

OCURRENCE OF THE REGULAR URCHIN *EUCIDARIS TRIBULOIDES*
FROM THE TAMIAMI FORMATION (PLIOCENE) OF FLORIDA

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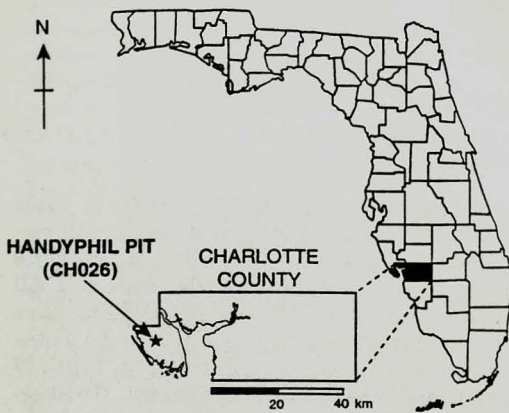
The echinoids of the Pliocene Tamiami Formation of Florida are typically abundant, well-preserved, and reasonably well-known. In a 1963 monograph, Kier listed nine species of echinoids from the Tamiami Formation. These were *Arbacia crenulata* Kier, 1963, *Lytechinus variegatus plurituberculatus* Kier, 1963, *Clypeaster crassus* Kier, 1963, *C. sunnilandensis* Kier, 1963, *Encope tamiamiensis* Mansfield, 1932, *E. michelini imperforata* Kier, 1963, *Mellita aclinensis* Kier, 1963, *Rhyncholampas evergladensis* (Mansfield, 1932), and *Echinocardium gothicum* (Ravenel, 1848). Phelan (1972) eliminated previous confusion between *E. michelini* L. Agassiz, 1841, and *E. aberrans* Martens, 1867, and re-identified Kier's *E. michelini imperforata* as *E. aberrans*. Kier (1992) agreed with Phelan's specific assessment but still considered his earlier (1963) subspecific designation to be valid. Since Kier (1963), no new additions to the echinoid fauna of the Tamiami Formation have been reported, until now.

Between 1989 and 1996, fossil collections were made by the Invertebrate Paleontology staff and volunteers of the Florida Museum of Natural History (FLMNH) at University of Florida (UF) locality CH026 (also known as the HandyPhil Pit) in western Charlotte County, Florida (text-figure 1). These collections yielded hundreds of isolated regular urchin test plates and radioles and three partial, but flattened, regular urchin tests (UF 39528, UF 60203, and UF 72022). Recent analysis of these urchin remains indicates that they belong to *Euclidaris tribuloides* (Lamarck, 1816), a genus and species not previously recorded from the Florida fossil record. Other common taxa collected at this locality included the brachiopod, *Glottidia inexpectans* Olsson, 1914; the gastropods, *Dicathais handgenae* Portell and Vokes, 1992, and *Ephora quadricostata* (Say, 1824); the barnacle, *Tamiosoma advena* Zullo, 1992;

and the echinoids, *Echinocardium gothicum* (Ravenel, 1848) and *Encope tamiamiensis* Mansfield, 1932. Numerous pectens and oysters were also collected. All specimens from UF locality CH026 were collected in a gray, medium- to fine-grained quartz sand with a modest amount of heavy mineral content. No aragonitic-shelled taxa were preserved, only calcitic-shelled taxa typically associated with the Tamiami Formation were present (see taxa above). At UF locality CH026, the Tamiami Formation is overlain by a 2 meter thick shell bed attributable to the Fort Thompson Formation.

