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REPRODUCTION OF THE SMALL GRAY SNAIL (*CORNU ASPERSUM ASPERSUM* SYNONYM *HELIX ASPERSA ASPERSA*) CONDUCTED IN AN EXPERIMENTAL BREEDING FARM UNDER CHANGING ATMOSPHERIC PRESSURE CONDITIONS*

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Abstract

The aim of the study was to check the impact of atmospheric pressure fluctuations in the period March – May 2022 on the reproductive efficiency of the small grey snail (Cornu aspersum aspersum) carried out at the experimental and production farm of the National Research Institute of Institute of Animal Production (IZ PIB) in Balice, in the conditions of a stable photoperiod and the air temperature of the breeding room. Observations were carried out on 1,000 snail-reproducers for 73 days after they were brought out of their winter numbness. The length of the observation period was justified by the appropriate period and date of the breeding phase, starting the production cycle on commodity farms of this species. From the beginning of the observations, 20 nesting cups with a suitable ground substrate were placed in breeding boxes, noting the dates of mass screwing of the snails into the substrate and the dates when the snails left the cups after laying the egg deposits. Every day, on the basis of reliable data from the Internet, atmospheric pressure values were recorded four times a day at the level of the Balice airport. During the 73 days of observation, it was found that 70% of the period of intense screwing and egg-laying occurred on days when the atmospheric pressure was in the range of 1015–1021 hPa. Such days in the 2022 season were only 30% in relation to the entire observation period. During periods of increased atmospheric pressure (1022–1043 hPa), intensification of reproductive behaviour was generally observed in the part concerning copulation of snails, while during periods of decreasing pressure (1015 – 1021 hPa) they screwed more into the ground substrate in nesting cups and laid eggs there.

Keywords: grey snail, Cornu aspersum, farm production, reproductive efficiency, atmospheric pressure

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Introduction

Heliculture associated with the commodity production of the grey snail (*Cornu aspersum* synonym *Helix aspersa*) is one of the most important areas of alternative animal production in Europe, including Poland. The largest demand for the meat of European snails of the grey snail subspecies (Cornu aspersum aspersum) is maintained, while the African large grey snail (*Cornu aspersum maxima*) is the second largest economic snail. The largest part of commodity biomass is produced in a mixed production system, where reproduction is carried out in appropriately air-conditioned farms in early spring, while commercial rearing takes place in ground-based field pens. Polish breeders often point out that despite scrupulous adherence to all feeding rules and regarding the appropriate microclimate, photoperiod and zoohygiene (Jess and Marks, 1998; Ligaszewski and Pol, 2019), in snail breeding rooms there are sometimes longer breaks in laying eggs. Their causes are difficult to diagnose, which raises concerns about obtaining the amount of grey snail brood stock needed during the production season. A gradual decrease in egg-laying intensity was observed in the grape snail (Helix pomatia) in breeding in the greenhouse, but in this case it was explained by the effect of a natural shortening of the light day in the period from May to August (*Ligaszewski et al., 2007).* In some insects, however, changes in atmospheric pressure have a strong influence on behavior, including reproductive behavior (Ankney, 1984; Austin et al., 2014). As part of the pilot observations, it was decided to investigate the possible influence of this independent atmospheric factor on the course of reproduction of the small grey snail under controlled conditions. It was assumed that atmospheric pressure, as in some other species, may be an important biometeorological factor and therefore may affect the course of physiological processes in snails, resulting in changing reproductive activity.

Material and methods

One thousand somatically mature snails from the subspecies small grey snail (Cornu aspersum aspersum) were brought out of winter numbness after 5 months' storage in a suitably adapted cold room at 4-7^{o}C. Then the snails were transferred to a specially constructed box intended for their reproduction in the conditions of an experimental and breeding farm. The air temperature in the breeding room with awakened sires ranged from 18 to 22^{o}C, the length of the light day, according to the rules of heliculture, was programmed for 18 days in a 24-hour cycle (18D:6N). The relative humidity in the room was always above 70%. Underneath the upper edges of the box divided by transverse partitions to increase the snails' living area,

boards were laid on the surface, on which a special dry vegetable industrial mix for snail-reproducers consisting of gritted cereal grains and legumes with mineral-vitamin additives containing 21% plant protein was fed, and nesting cups with soil suitable for laying eggs were placed. Every day before feeding the compound feed, the openwork box with snails was generously sprinkled with water, and the impurities flowed into the sewer grates in the floor of the room. The number of cups at each replacement was always 20 pieces. Each time during successive periods of mass snail drilling in the substrate, the cups were removed and then kept in a separate cuvette, and the eggs laid in them were counted after the snails had left them. After removing the cups with drilled snails, a new batch of them was immediately placed in the box. In order to prevent the snails from escaping, salt pellets were fixed around the perimeter of the breeding box.

