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## Notes on *Mesocapromys sanfelipensis* (Rodentia: Capromyidae) from Cuba

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### Abstract

The San Felipe Hutia, *Mesocapromys sanfelipensis*, is one of the most endangered species of rodents in the world, and little is known about its ecology, evolution, and ancient distribution. At present, this hutia has been found only in its type locality, Cayo Juan García, a cay in the southwest Cuban insular platform. Here we report for the first time a well preserved fossil skull referred to this species, collected in Cueva del Indio, Mayabeque province, western Cuba. This specimen shows that the modern population of *M. sanfelipensis* is a marginal relic of its former distribution, a consequence of climatic, eustatic, and neotectonic changes in the last 8 ka years. Also, we reevaluate the cranial characters and measurements that correspond to *M. sanfelipensis* and found that two of the eight specimens referred to this species and deposited at the Instituto de Ecología y Sistemática belong to *Mesocapromys auritus*. Finally, we include six unpublished photos of specimens of *M. sanfelipensis* captured in 1970 during two expeditions to Cayo Juan García.

**Key words:** *Mesocapromys sanfelipensis*, fossil, Quaternary, Cuba, extirpation, Cueva del Indio

### Resumen

La Jutiíta de la tierra, *Mesocapromys sanfelipensis*, es una de las especies más amenazadas de roedores a nivel global, y se conoce muy poco sobre su ecología, evolución y distribución en el pasado. Todos los ejemplares conocidos hasta el momento proceden de la localidad tipo, Cayo Juan García, el cual se localiza en la plataforma suroccidental de Cuba. Reportamos por primera vez un cráneo fósil en buen estado de preservación asignable a esta especie, colectado en Cueva del Indio, provincia Mayabeque, en el Occidente de Cuba. Este fósil demuestra que la población actual de *M. sanfelipensis* es un relicto marginal de la distribución de la especie en el pasado, resultado de cambios climáticos, eustáticos y neotectónicos en los últimos 8 ka años. También se reevalúan los caracteres craneales y medidas de *M. sanfelipensis* puesto que durante nuestra revisión de los especímenes modernos en el Instituto de Ecología y Sistemática encontramos que dos de los ocho ejemplares referidos a esta especie en realidad corresponden a *M. auritus*. Adicionalmente, incluimos seis fotos inéditas de individuos de *M. sanfelipensis* capturados en 1970 durante dos expediciones a Cayo Juan García.

**Palabras claves:** *Mesocapromys sanfelipensis*, fósil, Cuaternario, Cuba, extirpación

### Introduction

The San Felipe Hutia (*Mesocapromys sanfelipensis*) is one of the five species of the genus *Mesocapromys* (Upham & Borroto-Páez, 2017). With the exception of *Mesocapromys melanurus* (see Silva *et al.*, 2007), the taxa of this group are characterized by reduced body size and relictual distribution, confined to small offshore keys or swamps.

*Mesocapromys sanfelipensis* (Fig. 1) was discovered in an expedition led by Orlando H. Garrido in February–March of 1970 to Cayo Juan García. This key is localized within Cayos de San Felipe, on the western portion of the Archipiélago de los Canarreos, and around 30 km south of port La Coloma, in Pinar del Rio Province. The voyage was organized with the particular objective of verifying the existence of a new hutia, which the fishermen from the La Coloma called the Little Earth Hutia (Varona & Garrido, 1970). Four specimens were collected (Fig. 1A, B, C)

and used in the original description by Varona in Varona and Garrido (1970). In October of the same year, another expedition was carried out to explore Cayo Real, a larger key next to Cayo Juan Garcia, where the little ground hutia was supposed to inhabit, according to fishermen' accounts, but no evidence of the species was found. However, another six specimens were captured from the type locality (Garrido, 1973), and one of them was brought alive to the Instituto de Biología (Fig. 1E) and kept there until it died a week after (OHG personal communication). This hutia is known only from its type locality.



**FIGURE 1.** Unpublished photos of *Mesocapromys sanfelipensis* captured in February-March and October of 1970. **A** March 1<sup>st</sup>, 1970, first expedition to Cayo Juan Garcia. Orlando H. Garrido holding a Little ground hutias after capture. This specimen may be the holotype of the species CZAAC 1.198 (IB 6520) (♂). Notice the small body size of the hutia. Behind, the guide Alejandro Hernandez (Alejo) with his dogs. In the background can be seen mangrove and glass grass (*Batis maritima*). During this expedition most of the specimens were captured in glass grass. **B** Photograph taken between February 27 and March 2, 1970. Notes on the backside of the photo read: ‘The specimen was rescued before the dogs kill it, photographer Jorge Danilo Cortez’. **C** Photograph possibly taken on February 28, 1970. Note on the backside of the photo reads: “Tail of the little ground hutia, lost when she was winged alive from a cave, photographer Jorge Danilo Cortez”. The tail may correspond to the paratype CZAAC 1.205 (IB 6522) (♀) since Varona and Garrido (1970) in table 1 call attention to the smaller size of the tail, in contrast to the other specimens. This is because it was incomplete. This picture clarifies and corroborate that *M. sanfelipensis* had caudal autotomy like other species of the genus, as was supposed by Silva *et al.*, (2007). **D** Unknown date. The photo only says “With the Little ground hutia, Cayo Juan Garcia, Cayos de San Felipe”. **E** October 17, 1970. Instituto de Biología, La Habana. Lateral and anterior view of a male of *C. sanfelipensis* captured in the second expedition to Cayo Juan Garcia in October of 1970. This specimen was maintained alive for a week at the Instituto de Biología of La Habana. The other two know photos of *M. sanfelipensis* (see Kratochvil *et al.*, 1980 and Borroto, 2011) correspond to this individual and where taken by L. Kratochvil.

