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ORIGINAL RESEARCH PAPER

SOME TRAITS OF REPRODUCTIVE BIOLOGY IN *Viviparus viviparus* (Linnaeus, 1758) AND *V. sphaeridius* (Bourguignat, 1880) (GASTROPODA, VIVIPARIDAE) FROM UKRAINE

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SYNOPSIS

Some peculiarities of reproductive biology in *Viviparus viviparus* and *V. sphaeridius* were investigated in Ukrainian part of their areals. The seasonal variations of number and size of *Viviparus* embryos from two different habitats has been analyzed. The seasonal changes both of fertility and fecundity levels in these populations are also being examined. It is shown that female adults of *Viviparus* contain a three age-class embryos throughout the year. Embryos of second age-class (with 2.25-2.75 of shell whorls) are dominated in all periods, except summer 2010 (when embryos at the first age class was predominant). It was also noted that female fertility is predominated in Ukrainian populations during the year. Lowest fecundity in *V. viviparus* from river Bucha (2.63 embryos per mollusc individual) was noted in the summer 2010; highest fecundity (20.88) was noted in the winter 2010-2011 from South Bug river. It was observed that the *Viviparus* fertility levels in river Bucha was lower than in South Bug. We conclude that the environmental conditions in river Bucha are unfavourable for viviparids.

INTRODUCTION

Long-term observations on Viviparidae revealed some life history traits: the number and size of embryos, brood birth-rate activity, the sex ratio and age-structure, the proportions of fertility females in the populations, etc (Miroshnitshenko, 1958; Calow, 1973; Bernardi et al., 1976; Levina, 1992; Pavlyuchenkova, 1997; Jacubik, 2006; Beryozkina and Arakelova, 2010).

Nevertheless, it is still imperative to investigate some ontogenetic characteristics for related species such as *V. viviparus* and *V. sphaeridius*, inhabiting in the waters of Ukraine. The need for such research is dictated by the fact that

V. sphaeridius has been rarely noted in the fauna of Ukraine (Levina, 1992; Anistratenko and Anistratenko, 2001). Molluscs belonging to this species possible were often defined as *V. viviparus*.

It is known that the fertile females of Viviparidae contain the fully developed embryos in any season. Embryos in brood pouches located in one or two rows and moreover so that closer to the distal part of the uterus are molluscs which are fully formed, with well-colored shells, whereas in the proximal part of the uterus are empty egg capsules or capsules with very small embryos (Alyakrinskaya, 1969; Pavlyuchenkova, 1997).

It is agreed that the spring is major period of reproduction in Viviparidae (Miroshnitshenko, 1958; Jacubic, 2006).

Thus Miroshnitshenko (1958) concludes that the rate of the embryos production in the spring should be more intense than in the summer. According to Miroshnitshenko (1958) the youth is still growing and developing in winter time. However this statement is not supported by the direct observations.

In this paper we have tried in some way to fill the existing gap in the study of this issue and on the basis of our own data to clarify the reproduction biology traits of *V. viviparus* and *V. sphaeridius*.

The present article dealt with the key traits the reproductive biology and their seasonal dynamics in *V. viviparus* and *V. sphaeridius* from two Ukrainian populations.

MATERIAL AND METHODS

Material for present study was collected by author from June, 2010 to May, 2011 in river South Bug (village Balovnoe, Nikolaev region, Ukraine), river Bucha (village Lesna Bucha, Kiev region, Ukraine).

Samples of viviparids were collected and preserved in ethanol 96%. All the collected material is kept in the collection of Laboratory of zoogeography of Schmalhausen Institute of Zoology.

During investigations the 350 adult shells of *V. viviparus* (including 220 females) and 407 adult shells of *V. sphaeridius* (including 127 females) had been collected and dissected. The embryos with various degrees of development were extracted and investigated. After visual examination the embryos were cleaned from the soft tissue and measured under an optical stereomicroscope MBS – 9. Numbers of whorls in embryos and adults were studied also with MBS – 9. The 1396 embryos of *V. viviparus* and 517 embryos of *V. sphaeridius* were measured.

With the aim of finding of *Viviparus* development peculiarities the embryos were classified into three age classes: 1st has included the fragile shell which have up to 2 whorls, 2nd has included the shells with from 2.25 to 2.75 whorls and 3nd with shells from 3 or more whorls.

The fertility index was counted as the percentage females with embryos in populations (Jacubic, 2006).

The fecundity of viviparids was calculated as the average and maximum numbers of embryos at all stages of development which were contained in the brood pouches of *V. viviparus* and *V. sphaeridius* throughout the study period (Miroshnitshenko, 1958).

All quantitative data were processed using PAST 2.17c software (Hammer et al., 2001).

