

SHORT COMMUNICATION

NOTES ON THE PHALLY POLYMORPHISM IN *VERTIGO LILLJEBORGI* (WESTERLUND, 1871), *V. GEYERI* LINDHOLM, 1925, *V. GENESII* (GREDLER, 1856) AND *V. RONNEBYENSIS* (WESTERLUND, 1871) IN SWEDEN

TED VON PROSCHWITZ<sup>1,2</sup>, ZOFIA KSIĄŻKIEWICZ<sup>3\*</sup>

<sup>1</sup> Gothenburg Natural History Museum, Box 7283, 40235 Gothenburg, Sweden

<sup>2</sup> Gothenburg Global Biodiversity Centre, University of Gothenburg, Box 461, 40530 Gothenburg, Sweden (e-mail: [ted.v.proschwitz@vgregion.se](mailto:ted.v.proschwitz@vgregion.se))

<sup>3</sup> Department of General Zoology, Adam Mickiewicz University, Uniwersytetu Poznańskiego 6, 61-614 Poznań, Poland (e-mail: [ksiazkiewicz@amu.edu.pl](mailto:ksiazkiewicz@amu.edu.pl));  <https://orcid.org/0000-0001-9271-6599>

\* corresponding author

**ABSTRACT:** In this paper we present some new information about the phally polymorphism of four *Vertigo* species: *Vertigo lilljeborgi*, *V. geyeri*, *V. genesii* and *V. ronnebyensis*. Material for examinations was collected from 7 sites in Sweden in 2021 and 2023. Despite a small number of individuals examined, all three sexual morphs (aphally, euphally, and hemiphally) were found in *V. geyeri* and *V. genesii*. Hemiphallics were recorded in these two species for the first time. In *V. lilljeborgi* we only found aphyallics and euphallics, while in *V. ronnebyensis* only aphyallics were found.

**KEYWORDS:** aphally; euphally; hemiphally; sexual polymorphism

DARWIN (1877) described a sexual polymorphism as the co-occurrence of sexual morphs within the same population. In gastropods we are dealing with a phally polymorphism which is a type of genital polymorphism in hermaphroditic organisms (DOUMS et al. 1998). In *Vertigo* snails, in one population, we may find three different sexual morphs: euphallics which have a fully developed and functional penis, hemiphallics which have vestigial and non-functional penis, as well as aphyallics which totally lack penis. All morphs are able to self-fertilize, but only euphallics can transfer sperm to a mating partner during copulation (POKRYSZKO 1987, DOUMS et al. 1998).

The aphally in the Vertiginidae was described by WATSON (1923) and STEENBERG (1925) in the first half of the 20th century. More than sixty years later, POKRYSZKO (1987) extensively studied this phenomenon in *Vertigo* snails. Her studies focused mostly on animals collected from Poland, but she also dis-

sected some individuals from other countries such as Great Britain, Norway and Sweden. Shortly afterwards, her monograph on the European Vertiginidae (POKRYSZKO 1990) gave a detailed description of diversity in copulatory organs in representatives of this family. A recent study on phally polymorphism in some European *Vertigo* species was published by KSIĄŻKIEWICZ et al. (2023).

Here, we present new data on the phally polymorphism in snails collected in Sweden. The data concern four *Vertigo* species: *Vertigo lilljeborgi*, *V. geyeri*, *V. genesii*, and *V. ronnebyensis*. Snails for the study were acquired from 7 sites in total: two in central Sweden (1–2) and five in the northern part of the country (3–7) (Table 1).

Snails were collected using a combination of two methods: 1) Shaking decaying plant material, grass and mosses in a metal bowl and collecting the specimens by hand from the bottom of the bowl directly

in the field; 2) Sieving decaying plant material, grass and mosses in a sieve with mesh size of 10 mm. The material passing through the sieve was brought back to the laboratory and the snails picked out by hand under a magnifying glass. Only specimens with a complete shell (adults) were included in the study. Collected individuals were preserved in 96% alcohol.