The external morphology of *M. sanfelipensis* is very similar to that of other species of this genus (Varona & Garrido, 1970; Silva *et al.*, 2007; Borroto 2007). Within the genus it is considered a species of medium body size (Fig. 1), falling between of *M. angelcabrerai* and *M. auritus*. The characterization of the external morphology was based on three full-grown specimens and one subadult. In adults, the average total length (2 individuals) is 47.75 cm, average head-trunk length (3) is 27.73 cm, and average tail length (3) is 20.45 cm (Varona and Garrido, 1970). The weights of the captured specimens are unknown, but using cranial and external measurements are estimated at around 550 g (Borroto-Paez, 2011).

Observations on the ecology of the species are scarce and generally incomplete (Varona & Garrido, 1970; Garrido 1973). So far, the data suggest that the natural habitat during the dry season was the glass grass (*Batis maritima*) (Fig. 1A); while during the wet season, when the glass grass was partially inundated, they occupied higher areas of the key, including the mangrove. It seems the hutia also used iguana burrows if threatened (Garrido, 1973). Like many other rodents, the San Felipe hutia was mainly nocturnal; some individuals were observed walking in different parts of the key, including the beach at night. Garrido (1973) also noticed they could be active during the day, but after rain. Contrary to *M. auritus* and *M. angelcabreai*, *M. sanfelipensis* did not build communal lodges for protection and breeding; the only known newborn was found in the cavity of a mangrove (Garrido, 1970).

Fishers hunted the hutia frequently during their visit to the key before 1970, and at least another four hutias were captured by them between March and October of 1970 (Garrido, 1973). Garrido (1973) noticed that despite his observations of the Little Earth Hutia in the wild and the presence of fecal pellets around the key, the species was never common. Since October of 1970, no specimen has been collected or observed by researchers. Subsequent references on the sighting of the Little Earth Hutia have not been confirmed or adequately documented (see Borroto & Ramos, 2012; Garrido, 2011).

Silva *et al.*, (2007) called attention to the similarities between the San Felipe Hutia and the extinct taxa *Mesocapromys gracilis*, and the possibility the former represented a synonym of the first. Nonetheless, the holotype and only specimen available is too fragmentary to evaluate its proper taxonomic status, which is why it was considered “species inquirenda” by Silva *et al.* (2007). Until more fossils of *M. gracilis* are found, we are unable to determine its conspecificity with *M. sanfelipensis*.

Here we report the first fossil of *M. sanfelipensis* and more importantly, collected in a paleontological deposit on the Cuban mainland. This discovery along with previous geologic studies has helped us to generate a better understanding of the evolutionary history of this species.

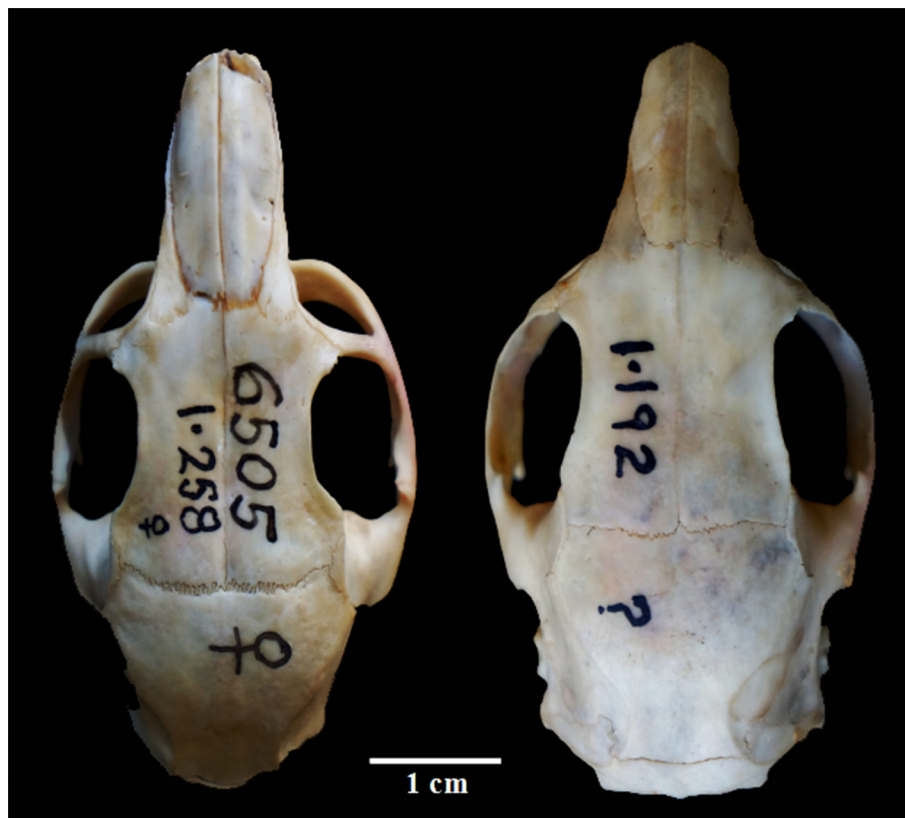
So far, only two photos of an individual of the San Felipe hutia have been published (Kratochvíl *et al.*, 1980; Borroto, 2011). Considering that the species is considered critically endangered, all photographic records are of great value. For this reason, we include here five unpublished pictures of *M. sanfelipensis* individuals captured in February-March and October of 1970 (Fig.1) from their habitat in Cayo Juan Garcia and one maintained in captivity.

