Flavism in *Viviparus contectus* (Millet, 1813) (Gastropoda, Architaenioglossa, Viviparidae) in the Biebrza region in Poland

C.J.P.J. Margry
Mozartlaan 41, 5283 KB Boxtel, The Netherlands; margry@home.nl

& J.J.M.M. van Ooijen
Diepenbrockstraat 12, 5283 LE Boxtel, The Netherlands; jjmm.van.ooijen@planet.nl

This paper presents the recent find in the Biebrza Valley in Poland of a population of *Viviparus contectus* (Millet, 1813) showing flavism of the body. Taxonomical and ecological data are compared to the literature. Observations on the colour and behaviour of two specimens are described. The main characteristics of colour formation in molluscs is reviewed. The yellow colour is apparently caused by an inherited lack of melanins. The find is compared to other records of molluscs with albinism or flavism.

Key words: Gastropoda, Caenogastropoda, Viviparidae, *Viviparus contectus*, flavism, carotenoids, melanin, partial amelanism, colour aberration, Poland.

Introduction

On April 21th, 2010, the wetlands in the Southern Basin of the Biebrza Valley in north-eastern Poland were visited during a guided tour from the village of Mścichy towards the tower at Biały Grąd on the western side of the Biebrza river. In the ditches on both sides of the sandy road, c. two kilometres from that river, just before the border of the Biebrza National Park, several specimens of *Viviparus contectus* (Millet, 1813) with yellow bodies were found. The ditches, usually keeping stagnant water, are typical for the habitat of that species (Jakubik, 2009). The snails could easily be observed due to the contrast of their body colour with the colour of the bottom of the ditch. The yellow colour was shown by both sexes. More closely to the tower in the National Park more specimens with yellow bodies but also animals with the common colour of this species were found. Other local species like *Planorbarius corneus* (Linnaeus, 1758) and *Lymnaea stagnalis* (Linnaeus, 1758) did not show any colour aberration.

Methods

The snails were studied at several locations. Pictures were taken and two animals with the aberrant colour, a male and a female, were taken along for further study. These animals were kept from April 21th, 2010, on in a big jar of 1.4 litres at room temperature and fed with algae and detritus. On November 13th, 2010 the two animals were transferred to an aquarium of 11 litres. Measurements of the shells were taken with a calliper to the nearest 0.1 mm. Winter rings on the shell and concentral rings on the opercula were counted in

order to determine the age (van der Spoel, 1958). The body colour was compared with Dutch specimens collected in Sint-Michielsgestel in the south of the Netherlands. As Meeuse (2006) recommended for specimens with albinism, several pictures were taken, especially of the yellow coloured parts.

Results

The collected animals were a male (Figs 1, 6) and a female (Figs 2-4), measuring 24.6 x 21.2 mm and 27.5 x 24.2 mm, respectively. According to the number of winter rings and concentral rings on the opercula both animals were about four years old. The yellow body colour is caused by the presence of yellow spots in combination with the absence of other pigments. Some parts of the body have more yellow pigments, other parts are almost transparent. Dorsally, the proboscis has both smaller and larger yellow spots whereas the ventral side of the proboscis lacks all pigments. The red-pink colour of the buccal mass is visible through the skin of the proboscis (Figs 2, 3) and the movements of this part with the radula can be observed. The left and right lobe of the mantle, its edge and parts of the foot have irregularly shaped yellow spots. The stretched tentacles show spots in the shape of small yellow stripes (Fig. 4). No black eye pigment could be seen.

Only the bodies of the snails show the aberrant yellow colour. The shell has the typical colour pattern with three dark brown bands. The operculum has the regular brown colour but in the middle of it the yellow parts of the body can be seen shining through. During the period from April 2010 till March 2011 the yellow colour did not change. At the end of March 2011, the female specimen turned out to be dead. It contained eleven light coloured embryos.