Other fossil occurrences of *E. tribuloides* are known from outside Florida. Donovan and Embden (1996) summarized the Jamaican occurrences, including specimens from the Plio-Pleistocene August Town Formation, early Pleistocene Manchioneal Formation and Old Pera Beds, and late Pleistocene Port Morant and Falmouth formations. Elsewhere, Lewis and Donovan (1991) reported radioles from the Pliocene and late Pleistocene of Tobago. Cutress (1980) confirmed several published reports from the Plio-Pleistocene Playa Grande Formation, and Pleistocene Abisinia, Cerro Gato, and Tortuga formations of Venezuela. Cutress also discounted reports by Jackson (1922) and Sánchez Roig (1949) of *E. tribuloides* from the Miocene (?) of Cuba.

Extant *E. tribuloides* occurs from Cape Hatteras, North Carolina, east to Bermuda, throughout the Caribbean, the Gulf of Mexico, and south to Rio de Janeiro, Brazil (Serafy, 1979). Its known depth range has been recorded between 0 and 800 meters. However, it is most commonly found at depths of less than 50 meters (Serafy, 1979). *Euclidaris tribuloides* inhabit rocky areas, typically under rocks and in small crevices. They are also known to inhabit seagrass beds (Hendler *et al.*, 1995).



Text Figure 1. Map showing locality of the first reported occurrence of the fossil *Eucidaris tribuloides* (Lamarck, 1816) from Florida.

ACKNOWLEDGMENTS

We are indebted to Phillip Whisler of Gainesville, Florida for his assistance in the field, and particularly, for collecting and donating fossil *E. tribuloides* specimens UF 72022 and UF 60203. Jimmy and Pat Philman, Englewood, Florida, kindly allowed access to their shell pit (UF locality CH026). Burchard Carter, Georgia Southwestern State University and Stephen Donovan, University of the West Indies reviewed earlier drafts of the manuscript and provided helpful comments. This is University of Florida Contribution to Paleontology 486.

SYSTEMATIC PALEONTOLOGY

Class ECHINOIDEA Leske, 1778
 Order CIDAROIDA Claus, 1880
 Family CIDARIDAE Gray, 1825
 Genus EUCIDARIS Döderlein, 1887
EUCIDARIS TRIBULOIDES (Lamarck, 1816)
 Plate 1, figures 1a-b, 2, 3

Description: Test typically flattened both adapically and adorally. Primary tubercles non-crenulate, perforate, having a conical boss nearly circular in outline, and grading into scrobicule without a basal terrace. Areoles circular at ambitus, becoming transversely elongate near apical and oral regions. Scrobicular tuber-

cles only modestly larger than surrounding secondary tubercles.

Ambulacra are narrow, slightly sinuous, and widest at ambitus. Poriferous zones in minor, sunken grooves. Pores round to slightly elliptical, separated by a low, interporal partition. Ambulacra approximately one-fourth as wide as interambulacra areas.

Interambulacra plates up to two times wider than tall. Interradial tract about two times wider than adradial tract. Secondary tubercles densely distributed throughout plate surface. Interradial suture simple, non-serrate.

Primary radioles have limited shape variation, but include both cylindrical and truncate forms. Shaft may be slightly inflated in proximal to medial portion. Acetabulum diameter approximately 44-61% of radiole width. Radioles up to 42.9 mm long, and 3.5 to 4.5 mm wide. Milled ring is located 2.0 to 2.7 mm above base, and collar is 1.6 to 2.4 mm long with conical shape widest at milled ring. Neck is narrow and located 3.5 to 4.6 mm above base. Shaft has numerous longitudinal series of low nodules, which may not be visible on more poorly preserved or altered samples. Distal end of radioles marked by low-ribbed crown, with a central prominence.

The three flattened tests (UF 72022, UF 60203, 39528) are incomplete and compacted; therefore, not all diagnostic features are well-preserved. More detailed species descriptions are available in Weisbord (1969), Phelan (1970), Cutress (1980), Donovan (1993), and Hendler *et al.* (1995).

