Oceanological and Hydrobiological Studies
Vol. XXXIII, No. 4

Institute of Oceanography (93-102) University of Gdańsk
2004

Research Article

REMARKS ON THE MORPHOLOGY AND THE LIFE CYCLE OF *RHITHROPANOPEUS HARRISII* SSP *TRIDENTATUS* (MAITLAND) FROM THE DEAD VISTULA RIVER

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Key words: *Rhithropanopeus harrisii* ssp. *tridentatus*, alien species, Vistula River estuary

Abstract

The aim of this study was to characterize the mud crab *Rhithropanopeus harrisii* ssp. *tridentatus* that occurs in the Dead Vistula. Of the 220 specimens collected, 57% were males and 43% were females. Females with eggs on the pleopods were present throughout June, July and August. The carapace width varied from 4.9 mm to 22.4 mm and length ranged from 4.1 mm to 16.3 mm. The highest frequency (49.1%) was observed in the 9.1-13.5 mm width class. The wet weight of the specimens varied from 0.045 to 4.299 g. The results obtained indicate that no significant changes in the morphology or life cycle of the *R. harrisii tridentatus* from the Dead Vistula River have occurred in the last 30 years.

INTRODUCTION

Rhithropanopeus harrisii ssp. *tridentatus* Maitland, 1874 is one of several crustacean species which now inhabit Polish waters as a result of human activity (Wolff 1954; Leppäkoski and Olenin 2000). This species originates from the Atlantic coast of North America (Williams 1965). Along with *Eriocheir sinensis* and *Carcinus maenas*, this is the third brachyuran species to be noted in Polish waters (Żmudziński 1956, 1959, 1961; Jażdżewski and Konopacka 1993). In 1951, Demel (1953) noted that this species was a constant component of the fauna of the Vistula Lagoon and Dead Vistula River (an abandoned arm of the Vistula River). Later *R. harrisii tridentatus* appeared in the Motława River and the Gulf of Gdańsk (Michalski 1957; Żmudziński 1961, 1967).

R. harrisii tridentatus is a species that is relatively resistant to environmental pollution from ship engine lubrication oil, phenol, and ammonia (Michalski 1957). It is able to survive for more than 24 h under anoxic conditions, but it does not occur in environments where hydrogen sulfide is present (Rychter 1997). Environmental salinity significantly influences the presence of this species, and when it is held in fresh water, *R. harrisii tridentatus* dies within two days (Kujawa 1957; Pautsch *et al*. 1969). The abundance of *R. harrisii tridentatus* suddenly decreased in the 1970's and 1980's in the Vistula River mouth (Jażdżewski and Konopacka 2000).

The biology and ecology of *R. harrisii tridentatus* from the Dead Vistula River was studied more than thirty years ago by Turoboyski (1973) and then more than a decade ago by Janta (1996). Rychter (1999) studied the population from the Vistula Lagoon.

The aim of this investigation was to characterize *R. harrisii tridentatus* living in the Dead Vistula River and to determine if it has changed over the last few decades. The study was also undertaken to compare specimens of this species that inhabit the Dead Vistula River with those from the Vistula Lagoon.

MATERIAL AND METHODS

R. harrisii tridentatus specimens were collected monthly from May to October 2001 from the Dead Vistula River using baited traps. The depth was approximately 1.5 m and the salinity varied between 1 and 2 psu. The animals collected were frozen at -20˚C. Following defrosting in the lab, four different size parameters (CL - carapace length , CW - carapace width, AW - abdomen width, CHL - chela length) were measured using a digital slide caliper (± 0.1 mm). Sex was determined from the abdominal structures (Buitendijk and

Holthius 1949). The specimens were weighed wet (± 1 mg) and then dried at 55°C to a constant weight. The crabs were divided into four width classes (4.6-9.0 mm, 9.1-13.5 mm, 13.6-18.0 mm, 18.1-22.5 mm), and the values were expressed as a mean with standard deviation (± SD). Linear and power regressions ($y = ax + b$ and $y = ax^b$, respectively; a = slope and b = intercept) and determination coefficients (R^2) were used to describe the relationship between the investigated parameters. The significance of differences was tested using the Mann-Whitney U-test at a significance level of 5%.

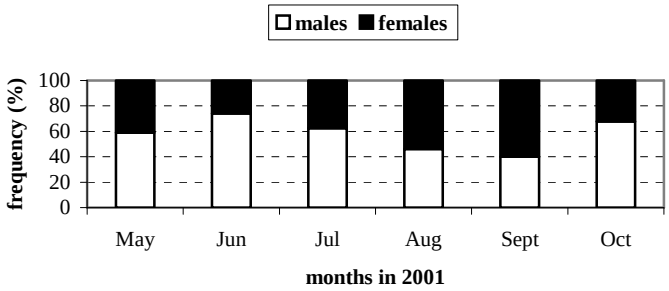

Fig. 1. Percentage of males and females of *R. harrisii tridentatus* collected from May to October 2001 from the Dead Vistula River.

