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Iridescence in land snails

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ABSTRACT For the first time, 14 genera of land snails that contain individuals who display iridescence on either the animal and/or shell are identified. This phenomenon has not been previously reported in the malacological literature. The biological significance of iridescence among these snails is currently unknown.

KEY WORDS Iridescence, land snails.

INTRODUCTION

Iridescence is often described as a phenomenon of particular surfaces that appear to switch color as the angle of view or illumination changes. It generates a wide range of color that may extend from violet to red and the visible light spectrum between. A wide range of plants and animals exhibit iridescence, which may serve a variety of biological functions, or the occurrence may simply be a serendipitous based on surface structure. Bioluminescence on the other hand is just light generated by animals or plants via a chemical reaction and is not a reflection.

Invertebrates employ all kinds of optical trickery to become themselves either unseen or conspicuous to predators. Somehow, those conspicuous strategies seem to work perfectly under certain scenarios, *e.g.*, cephalopods neural control readjusting their iridescence responsible protein structures in order to match their surroundings. Evolution of the optical effect of iridescence is related to several developed structures in the mineral, animal and plant kingdoms.

Pigmentary colours are generated by the selective absorption of some wavelengths by special molecules called pigments (which do not emerge by reflection or transmission) while *structural colours* are generated by the physical interaction of light with matter, causing dispersion, diffraction or interference (*e.g.*, coleopteran elytra cuticle contour). Among structural colours, iridescent colours change depending on the illumination or observation viewpoint. They can be produced by interferences of light after reflection by a thin-film or multilayer structure, or diffraction on a grating (Gruson *et al.* 2019; Hariyama *et al.* 2002). Therefore, the study of the evolution of iridescent colours requires a precise quantification of the angular dependency. The iridescence versatility versus pigment-based signaling could be mainly related to few or a myriad of processes in animals' visual communication (White 2018).

Despite being not so uncommon in nature (*e.g.*, fishes, birds, reptiles, arthropods, etc.), iridescence seems to be infrequent in land snails [bioluminescence is even rarer, with still only one known species *Dyakia (Quantula) striata* (Gray, 1834)]. The iridescence of snails could

be related to the animal's mantle, shell "mirror reflection" and layered crystal structures deposited in the animal tract and lung veins (*e.g*., guanine crystals).

During malacological photographic field expeditions in Ecuador between 2008-2012 we observed few land snails' species from mountain moist cloud forests which under intense flash light reflected pearly white, light green and bright red flecks or dots. Years later during an eastern Cuban land snail photoshoot in 2019 we came across a similar type of iridescent reflection seeing in the apical whorls of one common Cuban species that mainly inhabit central-eastern part of the archipelago.

We did a search on Internet and examine literature at hand in order to determine which snails could be considered as displaying iridescence. So, many of the mentioned species were found by pictures on several websites and some photos were kindly given to us by the photographers.

DISCUSSION

Pigmentary color in snails are common, sometimes the animals body are distinctive, *e.g*., *Platymma tweediei* (Tomlin, 1938). Sometimes the shells with its bright coloration steals all the protagonism, *e.g.*, *Polymita*, *Liguus*, *Asperitas*, and *Amphidromus*. On the other hand, iridescence seems to be an uncommon trait in land snails.

Iridescence in land snails is exhibited in two forms: 1) smooth, lustrous, helicoid, depressed or elongated translucent shells that could reflect iridescent shades in the shell or through it; and, 2) animals with reflective living tissue coloration with translucent or opaque shells. Sometimes iridescence in land snails are a combination of how translucent is the shell is and how reflective turns the animal pigmentation underneath in front of different light concentrations.

Land snails found with iridescent reflection in its shells:

- *Phaulocystis iris* (Muratov, Abdou & Bouchet, 2005). Locality: Mayotte, Mlima Tchaourembo, Comores Islands, Mozambique. Shell pale-corneus brownish with spiral riblets. Its radial, extremely compressed sculpture "*produces an iridescent effect*" (source: scientific paper).
- *Drepanostomella nautiliforme* (Porro, 1836). Locality: Northern Ecuador. Slight iridescent golden reflection in its helicoid shell.
- *Tamayoa decolorata* (Drouët, 1859). Locality: French Guiana, also introduced in other Caribbean islands (*i.e*., Guadeloupe). The bright yellow specimens seem to reflect a slight iridescent golden reflection through its semi-translucent helicoid shell when alive.
- Species unknown. Locality: Delos Mountain, Papua-New Guinea. Slight iridescent golden reflection in its nautiliform shell (source: internet photo in Flickr by Robert Lasley).
- *Proserpina depresa* (D'Orbigny, 1842). (Plate 1, Fig. 4) Locality: Cuba. Slight iridescent golden reflection in its helicoid shell.
- *Proserpina globulosa* (D'Orbigny, 1842). Locality: Cuba. Slight iridescent green reflection in its helicoid shell.
- Species unknown (Helicarionidae?). (Plate 1, Fig. 2) Locality: North Ecuador. Dark green-bluish iridescent reflection in its helicoid shell.
- *Kalidos* sp. (Helicarionidae). Locality: Northern Madagascar. Dark green-brownish iridescent reflection in its helicoid shell.
- *Oleacina* spp. Locality: Caribbean. *Oleacina* carnivorous snails exhibit translucent amber-yellow shells with orange to bright yellow animals, which depending of the light angle can surface a yellowish metallic iridescence.
- Species unknown (Helicarionidae). Costa Rica. Sort of blue metallic reflection from shell…seems

like animal internal organs (source: photo by Ira Richling).
- *Helicarion cuvieri* (Férussac, 1821). Victoria and Southern New South Wales in Australia and Tasmania. The red form of this semislug species got a sort of red metallic reflection on its shell.

Remarks: Additional species from *Happia*, *Hapiella*, *Tamayoa* and other genera (*i.e*, Helicarionidae family) must be examined alive to see if its shells expose iridescence as well.

Land molluscs found with some iridescence degree in their animal's body:

- *Synapterpes bicingulatus* (Fulton, 1908). (Plate 1. Fig.5) Locality: Northern Ecuador. Pearly iridescence in its whorls.
- *Euclastaria euclasta* (Shuttleworth, 1852). (Plate 1. Fig.1) Locality: Charrascales de Mícara, Santiago de Cuba. Green iridescence in its apex first whorls. In this locality among ophiolites is common to find metals such as cadmium, chrome and nickel.
- *Plekocheilus* sp. (juvenile). Locality: Laurel, Carchi, Ecuador. Bright red iridescence in its lung veins.
- Species unknown (Scolodonta?). (Plate 1. Fig. 6) Locality: La Bonita, Ecuador. Golden reflection and bright green specks through all the whorls.
- *Ubiquitarion iridis* (Hyman, 2007) [syn. *Peloparion iridis*]. Locality: Brooyar State Forest, Somerset Dam and Mt Glorious in South East Queensland. An iridescent semi-slug of pink-brownish coloration.
- Species unknown. (Plate 2, Fig. 8) Locality: Sri Lanka or Andaman Islands. Light blue-green iridescent slug (from a 2009 photo published in 2010 by Californian rare books librarian Katharine Donahue).
- *Ibycus rachelae* (Schilthuizen & Liew, 2008). (Plate 1, Fig. 3) Locality: Borneo and Sabah semi-slug, Indonesia. Also found in Raub, Pahang, Malasya. Bright green and yellow phosphorescent type of coloration in mantle that creates an iridescence sensation.
- *Satiella* sp. [*Satiella* (Blanford & Godwin-Austen, 1908) seem to contain interesting species]. Locality: Western Ghats, India. Both, the animal and the shell show iridescent reflections.
- *Gaeotis nigrolineata* (Shuttletvorth, 1854). (Plate 2, Figs. 5-6) Locality: Different locations from El Yunque National Forest in Porto Rico. This one and the other "named" species in this genus [*albopunctulata* (Shuttletvorth, 1854), *malleata* (Pilsbry, 1899), *flavolineata* (Shuttletvorth, 1901)] display in its transparent body bright green and yellow phosphorescent type of coloration in mantle, which depending on the light angle creates an iridescent sensation. It seems that all the species are in fact a single one (Genaro & Sánchez, 2019: 137, 142).
- *Drymaeus binominis* (Guppy, 1868) or (E. A. Smith, 1895). Locality: Saint Vincent and other Lesser Antilles Islands. Caribbean bluish-bodied *Drymaeus* usually display not so translucent shells, but this species exhibits a noticeable bluish iridescence.
- *Drymaeus sallei* (Pilsbry, 1899). Locality: Dominican Republic. Bluish iridescence in the animal.
- *Drymaeus laticinctus* (Guppy, 1868). Locality: Dominica. This species displays beautiful shells that can be bright sulphur yellow or red with dark bands. Its animal on the other hand is blue with translucent yellow tentacles displaying in occasions iridescence.
- *Drymaeus sulphureus* (Pfeiffer, 1857). Locality: Central America (e.g., Belize) and Lesser Antilles (*e.g*., Dominica). Bluish iridescence in the animal.
- *Drymaeus valentini* (Breure & Vega-Luz, 2020). (Plate 2, Fig. 2) Locality: Iquitos, Peruvian Amazon region. Animal with particular light blue-green iridescence.
-*Drymaeus sp.* Locality: Manzanares, Caldas, Colombia (picture by Jorge Eduardo Bernal Quintero). Bluish iridescence in the animal.
- *Bielzia coerulans* (Bielz, 1851). Locality: Carpathian area in Europe. Slug with blue iridescent reflection.