Discussion: Comparison of the fossil specimens from the Tamiami Formation with several modern *E. tribuloides* specimens from the Florida Keys show most morphologic characteristics to be similar among the samples. The Florida fossils also are comparable with *E. tribuloides* described by Donovan (1993) from the Falmouth Formation (Pleistocene) in Jamaica, as well as samples of this species reported by Weisbord (1969) from the Playa Grande Formation of Venezuela (Plio-Pleistocene). Many of Weisbord's Venezuelan samples are now deposited in the Florida Museum of Natural History and, therefore, were available for comparison by the authors.

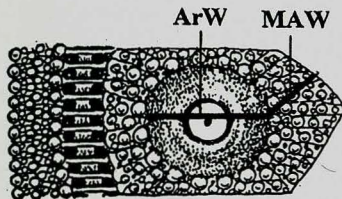
Cutress (1980) compared samples of fossil and modern *E. tribuloides* collected from sites in the Caribbean and Gulf of

Eucidaris tribuloides Biometrics SummaryI. Modern *Eucidaris tribuloides*

Number of Plates <u>Measured</u> n=15	Mean of Medial Area <u>Width (MAW)</u> $\bar{x}=2.48$ mm	Mean of Areole <u>Width (ArW)</u> $\bar{x}=6.18$ mm	MAW / ArW <u>Ratio Mean</u> $\bar{x}=0.40$
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II. Fossil *Eucidaris tribuloides* (Tamiami Formation, Pliocene)

Number of Plates <u>Measured</u> n=20	Mean of Medial Area <u>Width (MAW)</u> $\bar{x}=4.32$ mm	Mean of Areole <u>Width (ArW)</u> $\bar{x}=7.32$ mm	MAW / ArW <u>Ratio Mean</u> $\bar{x}=0.58$
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Text Figure 2. Summary statistics for single-plate measurements of medial area width (MAW), areole width (ArW), and medial area width / areole width ratio (MAW / ArW). Measurements are in mm, and were obtained from locations indicated on the test plate illustration and discussed in the text. (Illustration modified from Cutress, 1980).

Mexico region with several fossil and/or modern species of *Eucidaris*, including *E. madrugensis* (Sánchez Roig, 1949), *E. thoursii* (Valenciennes, 1846), and *E. clavata* Mortensen, 1928. Cutress reported several key differences between *E. tribuloides* and each of these species using both qualitative and quantitative (biometric) characteristics, and we have summarized these differences here. *Eucidaris clavata*, a modern species known only from Ascension and St. Helena Islands in the South Atlantic, has fewer interambulacral plates per column, contains more confluent areoles, and lacks fan-shaped septal bundles. Biometric analysis of the two species completed by Pawson (1978) revealed significant differences in the ratio of the median area width (MAW) of the interambulacral plates to the associated areole width (ArW), as well as in the ratio of the apical system diameter (ApD) to the peristome diameter (PerD) for the species. He reported a mean MAW/ArW

ratio of 0.51 for *E. clavata* and 0.97 for *E. tribuloides*, while the ApD/PerD mean ratio was 0.77 for *E. clavata* and 1.02 for *E. tribuloides*.

Eucidaris thoursii, a Recent species from the eastern Pacific Ocean, has wider median areas on interambulacral plates and wider associated areoles. Data accumulated by Chesher (1972) for the ratio of MAW/ArW of *E. tribuloides* shows a ratio range of 0.6-0.8, while on equivalent-sized specimens of *E. thoursii*, Cutress (1980) calculated the mean ratio to be slightly lower, 0.58, over a range of 0.4-0.78. An additional biometric ratio, areole width (ArW) to the width of a single interambulacral plate (IAMPIW) also supports a separation of the species, with the ArW/IAMPIW mean ratio for *E. thoursii* equal to 0.68 whereas for *E. tribuloides* the mean ratio is equal to 0.58.