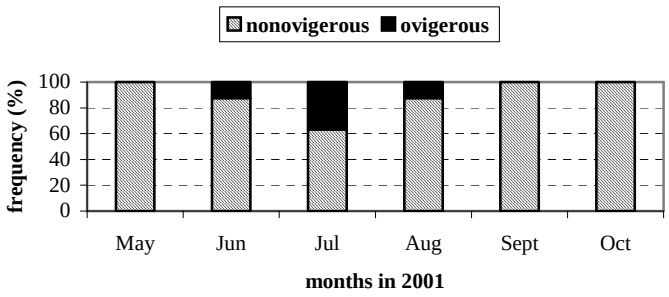

Fig. 2. Percentage of ovigerous and non-ovigerous females of *R. harrisii tridentatus* collected from May to October 2001 from the Dead Vistula River.

RESULTS

Of the 220 specimens caught, 95 (43%) were female and 125 (57%) were male. The sex ratio changed during the investigation period and was the highest in June at 2.9 males per female and the lowest in September at 0.7 males per female (Fig.1). Of the females collected, only 12 (13%) were ovigerous; they were present in the population throughout June, July, and August (Fig. 2). The

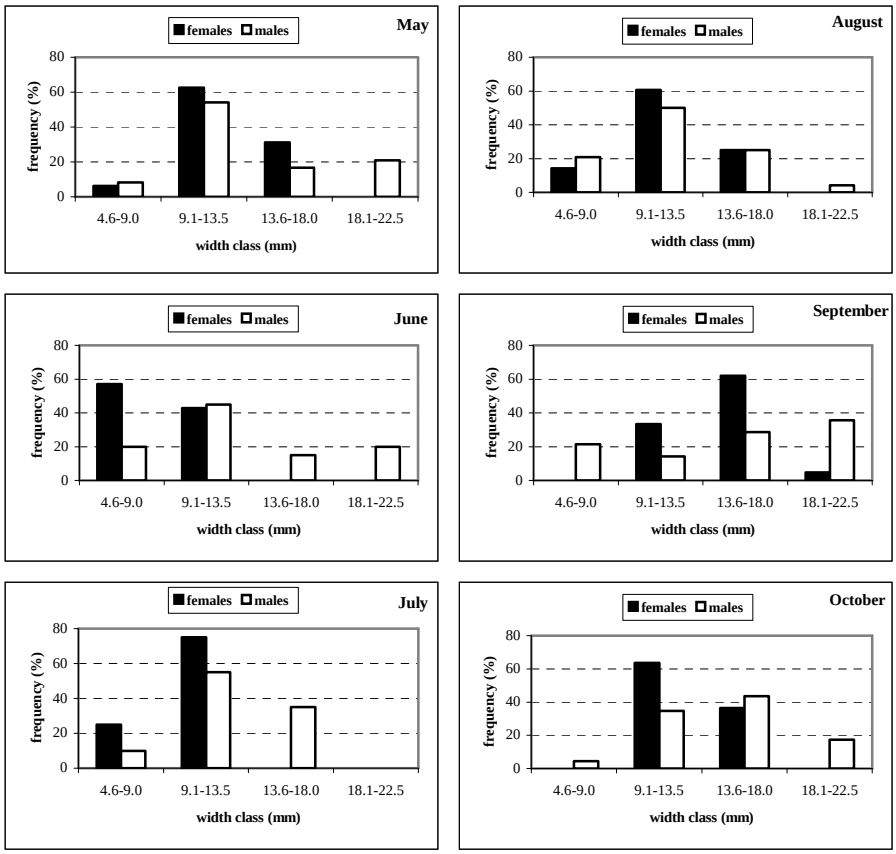

Fig. 3. Percentage of males and females of *R. harrisii tridentatus* in consecutive width classes from May to October 2001.

