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THE INHERITANCE OF *GOLDEN*, A SHELL COLOR VARIANT OF *MARISA CORNUARIETIS*. — **Robert T. Dillon, Jr.**

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Keen interest has been directed toward shell color polymorphism in pulmonate snails (Cain *et al.*, 1968; Murray & Clarke, 1976; Cowie, 1984) and bivalves (Chanley, 1961; Adamkewicz & Castagna, 1988), primarily because of the utility of visible markers in population genetic studies. Body pigmentation genes, also well-characterized in pulmonates, have proven valuable as tools for a variety of fundamental biological investigations in the laboratory (Richards, 1985; Dillon & Wethington, 1992). Shell color polymorphism is widespread in marine prosobranch snails, and some progress has been made toward an understanding of its genetic basis (Palmer, 1985; Reimchen, 1989). But to my knowledge, no pigmentation polymorphism has been genetically characterized in freshwater prosobranchs to date. In this note, I report the results of three generations of breeding studies indicating that the "golden" shell phenotype of the common ampullarild *Marisa cornuarietis* (Linnaeus) is inherited as a simple Mendelian recessive trait.

Although native to northern South America and Central America, the "Giant Colombian Rams Horn" *Marisa cornuarietis* has attracted worldwide attention as a possible control agent for both aquatic weeds (Seaman & Porterfield, 1969) and pulmonate snails of medical importance (Jobin *et al.*, 1977; Cedeno-Leon & Thomas, 1983). The snail seems to have been first introduced to North America in Coral Gables, Dade County, Florida (Hunt, 1958), perhaps by aquarium hobbyists, with a separate introduction some 25 years later near San Marcos, Texas (Neck, 1984). Populations have since spread through much of southern Florida, and the San Marcos and Comal river systems of central Texas.

The shell of *Marisa cornuarietis* ordinarily has a dark yellow background with 2-9 reddish-brown bands of variable width, the number of bands sometimes increasing with age (Fig. 1). However, in recent years a "Golden Rams Horn" has become available in stores catering to the aquarium and water-garden trade, sometimes selling at a premium price over the more typical, banded variety. The golden variety has an entirely unbanded shell, but is indistinguishable from the typical variety in body pigmentation and all other respects. Voucher specimens of both the typical and golden varieties have been deposited in the Academy of Natural Sciences of Philadelphia.

Breeding studies began in 1994 with two clutches of eggs. Sibship A contained 41 goldens and 41 bandeds, from eggs laid by a golden dam (sire unknown). The phenotype of neither parent was known for sibship B, 25 bandeds and 11 goldens hatched from a single mass collected in a large common tank. Ten pairs of these offspring (designated the F_1 generation) were reared in separate four-liter aquaria on diets of Romaine lettuce and commercial fish food flakes. Three pairs ultimately yielded offspring: two crosses of banded A x golden B and one banded B x golden B (Fig. 2). A random sample of the F_2 generation was divided by phenotype into two 40-liter common aquaria. F_3 egg masses were recovered from artificial plants in these aquaria, isolated, and scored as to phenotype upon hatching.

All three F_1 banded x F_1 golden crosses yielded F_2 ratios not significantly different from 1:1 by chi square goodness-of-fit tests. Combined, the F_2 total of 63 banded and 44 golden was likewise not different from 1:1 ($X^2 = 3.37$, 1 df). All three F_3 clutches recovered from the golden aquarium yielded entirely golden progeny. The banded aquarium yielded five F_3 clutches each not significantly different from 3 banded : 1 golden. In combination, the F_3 progeny from the banded aquarium totalled 135 banded and 50 golden, again not significantly different from 3:1 ($X^2 = 0.41$, 1 df). I suggest the symbol *"g"* to represent the simple recessive gene apparently encoding the golden phenotype.

The *golden* gene may prove to be a useful marker for population genetic studies, as has been the case in pulmonate snails. However, I am not aware that *golden* has appeared in wild populations of *Marisa cornuarietis* thus far. Only banded individuals were apparent in a random sample of 102 snails taken in February, 1997, from the Coral Gables Canal (at the Palmetto Expressway). Also entirely banded was a random sample of 138 individuals collected that same month from a more recently established *M. cornuarietis* population inhabiting a drainage canal west of Lake Worth, Palm Beach County, Florida. A sample of 115 individuals taken in June, 1997, from the San Marcos River at San Marcos, Texas, was likewise entirely banded.