Finally, comparisons with *E. madrugensis* are important, though the characters of this species are somewhat difficult to deci-

pher from the literature. Jackson (1922) and Sánchez Roig (1949) reported cidaroid specimens from the Miocene of Cuba, which Cutress subsequently reassigned to *E. madrugensis*. Sánchez Roig (1949) caused confusion in the process of naming the species, by using both the names *Dorocidaris madrugensis* (in the text) and *Leiocidaris madrugensis* (in the figure caption) for the same series of figures in his plates. Furthermore, Cutress (1980) determined through examination of the figured specimens that not all of the specimens were actually eucidarids, but were Cretaceous phyllacanthid species instead. Cutress determined that *E. madrugensis* is closely related (likely the ancestral form) to *E. tribuloides*, but differs by having whorled radioles in adults, a larger areole width, and having radiole collars that are only half as long as in *E. tribuloides*. In addition, Donovan and Paul (in press) described the presence of low spinules on the primary radioles of *E. madrugensis* whereas primary radioles of *E. tribuloides* do not possess such spinules.

A cautionary note must be made regarding the biometric data gathered and their use in the diagnostic ratios described above. Cutress (1980) pointed out that in most of her measurements of median area width (MAW) and calculations of the MAW/ArW ratios, she used only single-plate measurements. Since most of her work dealt with fossil cidaroids rather than modern specimens, she recognized that imperfect preservation of the fossils often resulted in incomplete skeletal remains to identify and measure. This is in contrast to Pawson (1978) and Mortensen (1928), where they determined the usual, "entire" median area measurements from the pair of associated and articulated interambulacral plates. The difference between these methods will cause a different ratio to result, because

only one of the two plates and its width is considered. Since the sum of two single-plate median area widths is not equal to the "entire" median area width determined from two plates, one cannot simply extrapolate data from one set to the other. A second problem in examining the data is distinguishing from which region on the plates a median area width was measured. Each interambulacral plate is pentagonal in outline, but the apex of the pentagon is asymmetrical, so measurements will vary unless specific endpoints are identified for the median area width position. No specific diagrams were provided in Pawson (1978) or Cutress (1980) to illustrate exactly where their measurements are located on the test plates, making replication of equivalent measurements on the Tamiami Formation specimens illustrated in Plate 1 less certain.

Text-figure 2 shows summary data and calculations for MAW, ArW, and MAW/ArW ratios (using single-plate measurements) for a specimen of *E. tribuloides* from the Florida Keys and for several FLMNH samples of the fossil *E. tribuloides* reported herein. In addition, text-figure 2 illustrates the exact location measured on each plate, for each of the biometric variables, to help alleviate any confusion in how our ratios were determined. It is interesting to note that the MAW/ArW mean ratio for the Florida fossils is 0.58 while the modern specimen has a mean ratio of 0.40. The implications of this may be that the fossil material is not from *E. tribuloides*, but rather a new species. Pawson (1978) believed such biometric ratios important enough to justify specific differentiation between *E. clavata* and *E. tribuloides*, so such variation between the modern and fossil samples used in this study may warrant further examination and interpretation if more complete specimens are recovered in the

PLATE 1

Figures 1-3. *Eucidaris tribuloides* (Lamarck, 1816)

- 1a-b. UF 72022. a. Oral surface of flattened test showing partially exposed lantern.
b. Aboral surface of flattened test. Both X1.
2. UF 60203. Lateral view of flattened test. X1.
3. UF 80300. Radiole. X2.