## Material and methods

Osteological terminology and measurements follow Silva *et al.*, (2007). We also use the taxonomic arrangement proposed by Silva *et al.*, (2007), but except with the inclusion of *M. melamurus* within the genus *Mesocapromys* (Upham & Borroto, 2017). Measurements were taken with a Mitutoyo digital caliper to the nearest 0.05 mm. The specimens CZACC 1.192 and 1.258 were found to belong to *M. auritus* and not to *M. sanfelipensis* as was previously identified (Ramos & Borroto 2004, Silva *et al.*, 2007 and Balseiro *et al.*, 2015). For an amended description see the re-identification of these specimens in the Results section. Only ten specimens of *M. sanfelipensis* have been collected by researchers, four during the first expedition in 1970 and used as the type series, and another six in the second expedition in 1970 (Varona & Garrido. 1970; Garrido, 1973). Currently, six of the specimens are deposited at the Instituto de Ecología y Sistemática (including the holotype and two paratypes). Another one, a mounted skin with skull and jaw, is in Orlando Garrido’s personal collection; two other skulls are in the Carlos Arredondo’s personal collection (originally Luis S. Varona’s collection), and the location of the last one is unknown.

Specimens used in this study are represented by skulls and mandibles housed at the Instituto de Ecología y

Sistemática (IES), La Habana, unless noted otherwise. The number inside the parenthesis indicates the previous catalog number (Instituto de Biología, later Instituto de Zoología), used in the original descriptions of the species. Other collections reviewed include: Lazaro Viñola's personal collection: CLV; Alberto Bermudez's Personal Collection (AB) Osteological Collection of the Gabinete de Arqueología: GA. Specimens without catalog number: Sn. *Mesocapromys sanfelipensis* ♂: 1.198 (6520; holotype; partial skeleton), 1.199 (paratype, 6521), 1.257 (6424), 1.260 (6528); ♀: 1.205 (6522, paratype), 1.261 (6526; partial skeleton), AB.d3000 (fossil) *M. auritus* ♂: 1.189 (6501; holotype), 1.195 (6503; paratype), 1.193, 1.360, 1.367, 1.368, 1.655, 1.655; ♀: 1.196 (6502; paratype), 1.361, 1.362, 1.364, 1.365, 1.369, 1.258 (6505); ?: 1.192 (partial skeleton), GA Sn (partial skeleton). *M. angelcabrerai* ♂: 1.279 (holotype), 1.282, 1.303, 1.324; ♀: 1.313, 1.299. *M. gracilis* 1.344 (holotype, fossil, mandible). *M. nanus* CLV. 2538-40 (three fossil skulls). *M. melanurus*: 1.582, 1.586, Sn (without catalog number). *Mysateles prehensilis*: 1.596, 1.598, 1.644, Sn. *Capromys pilorides*: CLV Sn, CLV Sn, CLV Sn. We also used the illustrations and descriptions given by Varona and Garrido (1970), Kratochvil *et al.*, (1978), and Silva *et al.*, (2007).



**FIGURE 2.** Dorsal view of skulls of *Mesocapromys auritus* (A) CZACC 1.258 (♀, juvenile) and (B) CZACC 1.192. **npp** nasal process of the premaxilla, **szr** dorsal projection of the superior zygomatic root. Photos are not in the same angle.

## Results

**Amended description and re-identification of the specimens CZACC 1.192 and 1.258.** As mentioned before, only ten individuals of *M. sanfelipensis* have been captured by researchers. Most authors have referred to the presence of eight of them in the Mammalogical Collection of the IES (Ramos & Borroto 2004, Silva *et al.*, 2007 and Balseiro *et al.*, 2015), including a partial skeleton (CZACC 1.192) illustrated by Borroto (2011). During our visit to the institutions mentioned above, one of the authors (LWV) found that two of the specimens (CZACC 1.192 and 1.258) were misidentified as *M. sanfelipensis* and belong to *M. auritus* (Fig. 2); this assertion is based on the following cranial characters. Dorsal view: wide posterior region of the nasal process of the premaxilla (**npp**), and very narrow dorsal projection of the superior zygomatic root (**szr**) like in *M. auritus* (Fig. 2, Fig. 3) The posterior edge of the nasals do not reach the posterior level of the **npp** like in most *M. auritus*; a discrete character used by

Varona to distinguish this species from *M. sanfelipensis*. However, Silva *et al.* (2007) mentioned its presence in some skulls of *M. sanfelipensis*; apparently, they were referring to the specimens we are reassessing here, since none of the six skulls of *M. sanfelipensis* in the IES collection present that character. On the other hand, some specimens of *M. auritus* display the posterior edges of the **npp**, and the nasals are at the same height (specimens CZACC 1.360, 1.362, 1.368). Anterior view: the lower zygomatic root is shallow as in *M. auritus* whereas it is deeper in *M. sanfelipensis*. Occlusal design of the premolar: The hypoflexid does not reach the mesoflexid, separated from it by a wide gap like in *M. auritus*, in *M. sanfelipensis* the gap is very narrow or does not exist, and the mesoflexid meets the hypoflexid by preposition.

Beside the cranial characters used for this reclassification, we also noticed that the skulls deposited at the Instituto de Ecología y Sistemática had consecutive numbers in the old catalog, ranging from the 6520 to the 6528. Three of the specimens are no longer at the IES (6523 (paratype), 6525, 6527), two of them were deposited in Luis Varona personal collection (Carlos Arredondo personal communication, 2017), while the location of the third one is unknown. None of the two specimens reevaluated by us has the enumeration of the missing specimen; even, one of them only has the new catalog number that indicates it was collected after 1986 when the IES acquired its current name (Ramos & Borroto, 2004).