The number of eggs in each cup, the number of eggs in each egg deposit from an individual snail, the number of deposits in each cup and the percentage of cups with eggs were counted. At the same time, based on current weather information from the internet, values of atmospheric pressure in the vicinity of the study site (Balice airport level) were recorded four times a day, and the average 24-hour pressure was calculated on this basis. It was observed at what values of this pressure the snails screw massively into the substrate of the nesting cups and at what values they come out of them after laying eggs. The results of the observations were placed in a table and prepared in the form of graphs.

Results

During the 73-day breeding of the grey snail, mortality among its sires was 46% at the end of the observation period. Similar mortality rates are always observed with intensive reproduction of snails in farm conditions. Table 1 shows the time when the snails were screwed into the nesting cups and when the egg-laying period of these snails ended, the number of deposits, the number of eggs laid and the percentage of cups in which the eggs were laid. The initial modest result in the form of the first eggs laid, while the sire population was still almost full, was the first signal of the physiological maturation of the snails' reproductive cells 21 days after their emergence from winter numbness. Only from the 28th day of observation can we talk about the beginning of effective reproduction and undertake the interpretation of the results (Table 1). During the breeding period of snails, strong fluctuations in the average daily atmospheric pressure values were noted, from very high (1043 hPa) to low (996 hPa), and moderate pressure in the range of 1015–1021 hPa was found only for 29.0% of the time of the 73 days of observation (Fig. 1). Despite this, in this narrow range of pressure fluctuations, 70% of cases of strong reproductive activity were found, consisting of mass screwing of snails into the ground substrate and subsequent laying of eggs (Fig. 2). The highest tendency for snails to screw into the substrate of the nesting cups in order

to lay eggs was found on the 50th and 52nd day of observations, resulting in a total of 11,600 eggs laid over the following week. The same phenomenon was observed on day the 58th, resulting in 9,050 eggs laid. On the remaining days of checking the contents of the nesting cups, the number of eggs laid in them ranged from 2800 to 4000 pieces (Table 1). In the seasonal course of egg-laying intensity (Fig. 3), three distinct, increasingly higher incremental peaks in the number of eggs laid were found, which coincided with the lower peaks of the atmospheric pressure variability characteristics (Fig. 1). After the 71st day, reproductive activity was temporarily discontinued. The periodic break in the reproductive behaviour described above at the end of the 73-day observations was accompanied by a gradual rise in atmospheric pressure again, to 127.8 hPa (Figure 1). Further observations were no longer reasonable from the point of view of the farm's commodity snail production cycle, as the end of May was the deadline for planting the field commodity pens with spring snail hatchlings. The average number of eggs in one bed was the lowest at the very beginning of the laying period (over 60 eggs) and the highest in the final period (over 100 eggs). In the period from the 32nd to the 58th day of observation, the average number of them in one deposit ranged from 80 to almost 100 pieces. (Fig. 4).

Table 1. Reproduction of the small gray snail in 2022

Snails digging intensely into hatching cups substrate		End of egg laying by snails that dug into the substrate				
Date	Day of observation	Date	Day of observation	Number of eggs	Number of clutches	Percentage of cups with eggs
15.03	8.	28.03	21.	516	8	25
28.03	21.	04.04	28.	3941	48	85
04.04	28.	08.04	32	4002	46	80
08.04	32.	15.04	39.	2083	26	80
15.04	39.	20.04	44.	2519	26	80
19.04	43.	26.04	50.	4905	62	100
20.04	44.	28.04	52.	6704	79	95
28.04	52.	04.05	58.	2990	35	60
04.05	58.	11.05	66.	9057	110	100
11.05	66.	17.05	71.	3005	28	45
17.05	71.	19.05	73.			
				Laying pause		