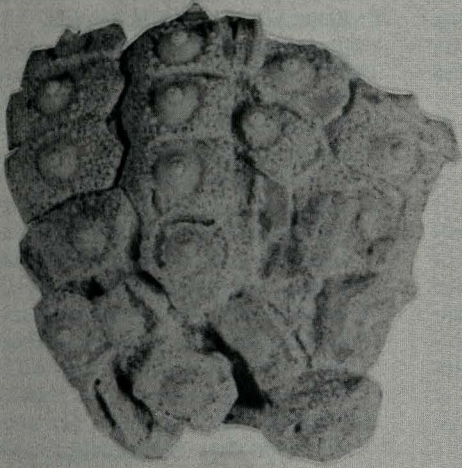
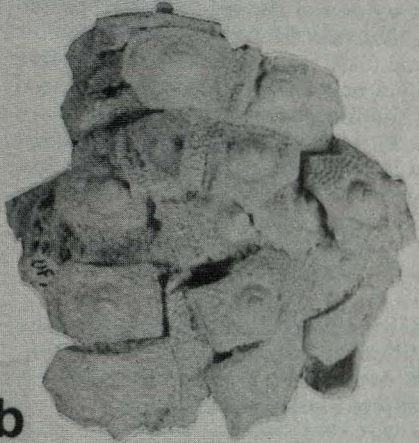
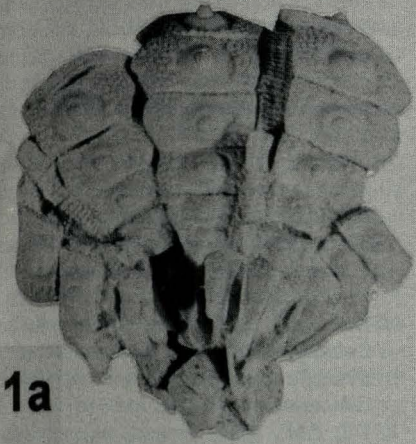


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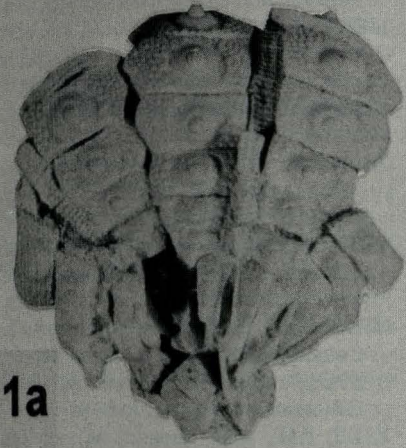
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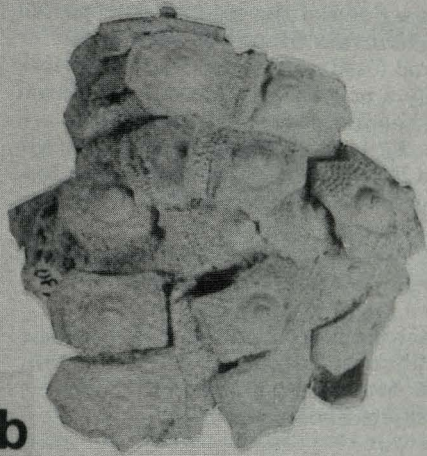
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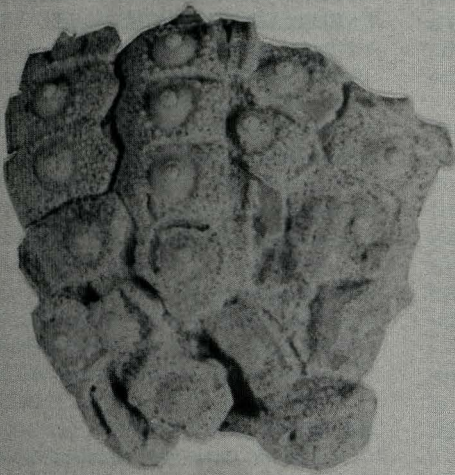
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1a



1b



2



3

future. Unfortunately, the fossils currently available are not articulated and have been flattened during fossilization, preventing a more thorough qualitative and quantitative analysis of the specimens with a broader group of biometric features. It appears as though at least two of the three best fossil specimens are near the largest end of the size range reported for *E. tribuloides*. However, without better preserved fossil specimens, it is impossible to justify a new species description. Based on the fossils currently available, we believe the best interpretation is to treat them as *E. tribuloides*. This is the first fossil occurrence of this species from the United States.