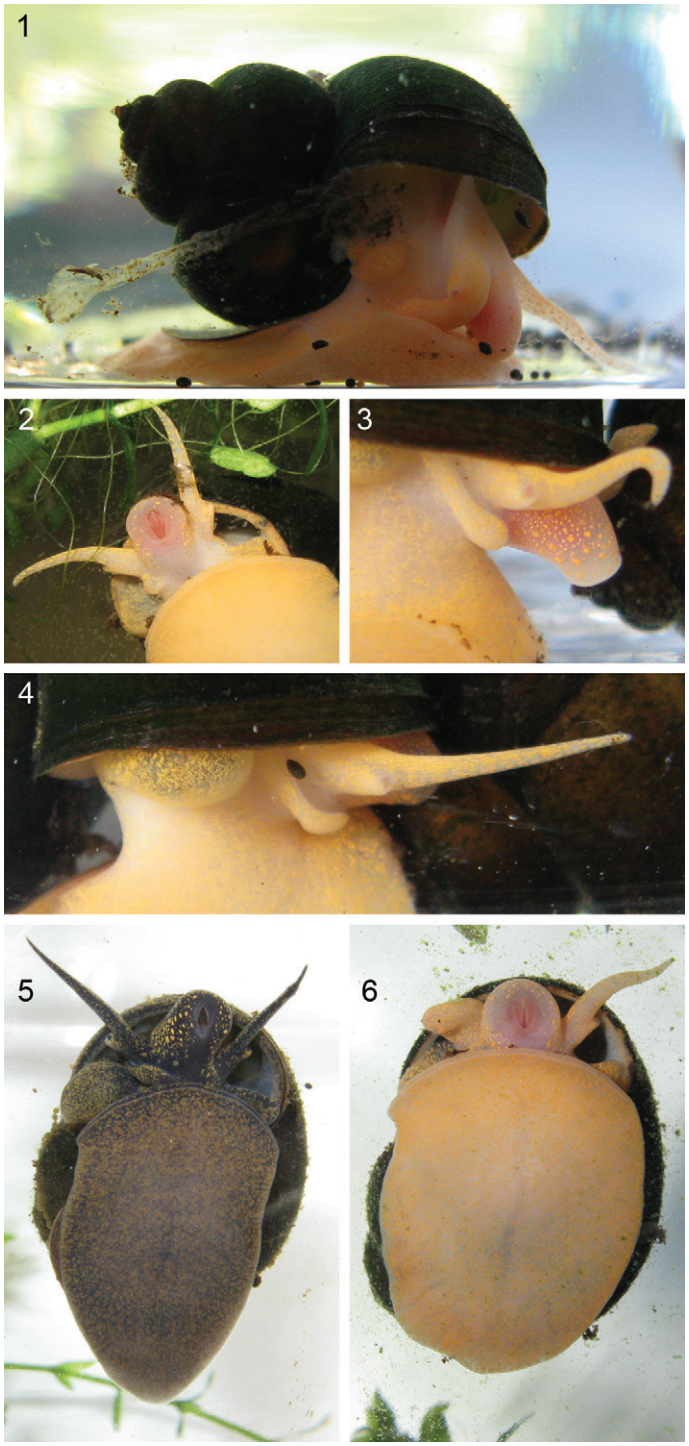
Discussion and conclusions

The regular colour of *Viviparus contectus* is caused by dark melanin pigments alternating with spots of yellow carotenoids (Vershinin, 1996; Gittenberger et al., 1998). The yellow spots in the aberrant animals have the same shape and pattern as those in normally coloured specimens (compare with Fig. 5 of a Dutch specimen and to plate 1, fig. 1 in Gittenberger et al., 1998). Only the dark pigments are missing (Fig. 6).

The body of *Viviparus* spp. is normally greyish dark in combination with yellow spots. Flavistic specimens are very rare. Jakubik (2009) collected a considerable number of *Viviparus contectus* near the Bug Valley, also in eastern Poland but does not mention any flavism. Gittenberger et al. (1998), Glöer (2002) and Glöer & Meier Brook (2003) do not mention any colour aberration of the body of freshwater molluscs. In Gittenberger et al. (1998: pl 2 figs 1-4) no comments are given on the yellow body colour on photos of mating great pond snails *Lymnaea stagnalis.* Clessin (1873) describes several colour aberrations of bodies and shells. Also aberrations on the colour of slugs are reported. However, no yellow colour aberration is mentioned. An aberrant yellow colour of the body and the shell is known from the apple snails *Pomacea bridgesii* (Reeve, 1856) and *P. canaliculata* (Lamarck, 1819). Apple snails appear in a wide variety of colours (Perera & Walls, 1996). Yellow animals are sold as "golden apple snails".

