FLORIDA FOSSIL INVERTEBRATES

Part 1 **JUNE 2001**

SINGLE ISSUE: $7.00

EOCENE ECHINOIDS

ROGER W. PORTELL[1] and CRAIG W. OYEN[2]

[1]Florida Museum of Natural History
University of Florida
P. O. Box 117800
Gainesville, FL 32611-7800
e-mail: portell@flmnh.ufl.edu

[2]Department of Geography and Earth Science
Shippensburg University
1871 Old Main Drive
Shippensburg, PA 17257-2299
e-mail: cwoyen@ark.ship.edu

A PUBLICATION OF THE FLORIDA PALEONTOLOGICAL SOCIETY, INC.

FLORIDA FOSSIL INVERTEBRATES

ISSN Pending

Florida Fossil Invertebrates is a new publication of the Florida Paleontological Society, Inc., and is intended as a guide for identification of the many, common, invertebrate fossils found around the state. It will deal solely with named species; no new taxonomic work will be included. Two parts per year will be completed with the first three parts discussing echinoids. Part 1 (June 2001 publication) covers Eocene echinoids, Part 2 (January 2002 publication) will be about Oligocene and Miocene echinoids, and Part 3 (June 2002 publication) will be on Pliocene and Pleistocene echinoids. Each issue will be image-rich and, whenever possible, specimen images will be at natural size (1x). Some of the specimens figured in this series soon will be on display at Powell Hall, the Florida Museum of Natural History's Exhibit and Education Center. Each part of the series will deal with a specific taxonomic group (i.e., echinoids) and contain a brief discussion of that group's life history along with the pertinent geologic setting. **This publication is possible through the generous financial support of James and Lori Toomey. Additional financial support for Part 1 was kindly provided by Jewel Karpel.**

The Florida Paleontological Society, Inc., a group of avocational and professional paleontologists, is dedicated to the advancement of paleontology in Florida. Annual dues are $5.00 for Associate Membership (persons under age 18) and $15.00 for Full Membership and Institutional Subscriptions. Members receive the quarterly Florida Paleontological Society Newsletter, *Florida Fossil Invertebrates*, and another new series, *Fossil Species of Florida*, that will discuss a single taxon at a time. In addition, there are FPS sponsored fossil collecting trips (both invertebrate and vertebrate) in conjunction with our society meetings.

For more information on membership or to purchase publications please e-mail: **fps@flmnh.ufl.edu** or write to:

Florida Paleontological Society
Florida Museum of Natural History
P. O. Box 117800
University of Florida
Gainesville, FL 32611-7800

EOCENE ECHINOIDS

Roger W. Portell[1] and Craig W. Oyen[2]

[1]Florida Museum of Natural History, University of Florida, P. O. Box 117800, Gainesville, FL 32611-7800 e-mail: portell@flmnh.ufl.edu

[2]Department of Geography and Earth Science, Shippensburg University, 1871 Old Main Drive, Shippensburg, PA 17257-2299 e-mail: cwoyen@ark.ship.edu

INTRODUCTION

Echinoids originated in the Late Ordovician Period (~450 million years ago) and significantly diversified during the Mesozoic Era (from ~245 to ~65 million years ago). They are an important part of the fossil record of the Eocene Epoch, with 40 species currently known from Florida (some of which are still awaiting formal description). The Eocene was the time in Florida's geologic history when the highest diversity of echinoids lived and ultimately became fossilized. No epoch since has had more than about two-thirds the diversity of fossil echinoids found during the Eocene. Therefore, we interpret this to mean that both the living conditions and the conditions for fossilization were favorable to preserve their history. In this paper 31 Florida Eocene echinoid taxa are figured in Plates 1-7. Table 1 lists the 34 currently described Florida Eocene echinoid species in systematic order within their family and provides a brief synonymy (an older name no longer in use) for some. Subspecies were not treated in this work and three taxa listed in Table 1 were not figured because they were unavailable at the time.

Echinoids are given common names including sea urchins, sea biscuits, and sand dollars. The differences among the various forms of echinoids are generally based on two skeletal properties of the animals: 1.) the symmetry of their body, and 2.) the position of the anus relative to the apical system (i.e., the skeletal plates on the top of the animal).