Snails were identified to species according to POKRYSZKO (1990) and VON PROSCHWITZ et al. (2023). All individuals tested for the phally polymorphism were adults i.e. had a fully developed shell with the completed apertural barriers. The shell of each of the snail was measured with the OLYMPUS SZX16 stereo microscope with OLYMPUS DP74 digital camera and software: cellSens Dimension and Helicon Focus 7. Measurements included shell height (referred in tables as H1), body whorl height (H2), aperture height (H3), aperture width (W1), shell width (W2). All measurements were taken after POKRYSZKO (1990). After taking the measurements, snails were dissected and the sexual morph was determined also according to POKRYSZKO (1990).

Aphallics were found in all studied species, euphallics were detected in three of them (*V. lilljeborgi*, *V. geyeri*, *V. genesii*), and hemiphallics in two of them (*V. geyeri*, *V. genesii*) (Tables 2–5). POKRYSZKO (1987, 1990) detected just two sexual morphs: euphallics and aphallics in all studied species. The individuals she dissected were found in Poland (*V. ronnebyensis* – 5 individuals), England (*V. genesii* – 6 individuals and *V. geyeri* – 7 individuals), as well as Norway, Sweden, Great Britain, and USSR (*V. lilljeborgi* – 61 individuals). Although the material we present does not allow comparative analysis of the morph frequencies, we report for the first time hemiphallics in *V. geyeri* and *V. genesii* populations.

Comparing shell descriptions provided by POKRYSZKO (1990), descriptions provided by VON PROSCHWITZ et al. (2023) and measurements taken by us, we also noticed the Swedish snails tend to be smaller than those studied by POKRYSZKO (1990). We recorded following shell dimensions for *V. lilljeborgi* in Sweden (minimum and maximum values) H1: 1.80–2.05 mm; W1: 1.28–1.38 mm (Table 2). To compare, POKRYSZKO (1990) provided following shell dimensions for the species H1: 2.00–2.35 mm; W1: 1.15–1.33 mm, while VON PROSCHWITZ et al. (2023) H1: 1.70–2.40 mm; W1: 1.10–1.40 mm.

In the case of the Swedish *V. geyeri* the shell dimensions were as follows H1: 1.61–1.82 mm; W1: 1.02–1.14 mm (Table 3). Dimensions provided by POKRYSZKO (1990) for the species were: H1: 1.63–1.93 mm; W1: 1.05–1.20 mm; dimensions recorded by VON PROSCHWITZ et al. (2023): H1: 1.60–2.00 mm; W1: 1.00–1.20 mm.

Shell dimensions of *V. genesii* in Swedish individuals were as follows H1: 1.54–1.81 mm; W1: 0.68–1.14 mm (Table 4). Dimensions provided by POKRYSZKO (1990) for the vertiginid were: H1: 1.63–2.00 mm; W1: 1.03–1.20 mm and by VON PROSCHWITZ et al. (2023) H1: 1.60–2.10 mm; W1: 1.00–1.20 mm.

In the case of *V. ronnebyensis* we recorded following minimum and maximum dimensions H1: 1.98–2.20 mm; W1: 1.20–1.22 mm (Table 5). POKRYSZKO (1990) provided shell dimensions as follow H1: 2.00–2.32 mm; W1: 1.15–1.33 mm; VON PROSCHWITZ et al. (2023): H1: 2.00–2.40 mm; W1: 1.10–1.40 mm.