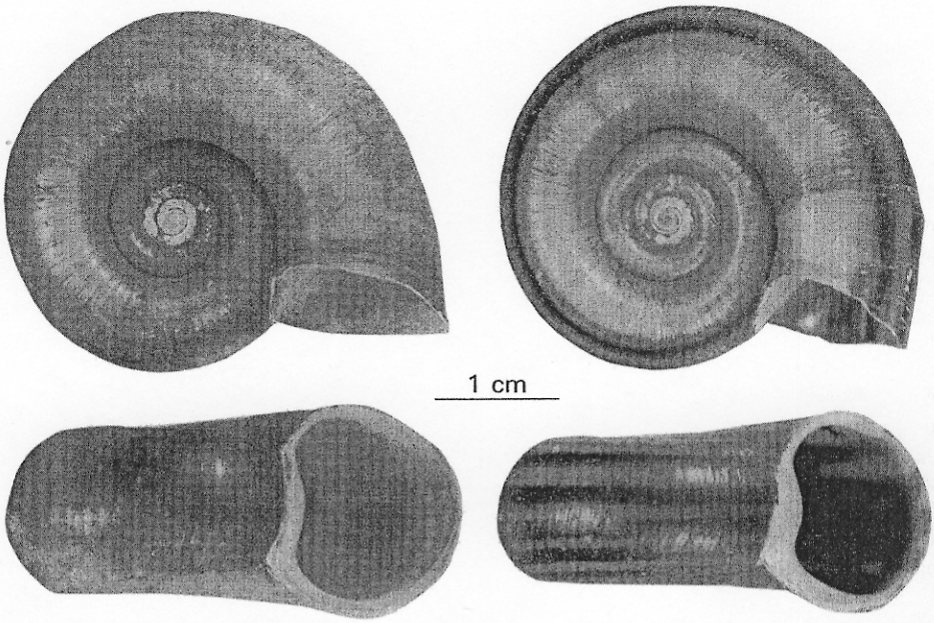

FIG. 1. *Marisa cornuarietis*. The golden variety is shown at left, and the typical (banded) variety is at right.

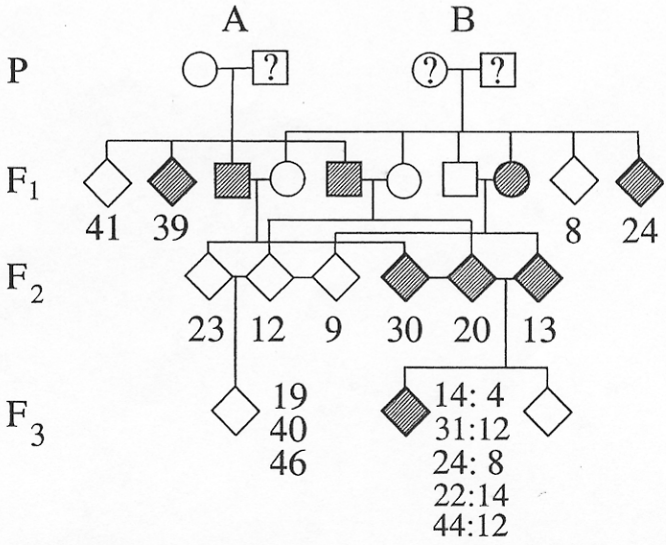

FIG. 2. Results of breeding studies on the golden phenotype. Circles are female and squares are male. Filled symbols indicate banded individuals, unfilled symbols are golden. Diamonds indicate groups of progeny showing the same phenotype, with the count given below.

Ampullariid "apple snails" or "mystery snails" (primarily the genus *Pomacea)* have attracted more attention from hobbyists than *Marisa cornuarietis* (Perera & Walls, 1996). Both *Pomacea canaliculata and P. bridgesii* are also commercially available in their typical form (dark shells with brown bands) and as a "golden" (unbanded) variety. At least some populations of the pest "golden apple snail" (introduced

into Asia as a food source, Vitousek *et al.*, 1996) may have been derived from a stock of *P. canaliculata* with pigmented, unbanded shells much like golden *M. cornuarietis*. In contrast to the situation in *M. cornuarietis*, however, additional *Pomacea* stocks have been commercially developed that show body color variation as well as variation in shell color. Available varieties of *P. bridgesii* include animals showing exceptionally dark body pigmentation or somatic albinism, as well as varieties showing golden shells or completely unpigmented shells. Body and shell pigmentation seem inherited separately, such that a black animal may carry an unpigmented shell. Clearly much remains to be learned regarding the inheritance of pigment polymorphism in the Ampullariidae.

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