Echinoid workers use these morphological characteristics to begin separating the echinoids into the two general categories of regular and irregular echinoids. The regulars (also known as sea urchins) have a nearly circular outline when viewed from above, nearly perfect pentameral (5-fold) symmetry, and their anus (periproct) is located within the apical system. An example of a regular echinoid from the Eocene is Phyllacanthus mortoni (Conrad, 1850). The irregulars (either known as sea biscuits or sand dollars) have bilateral symmetry, which means each half of a specimen is a mirror image of the other half when viewed from above. Furthermore, in the irregular echinoids the anus (periproct) is located somewhere outside of the apical system. Most of the fossil echinoids from the Eocene are irregular echinoids. These include the sand dollars such as Periarchus floridanus Fischer, 1951 and Neolaganum durhami Cooke, 1959, and the sea biscuits such as Oligopygus wetherbyi de Loriol, 1887 and the proposed State Fossil of Florida, Eupatagus antillarum (Cotteau, 1875).

Echinoids have a variety of shapes and specialized body structures that evolved as adaptations for specific life habits and ecological conditions (Figure 1). Regular echinoids are epifaunal. This means they live on top of the sediment on the sea floor, and they often inhabit rock rubble or cavities in a reef. The regulars typically have large spines and a strong jaw system (tooth-like structures called Aristotle's lantern) that allows the animal to graze on food sources such as algae. Most irregular echinoids are either semi-infaunal or infaunal animals. This means they live partly covered in the sediment on the sea floor (semi-infaunal) or completely covered or burrowed in the sediment of the sea floor (infaunal). The spines found on irregular echinoids normally are smaller than those of the regulars which enables the irregular echinoids to burrow through sediment more easily. Some of the deeper burrowers have a modest groove at the anterior end of their body to enhance burrowing capabilities. One such deep burrower is Schizaster armiger (Clark, 1915). Most irregulars lack the Aristotle's lantern (only sand dollars in the Order Clypeasteroida have them), and they have a smaller mouth and larger anus that evolved as adaptations so they could swallow sediment and organic detritus and pass out the large volume of undigested sediment. Infaunal echinoids include common species such as Eupatagus antillarum (Cotteau, 1875) and Plagiobrissus curvus (Cooke, 1942), and semi-infaunal examples include species of the genus Rhyncholampas and sand dollars such as species in the genus Neolaganum, among numerous others.