This misidentification was possibly caused by the reorganization of the collection after moving it from its previous location. We remeasured all specimens of *M. sanfelipensis* (Table 1 and 2). Previous morphometric analysis of the species offered by Silva *et al.* (2007) should be dismissed because they include the specimens CZACC 1.192 and 1.258, mixing measurements of *M. sanfelipensis* and *M. auritus*.

## Systematic

### Orden RODENTIA Bowdich, 1821

### Family CAPROMYIDAE Smith, 1842

### Subfamily Capromyinae

### Genus *Mesocapromys* Varona, 1970

### *Mesocapromys sanfelipensis* (Varona in Varona & Garrido, 1970)

San Felipe Hutia, Little Earth Hutia

*Capromys sanfelipensis* Varona in Varona & Garrido, 1970:3.

*Capromys sanfelipensis* Varona, 1974b:66 (subgen. *Mesocapromys*).

*Mesocapromys* (*Paracapromys*) *sanfelipensis*: Kratochvil *et al.*, 1978b:46.

*M*[*esocapromys*]. *sanfelipensis*: Woods *et al.*, 2001: 336.

*Mesocapromys sanfelipensis*: Silva *et al.*, 2007: 156.

**Referred material:** An almost complete skull, very well preserved (Fig. 3B and fig.4C). The specimen lacks the posterior portion of the parietal, most of the occipital, basioccipital, left temporal, and the left auditory bulla. Of the dentition, only the left fourth premolar is preserved. The specimen is currently deposited in Alberto Bermudez's personal collection. (AB.d3000).

**Locality and age:** It was collected by Runel Riveron on July of 2015 in Salon del Cuervo, a cave room within Cueva del Indio, close to the town La Jaula, Municipality of San Jose de las Lajas, Mayabeque Province, western Cuba. Rojas *et al.* (2012) carried out an extensive paleontological study in this cave and made some interpretations about the origin and evolution of the deposit and the surrounding area, based on the taphocoenosis association and the stratigraphy of the deposit. Neotectonic and stratigraphic data, and ecological requirements of some of the species found (e.g. *Cyanolimnas cerverai*, †*Grus cubensis*, †*Chelonoidis cubensis*) suggest the region was dominated by semideciduous forest and periodically inundated savannah during the Pleistocene-Holocene transition around 10 ka years ago. However, Rojas *et al.* (2012) did not report remains of *Mesocapromys*. The age proposed for the deposit was based on paleoecological association (see Rojas *et al.*, 2007). Macroscopic and microscopic analysis of some fossils found in association to AB.d3000; shows great replacement and destruction of the original organic matrix by minerals during diagenesis, indicating it is not a good candidate for C-14 dating.



**FIGURE 3.** Dorsal view of the skull of *M. sanfelipensis* (A) CZACC 1.198 holotype (♂), (B) AB.d3000 (fossil), and *M. auritus* (C) CZACC 1.189 holotype (♂).



**FIGURE 4.** Ventral view of the skull of *Mesocapromys sanfelipensis* (A) CZACC 1.198 holotype (♂), (B) CZACC 1.261 (♀), (C) AB.d3000 (fossil), and *M. auritus* (D) CZACC 1.189 holotype (♂). Notice in A and B the extreme variation in the size and disposition of the basicranial foramina.

**Description and comparison:** The generic position of the specimen is beyond question (Kratochvil *et al.*, 1978; Silva *et al.*, 2007). As mentioned by Varona in Varona & Garrido (1970), the only taxon with which *M. sanfelipensis* could be confused is *M. auritus*, but there are well-defined cranial characters that separate both taxa. The skull AB.d3000 is relatively larger than modern *M. sanfelipensis* and *M. auritus* while maintaining the same proportions observed in *M. sanfelipensis* with respect to the relationship between length vs. width of the premolar and length of the diastema vs. alveolar length of the molariform series. The skull is large and low in both species. The frontal is depressed in the interorbital region with the external edges curving upwards, forming well defined supraorbital crests and lacking the postorbital process. Narrow posterior **npp** are like modern *M. sanfelipensis* (in contrast to wide in *M. auritus*) and lies at the same height of the nasals. The lower zygomatic root is of similar deep as in *M. sanfelipensis*, while shallower in *M. auritus*. The **szr** is wide as in *M. sanfelipensis* while almost absent or very narrow in *M. auritus*. The auditory bulla is relatively large, being nearly the length of the molariform series like modern *M. sanfelipensis* (Varona & Garrido, 1970). On the premolar, the hypoflexid meets the mesoflexid by preposition like in *M. sanfelipensis*, while the hypoflexid is separated from the mesoflexid in *M. auritus* (Fig. 5). The inferior edge of the zygomatic arch is slightly inclined interiorly, like in the San Felipe Hutia.

The morphology, size, and disposition of the basicranial foramina in *M. sanfelipensis* is highly variable (Fig. 3) and overlies with the variation range of *M. auritus* (Silva *et al.*, 2007); indeed, this character cannot be used to separate the two species as was assumed in the original description (Varona & Garrido, 1970). The width of the



basioccipital and the basisphenoid is also variable; in some skulls, both are wide (Fig. 3a) whereas in others are narrow (Fig. 3b). In the fossil specimen, the basisphenoid bone is narrower than the modern ones (Fig. 4c). The posterior edge of the palatine of AB.d3000 is nearly U-shaped and presents a middle spine, as in other recent specimens. The external edge of the palatine is also more open in modern skulls (Fig. 4a). The vertex of the anterior edge of the palatine is localized at the height of the limit between the 2<sup>nd</sup> and the 3<sup>rd</sup> molar, in modern specimens it can be found between the limit of the 2<sup>nd</sup> and the 3<sup>rd</sup> and the middle of the 3<sup>rd</sup> molar.

