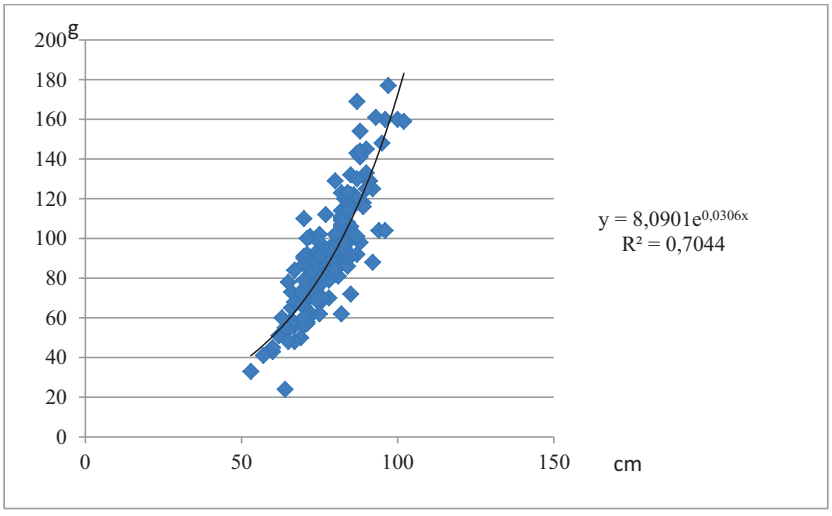

Figure 8. Length - weight correlation in *R. venosa* harvested in 2016

CONCLUSIONS

As a follow-up of investigations made by NIMRD "Grigore Antipa" during 2009-2016, the gastropod *R. venosa* was identified in almost all perimeters at depths ranging between 3-25 m, located along the Romania coast, especially in 18-26 water depth, in areas covered by beam trawl fishing on sandy substrate. In rocky areas, where rapa whelk is harvested by divers, it is encountered at depths between 3 and 10 m.

Rapa whelk catches at the Romanian Black Sea coast increased from year to year, ranging between 1 t in 2009 and approximately 6,500 t in 2016. In 2016, *R. venosa* catches counted for 87.5% of the total marine living resources catches along the Romanian Black Sea coast.

As a consequence of exploitation, the drop of *R. venosa* populations was acknowledged, which requires future research meant to determine the stock size and total allowable catch (TAC), aiming at underpinning the rapa whelk fisheries on a scientific background.

ACKNOWLEDGEMENTS

This research was completed within the PhD research program of the Doctoral School of Engineering, "Lower Danube" University of Galati, Romania, with the full support of colleagues from NIMRD "Grigore Antipa" Constanta, Romania.

REFERENCES

Antipa G., 1941. Black Sea. Vol. I Oceanography, bionomy and general biology of the Black Sea. National Printing House, Bucharest, 313.

Bacescu M., Carausu S., 1964. Black Sea fauna. The Romanian Book, Publishing House, Bucharest, 64.

Chukchin V., 1984. Ecology of the Gastropod Molluscs of the Black Sea. Academy of Sciences, USSR, Kiev Naukova Dumka, 122-175.

Gomoiu M.T., 1972. Some ecologic data on the gastropod *Rapana thomasiana* Crosse1861 along the Romanian Black Sea Shore. Recherches marines, IRCM, Constanţa, 4, 169-180.

Gomoiu M.T., Skolka M., 1996. Changements recents dans la biodiversite de la Mer Noire dus aux immigrants. Geo-Eco-Marina, RCGGM, V. 1, "Danube Delta-Black Sea System under Global Changes Impact", Bucuresti-Constanta, 49-65.

Grossu A.V., 1986. Gastropoda Romaniae. I. General characters, history and biology of gastropods; II. Prosobranchia and Opistobranchia Subclass. Litera Publishing House, Bucharest, 1, 150-315.

Grossu A.V., 1993. The Catalogue of Molluscs from Romania. Travaux du Muséum d'Histoire Naturelle „Grigore Antipa", 33, 291-366.

Goulletquer P., 2002. Report on the current status of introductions in France (Marine Environment). Report of theWorking Group on Introductions and Transfers of Marine Organisms, Gothenburg, Sweden, March 20-22, 2002. International Council for the Exploration of the Sea, Copenhagen, Denmark, 31-33.

Golikov A.N., Ya. I. Starobogatov, 1972. The guide to fauna of the Black Sea and the Sea of Azov. Bivalves. III. Kiev, Naukova Dumka, 82-166.

Harding J.M., 2006. Growth and development of veined Rapa whelk *Rapana venosa* veligers. Journal of Shellfish Research, 25, 941-946.

Harding J.M., Mann R., Kilduff C.W. 2007. The effects of female size on fecundity in a large marine gastropod Rapana venosa (Muricidae). Journal of Shellfish Research, 26(1), 33-42.

Harding J.M., Mann, R., Kilduff, C.W., 2008. Influence of environmental factors and female size on reproductive output in an invasive temperate marine gastropod *Rapana venosa* (Muricidae). Marine Biology, 155, 571-581.

Skolka M., Gomoiu M.T., 2004. Invasive species in the Black Sea, Ecological impact of penetration of new species into aquatic ecosystems. Ovidius University Press, Constanta, 56-57, 101-106.

Mann R., Harding J.M., 2000. Invasion of the North American Atlantic coast by a large predatory Asian mollusc. Biological Invasions, 2, 7-22.

Mann R., Harding, J.M., 2003. Salinity tolerance of larval *Rapana venosa*: implications for dispersal and establishment of an invading predatory gastropod on the North American Atlantic coast. Biological Bulletin, 204, 96–103.

Mann, R., Harding, J.M., Westcott, E. 2006. Occurrence of imposex and seasonal patterns of gametogenesis in the invading veined rapa whelk *Rapana venosa* from Chesapeake Bay, USA. Marine Ecology Progress Series, 310, 129-138.

Teaca A., Begun T., Surugiu V., Gomoiu M.T., 2010. Changes in the structure of the rocky mussels littoral biocoenosis from the Romanian Black Sea coast. Scientific Annals of Al. I. Cuza University, Iasi, Animal Biology, Vol. LVI, 7-22.

Tiganov G., Danilov C.S., Nenciu M.I., Anton E., Nastase A., 2017. Chapter 23. New Equipment and Technologies used for Rapa Whelk Harvesting at the Romanian Black Sea Coast, in Finkl, Charles W., Makowski, Christopher (Eds.), Diversity in Coastal Marine Sciences. Historical Perspectives and Contemporary Research of Geology, Physics, Chemistry, Biology, and Remote Sensing, Coastal Research Library (23). Springer International Publishing AG, 397-404.

Zaitsev Yu., Ozturk B., 2001. Exotic species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul, 265.

Zolotarev V., 1996. The Black Sea ecosystem changes related to the introduction of new mollusc species. P.S.Z.N.I. Marine Ecology, 17, 227-236.