CLARIFICATION OF THE TAXONOMIC STATUS OF *ISOMERIA MORULA* (HIDALGO 1870), FROM ECUADOR (GASTROPODA: PLEURODONTIDAE)

FRANCISCO J. BORRERO[1] & RAFAEL ARAUJO[2]

[1]Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, OH 45203, USA (Present address: Department of Malacology, Academy of Sciences, Drexel University, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, USA)
[2]Museo Nacional de Ciencias Naturales (C.S.I.C.), c/ José Gutiérrez Abascal 2, 28006 Madrid, Spain

Abstract *A clarification of the status of* Isomeria morula *(Hidalgo 1870) is given, based on the recently rediscovered, likely type specimen at Museo Nacional de Ciencias Naturales (MNCN, Madrid, Spain), and additional material from University of Michigan Museum of Zoology (UMMZ, Ann Arbor USA). The available material (three specimens) comes from older collections (i.e., mid- to late 1800's) from Ecuador. The specimen at MNCN is here designated as the lectotype of* I. morula *(Hidalgo 1870). Conchological characteristics are discussed and this species is fully illustrated for the first time. Comparisons of this taxon with other* Isomeria *from western South America and a partial key are also given, thus contributing to clarifying its status and recognizing it from other species in the genus. The geographic distribution of* I. morula *and its conservation status remain unknown.*

Key words *Pulmonata, taxonomy, biodiversity, Neotropics, northern South America.*

INTRODUCTION

The land snail genus *Isomeria* is known only from western South America, and thus far species have been recorded from Colombia, Ecuador, and Peru. Thirty-five species and subspecies of *Isomeria* are currently recognized, but their biology, ecology, and conservation status are virtually unknown. In his monographic revision of the Neotropical pleurodontid genera *Labyrinthus* and *Isomeria*, Solem (1966) pointed out the limitations posed by insufficient surveying efforts, and insufficient material in museum collections, to the understanding of interspecific morphological variation and distributions of these land snails. Considering that pleurodontid land snails are among the largest and most conspicuous (although not always the most colourful or abundant) snails in the Neotropics, such an incomplete knowledge reflects the poor overall current knowledge of the Neotropical malacofauna. A number of species are known only from original (type) material, often with vague or no locality data, which is typical of many collections made between the late 17th through early 20th centuries. For the majority of taxa, the material consists only of shells, hindering anatomical or molecular phylogenetic analyses. Further, the status of a few described taxa remains unclear because the type material has not been located or may have been destroyed, and no additional material is known. In some cases, only the original descriptions are available. Such is the case of the species referred to in this paper, *Isomeria morula* (Hidalgo 1870). Clarifying the systematics of these poorly known species is critical for modern assessments of local and regional biodiversity, as well as for conservation planning, particularly in regions such as western South America, recognized as including some of the world's most imperilled, yet poorly known biodiversity hotspots. Land snails of the genus *Isomeria* do not occur outside of this region.

Helix martinii Bernardi 1858 was described from "Quito" [Ecuador], and was stated to be part of the Paz Collection of molluscs. Paz (D. Patricio María Paz y Membiela) was a naval captain and respected Spanish naturalist specializing in molluscs, who was later appointed to head the Scientific Commission of the Pacific (hereafter referred to as Comisión Científica), a major expedition to the Americas, commissioned by Spain during 1862–1865 (Hidalgo, 1869; Miller, 1968). The terrestrial molluscs were covered by Hidalgo (1869, 1870, 1893a,b). Hidalgo's (1869, 1893b) accounts of the Mollusca from the expedition of the Comisión Científica do not include *Helix martinii* Bernardi, but this taxon is treated by Hidalgo (1870). In the latter publication, Hidalgo renamed this species as *Helix morula* Hidalgo 1870, on account of a previously described species of a different family,

Contact author : borrerofcoj@gmail.com

but with a similar name (*Helix martini* Pfeiffer 1854); however, he later reconsidered this action and suggested going back to using *Helix martinii* Bernardi (Hidalgo, 1893a). The collection date of the type material of *Helix martinii* Bernardi remain unclear, but it may have been collected prior to the Comisión Científica, since Bernardi (1858) mentioned that the specimen was part of Paz's collection. Measurements of a single specimen are given in Bernardi's (1858) description, and it appears that no additional specimens were available to him. Today, Paz's collection is part of the Malacology Collection at Museo Nacional de Ciencias Naturales (MNCN) in Madrid, Spain.