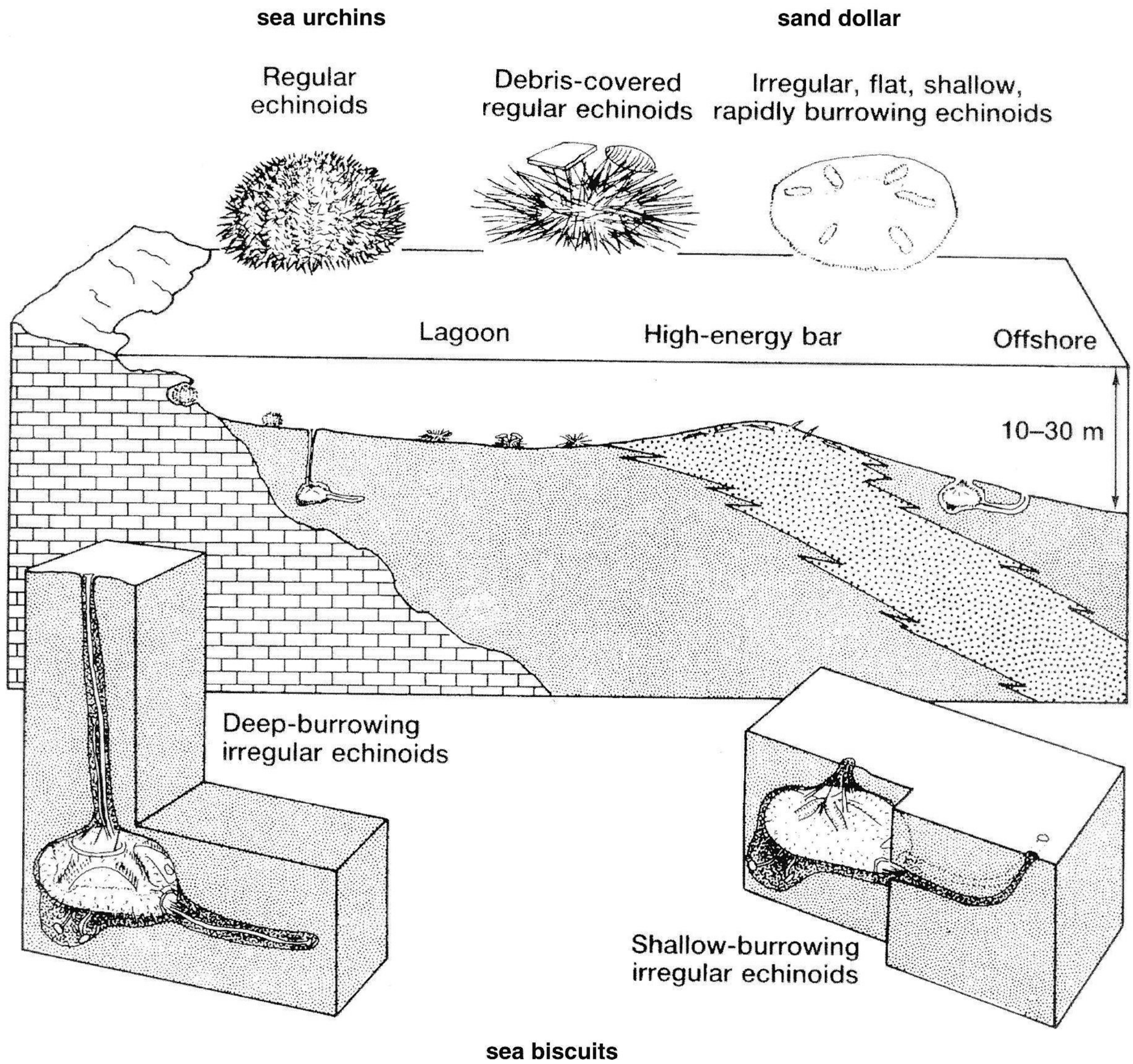


Figure 1. Mode of life illustration for general echinoid groups. The regular echinoids (sea urchins) live above the sediment, often in reef or rock rubble and sometimes in cavities or small openings in rock. The irregular echinoids are semi-infaunal, burrowing just beneath the surface of the sediment on the sea floor (e.g., sand dollars), or infaunal (e.g., sea biscuits), burrowing deeper into the ocean floor sediment. All variations of these life habits are represented by the echinoids fossilized in the Eocene sediments of Florida. (modified from Prothero, 1998).

GEOLOGICAL SETTING

All formations from the Middle through Upper Eocene that are exposed at the surface in the state contain fossil echinoids. The general distribution of these echinoid-bearing Eocene rocks is from the central portion of peninsular Florida northward and westward into the panhandle region (Figure 2). The names given to these fossiliferous formations have not always been used in the same fashion. The name "Ocala" is familiar to most fossil collectors in Florida and it generally is associated with many of the fossil species from the Eocene. However, the details regarding how the name should be used has changed over the years since W. H. Dall and G.D. Harris first described the "Ocala limestone" in 1892. Figure 3 illustrates how the names Ocala Limestone and Ocala Group have been applied to the Upper Eocene strata in Florida from the middle to late 1900s. Currently, the Florida Geological Survey and the United States Geological Survey recognize the Ocala Limestone as a formation name applied to Upper Eocene limestone in the state. However, some literature on Eocene fossils contains terminology of the Ocala Group that is subdivided into the Inglis, Williston, and Crystal River formations. Additionally, others such as Fischer (1951) use the Inglis member of the Moodys Branch Formation. The most important information to remember is that the rocks are Upper Eocene units, regardless of whether the name applied to the rock and fossil material is the Ocala Group or the Ocala Limestone.

The rocks of the Middle to Upper Eocene strata normally are composed of nearly pure limestone having less than 10% quartz sands or clays. Some portions of the formations, particularly in the Avon Park and Lower Member of the Ocala Limestone, have been chemically altered via dolomitization or silicification such that certain beds may have significant dolostone or chert present. This alteration of the limestone also produced changes in some of the fossils. Therefore, species located in these beds often were preserved as dolomitic molds rather than as the original calcite skeletons (for example, the dolomitic internal mold of Eupatagus clevei (Cotteau, 1875) in Plate 7 and Rhyncholampas georgiensis (Twitchell, 1915) in Plate 5).

The Eocene echinoid record is diverse and relatively abundant, but questions still remain unanswered regarding why the Eocene diversity is so high. Paleontologists have completed experiments that show how infaunal animals, including echinoids, have a higher probability of being preserved and fossilized than epifaunal animals.