In conclusion, this short study revealed that our knowledge on the phally polymorphism is just the tip of an iceberg. Dissections of a small number of snails revealed new data on the hemiphally on the

Table 1. Location description (coordinates and descriptive location) of the study sites (S1–S7) along with the habitat description (Habitat), collection date (Colldat), and number of adult snails found at each site (V.LIL – *Vertigo lilljeborgi*; V.GRI – *V. geyeri*; V.GSI – *V. genesii*; V.RON – *V. ronnebyensis*)

Site	Co-ordinates (WGS84 dec) N/E	Location	Habitat	Colldat	V.LIL	V.GRI	V.GSI	V.RON
S1	59.863746 14.468480	prov. Västmanland, Hällefors parish, Kocktjärnen	Intermediate- rich fen	2021-VII-09	2	0	0	0
S2	58.417616 15.052170	prov. Östergötland, Allhelgona parish, Lagmansro	Calcareous fen	2021-IX-06	0	5	0	0
S3	63.235467 14.620383	prov. Jämtland, Ås parish, Tysjöarna	Calcareous fen	2021-VII-05	0	0	7	0
S4	64.401691 15.926138	prov. Lappland, Åsele lappmark, Dorotea parish, Bergmyran	Spruce woodland	2023-VII-02	0	0	0	4
S5	64.433867 15.776165	prov. Lappland, Åsele lappmark, Dorotea parish, Stor-Jenmyran	Intermediate fen	2023-VII-02	0	1	1	0
S6	64.506573 15.586235	prov. Lappland, Åsele lappmark, Risbäck parish, Brattmyran	Intermediate fen	2023-VII-03	1	0	0	0
S7	64.462470 15.626884	prov. Lappland, Åsele lappmark, Risbäck parish, Brattmyran (Saxåmon)	Rich fen	2023-VII-03	1	1	1	0

Table 2. Phally morphs and shell dimensions [mm] in adults of *V. lilljeborgi*: H1 – shell height; H2 – body whorl height; H3 – aperture height; W1 – shell width; W2 – aperture width; A – aphyallics; E – euphallics

Morph	H1	H2	H3	W1	W2	Site
E	2.05	1.38	0.77	1.38	0.79	1
E	1.96	1.29	0.76	1.31	0.72	1
E	1.80	1.25	0.72	1.28	0.76	6
A	1.92	1.31	0.76	1.32	0.73	7
SD	0.10	0.06	0.02	0.04	0.03	
MEAN	1.93	1.31	0.75	1.32	0.75	
MIN	1.80	1.25	0.72	1.28	0.72	
MAX	2.05	1.38	0.77	1.38	0.79	

Table 3. Phally morphs and shell dimensions [mm] in adults of *V. geyeri*: H1 – shell height; H2 – body whorl height; H3 – aperture height; W1 – shell width; W2 – aperture width; E – euphallics; A – aphyallics; H – hemiphallics

Morph	H1	H2	H3	W1	W2	Site
E	1.65	1.11	0.65	1.02	0.65	2
E	1.64	1.11	0.59	1.11	0.63	7
A	1.71	1.16	0.64	1.13	0.62	2
A	1.82	1.18	0.66	1.14	0.66	2
A	1.82	1.18	0.67	1.14	0.63	2
A	1.61	1.06	0.59	1.12	0.62	5
H	1.77	1.15	0.66	1.12	0.66	2
SD	0.09	0.04	0.03	0.04	0.02	
MEAN	1.72	1.13	0.64	1.11	0.64	
MIN	1.61	1.06	0.59	1.02	0.62	
MAX	1.82	1.18	0.67	1.14	0.66	

Table 4. Phally morphs and shell dimensions [mm] in adults of *V. genesii*: H1 – shell height; H2 – body whorl height; H3 – aperture height; W1 – shell width; W2 – aperture width; E – euphallics; A – aphyallics; H – hemiphallics