As part of a critical re-examination of the Pleurodontidae of northern South America (Borrero *et al*., 2007; Borrero, submitted), a lot containing two individuals labelled as "*Pleurodonte martini* Bern" [sic, *martinii*] was found in the mollusc collection at University of Michigan Museum of Zoology in Ann Arbor, USA (UMMZ), which matched well the description and figure of *Helix martinii* Bernardi. Upon enquiring at various museums including MNCN for the type material of this taxon, a single specimen was found in Madrid, now considered the, thus far, unrecognized type of *Isomeria morula* (Hidalgo 1870). Very likely, this same specimen is the type of *Helix martinii* Bernardi, since Bernardi (1858) mentioned specifically that the specimen he described was part of the Paz collection, and no additional material is present in the Paz collection or elsewhere at MNCN in Madrid, nor at other major European museums. In addition, the measurements given in the original description match the dimensions of the shell referred to here, currently in Madrid. This material, consisting of the type and two additional specimens is used here to clarify the taxonomic status of *Isomeria morula* (Hidalgo 1870), and to fully illustrate this species for the first time. This action is considered necessary for the stability of this taxon and the better understanding of the pleurodontid land snails of northern South America.

Material and Methods

Shell measurements generally follow those of Burch (1962), with clarifications noted in parenthesis as follows: AH aperture height (taken from attachment of peristome and body whorl to lowest, outer edge of peristome, parallel to axis of coiling); AW aperture width (from outer edge of umbilical plate to outside edge of peristome, roughly perpendicularly to the axis of coiling); H shell height (from shell apex to lowest edge of basal lip); MxD shell maximum diameter (taken including the width of the outer lip of the peristome); MnD shell minimum diameter (measured perpendicular to MxD); W number of whorls.

Systematics

Family Pleurodontidae Ihering 1912

Genus *Isomeria* Albers 1850
Type species: *Helix oreas* Koch 1844.

Isomeria morula (Hidalgo 1870)
(Figs 1–10, Table 1)

Helix martinii Bernardi 1858 (not Pfeiffer 1854): 93, pl. 1, fig 3; type locality Quito.
Helix morula Hidalgo 1870: 32 ; type locality Quito, République de l'Equateur ; lectotype MNCN 15.05/60012 (new designation).
Isomeria martinii (Bernardi 1858), Miller, 1878.
Isomeria morula (Hidalgo 1870), Cousin, 1887.
Helix (*Isomeria*) *martinii* Bernardi 1858, Pilsbry, 1889.
Pleurodonte (*Labyrinthus*) *martinii* Bernardi 1858, Pilsbry, 1894
Helix morula Hidalgo 1870, Azpeitia, 1924.
Isomeria morula (Hidalgo 1870), Solem, 1966; Richardson, 1985: 160.

Material examined Ecuador, Quito (lectotype of *Helix morula* MNCN 15.05/60012, new designation); coll. D.P. Paz y Membiela. Ecuador (UMMZ 312 (2 specimens), as *Pleurodonte martini* [sic] Bern).

Measurements and morphological variation The three specimens known are remarkably similar in size, all approximately 32 mm in maximum diameter (Table 1). Both specimens in lot UMMZ 312 are very slightly taller than the lectotype, but they are also just slightly larger in diameter. Whorl counts (4.4–4.7) and the various ratios of measurements are also within a very narrow range for the three specimens. A slight degree of variation is present in the basal teeth (see also comments below, under remarks). In the lectotype, a single basal tooth or swelling is present, whereas in specimen UMMZ 312(1)

Figures 1–10 *Isomeria morula* (Hidalgo 1870). 1–4 Lectotype MNCN 15.05/60012 (MxD 32 mm). Views: 1 dorsal; 2 ventral; 3 side 1; 4 label of same. 5–10 UMMZ 312(1) (MxD 32.1 mm). Views: 5 dorsal; 6 side 1; 7 base (approximately perpendicular to plane of aperture); 8 ventral; 9 side 2; 10 detail of protoconch and adjacent region, apical view. Scale = 2.5 mm.