width of the carapace of *R. harrisii tridentatus* varied from 4.9 mm to 22.4 mm (average 12.9 ± 3.5 mm), whereas the length ranged from 4.1 to 16.3 mm (average 9.9 ± 2.4 mm). The largest specimens, both males and females, occurred in September, whereas the smallest were observed in June and July. Both male and female frequencies were the highest in the 9.1-13.5 mm width class and ranged from 14.3% and 33.3% in September to 55.0% and 75.0% in July (Fig. 3). The frequency of the smallest individuals from the 4.6-9.0 mm width class varied from 20.0% (males) and 57.1% (females) in June to 4.4% (males) in October. The opposite tendency was observed in the 13.6-18.0 mm width class. The lowest value (15.0% - males) was noted in June and the highest in September at 28.6% and 60.2% for males and females, respectively. All of the measured parameters, except abdomen width, were greater in males

than in females (Tab. 1). The carapace of the mud crab is broader than it is long and the isometric growth is described by the function CW= 0.688·CL + 1.047, R^2 = 0.99. The isometric growth of the carapace differed between males and females. The comparison of the relations between carapace width and length for males (CW = 0.681 CL + 1.148, R^2=0.99) and females (CW=0.797 CL + 0.707, R^2=0.97) revealed that females of *R. harrisii tridentatus* have insignificantly longer carapaces than males of the same carapace width.

Table 1

Comparison of studied size parameters of males and females of *R. harrisii tridentatus* collected from May to October 2001 in the Dead Vistula River

parameter	Min (mm)	Max (mm)	males mean ± SD (mm)	females mean ± SD (mm)
carapace width	4.9	22.4	13.4 ± 3.6	12.2 ± 2.6
carapace length	4.1	16.3	10.3 ± 2.7	9.4 ± 1.8
abdomen width	1.6	8.3	3.8 ± 1.0	5.4 ± 1.4
chela length	3.2	20.4	10.2 ± 4.0	7.6 ± 1.7

The wet weight of the specimens varied from 0.045 to 4.299 g. The average wet weight of males was higher than that of females at 1.098 ± 0.942 g and 0.665 ± 0.355 g, respectively. The carapace width (CW)/specimen wet weight (WW) ratios for males and females of *R. harrisii tridentatus* are determined by the functions $WW = 0.0003\ CW^{3.02}$ (R^2 = 0.96) and $WW = 0.0006\ CW^{2.79}$ (R^2 = 0.96), respectively. The water content in specimens varied from 54.0 to 84.6%; the average was 64.3 ± 7.7% of the total specimen weight.

DISCUSSION

R. harrisii tridentatus has found a suitable ecological niche in the waters of the Dead Vistula. For over fifty years this crab has been a component of the fauna in Polish waters and has coexisted with indigenous species. Unlike many alien species, a wider invasion of this species has yet to be observed in Polish waters. Perhaps the abundance of the *R. harrisii tridentatus* population is regulated to a great extent by predators who have included the crab in their diets (Kujawa 1963; Filuk and Żmudziński 1964). Information has yet to be reported regarding the presence of *R. harrisii tridentatus* in the region of the Gulf of Gdańsk, *i.e.*, in waters with slightly higher salinity. However, it has recently been observed more frequently in this region at a depth of 15 m near Sopot (personal observations).

The results of the present study indicate that no significant changes in morphology and life cycle of the *R. harrisii tridentatus* from the Dead Vistula

River have occurred in the last 30 years. The studied individuals were dominated by sexually mature specimens that were able to reproduce and that came from average age classes (width class 9.1 to 13.5 mm). Rychter (1999) made similar observations in the population from the Vistula Lagoon in 1994 when males and females from the same carapace width classes constituted 40 and 52% of the population, respectively. This situation changed slightly in 1995 when smaller specimens belonging to the first carapace width class (4.6 to 9.0 mm) dominated among both males and females. This indicates that size (age) distribution might change annually.

Table 2

Comparison of minimum, maximum, and mean (± SD) carapace widths of male and female *R. harrisii tridentatus* collected at different times from the Dead Vistula River and Vistula Lagoon

Males				females				References
carapace width (mm)			N	carapace width (mm)			n	
min	max	mean ± SD		min	max	mean ± SD		
4.4	26.1	11.32 ± 3.49	637	4.4	19	10.76 ± 2.43	555	Turoboyski (1973)
14	20	16.80	20	10	18	13.11	28	Janta (1996)
2.9	21.9	11.27 ± 4.43	733	1.9	16.1	9.23 ± 3.14	372	Rychter (1999)
5.0	22.4	13.37 ± 3.95	125	4.9	18.3	12.16 ± 2.56	95	present study

The average width of the *R. harrisii tridentatus* carapace noted in the current study was slightly greater than that observed by Turoboyski (1973) for the population in the Dead Vistula in 1966-69 and by Rychter (1999) for the population from the Vistula Lagoon (Tab. 1). The *R. harrisii tridentatus* specimens of both sexes observed by Janta (1996) in the Dead Vistula in 1989-90 had the greatest average width, although the maximum widths were lesser than those obtained by other researchers (Tab. 2). The greatest maximum sizes for both male and female *R. harrisii tridentatus* were observed by Turoboyski (1973).

