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White Chestnut Cowry *Neobernaya spadicea*

Paul Tuskes
3808 Sioux Ave, San Diego, California 92117
tuskes@aol.com

ABSTRACT *Neobernaya spadicea* (Swainson, 1823) occurs from Southern California to central Baja California Sur, Mexico. Although there is no notable geographical variation in the phenotype, there are numerous color forms and unique patterns that occur throughout the population. The most unique color form is white. An examination of a limited number of white specimens determined that shell color changed after maturity; the factors that may have contributed to such a transformation are discussed.

INTRODUCTION

In this paper the unusual white form of *Neobernaya spadicea* (Swainson, 1823) is illustrated (Figure 1) and both when and how the shell might become white are discussed. In April of 2014, the author found a white *N. spadicea* at a study site on the Mission Bay Jetty, San Diego, California, and then in May 2014, the author collected a second specimen near Fish Hook on the north side of San Clemente Island. During fifty plus years of diving in Southern California these were the first the author had seen *in situ*, and it provided the opportunity to examine the nature of this unique color form.

Cypraea, and for that matter all other marine gastropods, extract calcium carbonate ($CaCO_3$) from the ocean water to build shell, a process within the scope of biomineralization. The $CaCO_3$ has a white appearance when incorporated into the shell structure. The binding material is the protein conchiolin and it is during this process that various pigments are laid down to give the shell its characteristic pattern and color (Abbott & Sandstrom, 1968). Numerous types of pigments have been identified as contributing to shell coloration and include but not limited to: carotenoids, pyrrole, indigoids, melanin, polyenes, pteridines, and porphyrins (Comfort, 1949; Comfort, 1951; Vershinin 1996; Hedegaard, *et. al.*, 2006). These materials typically have biological functions beyond pigmentation.

Figure 1. White *N. spadicea* (from the Don Pisor Collection), showing mature color and pattern under the overlaid white shell.

DISCUSSION

Neobernaya spadicea is a generalist, feeding on sessile marine invertebrates (MacGinitie & MacGinite, 1968; Tuskes, 2013). The diet of

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mollusks is the source of pigments that color the shell. One common suggestion is that the white color form specimens of *N. spadicea* have a diet that lacks the necessary pigments. However, even if one organism in the diet did not have the correct assortment of pigments, or their precursors, these may be available from other organisms in their diet. This species of *Cypraea* is often found in clusters, and if diet was the cause, one might expect others feeding in the same area to also produce non-pigmented shells, however that is not the case. Although this article refers to the shell of the white color form of *N. spadicea* as non-pigmented, there is no proof that it is truly not pigmented, as white pigments could be involved.

When in development did these specimens become white? In *Cypraea* the dark browns, brown, orange, and red are thought to be derived from porphyrin groups (Comfort, 1951). Three hypotheses for when *N. spadicea* becomes white came to mind and all center on a block in the pathway that incorporates pigment (especially porphyrins) into the shell: (1) The shells may have been white since their earliest development, an albino; (2) they may have become white as the snail matured and changed from the juvenile to the adult when shape, color, and pattern change; or, (3) it may have become white after maturity. It seemed most likely that a break-down in the metabolic pathway during the change from juvenile to adult was probable. For more information on the transition of *N. spadicea* from the juvenile to the adult stage *see* Ingram, 1938.

Having two white specimens, the author masked half of the shell and removed the upper most layer of shell from the other half to determine what lay beneath. In both instances the pattern and color under the white *N. spadicea* was that of the typical mature adult specimen (see Figures 2 and 3). Placing a high intensity light on two other white specimens of *N. spadicea* (in the collection of Don Pisor) revealed that both specimens had a faint outline of the typical mature color pattern beneath the white overlay. (Figure 1) White *N. spadicea* are rarely seen, and based on these four specimens the author could not conclude that all *N. spadicea* that become white achieve this rare color form by only one path. In this instance, all four individuals had successfully incorporated pigments in the recent past and had the typical adult color and pattern prior to becoming white.

Figure 2. White *N. spadicea* from Mission Bay Jetty.

Figure 3. White *N. spadicea* from San Clemente Island.

How might these specimens become white? Rather than pigments missing from the diet of the snail, the author suspects that a failure in the metabolic pathway that: (1) prevents the pigments from passing through the gut membrane; (2) pigments are not transported to the glands that secrete them in the mantle; (3) the glands in the mantle become defective (4) a defect in the synthesis results only in the production of white pigments. or, (5) the pigments are metabolically modified in the gut or snail tissue such that they lose their activity. In other organisms the author has researched (including arthropods), pigments such as pteridines are modified to form a family of pigments such as sepiapterin (browns),

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xanthopterin (yellow), erythopterin (red) and leucopterin (white), with multiple pigment pathways having different end points such that various pigments may be supplied from an initial precursor. If the end point of the pathway is leucopteirn only white pigments are observed.

The author was not able to locate literature describing metabolic manipulation of porphyrins or pteridines in gastropods, only their presences in the shells of mollusks. As *N. spadicea* is a generalist feeder, the author doubts that diet alone is the cause of white *N. spadicea*, but rather that any number of metabolic processes may fail, preventing normal pigmentation in this species.