Table 1 Measurements of *Isomeria morula* (Hidalgo 1870). All measurements in mm. LT = lectotype; MxD = maximum diameter; MnD = minimum diameter; H = height; AW = aperture width; AH = aperture height; W = no. of whorls.

Specimen	MxD	MnD	MxD/MnD	H	H/MxD	AW	AH	AW/AH	W
LT MNCN 15.05/60012	32	25	1.280	15	0.469	16	15	1.067	4.7
UMMZ 312(1)	32.1	27.1	1.184	16.6	0.517	15.9	16.0	0.994	4.5
UMMZ 312(2)	32.3	26.3	1.228	17.0	0.526	15.0	13.9	1.079	4.4

figured herein, two basal swellings are present, the first barely noticeable, and specimen UMMZ 312(2) exhibits two small, equal-sized basal teeth. The parietal lip edge also shows minor variation among the three specimens, forming a continuous edge with the rest of the peristome in specimen UMMZ 312(2), but it is somewhat interrupted in the lectotype, and more so in specimen UMMZ

312(1). The latter minor variation probably reflects slight differences in ontogenic development, although all three specimens appear to be adult.

Diagnosis ("adapted from the original illustration and description" (Solem, 1966) [which closely matches Bernardi's Latin description]): "Basal lip with single prominent tooth; upper palatal lip with moderately prominent denticle; umbilicus widely open; parietal callus with thick, raised edge; periphery obtusely angulated; surface granulated with malleations on body whorl; lip white. Diameter 32 mm." Additions to the description of this species are given below.

Habitat and Geographic range No precise location data or habitat characteristics are available.

Comparisons Individual characteristics of *Isomeria morula* resemble those of several different species of *Isomeria.* However, in combination, these characteristics are not helpful in clarifying possible relationships of this species. The presence of one to two basal teeth, which may coalesce into a single basal prominence (Figs 2, 8, see remarks below), and the single upper palatal tooth (Figs 2, 6 & 9) are within the range of apertural tooth variation exhibited by *I. bituberculata* (Pfeiffer 1853). However, most shells of *I. bituberculata* are proportionally taller, although this species exhibits wide variation in size, shape, apertural dentition and umbilical opening, and may prove to include more than one taxon (Solem, 1966). The widely open and large umbilicus of *I. morula* contrasts with the smaller, most frequently nearly to fully closed umbilicus of *I. bituberculata*. *Isomeria anodonta* Pilsbry 1949, *I. continua* (Pfeiffer 1854) and *I. subelliptica* (Mousson 1869) share the general shape of *I. morula*, and have a large, open umbilicus as in this species; however, they either exhibit no dentition (*anodonta*), or have a strong parietal tooth (*subelliptica*), which may vary in strength (*continua*). Similar large, open umbilical openings are seen in *I. oreas* (Koch 1844) and *I. kolbergi* Miller 1878, but both species are considerably larger, and have a strong lower palatal tooth, absent in *I. morula*. A partial key to known species of *Isomeria* is appended to this paper, allowing separation of *I. morula* from other species of the genus.

Remarks Neither Pilsbry (1889), nor Solem (1966) saw specimens of this taxon, and both gave descriptions based only on the original description of Bernardi (1858). Bernardi's description included a figure of the ventral view of the shell, and allows recognition of this taxon whose combination of aperture shape, dentition, and open umbilicus are unique among species of *Isomeria*. Pilsbry (1889) wrote a translation of Bernardi's Latin description, and reproduced the original figure. Solem (1966) was unable to locate any material of this species in Madrid or any other museum collection. Bernardi's description stated the shell having 5 whorls, a number slightly larger than the 4.7 here reported for the single specimen in Madrid; this slight discrepancy is common between older and recent descriptions and likely resulted from slightly different methods used for counting. Interestingly, neither Bernardi (1858) who had the type at hand, nor Hidalgo (1870), who probably examined the same specimen from the Paz Collection, mentioned a distinctive sculpture of the early whorls of *I. morula*, which is evident in Paz's specimen. This characteristic sculpture is here described and shown in Fig. 10, and is present in all three specimens examined. Moreover, two more features of this taxon can be added from examination of the material now available, regarding the strength of development of the parietal callus (Figs 2, 7 & 8), and variation in the number and size of the basal teeth (Figs 2 & 8).