Ten of the seventeen measurements evaluated on the fossil skull are larger than on modern specimens (Table 1). However, only 4 of them are 5% greater, the interorbital width (5.3%), the nasal width (8.9%), the premolar length (6.4%), and the alveolar length of the molariform (11.6%).

**TABLE 1.** Cranial measurements (mm) of modern and fossil specimens of *Mesocapromys sanfelipensis* compared with *M. auritus*. (N) Mean ± DE (Range).

Measurement	<i>M. sanfelipensis</i> (modern)	<i>M. sanfelipensis</i> (fossil)	<i>M. auritus</i> (from Silva <i>et al.</i> , 2007)
<b>Skull</b>			
Interorbital width	(6) 14,09 ± 0,5 (13,15–14,55)	(1) 15.36	(4) 14,3 ± 0,71 (13,4–15,1)
Frontal width	(6) 16,26 ± 0,93 (14,84–17,58)	(1) 15.82	(4) 16,8 ± 0,72 (15,8–17,4)
Temporal width	(6) 20,77 ± 0,52 (20,04–21,57)	(1) 21.25	(4) 20,7 ± 0,84 (19,6–21,6)
Intertemporal width	(6) 6,98 ± 0,56 (6,24–7,75)	(1) 6.82	(4) 6,2 ± 1,46 (4,8–8,0)
Nasal width	(6) 7,75 ± 0,5 (7,26–8,4)	(1) 9.22	(4) 7,9 ± 0,51 (7,3–8,5)
Zygomatic width	(6) 31,7 ± 0,84 (30,82–33,19)	(1) 33.98	(4) 31,2 ± 0,81 (30,1–32,1)
Mastoid width	(6) 23,52 ± 0,48 (22,85–24,26)		(4) 23,6 ± 0,92 (22,7–24,8)
Alveolar length of the molariform series	(6) 12,99 ± 1,13 (11,99–13,56)	(1) 15.34	(4) 12,4 ± 0,21 (12,2–12,7)
Coronal length of the molariform series	(6) 12,92 ± 0,73 (11,79–13,71)		(4) 22,4 ± 0,90 (21,6–23,3)
Acoustic width	(6) 23,49 ± 0,74 (22,54–24,67)		(4) 24,4 ± 0,76 (23,8–25,4)
Condylar width	(6) 11,85 ± 0,71 (11,05–12,86)		(4) 11,4 ± 0,54 (10,9–12,1)
Incisive width	(6) 3,83 ± 0,37 (3,37–4,41)		(3) 3,6 0,15 (3,5–3,8) 4,2
Alveolar premolar width	(6) 8,68 ± 0,41 (8,27–9,4)	(1) 9.42	(4) 7,8 ± 0,31 (7,4–8,1) 4,0
Coronal premolar width	(6) 8,75 ± 0,42 (8,27–9,5)		(4) 8,3 ± 0,30 (8,0–8,6) 3,6
Alveolar molar width	(6) 11,12 ± 0,67 (10,58–12,38)	(1) 12.84	(4) 10,1 ± 0,23 (9,8–10,4) 2,3
Coronal molar width	(6) 11,44 ± 0,77 (10,82–12,93)		(4) 10,8 ± 0,29 (10,4–11,1)
Basioccipital width	(6) 3,54 ± 0,64 (2,66–4,33)	(1) 3.37	(4) 3,3 ± 0,42 (2,9–3,9)
Condyle-premaxilla length	(6) 58,4 ± 2,83 (56–63,39)		(4) 59,7 ± 1,42 (57,6–60,8)
Occipitopremaxilla length	(6) 62,25 ± 1,18 (60,8–63,39)		(4) 63,0 ± 1,05 (61,8–64,3)
Height of the occipital region	(6) 14,77 ± 0,71 (13,91–15,65)		(4) 14,8 ± 0,88 (13,7–15,8)
Diastema length	(6) 16,04 ± 0,76 (15,14–16,86)	(1) 17.63	(4) 16,8 ± 0,91 (15,5–17,5)
Nasal length	(5) 19,63 ± 0,58 (19,06–20,34)	(1) 19.84	(4) 19,0 ± 0,87 (17,9–20,0)
Frontal length	(6) 21,23 ± 0,57 (20,46–21,95)	(1) 22.13	(4) 21,5 ± 0,67 (20,7–22,3)
Preorbital Arch width	(6) 2,14 ± 0,29 (1,75–2,56)	(1) 2.04	(4) 1,8 ± 0,43 (1,4–2,4)
Zygomatic length	(6) 23,28 ± 0,73 (22,45–24,14)		(4) 22,4 ± 0,90 (21,6–23,3)
Postfrontal length	(6) 23,4 ± 0,7 (22,17–24,31)		(4) 22,8 ± 0,47 (22,2–23,2)
Horizontal diameter of the foramen magnum	(6) 8,55 ± 0,41 (7,93–9,02)		(4) 7,3 ± 0,67 (6,6–8,2)
Vertical diameter of the foramen magnum	(6) 8,92 ± 0,4 (8,56–9,62)		(4) 7,8 ± 0,42 (7,4–8,4)
Coronal Premolar length	(6) 3,94 ± 0,16 (3,76–4,23)	(1) 4.52	
Coronal Premolar width	(6) 3,23 ± 0,23 (2,86–3,45)	(1) 3.43	