- *Triboniophorus graeffei* (Humbert, 1863). East Australia. In this wide-ranging colored species, the greenish and light blue color forms could reflect slight iridescence.

Remarks: Other small snails with shining smooth shells displaying noteworthy translucent bright colorations in their bodies such as Jamaican *Proserpina pisum* (Adams, C. B., 1850) (Plate 2, Fig. 3) or *Happia decolorata* (Drouët, H., 1859) need more scrutiny.

CONCLUSIONS

A somewhat metallic iridescence occurs in smooth helicoid shells among different species seemingly occur across the globe. It appears that this type of shell iridescence is the most frequent in land molluscs. Land shells with elongated shape, periostracum "hairs", pronounced ribs and spines seem less likely to be iridescent. The existence of transparent or slightly translucent shells with animals of vivid or contrasting colors doesn't mean a certainty of iridescent flakes finding. In many cases, the remarkable animal body color may look different through its semi-translucent or semi-opaque shells, *e.g.*, Cuban *Cysticopsis lassevillei* (Gundlach in Pfeiffer, 1861) (Plate 2, Fig. 4), and probably the Hispaniolan *Helicina* cf. *viridis* (Lamarck, 1799 and 1822) (Plate 2, Fig. 1), Indonesian *Rhinocochlis nasuta* (Thiele, 1931) (Plate 2, Fig. 7), and Indian *Euplecta* sp. (Ariophantidae). In fact, only a very small fraction of the species with translucent shells we know could display iridescent specks.

In our review of land snails, we might have misunderstood some iridescence with certain bright colors reflection (*i.e.*, *Gaeotis* species, unidentified Ecuadorian mollusk, etc.). Snails with semi-translucent shells displaying bright-colored organs sometimes nearly "photo-sensitives" or phosphorescent [*e.g.*, *Simpulopsis citrinovitrea* (Moricand, 1836), *Habroconus cassiquiensis* (Newcomb, 1853), *Simpulopsis corrugata* (Guppy, 1866)] not necessarily must be considered as iridescent.

Guanine crystals could be one of the sources of iridescence in some land snails' digestive tract, lung veins, or any other organ in its anatomy. However, the animals that reflect iridescence in their foot, head and tentacles seem to have another explanation.

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Plate 1. 1= *Euclastaria euclasta*. Charrascales de Mícara, Santiago de Cuba province. **2=** Species unknown (Helicarionidae?). North Ecuador. **3=** *Ibycus rachelae*. Malasya. **4=** *Proserpina depresa*. Sierra de los Órganos, western Cuba. **5=** *Synapterpes bicingulatus*. Nanegalito, Ecuador. **6=** Species unknown (*Scolodonta*?). La Bonita, North Ecuador. Picture credits: #2 Courtesy of Francisco Tobar. #3 Arnold Wijker (inaturalist.org). # 1, 4-6 Adrián González-Guillén.