Early whorls sculptured with a pattern of raised, sub-circular pustules, progressively increasing in size from the first whorl, reaching a maximum in the second, and decreasing again to become obsolete beyond the first 2.7 whorls. In the second whorl, pustules tend to coalesce, appearing as beaded cords. In whorls 1–3, raised, oblique rays radiate from the sutures, decreasing in strength away from the sutures, becoming obsolete after about half the width of each whorl. Parietal callus consisting only of an interrupted, to complete, thin edge, not raised, but rather adpressed to the body whorl, otherwise absent from the main parietal region. Basal teeth ranging from a single prominent tooth, to two smaller, close together equal-sized teeth, or a smaller, nearly inconspicuous first tooth (proximal to umbilicus) and a larger second tooth.

The label currently present with the type specimen in Madrid (Fig. 4) appears to have been written by Paz (i.e. it matches other labels at MNCN, known to have been written by Paz), but

at a later time than the description of Bernardi in 1858. If another, earlier label existed this label may have been lost. This conclusion stems from the observation that the current label has both names ("*Helix martinii* Bern." and "*morula* Hidalgo"). Evidently it was written after the current name was coined, whose publication was over a decade after the original description. The collection date and precise locality of the material at UMMZ are not known. An original label may have accompanied the material, but this label also appears to have been lost. The current label present with the specimens is an UMMZ-lithographed label most likely produced at a later date. An entry in the ledger catalogues at UMMZ reveals that the lot registered as *Pleurodonte martinii* Bernardi and consisting of two specimens, was incorporated into the UMMZ collection as part of the Beal & Steere Collection (Taehwan Lee, pers. com.). Joseph B. Steere was a professor and curator at University of Michigan, who between 1870 and 1901, carried out several expeditions to varied tropical locations in the Americas and Asia, including Brazil, the Amazon and the Andes (Stephenson, 1999). The comparatively early catalogue number of the lot referred to here (i.e., UMMZ 312), is consistent with material incorporated into the University of Michigan collections within that time period.

DISCUSSION

Examination of the specimen in Madrid, and of the material from UMMZ leaves no doubt of the status of *I. morula* (Hidalgo 1870) as a distinct taxon, currently known from only these three specimens. Unfortunately, the only locality information available is the imprecise "Quito", and "Ecuador". The specimen in Madrid, here designated as the lectotype of *I. morula*, is almost certainly the same specimen from which Bernardi described *Helix martini* in 1858, from the Paz collection. Paz may have made the material available to Bernardi, who presumably returned the specimen to Paz. Later, the Paz collection was incorporated into the collection at MNCN in Madrid. Because Bernardi did not specifically state how many specimens he used for his description, there is a small amount of doubt whether Bernardi's specimen is the same as the shell now present at MNCN. For this reason, we choose to follow recommendation 73F of ICZN (1999) in designating this specimen as a lectotype, in favour of holotype.

The inclusion of *Isomeria morula* in some, but not all Hidalgo's publications referring to the molluscs collected by Spanish scientists in the Americas merits clarification, as it bears some relationship with the likely collection date of the type material of *Helix martinii* Bernardi 1858. As stated, some doubt remains about the collection date of the material from Paz used by Bernardi in describing this taxon. It is known that Paz y Membiela collected abundant material in the Americas, prior to, during, and after the Comisión Científica (Hidalgo, 1893a; Azpeitia, 1924), and that his large collection included material examined by Bernardi and others (Barreiro, 1992). Following Azpeitia (1924) it could be interpreted that the type of *Helix martini* Bernardi 1858 was collected by Paz after 1865; however this is not possible since Bernardi described this species in 1858, a number of years prior to the Comisión Científica. Some of Hidalgo's publications (i.e., 1870 and 1893a) include material collected as part of the Comisión Científica to América Meridional (1862–1865), but also other material collected by Spanish scientists in the Americas; in contrast, Hidalgo (1969, 1893b) refers only to material from the Comisión Científica (Azpeitia, 1923), and thus, does not include *Isomeria morula*.