The colours of molluscan bodies may be influenced by a few basic types of pigments, viz. yellow carotenoids, indole pigments (indigoids and black melanines) and tetrapyrroles (porphyrins and bilichromes). For every species the basic body colour is determined genetically. Besides this, variation in colour can depend on environmental factors and food supply. Temporarily, hormonal influences may also be important (Fox, 1966).

Vershinin (1996) studied the two kinds of yellow colour carotenoids, viz. carotenes and xanthophylls, in eight species of sea- and freshwater-molluscs, including *Viviparus contectus*. He found carotenes only in the hepatopancreas and xanthophylls in nonreproductive organs. So the yellow colour of the recorded *Viviparus* of the Biebrza is caused by xanthophylls. Carotenoids are synthesized by algae and plants. Primary consumers store these substances in different body parts. Most molluscs with a herbivorous way of life seem to be nonselective assimilators. Sometimes limited metabolic changes occur. Fox (1966: 254) mentions for example the formation of the xanthophyll mytiloxanthin by the marine species *Mytilus californianus* (Conrad, 1837).



For the synthesis of melanin the amino acid tyrosine is needed as a precursor. In Fox (1966) and Junqueira et al. (1977) the conversion of tyrosine to melanine is explained. Bosch et al. (2009) mention two kinds of melanins, viz. eumelanine (black to brown bars) and phaeomelanine (brown-yellow to red-brown grains). Both pigments derive from the amino acid tyrosine if the enzyme tyrosinase is available. For the synthesis of phaeomelanine the amino acid cystein is required as well. When tyrosinase is missing there will be no melanins. If so, the other pigments will determine the colour. In case of albinism all pigments are missing. According to Dorsman & de Wilde (1929: 24, 91) albino molluscs do not lack all colour. Snails still have pigment in their body, especially in their eyes. According to Fox (1966) the black eye pigment of snails "is said to be melanine". In the yellow specimens found in the Biebrza basin the eyes do not have any colour. This could be explained by the lack of melanins in the eyes as well. Fox (1966: 262) explains that the buccal mass of pharyngeal muscles in many gastropods is red-coloured with myoglobin and may serve as a kind of "oxygen bank", particularly in those species living on mud flats. This explains the colour of the buccal mass shining through the proboscis.

Clessin (1873: 40; 1880) states that the colour of the body of freshwater snails seems not to have any influence on the colour of the shell. He gives examples of *Lymnaea stagnalis*. The colour of the shell however may be influenced by nutrition and climate. For instance, when considerable amounts of iron are available in the bottom the colour of the shells may turn into red. Since specimens of the snails with both yellow and normally coloured bodies are found together in the same ditches it is not obvious that the colour aberration depends on the availability of organic pigments

Figs **1-6**. *Viviparus contectus*. **1-4**, **6**, *Viviparus contectus* with yellow bodies from Mścichy, Biebrza Valley, northeastern Poland, kept in a jar. (photos Ingrid A.M. Margry – Moonen). **1**, **6**, male. **2**, female with ventral side of proboscis and red colour of buccal mass. **3**, proboscis, right side. **4**, right lobe of the mantle and tentacle. **5**, *Viviparus contectus* from Sint-Michielsgestel, the Netherlands. August 30th, 2010. (photo C.J.P.J. Margry).

in their food or on other environmental aspects. The aberration in the Biebrza riversnails is likely to have a genetic origin.

Inherited albinism is well known amongst molluscs. Boycott et al. (1929) used albino strains of *Lymnaea peregra* (cf. *Radix* spec. Montfort, 1810) while studying the inheritance of sinistrality. It is concluded that albinism is based here on an autosomal recessive allel. It is not clear however, whether these specimens lack all pigments (strict albinism) or only melanin and then still have yellow pigments (flavism).