RESULTS AND DISCUSSION

Molluscs of genus *Viviparus* are widespread in the fresh-waters of Europe (Zhadin, 1928; Anistratenko & Anistratenko, 2001).

According to our observations (Fig. 1) in the spring 2011 *Viviparus* brood pouches contain only white egg capsules without formed embryos (so-called "white packets") while in the summer the growth of embryos and the number of packets sharply decreased and the embryos of the first age class were formed.

Notice that the maximum contents of embryos of 1st age class in *Viviparus* females were observed in the winter (28% in *V. sphaeridius* from river Bucha) and in the summer (55% and 56% in *V. viviparus* from rivers South Bug and Bucha, respectively), and 52% in *V. sphaeridius* from river South Bug) (Fig. 1).

In the summer 2010 the transition of embryos out of the first to the second age class was occurred very slowly. At that time the least amount of the second age class embryos (with 2.25-2.75 whorls) was marked in the *Viviparus* from both sampling sites. In the autumn 2010 we observed an increase in the percentage of second class embryos (75% in *V. viviparus* from river South Bug and 78% in *V. sphaeridius* from river Bucha). In the winter 2010-2011 the highest percentage of second age embryos was registered in *V. viviparus* (71%) from river Bucha. In spring of 2011 the percentage of embryos with 2.25-2.75 whorls was maximally (73%) in *V. sphaeridius* from river South Bug.

The domination of the second age class embryos was noted in *Viviparus* from both sampling sites during the entire study period except summer of 2010 when embryos at the first age class were predominant. This phenomenon we attribute to the fact that middle-aged females (third year), in which brood pouches a significant number of second age class embryos is contained, prevailed in the studied samples. In the summer of 2010, after spring copulation, the viviparid brood pouches were filled with a significant numbers of white packets.

As a result the adult females with a minimum (from 7% to 13%) content of third age class embryos was observed in all populations in the summer of 2010. At autumn of 2010 the percentage of such embryos sharply increased in all studied populations

(Fig. 1). During the winter 2010-2011 the embryos of the second age class were developed into the third one. In this period the maximum contents of embryos with 3 or more whorls in *V. viviparus* (25%) and *V. sphaeridius* (57%) from river South Bug were marked, yet in *Viviparus* from river Bucha the maximum of the third age embryos was observed in the spring of 2011. Perhaps it is due to the late production of embryos in molluscs from this biotope (late spring of 2011).

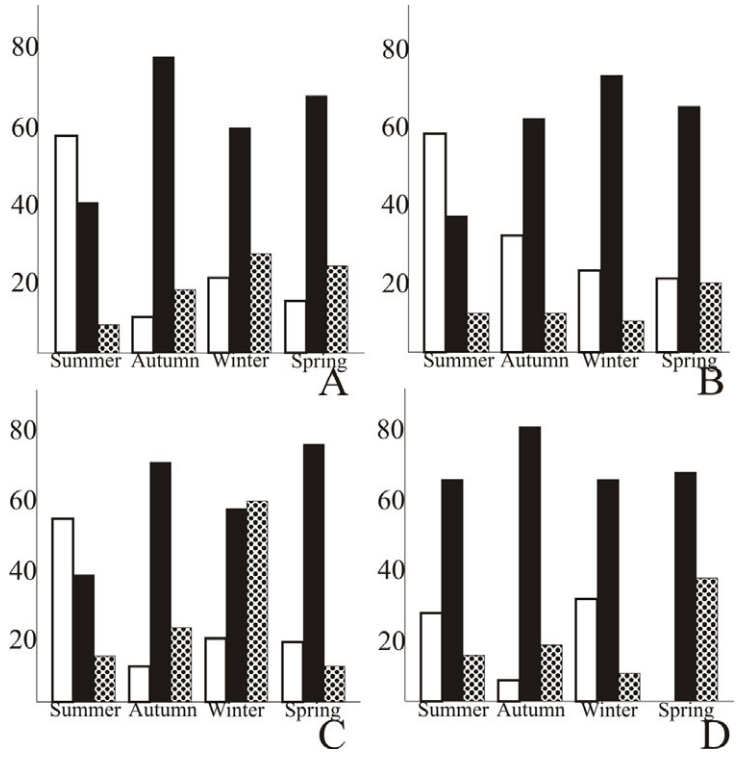

Figure 1: Seasonal changes in the proportions of embryos at three age classes in *V. viviparus* and *V. sphaeridius* from rivers South Bug and Bucha (June, 2010 - May, 2011.) The first age class of embryos is marked by white, the second age class by black color and the third age class by dotted pouring. A – *V. viviparus* from river South Bug river; B – *V. viviparus* from river Bucha; C – *V. sphaeridius* from river South Bug; D – *V. sphaeridius* from river Bucha.