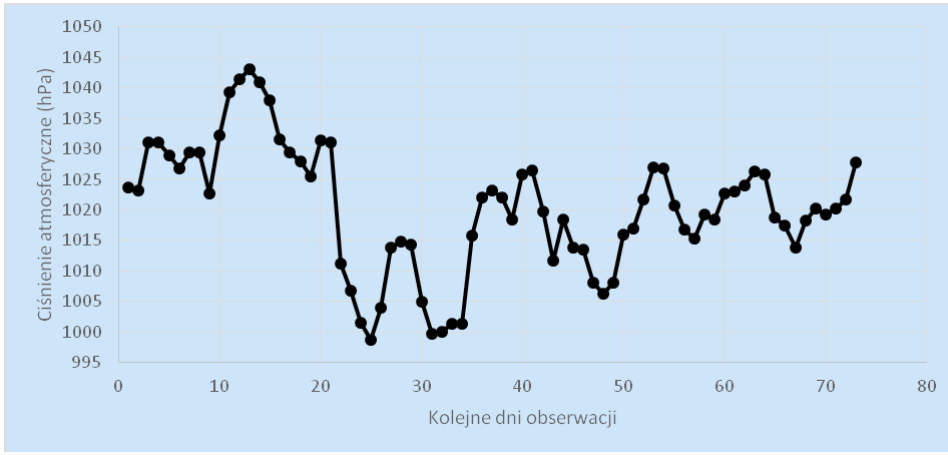
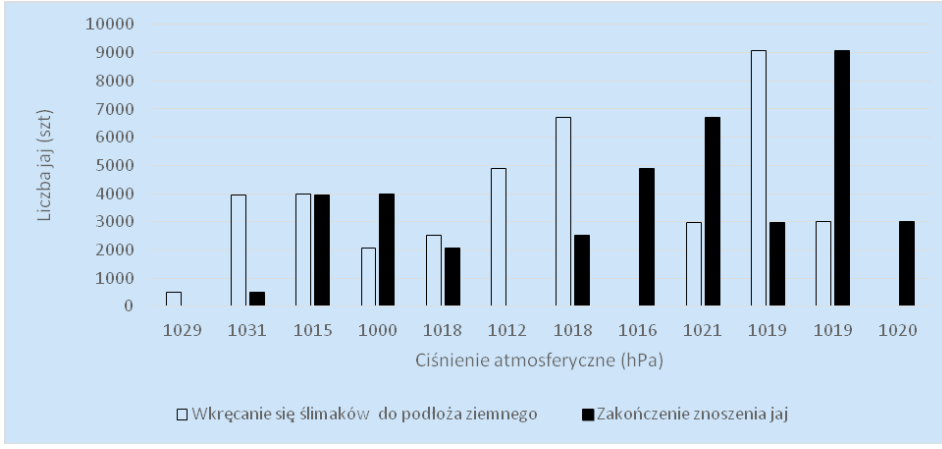


Fig. 1. Characteristics of daily average variation in atmospheric pressure during reproductive period of the snail



White bar – number of eggs that will be laid by snails digging into the ground.
Black bar – number of eggs laid by snails that had dug into the ground.