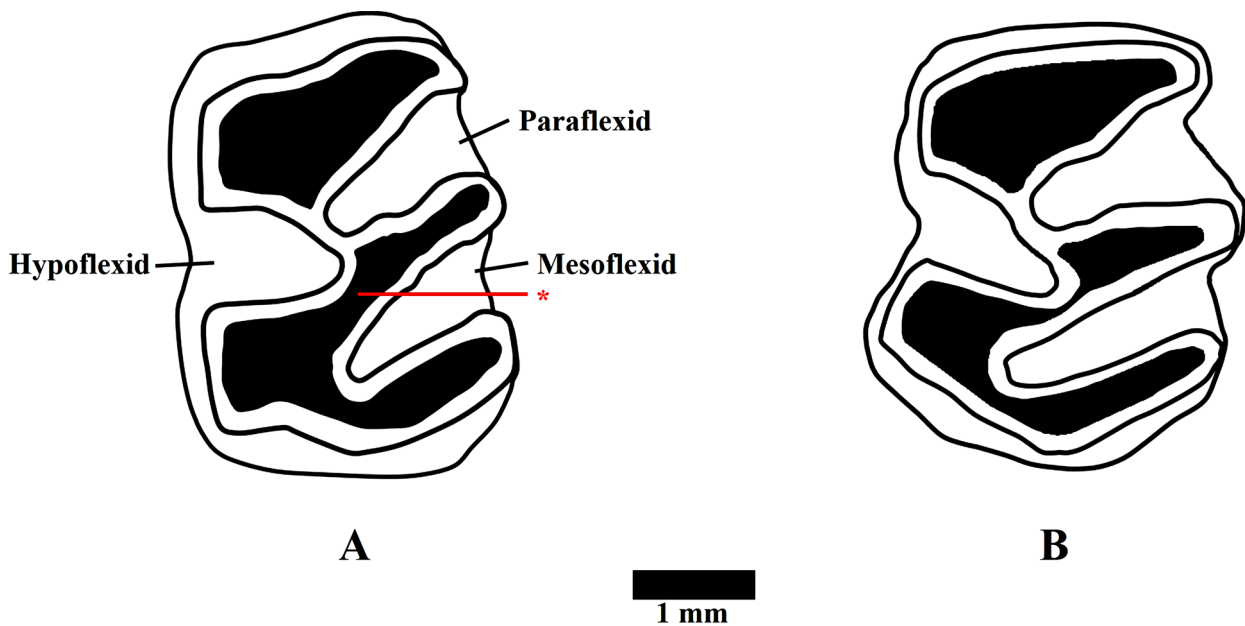
**TABLE 2.** Measurements (mm) of the postcranial elements of *Mesocapromys fanfelipensis*. \* Include measurements given by Varona and Garrido (1970).

Measurements	<i>Mesocapromys fanfelipensis</i>
Mandible	(N) Mean $\pm$ DE (Range)
Incisive width	(6) 1,44 $\pm$ 0,08 (1,35–1,57)
Coronal length of the molariform series	(6) 12,95 $\pm$ 0,49 (12,14–13,52)
Alveolar length of the molariform series	(6) 13,25 $\pm$ 0,47 (12,73–13,9)
Diastema length	(6) 9,67 $\pm$ 0,24 (9,32–9,93)
Angulosynphial length	(6) 44,48 $\pm$ 1,2 (43,72–46,6)
Coronoid height	(6) 16,39 $\pm$ 0,46 (15,75–17,14)
Condylar height	(6) 17,88 $\pm$ 0,57 (17,27–18,8)
Corporal height	(6) 12,14 $\pm$ 0,59 (11,02–12,65)
Greater width of ascending branch	(6) 12,74 $\pm$ 0,43 (12,11–13,28)
Lesser width of ascending branch	(6) 4,88 $\pm$ 0,22 (4,62–5,14)
Synphysis length	(6) 16,88 $\pm$ 0,79 (15,96–17,9)
Condylsynphial length	(6) 38,94 $\pm$ 0,82 (38,36–40,21)
Humerus	
Total length	(4) 40,74 $\pm$ 1,39 (38,84–42)*
Proximal width	(2) 7,85 $\pm$ 0,19 (7,71–7,98)
Diaphysis width	(2) 3,22 $\pm$ 0,05 (3,18–3,25)
Distal width	(2) 9,92 $\pm$ 0,4 (9,63–10,2)
Deltoid length	(2) 19,95 $\pm$ 1,29 (19,04–20,86)
Deltoid depth	(2) 7,3 $\pm$ 0,13 (7,2–7,39)
Ulna	
Total length	(3) 48,11 $\pm$ 0,61 (47,64–48,8)*
Diaphysis width	(1) 1,78
Diaphysis depth	(1) 3,65
Radius	
Total length	(3) 37,35 $\pm$ 0,48 (36,84–37,8)*
Proximal width	(1) 5,35
Distal width	(1) 4,31
Diaphysis depth	(1) 2,14
Pelvis	
Total length	(2) 58,97 $\pm$ 2,26 (57,37–60,56)
Posterior width	(2) 23,46 $\pm$ 3,02 (21,32–25,59)
Greater diameter of the acetabulum	(2) 6,2 $\pm$ 0,17 (6,08–6,32)
Lesser diameter of the acetabulum	(2) 16,73 $\pm$ 0,13 (16,64–16,82)
Femur	
Total length	(4) 49,34 $\pm$ 1,8 (46,8–50)*
Proximal width	(2) 12,67 $\pm$ 1,99 (11,26–14,08)
Distal width	(2) 11,02 $\pm$ 0,62 (10,58–11,46)
Diaphysis width	(2) 5,97 $\pm$ 1,65 (5,38–6,55)
Intertrochanteric length	(2) 13,36 $\pm$ 1,52 (12,28–14,43)
Diaphysis depth	(2) 4,01 $\pm$ 0,46 (3,68–4,33)