Pilsbry (1889, 1894) continued to use Bernardi's species name (*martinii*), and felt that the change of name proposed by Hidalgo [1870] was unnecessary, "as Pfeiffer's "*H. martini*" belongs to a distinct genus and family" (Pilsbry, 1889: 149). Possibly Hidalgo came to the same conclusion, judging from his return to Bernardi's name (Hidalgo, 1893a). However, Solem (1966) referred to this species as *I. morula* (Hidalgo 1870), arguing that the names *Helix martini* Pfeiffer 1854 and *Helix martinii* Bernardi 1858 are homonyms, and that Hidalgo's substitute name must be used for this species, even though Pfeiffer's taxon belongs to a different family and genus. We share Solem's (1966) view, also shared by Azpeitia (1924). Both Pfeiffer and Bernardi stated they were naming their species after a Captain Martin; whether the same Captain Martin was being honoured by these authors is not certain, but the last name Martin seems to have a single derivation in European languages, coming from the Latin "Martinus". Thus, the names are homonyms, and since both species were named as *Helix*, they are

primary homonyms, and the preoccupied name must be replaced under ICZN Article 57.2.

Solem (1966) mentioned finding museum material labelled as *I. morula*, which probed to be misidentified specimens of *I. bituberculata* (Pfeiffer 1853). For this reason, he suggested that *I. morula* could be a widely umbilicated variety of *I. bituberculata*, but considered its status as uncertain until specimens could be examined. As mentioned above, *I. morula* shares a rather similar type of apertural dentition with *I. bituberculata*, specifically the presence and position of basal and upper palatal teeth. This pattern of dentition is also shared by *I. basidens gudeana* (Ancey 1904), another species in the "Group of *Isomeria bituberculata*" (sensu Solem (1966)); *I. basidens gudeana* has similar dentition as in *I. bituberculata* and *I. morula*, and has an early whorl sculpture that includes heavy malleations in the upper part of the spire, somewhat similar to that of *I. morula*. However the open umbilicus of *I. morula* immediately separates it from both *I. bituberculata* and *I. basidens gudeana*. Probably based on the open umbilicus and comparatively weaker to absent apertural dentition shared by the six species in his "Group of *Isomeria subelliptica*", Solem (1966) placed *I. morula* in this group. As indicated above, despite similarities with some of these species, important differences can also be seen, particularly in the presence of basal teeth in *I. morula*, and the absence of parietal teeth.

Much of the difficulty in understanding relationships among species of Neotropical Pleurodontidae stem from the fact that the relative value of various conchological features in defining phylogenetic relationships is unknown. Since most species are currently known only from their shells, anatomical and molecular analyses cannot yet help unravel their relationships. The groups of species proposed by Solem (1966) are useful for comparing, and recognizing individual species, but whether they bear relationship with phylogeny is as yet unknown, as is having a certain dentition, umbilical opening or sculpture. Borrero (2012) recently discussed these limitations, which extend to the very placement of species within the two recognized, rather similar genera of "toothed" South American Pleurodontidae (*Isomeria* and *Labyrinthus*). Overall, the shell shape and umbilical opening of *I. morula* resemble more those of several species in the Group of *Isomeria subelliptica*, but placing it within this group, and the cohesiveness of the group itself, lack a solid basis. The geographical distribution of *I. morula* and its current conservation status are unknown, as the only material available of this species dates from the late 19th century, and the collection localities are imprecise.