According to Clessin (1873: 50), freshwater molluscs with albinism are rare, but if albinism is found on one spot many specimens can be found. This is exemplified by the population in the Biebrza Valley. Butot (1964) reported an albinistic population of the terrestrial snail *Aegopinella nitidula* (Draparnaud, 1805) in the Noordhollands Duinreservaat in the Netherlands. Forty years later Neckheim (2006: 36) still found albino *A. nitidula* at the same site. So a colour aberration can survive in a population during many generations.

Further study is necessary to investigate how far the flavism in *Viviparus contectus* is distributed in the area. Animals with such a strikingly aberrant colour should be more liable to predation. The presence of these snails has to be investigated in all age groups. More research should be done in order to find out in which way this strain is viable in the long run.

Acknowledgements

Thanks to K. Ramotowska for her guiding into the Biebrza region, F. van Asten, B. van der Bijl, T. Lenders and R. Moolenbeek for their help with literature and Ingrid Margry-Moonen for taking pictures of the snails.

References

Bosch, B., Wijgerde, P. & Kriesels, F., 2009. De zebravink. 1-319. Nederlandse Zebravinken Club, Bergen op Zoom.

Boycott, A.E., Diver, C., Hardy, S. & Turner, F.M., 1929. The Inheritance of Sinistrality in *Lymnoea peregra*. – Proceedings of the Royal Society B 104: 152

Butot, L.J.M., 1964. De molluskenfauna. "Recreatie en natuurbescherming in het Noordhollands Duinreservaat". Meded. Ltbon nr. 69/1964; suppl. 3 ("fauna") hfds. "Uitkomsten van de inventarisatie". RIVON-mededeling 167.

Clessin, S., 1873. Ueber Missbildungen der Mollusken und ihrer Gehäuse. — Bericht des naturhistorischen Vereins in Augsburg 22: 21-107.

Clessin, S., 1880. Farblose Helix obvoluta. — Malakozoologische Blätter, Neue Folge 2: 155-157.

Dorsman, L. & de Wilde, A.J., 1929. De land- en zoetwatermollusken van Nederland. 1-276. Wolters, Groningen.

Fox, D.L., 1966. Pigmentation of molluscs. In: WILBUR, K.M. and YOUNGE, C.M., 1966. Physiology of Mollusca, Vol. II: 249-272. Academic Press, London.

Gittenberger, E., Janssen, A.W., Kuijper, W.J., Kuiper, J.G.J., Meijer, T., Velde, G. van der & Peeters, G.A., 1998. De Nederlandse Zoetwatermollusken. Recente en fossiele weekdieren uit zoet en brak water. Nederlandse Fauna 2. 1-288. Leiden.

Glöer, P., 2002. Die Süsswassergastropoden Nord- und Mitteleuropas. Bestimmungsschlüssel, Lebensweise, Verbreitung. 1-327. Hackenheim.

Glöer, P. & Meier-Brook, C., 2003. Süsswassermollusken. 1-134. Hamburg

Jakubik, B., 2009. Reproduction of the freshwater snail *Viviparus contectus* (Millet, 1813) (Gastropoda: Architaenioglossa: Viviparidae). — Folia Malacologica 17: 223-230.

Junqueira, L.C., Carneiro, J. & Contopoulos, A., 1977. Basic histology. 2nd edition. i-xi, 1-468. Lange, Los Altos.

Meeuse, A.D.J., 2006. Albinism in Gastropoda. — Basteria, supplement 3: 49-50 .

Neckheim, C.M., 2006. De land- en zoetwaterweekdieren (Molluska of mollusken) van het Noordhollands Duinreservaat. Mollusken-inventariatie 2001 – 2005. 1-70. PWN, Velserbroek.

Perera, G. & Walls, J.G., 1996. Apple snails in the aquarium. Ampullariids: their identification, care, and breeding. 1-121. T.F.H. Publications, Neptune.

Spoel, S. van der, 1958. Groei en ouderdom bij *Viviparus contectus* (Millet, 1813) en *Viviparus viviparus* (Linné, 1758) — Basteria 22: 77-90.

Vershinin, A., 1996. Carotenoids in mollusca: approaching the functions. — Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology: 113 (1): 63-71.