ACKNOWLEDGMENTS

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EDITORS' NOTE

Errata:

Berschauer, D.P. & E.J. Petuch. 2016. A New Species of Harpa (Gastropoda: Harpidae) from the Coral Sea Archipelago of Queensland, Australia. The Festivus 48(2):102-108.

- Type Locality: change to "dredged at 10 m depth in coral sand off East Diamond Islet, Queensland, Australia."
- Etymology: change to "species" not subspecies.
- Figure 2: Holotype shown as image "C" is 34.5 mm.

Updates:

Clark, R.N. 2016. Notes on Some Little Known Arctic Alaskan Mollusks. The Festivus 48(2):73-83.
In this paper the author introduces a new combination for the forgotten buccinid, *Buccinum rodgersi* Gould, 1860, *Anomalosipho rodgersi.* Dr. Yuri Kantor, Severtzov Institute of Ecology and Evolution, Russian Ac. Sci. Moscow, Russia. recently brought to the author's attention a very recent paper by A. V. Merkuljev, "Forgotten species from the Bering Strait – Buccinum rodgersi Gould, 1860 (Neogastropoda: Buccinidae)" Ruthenica 25 (3): 89-92. In this paper (in Russian) that author reports on the forgotten species, assigning it to the genus *Plicifusus* Dall, 1902, and includes a synonym, *Plicifusus mcleani* Sirenko, 2009. However the author believes that this species should be retained in the genus *Anomalosipho* Dautzenberg & H. Fischer, 1812, due to its lack of axial sculpture and because members of the genus *Plicifusus* have well developed axial ribs.

Clark, R.N. 2016. *Pteropurpura festiva* in Monterey Bay. Festivus 48 (1): 32.
The author reported on the finding of two specimens of *Pteropurpura festiva* in Monterey Bay, on May 7, 2011, at 12 m, and again on April 8, 2015 at 8 m. On April 4, 2016 another dive was made at the site, and several specimens *P. festiva,* up to 4 cm in length were observed and photographed.

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Haliotis arabiensis Owen *et al.*, 2016 specimens from Oman in the Naturalis Museum, Leiden, The Netherlands, Incorrectly Identified as *H. varia* Linnaeus, 1758, and *H. pustulata* Reeve, 1846

Buzz Owen[1] and Wilco Regter[2]
[1] P.O. Box 601, Gualala, California 95445
buzabman@mcn.org
[2] 1 Cleadon Gardens, Gateshead, NE9 7BA, United Kingdom
wilco-regter@hotmail.com

INTRODUCTION

This brief paper closely follows the publication of a *Haliotis* species new to science (*H. arabiensis* Owen, Regter, and Van Laethem, 2016), and presents the results of an examination of Omani *Haliotis* deposited in the Naturalis Museum of Leiden, Netherlands (NCB). Of the 35 total lots in this collection, 18 are catalogued as either *H. pustulata* Reeve, 1846 (now *H. rugosa pustulata*) or *H. varia* Linnaeus, 1758. The remaining 17 lots can clearly be attributed to *H. mariae* W. Wood, 1828, the common commercially taken *Haliotis* of Oman.

Regter visited the Museum in April, 2016, and photographed all specimens identified as *H. pustulata* or *H. varia*. Examination of this material clearly revealed the entire group of 27 shells were the newly described species (with the exception of one specimen of typical Philippine *H. varia* labeled as being from "Kuwait" – an obvious error).

Twenty five of the 27 specimens are illustrated on Figures 1 and 2, while Figure 3 (Tables 1 and 2) provides a key to the data for each lot when compared to the number accompanying each of the 25 specimens.

Remarks: The following background information provides details on how these specimens arrived into the Naturalis Museum collection: Robert G. Molenbeek and several other malacologists were involved with the publication of the book "Seashells of Eastern Arabia" (Bosch *et al.*, 1995) and shells collected in Oman by him and other malacologists were added to Zoological Museum Amsterdam (ZMA), Netherlands. A few years ago this ZMA collection was consolidated into the Dutch National Biodiversity Collection (NBC) in Leiden. Information on the shell data tags in the NCB collection seems to indicate that the species can also be found intertidally. Perhaps due to increased collection pressures locally, or an increased human population, this might now be more difficult. Currently, it is against the law to collect any mollusks in Oman.

The type and two paratype specimens of *H. arabiensis* are illustrated on Figure 2, images 13-15, and three specimens from United Arab Emirates are on Figure 3, images 1-4. Figure 3 also has a map of the areas where specimens have been found. (Owen *et al.*, 2016)

Abbreviations of Collections: NMNZ: National Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand; WRC: Wilco Regter Collection, United Kingdom; BOC: Buzz Owen Collection; ARC: Arjay Raffety Collection.

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Owen, B., W. Regter & K. Van Laethem, 2016. Review of the Haliotis of Yemen and Oman with Description of a New Species, *Haliotis arabiensis*, from Oman and United Arab Emirates. The Festivus 48(2):84-87, 5 figures.