Morph	H1	H2	H3	W1	W2	Site
E	1.64	1.11	0.59	1.11	0.63	7
E	1.74	1.14	0.68	1.12	0.68	3
A	1.79	0.68	1.13	0.68	0.71	3
A	1.54	1.08	0.59	1.05	0.63	3
A	1.61	1.06	0.59	1.12	0.62	5
H	1.64	1.13	0.58	1.09	0.63	3
H	1.81	1.18	0.68	1.13	0.68	3
H	1.67	1.12	0.63	1.08	0.68	3
H	1.74	1.15	0.71	1.14	0.71	3
SD	0.09	0.15	0.17	0.14	0.04	
MEAN	1.69	1.07	0.69	1.06	0.66	
MIN	1.54	0.68	0.58	0.68	0.62	
MAX	1.81	1.18	1.13	1.14	0.71	

Table 5. Phally morph and shell dimensions [mm] in adults of *V. ronneyensis*: H1 – shell height; H2 – body whorl height; H3 – aperture height; W1 – shell width; W2 – aperture width; A – aphyallics

Morph	H1	H2	H3	W1	W2	Site
A	2.20	1.34	0.74	1.22	0.75	4
A	2.19	1.29	0.74	1.20	0.76	4
A	2.17	1.25	0.75	1.20	0.73	4
A	1.98	1.23	0.77	1.21	0.71	4
MEAN	2.14	1.28	0.75	1.21	0.74	
SD	0.10	0.05	0.01	0.01	0.02	
MIN	1.98	1.23	0.74	1.20	0.71	
MAX	2.20	1.34	0.77	1.22	0.76	



two *Vertigo* species: *V. genesii* and *V. geyeri*. Previous studies suggested that the hemiphallics may be “enfeebled” euphallics, and occur in high numbers in somehow disturbed environments (KSIĄŻKIEWICZ et al. 2023). Facing increased anthropogenic pressure and the climate crisis we may therefore suspect an increased share of hemiphallics in populations. Since this sexual morph is unable to transfer sperm during the copulation, such disturbed balance of sexual morphs may have profound effect on the genetic

diversity of the species populations. Therefore, we emphasize the need for more extended research on the phally polymorphism to understand better its background and consequences for *Vertigo* species conservation.

#### ACKNOWLEDGEMENTS

The authors are grateful to the three reviewers for their valuable comments.

#### REFERENCES

- DARWIN C. 1877. The different forms of flowers on plants of the same species. John Murray, London.  
<https://doi.org/10.5962/bhl.title.46988>
- DOUMS C., VIARD F., JARNE P. 1998. The evolution of phally polymorphism. *Biological Journal of the Linnean Society* 64: 273–296.  
<https://doi.org/10.1111/j.1095-8312.1998.tb00334.x>
- KSIĄŻKIEWICZ Z., SULIKOWSKA-DROZD A., VON PROSCHWITZ T., RYBAK M. 2023. To have or not to have a penis? Phally polymorphism in minute, hermaphroditic gastropods from the Vertiginidae family. *Zoological Journal of the Linnean Society* 202: zlad189.  
<https://doi.org/10.1093/zoolinnean/zlad189>
- POKRYSZKO B. 1987. On the aphally in the Vertiginidae (Gastropoda: Pulmonata: Orthurethra). *Journal of Conchology* 36: 365–375.
- POKRYSZKO B. M. 1990. The Vertiginidae of Poland (Gastropoda: Pulmonata: Pupilloidea): A systematic monograph. *Annales Zoologici* 43: 133–257.
- PROSCHWITZ T. VON, ROTH J., LUNDIN K., BACK R. 2023. Nationalnyckeln till Sveriges flora och fauna. Blötdjur: Snyltsnäckor-skivsnäckor. Mollusca: Pyramidellidae – Planorbidae. SLU Artatabanken, Uppsala.
- STEENBERG C. M. 1925. Études sur l’anatomie et la systématique des maillots (*Pupillidae* s. lat.). Libraire C. A. Reitzel, Copenhagen.
- WATSON H. 1923. Masculine deficiencies in the British Vertiginidae. *Proceedings of the Malacological Society of London* 15: 270–280.

Received: June 19th, 2024

Revised: August 1st & 28th, 2024

Accepted: August 28th, 2024

Published on-line: November 12th, 2024