These results confirm the data on the all-year brooding period without a winter break in *Viviparus* snails (Anistratenko et al., 2012).

On the literature data (Samochvalenko, Stanczykowska, 1972; Jacubic, 2006) the maximum percentage of viviparid females fertility (up to 90%) was recorded in summer whereas in autumn fertility decreases up to 20%.

According to our data (Tab. 1) the minimal proportion of fertile females in *Viviparus* was noted in summer of 2010 (73% in *V. viviparus*, 65% in *V. sphaeridius* from South Bug and 60% in *V. sphaeridius* from Bucha). It can be assumed that the

mass spring embryo production has caused the increasing of young individual proportions and accordingly the decreasing of fertile female proportions.

Table 1: Seasonal dynamics of fertility in *Viviparus* from South Bug and Bucha rivers (from June, 2010 to May, 2011).

	South Bug river		Bucha river	
	V. viviparus	*V. sphaeridius*	*V. viviparus*	*V. sphaeridius*
summer	73 %	65 %	60 %	60 %
autumn	100 %	83 %	67 %	76 %
winter	100 %	94 %	50 %	89 %
spring	91 %	93 %	92 %	77 %

The increasing of the fertile female proportion was observed in the autumn of 2010 in *V. viviparus* and *V. sphaeridius* in South Bug and Bucha. Thus, in *V. viviparus* from South Bug the maximum proportion of females with embryos ranges up to 100%.

In the winter the proportions of fertile females were 100% in *V. viviparus* and 94% in *V. sphaeridius* from South Bug and 89% in *V. sphaeridius* from river Bucha).

The slight decreasing of fertile female proportion was observed in spring of 2011.

The minimal percentage of females with embryos (50%) was detected in *V. viviparus* from Bucha in the winter (Tab. 1). Perhaps it was connected with increasing of the species mortality in the autumn of 2010 in this biotope. The maximal proportion of such females was noted in spring 2011 that obviously due to the fact that by that time the brood pouches of the females which had copulation before began to be filled with embryos.

Hence the fertile females have dominated throughout the study period in the populations of *V. viviparus* and *V. sphaeridius*.

There are contradictory data on viviparid molluscs fecundity. Thus up to 64 embryos per female were found in *V. viviparus* by Miroshnitshenko (1958), 85 in *V. viviparus* by Zhadin (1928), 45 by Alyakrinskaya (1969) and from 12 to 74 by Levina (1992).

According to our data (Tab. 2) the minimum fecundity (up to 32 embryos per female) was observed in *V. sphaeridius* from South Bug).

The average numbers of *Viviparus* embryos per female have increased in the autumn of 2011 (up to 16.13 in *V. viviparus* and up to 13.94 in *V. sphaeridius* from South Bug). At this time the greatest number of embryos (34) we found in the *V. sphaeridius* female from South Bug.

It should be noted that the maximal fecundities in *V. viviparus* and *V. sphaeridius* were observed in winter (20.88 and to 15.38, respectively on the average). During this period the maximum number of embryos (40) was noted in *V. viviparus* from South Bug.

In the spring 2011 the decreasing of fecundity up to 14.85 in *V. viviparus* and 16.00 in *V. sphaeridius*) from South Bug were observed (Tab. 2). The average numbers of embryos per female increased up to 7.36 in *V. viviparus* and 5.00 in *V. sphaeridius* from Bucha.

Table 2: Seasonal dynamics of fecundity in *V. viviparus and V. sphaeridius* from South Bug and Bucha rivers (from June, 2010 to May, 2011).

	South Bug river			Bucha river		
	number of females	the mean number embryos per female	max number embryos per female	number of females	the mean number embryos per female	max number embryos per female
V. viviparus						
summer	22	5,64	27	30	2,63	20
autumn	23	16,13	28	21	7,19	26
winter	26	20,88	40	30	4,87	25
spring	34	14,85	35	25	7,36	25
V. sphaeridius						
summer	20	5,3	32	16	3,06	9
autumn	18	13,94	34	21	5,76	13
winter	16	15,38	30	9	8,22	20
spring	14	16	39	13	5	12

CONCLUSIONS

The domination of the second age class embryos was noted in *Viviparus* from South Bug and Bucha rivers during the entire study period except summer of 2010 when embryos at the first age class were predominant. Our data support the data on the all-year brooding period without a winter break in *Viviparus* snails.

Thus the fertile females have dominated throughout the study period in the populations of *V. viviparus* and *V. sphaeridius*.

Seasonal dynamics of fecundity in *V. viviparus* and *V. sphaeridius* from both sampling sites demonstrate that the fecundity levels in both *Viviparus* species in river South Bug was higher than in river Bucha. It is our opinion that the environmental conditions in river Bucha are unfavorable for viviparids.

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