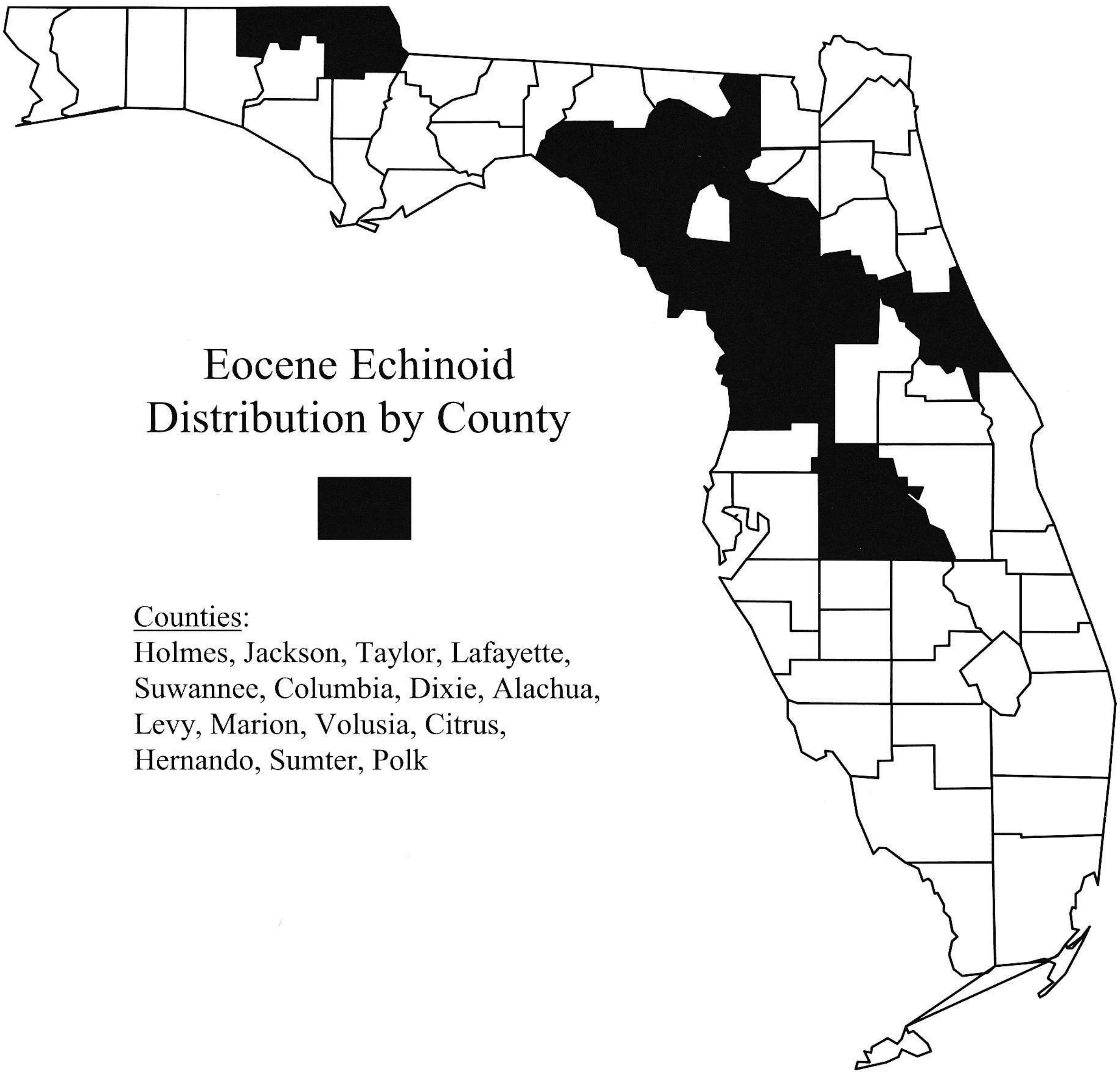


Figure 2. Eocene echinoid distribution in Florida. Shaded counties have records of echinoids from surface exposures, quarries (mined above groundwater or below groundwater levels), and along rivers or streams (either above or below water level). Data are from the Invertebrate Paleontology collection in the Florida Museum of Natural History in Gainesville, Florida.