LOCALITY DATA

The following is a collecting locality of the Invertebrate Paleontology Division, Florida Museum of Natural History, University of Florida (UF).

CH026 Shell pit approximately 1.2 kilometers east of Grove City, Charlotte County, Florida (NE 1/4, NE 1/4, Sec. 16, T41S, R20E; Englewood Quadrangle, USGS 7.5 minute series, 1987).

LITERATURE CITED

- CHESHER, R.H., 1972, The status of knowledge of Panamanian echinoids, 1971, with comments on other echinoderms: *Biological Society of Washington Bulletin*, v. 2, pp. 139-158.
- CUTRESS, B.M., 1980, Cretaceous and Tertiary Cidaroida (Echinodermata: Echinoidea) of the Caribbean area: *Bulletins of American Paleontology*, v. 77, no. 309, 221 p.
- DONOVAN, S.K., 1993, Jamaican Cenozoic echinoidea, in *Biostratigraphy of Jamaica* (R.M. WRIGHT, and E. ROBINSON, eds.): *Geological Society of America Memoir* 182, pp. 371-412.
- DONOVAN, S.K., and B.J. EMBDEN, 1996, Early Pleistocene echinoids of the Manchioneal Formation, Jamaica: *Journal of Paleontology*, v. 70, no. 3, pp. 485-493.
- DONOVAN, S.K., and C.R.C. PAUL, in press, Echinoderms of the Pliocene Bowden shell bed, southeast Jamaica: *Contributions to Tertiary and Quaternary Geology*, Leiden.
- HENDLER, G., J.E. MILLER, D.L. PAWSON, and P.M. KIER, 1995, Sea stars, sea urchins, and allies: Echinoderms of Florida and the Caribbean: *Smithsonian Institution Press*, 390 p.
- JACKSON, R.T., 1922, Fossil echini of the West Indies: *Carnegie Institute of Washington, Publication no. 306*, 102 p.
- LEWIS, D.N., and S.K. DONOVAN, 1991, The Pliocene Echinoidea of Tobago, West Indies: *Tertiary Research*, v. 12, pp. 139-146.
- KIER, P.M., 1963, Tertiary echinoids from the Caloosahatchee and Tamiami formations of Florida: *Smithsonian Miscellaneous Collections*, v. 145, no. 5, 63 p.
- KIER, P.M., 1992, Neogene paleontology in the northern Dominican Republic: The class Echinoidea (Echinodermata): *Bulletins of American Paleontology*, v. 102, no. 339, pp. 13-27.
- MORTENSEN, T., 1928, A monograph of the Echinoidea: vol. 1, Cidaroida, C.A. Reitzel, Copenhagen, 551 p.
- PAWSON, D.L., 1978, The echinoderm fauna of Ascension Island, South Atlantic Ocean: *Smithsonian Contributions to the Marine Sciences*, no. 2, 31 p.
- PHELAN, T.F., 1970, A field guide to the cidaroid echinoids of the northwestern Atlantic Ocean, Gulf of Mexico, and Caribbean Sea: *Smithsonian Contributions to Zoology*, no. 40, 67 p.
- PHELAN, T.F., 1972, Comments on the echinoid genus *Encope*, and a new subgenus: *Proceedings of the Biological Society of Washington*, v. 85, no. 8, pp. 109-130.
- SÁNCHEZ ROIG, M., 1949, Los equinodermos fósiles de Cuba: *Paleontología Cubana*, v. 1, 302 p.
- SERAFY, D.K., 1979, Echinoids (Echinodermata: Echinoidea): *Memoirs of the Hourglass Cruises*, v. 5, part 3, 120 p.
- WEISBORD, N.E., 1969, Some Late Cenozoic echinoidea from Cabo Blanco, Venezuela: *Bulletins of American Paleontology*, v. 56, no. 252, pp. 273-372.