As an aid in recognizing *I. morula* from other species of *Isomeria*, a partial key to land snails of this genus (shells only) is given below. Not all taxa are keyed out to species, but *I. morula* is fully separated from all other known species (35 in total). Following each species name, data on known distribution is given as country(ies) abbreviation(s), as follows: Colombia [C], Ecuador [E], Peru [P], Unknown [U], and Venezuela [V]. This information is admittedly preliminary in character and is based on Solem (1966), Cuezzo (2006), and Borrero (2012, and unpublished data). For two taxa (*I. bituberculata* and *I. kolbergi*), adult specimens are available with very variable umbilicus size, thus appearing twice in the key.

1 Adults with closed, or narrowly open umbilicus (less than ½ of umbilicus uncovered).....2
Adults with ½ or more of the umbilicus uncovered.....4
2 Parietal tooth/lamella present..... 2 taxa
cymatodes (Pfeiffer 1852) [E], goettingi (Borrero, 2012) [C]
Parietal tooth/lamella absent.....3
3 Lower palatal tooth/lamella present.. 14 taxa
aequatoria (Pfeiffer 1860) [E], *aequatoriana* (Hidalgo 1867) [E], *bourcieri* (Pfeiffer 1853) [C, E], *calomorpha* (Jonas 1839) [U], *equestrata* (Moricand 1858) [P], *fordiana* (Pilsbry 1889) [C], *hartwegi* (Pfeiffer 1846) [E], *gealei* (Smith 1877) [E], *globosa* (Broderip 1832) [C, E], *kolbergi* Miller 1878 [in part] [E], *medemi* Solem 1966 [C], *meobambensis* (Pfeiffer 1857) [P], *stoltzmanni* (Lubomirski 1879) [P], *triodonta* (d'Orbigny 1835) [E]
Lower palatal tooth/lamella absent ..... 7 taxa
basidens basidens (Mousson 1873) [C], *basidens gudeana* (Ancey 1904) [E], *bituberculata* (Pfeiffer 1853)[in part] [C, E], *juno* (Pfeiffer 1850) [E], *meyeri* (Strubell 1894) [E], *neogranadensis* (Pfeiffer 1945) [C], *scalena* (Martens 1881) [E]
4 Parietal tooth/lamella present..... 5 taxa
awa Cuezzo 2006 [C], *inexpectata* Solem 1966 [C], *oreas* (Koch 1844) [C, E], *subelliptica* (Mousson 1869) [C], *tamsianus* (Dunker 1847) [V]
Parietal tooth/lamella absent.....5
5 Upper palatal tooth/lamella present.....6

Upper palatal tooth/lamella absent.....7 taxa
aloagana Jousseaume 1887 [E], *anodonta* Pilsbry 1949 [P], *continua* (Pfeiffer 1854) [C], *fauna* (Philippi 1851) [E], *jacksoni* Solem 1966 [E], *kolbergi* Miller 1878 [in part] [E], *minuta* Solem 1966 [C]

6 Protoconch sculpture with pustules (Fig 10); body whorl malleated; peristome white; umbilicus fully open .....1 taxon
morula (Hidalgo 1870) [E]

Protoconch without pustules, body whorl not malleated; peristome usually tinted brown; umbilicus closed or less than ½ uncovered .....1 taxon
bituberculata (Pfeiffer 1853)[in part] [C, E]

ACKNOWLEDGEMENTS

We thank Diarmaid O'Foighil, Taewan Lee, John B. Burch, and Thomas Duda (all from Ann Arbor, MI) for supporting FJB's research visit to the UMMZ collection and later sending material on loan. T. Lee kindly searched the paper ledgers at UMMZ for information on UMMZ lot 312 and made this information available to us. We also greatly acknowledge Lola Bragado and Javier de Andrés, collection assistants, and the photographic services division at MNCN (Madrid, Spain) for their support in finding and imaging material. Virginie Héros (Paris) kindly searched for material at MNHN. Dr. John W. Thomas and Mrs. Elizabeth Thomas (both from Cincinnati, OH) generously helped in reading and interpreting Bernardi's original Latin description. Discussions with Gary Rosenberg (Philadelphia, PA) and Timothy A. Pearce (Pittsburgh, PA) about nomenclatural issues, greatly contributed to shape the current form of this paper. T. Pearce read an earlier version of the manuscript and his suggestions and those of an anonymous reviewer are thankfully acknowledged.

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