Żmudziński (1961) reported that one feature of *R. harrisii tridentatus* is that the carapace width is 1.3 times greater than its length. The measurements of crab specimens from the Dead Vistula confirm this dependence. From the analyses it can be concluded that males of *R. harrisii tridentatus* from the Dead Vistula River have slightly shorter carapaces than those from the Vistula Lagoon of a similar carapace width (slopes 0.75 and 0.68, respectively). Similar differences were observed by Normant *et al.* (2000, 2002) for another crab species that inhabits Polish waters, *E. sinensis*. Specimens from Lake Dąbie (Szczecin Lagoon) had longer carapaces than did those of the same carapace

width from the Gulf of Gdańsk. These morphological differences result rather from different environmental conditions than from changes of genotype (Cobo and Fransozo 1998; Willmer *et al*. 2000). To solve this problem, more detailed morphometric or genetic studies are necessary.

Males dominated slightly over females in the studied group of individuals, and the overall sex ratio was 1.3 : 1. Turoboyski (1973) reported a similar ratio for the population in the Dead Vistula in 1966-69 at 1.2 : 1. Male domination was even more evident in the Vistula Lagoon population as the sex ratio was 1.8 : 1 in 1994 and 2.4 : 1 in 1995 (Rychter 1999). Female domination in this region was not observed in any month and in August 1995 they constituted only 20% of the studied population. Only Janta (1996) reported the opposite - males constituted 13.8% and females 19.3%, with juvenile specimens comprising 66.9% of all specimens caught (the sex ratio was 0.7 : 1). These differences might have resulted from different sampling methods. Janta (1996) employed various sampling devices, including a triangular drag net, an Ekman grab and a Kajak core barrel. The number of specimens caught with this gear was 145 (adults and juveniles). The low number of females in the sample material might have resulted from the fact that the females of this species are less mobile than the males, especially during the reproduction period. This behavior might result in smaller numbers being caught in the traps. Only males were caught at some of the sampling stations in the Vistula Lagoon, and Rychter (1999) explained that this phenomenon was due to lesser female mobility. Krzywosz *et al*. (1995), who studied a population of American crayfish *Orconectes limosus*, concluded that the dominant number of male specimens is a characteristic feature of the trapping method.

Similarly to the reports by Turoboyski (1973), *R. harrisii tridentatus* was found to reproduce in the study area between June and August. The greatest number of females with eggs on the pleopods was observed in July 2001. The highest number of reproducing females (40% of the total number of females) in the population from the Dead Vistula in 1966-69 was also observed in July. According to Gonçalves *et al*. (1995), the larvae of this species are produced from April to September in temperate zones, but in colder regions the reproductive season is shorter. The situation of the crab population in the Vistula Lagoon was similar in that the greatest number of reproducing females was also observed in July, although they constituted only 4% of the studied population (Rychter 1999).

The wet weight of crab specimens caught in the Dead Vistula in 2001 did not significantly differ from the weight of specimens in the same area in 1966-69 or that observed for this species in the Vistula Lagoon (Turoboyski 1973; Rychter 1999). The comparison of the exponents in the dependence between

carapace width and specimen wet weight leads to the conclusion that the specimens from the Dead Vistula are characterized by a greater wet weight than those from the Vistula Lagoon of the same carapace width (Rychter 1999). *R. harrisii tridentatus* from the Dead Vistula contained on average 3% more water in their tissues, which might explain this fact. The differences in mass might also result from the better trophic conditions in the Dead Vistula, which induce a more rapid increase in specimen mass. A similar situation was observed by Normant *et al.* (2000, 2002) during her studies of the Chinese mitten crab *E. sinensis* from Lake Dąbie and the Gulf of Gdańsk. However, the water content did not differ significantly between the two areas, and specimens from the Gulf of Gdańsk were heavier when the width of the carapace was the same.

The presence of *R. harrisii tridentatus* in the Dead Vistula River ecosystem has presumably not had a negative impact over the past fifty years. However, studies of the population dynamics of this species are indeed ecologically significant. This is evident since the environment is constantly changing under pressure from the progressive development of civilization that impacts the animals inhabiting it.

ACKNOWLEDGEMENTS

We would like to thank the staff of the Biological Station of the Gdańsk University, especially Stanisław Parszo, for their assistance in collecting the material for this study. Professor Ludwik Żmudzinski is gratefully acknowledged for improving an earlier version of this manuscript. This research was supported by grant no. 127/E-335/S/2002 from the Polish Ministry of Scientific Research and Information Technology.

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