.....continued on the next page

**TABLE 2.** (Continued)

Measurements	Mesocapromys fanfelipensis
Greater diameter of the head	(2) 6,21 ± 0,66 (5,74–6,68)
Tibia	
Total length	(3) 57,09 ± 0,19 (56,96–57,3)*
Diaphysis width	(2) 3,44 ± 0,2 (3,3–3,59)
Diaphysis depth	(2) 4,59 ± 0,18 (4,46–4,71)
Diaphysis width	(2) 6,86 ± 0,36 (6,6–7,11)
Proximal width	(2) 10,64 ± 0,46 (10,31–10,96)



**FIGURE 5.** Occlusal view of the superior premolar of *M. auritus* (A) and *M. sanfelipensis* (B) Notice the gap between the hypoflexid and the mesoflexid (\*) in *M. auritus*.

## Discussion

The species *C. pilorides* and *My. prehensilis* are the only polytypic species of hutias in Cuba. Both species have a subspecies on the mainland, *My. Prehensilis* also has two in Isla de la Juventud, while *C. pilorides* has one subspecies on this island and another two in keys around Cuba (Silva *et al.*, 2007). Recent molecular data indicates the presence of a second undescribed species of *Capromys* in eastern Cuba that include some of the subspecies previously assigned to *C. pilorides* (Upham & Borroto-Páez, 2017). The subspecies of hutia are differentiated by external and skeletal characters. *M. sanfelipensis*, does not follow the pattern of one subspecies on the mainland and another in a key. Despite the limitation of only one fossil specimen, there are no significant qualitative or quantitative characters to separate it from *M. sanfelipensis*, even at the subspecific level. Characters like a proportionally larger skull, relatively larger alveolar length of the molariform series and a thinner basisphenoid bone, fall within the range of temporal, ecotypic, spatial and individual variation in other species (Silva *et al.*, 2007; Smith & Berovides, 1984). At the same time, the variation that we observed in the only known modern population is a fraction of what it would be expected. The characters observed in the specimen and shared with modern specimens are those that distinguish this species from *M. auritus*. The specimen AB.d3000, in comparison with recent conspecific, represent a slightly larger hutia, with larger masticatory apparatus, possibly specialized in a different type of diet.

With exception of the iguana (*Cyclura nubila*), the Little Earth Hutia was the larger terrestrial vertebrate on

Cayo Juan Garcia, with no competitor for resources and no natural predator. However, the fossil specimen was found in association with another four species of hutias, two spiny rats, four sloths, among other potential competitors for food resources and space. Fossils remains of the predator were also recovered from the deposit, the Cuban Boa (*Chilabothrus angulifer*), the giant owl (†*Ornimegalomys* sp.) and two species of hawks (*Buteo jamaicensis*, †*Buteogallus borrasis*) (Rojas *et al.*, 2012). The ecological interactions in mainland should be more complex due to the greater diversity of ecosystems, vertebrates, and food resources.

Until now, *M. sanfelipensis* was known only for ten recent specimens collected in its type locality, localized 20 km S of the coast of Pinar del Rio and 196 km X from Cueva del Indio. This discovery shows that this species is not a microinsular endemic rodent; instead it seems to have evolved in the mainland. As Kratochvil (1978) proposed, the only modern population of this species is no more than a marginal relict of the former distribution of the species, which was larger during the Quaternary. It seems to be a similar case to other micro-localized vertebrates as *M. nanus*, *Natalus primus*, *Crocodylus rhombifer*, *Cyanolimnas cerverai*, among others, with a well documented fossil records beyond their current ranges of distribution, indicating a wider distribution during the Late Pleistocene and the Early-Middle Holocene (Rojas *et al.*, 2005; Jimenez, 2001; Jimenes *et al.*, 2014, Iturralde, 200; Olson, 1978, Silva *et al.*, 2007). Iturralde (2003) states that approximately 7-8 ka years ago a combination of rising sea level and the water table, and an increment of pluviosity led to the extensive development of wetlands and swamps. It brought an explosive expansion of the distribution of species associated with these ecosystems (e.g. *M. nanus*, *C. rhombifer*, *C. cerverai*). Evidence of this phenomenon is well known in the Cuban fossil record (Ortega, 1982, 1983; Curtis *et al.*, 2001, Iturralde, 2003; Jimenez *et al.*, 2014; Steadman, 2005; Jimenez *et al.*, 2005; Iturralde *et al.*, 2000) and *M. sanfelipensis* possibly benefited from these changes. Paleocological reconstructions of the deposit in Cueva del Indio indicates a predominance of semideciduous forest and wetlands (Rojas *et al.*, 2012). If new fossils of *M. gracilis* show this taxon is synonymous of *M. sanfelipensis*, then the paleodistribution of this species was through western Cuba (Silva *et al.*, 2007). Iturralde (2003) states that posterior slow rising of the sea level and faster neotectonic uprising in different regions in Cuba have driven to the reduction of wetlands and similar habitats, and consequently its fauna. The moist period established during the Middle Holocene finished around 3000 years ago, with a permanent increase of drier conditions (Curtis *et al.*, 2001, Gregory *et al.*, 2015).