Fig. 2. Atmospheric pressure values observed in egg laying phases

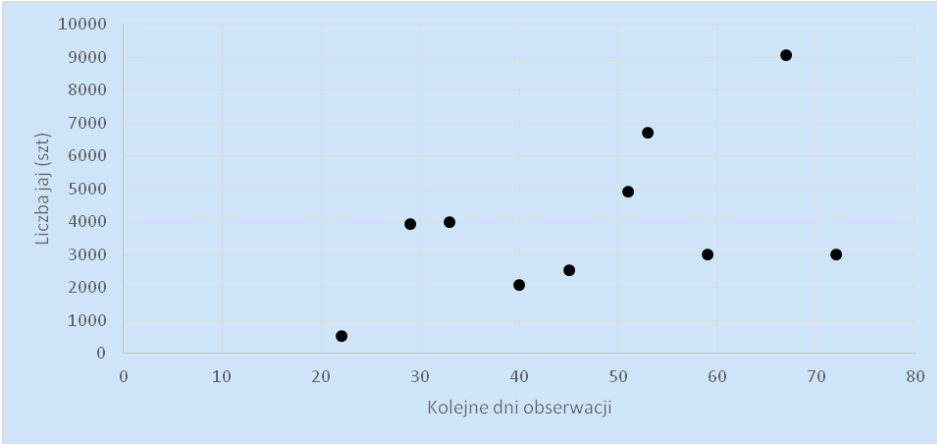


Fig. 3. Total number of eggs obtained on successive days of observation

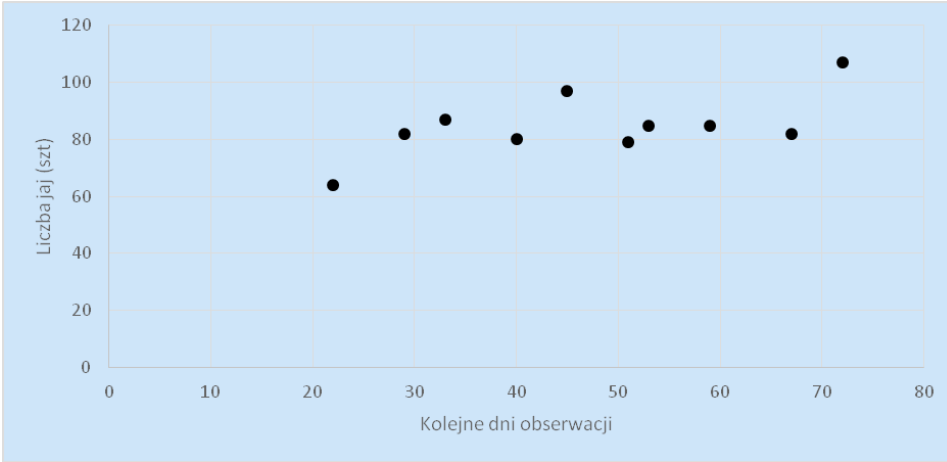


Fig. 4. Average number of eggs per clutch on days of observation

Disscusion

The results of reproduction of the experimental group of the grey snail (*Cornu aspersa aspersa*) obtained under experimental and production conditions should be considered very successful. This can be said because after only 4 weeks from the moment the snails emerged from the winter stupor, they began to reproduce effectively, and this process increased until the 66th day. The first sign that the snails were ready to lay eggs was when the first few sires had already laid them

a week earlier. Until this signal was obtained, for the first 21 days of observations, a very high atmospheric pressure was found, reaching an average of 1031 hPa. Then, in the period from the 22nd to the 35th day of observation, the average value was 1006 hPa, and for most days of the remaining study period it oscillated within the pressure characteristic of early spring in Poland, amounting to an average of about 1014 hPa, with deviations in the range of 1008–1028 hPa found during the study period. As stated in the results, 70% of the time of intensive screwing of the snails and laying of eggs occurred in the narrower pressure range, 1015-1020 hPa. In contrast, during periods of high atmospheric pressure, an intensification of reproductive behaviour was generally observed in the copulation part of the snails, while during periods of decline, they screwed themselves in large numbers into the soil substrate cups in the hatching cups and laid eggs there. This type of finalization of the reproductive cycle is also known, for example, in calving cows, where it was found in a statistically significant way that most calvings occurred with a downward trend in atmospheric pressure, and decreased at the beginning of the period of increasing pressure. This was due to the induction of maternal biometeorological stress stimulating the increased corticoid secretion (Dvorak, 1978; Akutagawa et al., 2007). A similar division of behaviour and reproductive cycle into mating at high or increasing pressure and egg-laying period at low pressure has been observed in flies of the genus *Drosophila* (Pellegrino et al., 2013; Dagaeff et al., 2016; Bloch Quazi et al., 2003; Adonyeva et al., 2021) and plum curcus (*Contrachelus nenuphar*) (Leskey and Prokopy, 2003). In the latter species, the distinction between volatile substances was high at high pressure. This indicated the ripening of the fruit, in which these insects laid eggs, which gave a signal for mating behavior and copulation. The same effect of higher pressure on soil odor in nesting cups could also occur in the observed snails, initiating their mating behavior.

Summary

It was found that under normal breeding conditions, consistent with the principles of heliculture, with a constant photoperiod (18D:6N) and temperature fluctuations in a narrow range (18–22°C), the effectiveness of egg-laying by snails of the subspecies of the small grey snail (*Cornu aspersum aspersum*) depended on the long-term variability of atmospheric pressure on the production farm. In the conducted research, snails laid eggs most intensively with pressure drops to 1015–1020 hPa. The research carried out in this direction should be continued in subsequent years, with the seasonal characteristics of atmospheric pressure fluctuations differing for a given year, while extending it to include histological imaging of the gonads and studies of hormone levels and repeating it in the next few years. Such studies are of particular scientific interest and utilitarian importance, as there is a lack of information in the literature relating to the above-discussed issues for terrestrial snails, and in particular for the grey snail (*Cornu aspersum*), the heliculture of which is of great economic importance as part of alternative livestock production.

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SUMMARY

The aim of the research was to determine the possible impact of long-term fluctuations in atmospheric pressure in the period March to May 2022 on the reproductive efficiency of the small gray snail (*Cornu aspersum aspersum*) at the experimental and production farm of the National Research Institute of Animal Production in Balice,

under stable photoperiod and air temperature in the breeding facility. The observations were conducted with 1000 breeding snails for 73 days after they emerged from winter torpor. The observation period was based on proper period and phase of reproduction initiating the production cycle on the commercial farms of this species. At the start of the observations, 20 hatching cups with proper soil substrate were placed in breeding boxes while noting the dates on which snails dug into the soil and the dates when they left the cups after laying eggs. Atmospheric pressure values were noted four times a day based on reliable Internet data from the level of the Balice Airport. Seventy- three days of observation showed that 70% of the period when snails dug intensively into the ground and laid eggs, was on days in which atmospheric pressure ranged from 1015 to 1020 hPa. In the 2022 season, there were only 30% of such dates in relation to the entire observation period. During the periods of increased atmospheric pres- sure (1022–1043 hPa), breeding behaviour generally intensified in terms of mating. When atmospheric pressure declined (1015–1020 hPa), snails dug more intensively into hatching cups and laid eggs.

Key words: gray snail, Cornu aspersum, farm production, reproductive efficiency, *atmospheric pressure*