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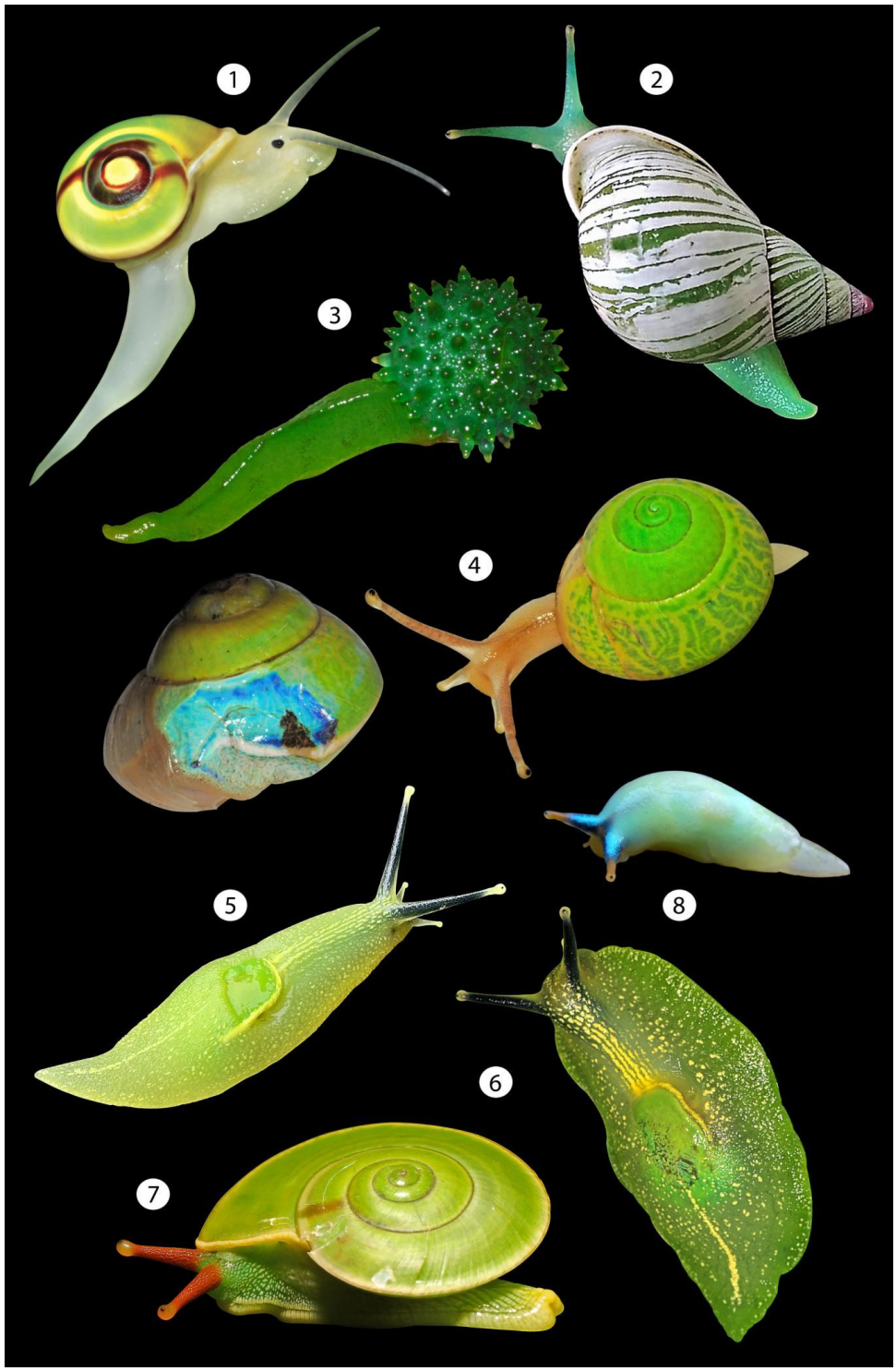

Plate 2. 1= *Helicina viridis*. Dominican Republic. **2=** *Drymaeus valentini*. Iquitos, Amazonian Peru. **3=** *Proserpina pisum*. Jamaica. **4=** *Cysticopsis lassevillei*. Pico La Bayamesa, Santiago de Cuba province. **5 & 6=** *Gaeotis flavolineata*. Rio Grande vicinity, Yunque national forest, Porto Rico. **7=** *Rhinocochlis nasuta*. Serian, Sarawak, Malasya. Picture credits: #1 Courtesy of Carlos de Soto Molinari. #2 Courtesy of Víctor Castillo Villanueva. #3 Courtesy of Simon Aiken. #4 Adrián González-Guillén. #5 ianprincecordero (inaturalist.ca). #6 Tom Kennedy (inaturalist.ca). #7 danolsen (inaturalist.uk).