Cayo Frago, Cayos Salinas, and Cayo Juan Garcia are the only localities known for *M. auritus*, *M. angelcabrerai*, and *M. sanfelipensis* respectively, and are localized in the Cuban insular shelf. At the end of the Pleistocene, around 20-25 ka years ago, the sea level dropped 120m below current level (Fairbanks, 1989; Iturralde, 2003; Iturralde, 2006.), and the shelf was completely exposed including the keys mentioned before. The fauna that colonized those territories, mainly terrestrial vertebrates, became isolated from the mainland and other populations when the sea level rose again. In some cases, populations from the mainland went extinct while those in keys survived. The new finding of fossil *M. sanfelipensis* on the mainland supports this hypothesis. At the same time, it is very likely that *M. auritus* and *M. angelcabrerai* shared a similar history, but fossils of those species haven't yet been found in mainland.

Another line of evidence that supports this island relict hypothesis comes from a host-parasite sharing. Two Little Ground Hutia were found to be infected by the nematode *Pseudoheligmomum howelli*, a species of endoparasite initially described from *C. pilorides* and found in specimens from Las Villas, Matanzas, La Habana and Isla de la Juventud (Otero & Barus, 1980). However, modern populations of *C. pilorides* were neither found in Cayo Juan Garcia nor Cayo Real (Varona & Garrido, 1970; Garrido 1973). The presence of *P. howelli* in *M. sanfelipensis* indicates the ancestor of this population was sympatric with a population of infected *C. pilorides*, from which it received the nematode before their population was isolated in Cayo Juan Garcia. Indeed, fossils of other four species of hutias were found associated to *M. sanfelipensis* in Cueva del Indio (Rojas *et al.*, 2012, and AB personal observations), they are *C. pilorides*, *My. prehensilis*, †*G. columbianus* and †*Macrocapromys acevedo*. This evidence corroborates the hypothesis that the San Felipe hutia was once widespread and sympatric with other hutias.

Four species of the genus *Mesocapromys* and *Mysateles* are known for displaying caudal autotomy (Silva *et al.*, 2007, Borroto *et al.*, 2011); an anti-predator skill that allows the hutia to detach the tail from the body at the level of the fifth caudal vertebrae (Borroto *et al.*, 2012). Silva *et al.*, (2007) supposed that *M. sanfelipensis* have this capacity, it is confirmed now by a photo (Fig. 1C) of a partial tail detached from a hutia when it was tried to get out of a burrow.

We share the concern of other authors about the situation of the only known modern population of this species (Frias *et al.*, 1988; Kratochvil 1978; Silva *et al.*, 2007; Borroto-Paez, 2012, Borroto-Paez & Ramos, 2012). In the last 40 years, several expeditions have been carried out trying to localize direct or indirect evidence of the species, but none of them have been successful. The last specimen collected and deposited in collections was captured 47 years ago, in October 1970 during a second expedition to the key after the species was discovered in March of the same year. Frias *et al.* (1988) in the first evaluation of the conservation status of the species, mentioned that one of the leading causes of extinction was overhunting; they refer to around 18 *M. sanfelipensis* caught between 1974 and 1975, and another 43 in 1978. However, A. I. Frias in personal communication to Borroto & Ramos (2012) unknown the primary source that provide the data about the captures and its reasons. At the same time, there is no record of any of those specimens in any national or international collection (Ramos & Borroto, 2005; Silva *et al.*, 2007, Borroto *et al.*, 2012, Ramos & Borroto, 2012; Balseiro *et al.*, 2015). We recommend caution regarding the information given by Frias *et al.*, (1988) about the dates and number of specimens captured. Some authors considered *M. sanfelipensis* extinct (Frias *et al.*, 1988; Valdez *et al.*, 1998, Borroto and Ramos, 2012) while others as critically endangered (Perera *et al.*, 1994; Silva *et al.*, 2007, Borroto, 2012; Amaro, 2012). The possible causes of this status have been well documented by the authors mentioned above and include professional collection, hunting by fishermen and temporary residents of the key, destruction of its refuge by fire, competition with introduced rats, among others. Also, Borroto and Mancina (2017) called attention about the effect that the introduction of new parasites, infections, and diseases brought by invasive mammals would have on the conservation status of Cuban mammals.

In our opinion, the conservation status of *M. sanfelipensis* in Cayo Juan Garcia is the result of direct and indirect human pressures. However, the current distribution of the species is smaller than during the Quaternary and does not seem to have an anthropogenic origin. At least four living (*C. pilorides*, *My. prehensili*, *M. melanurus*, *M. nanus*) and four extinct (*G. columbianus*, *B. torrei*, *B. offella*, *M. kraglievichi*) Cuban rodents were consumed by Amerindians (Silva *et al.* 2007), however, there is not a single evidence of predation of *M. sanfelipensis* by human during this period. On the other hand, there are sedimentologic, palynologic, neotectonic, and paleoecological evidences indicating that the climate in Cuba started turning dryer around 3 Ka (Curtis *et al.*, 2001; Gregory *et al.*, 2015; Ortega *et al.*, 2008; Jaimez & Ortega, 2009). This caused the reduction of swamps, marshes and flooded forest, the habitat associated to most species of *Mesocapromys*. These processes affected species in different degrees and moments (Jimenez *et al.*, 2005; Silva *et al.*, 2007), driving some of them to extinction, others near it, another remained stable, and some were benefited. In order to have a better understanding of the Quaternary extinctions it is fundamental to generate more information on paleoclimate, paleoecosystems distribution, species distribution, ecological interaction and human influence.

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