<table>
<tr><th>SERIES</th><th colspan="2">Applin & Applin, '44</th><th colspan="2">Vernon, 1951</th><th colspan="2">Puri, 1957</th><th colspan="2">Scott, 1991</th></tr>
<tr><td rowspan="3">UPPER EOCENE</td><td rowspan="3">Ocala Limestone</td><td>Upper Member</td><td colspan="2">Ocala Limestone (restricted)</td><td rowspan="3">Ocala Group</td><td>Crystal River Formation</td><td rowspan="3">Ocala Limestone</td><td rowspan="2">Upper Member</td></tr>
<tr><td rowspan="2">Lower Member</td><td rowspan="2">Moodys Branch Formation</td><td>Williston Member</td><td>Williston Formation</td></tr>
<tr><td>Inglis Member</td><td>Inglis Formation</td><td>Lower Member</td></tr>
</table>

Figure 3. Upper Eocene stratigraphic nomenclature history and correlation. Please note that when reading research articles regarding the Upper Eocene limestone in Florida, any of these formation designations may be encountered. The Florida Geological Survey currently follows the designations applied by Scott, 1991. The oldest rock unit exposed at the surface in parts of Florida, the Avon Park Formation (Middle Eocene), lies beneath which ever of these Upper Eocene formations may be described in the literature.

This is true because infaunal animals live within the sediment and therefore minimal transportation, abrasion, and breakage of the skeleton occurs upon death of the animal. Epifaunal animals, such as the regular echinoids, leave their skeletons on the surface of the sea floor and are subject to rolling, abrasion, and compacting prior to and during burial in sediment. The fossil echinoid record in the Eocene of Florida reflects the preservation bias toward irregular echinoids with 37 of the 40 known species being infaunal or semi-infaunal animals, while only three of the species are epifaunal inhabitants.

Why does the Eocene have a higher diversity of echinoids than other epochs? This question is more difficult to answer and understand than the epifaunal versus infaunal preservation preferences. Part of the answer may be that the preservation for fossil echinoids is higher in carbonate environments such as those that existed in the Eocene. Quartz sand-dominated environments existed in the Miocene and younger epochs, and due to the style of sedimentation associated with quartz sands and pebbles, the preservation potential is lower. Another part of the answer may be that ecological conditions changed enough for diversity changes to occur. Certain fossil evidence has shown that ocean temperature dropped somewhat at the end of the Eocene, and this may have had an effect on which echinoids could tolerate living in cooler waters. Collector bias also may have a part in the explanation of higher diversity in the Eocene. Many of the echinoids found in rocks younger than the Eocene are poorly preserved, and therefore, often only found as incomplete parts or fragments of the original skeleton. People tend to prefer to collect complete fossils rather than fragments of them. Thus, perhaps part of the answer to the unusually high diversity in the Eocene is a result of the higher proportion of more complete echinoids found in the Eocene rocks than in most of the younger rocks.

The Eocene sea that covered Florida provided many niches for echinoids to inhabit, and has left a wonderful fossil record of Eocene echinoids. Some answers to the evolutionary history for these fossils are known and other questions are yet unanswered. The fossil collection in the Florida Museum of Natural History provides paleontologists with many areas to continue research on echinoids from the Eocene Epoch.

PLATE 1

A) Phyllacanthus mortoni (Conrad, 1850); UF 66913; aboral view; 1x.

B) Phyllacanthus mortoni (Conrad, 1850); UF 66913; lateral view; 1x.

C) Phyllacanthus mortoni (Conrad, 1850); UF 66913; adoral view of test; 1x.

D) Dixieus dixie (Cooke, 1941); UF 5467; aboral view; 1x.

E) Dixieus dixie (Cooke, 1941); UF 66559; aboral view of partial test with intact lantern; 1x.

F) Oligopygus phelani Kier, 1967; UF 18017; aboral view; 1x.

G) Oligopygus phelani Kier, 1967; UF 18017; adoral view; 1x.

H) Oligopygus haldemani (Conrad, 1850); UF 47257; aboral view; 1x.

I) Oligopygus haldemani (Conrad, 1850); UF 47257; adoral view; 1x.

J) Oligopygus wetherbyi de Loriol, 1887; UF 17756; aboral view; 1x.

K) Oligopygus wetherbyi de Loriol, 1887; UF 17756; adoral view; 1x.

L) Fibularia vaughani (Twitchell, 1915); UF 38211; aboral view; 2x.

M) Fibularia vaughani (Twitchell, 1915); UF 38211; adoral view; 2x.

N) Neolaganum dalli (Twitchell, 1915); UF 104422; aboral view; 1x.

O) Neolaganum dalli (Twitchell, 1915); UF 104422; adoral view; 1x.

P) Neolaganum durhami Cooke, 1959; UF 13026; aboral view; 1x.

Q) Neolaganum durhami Cooke, 1959; UF 13026; adoral view; 1x.

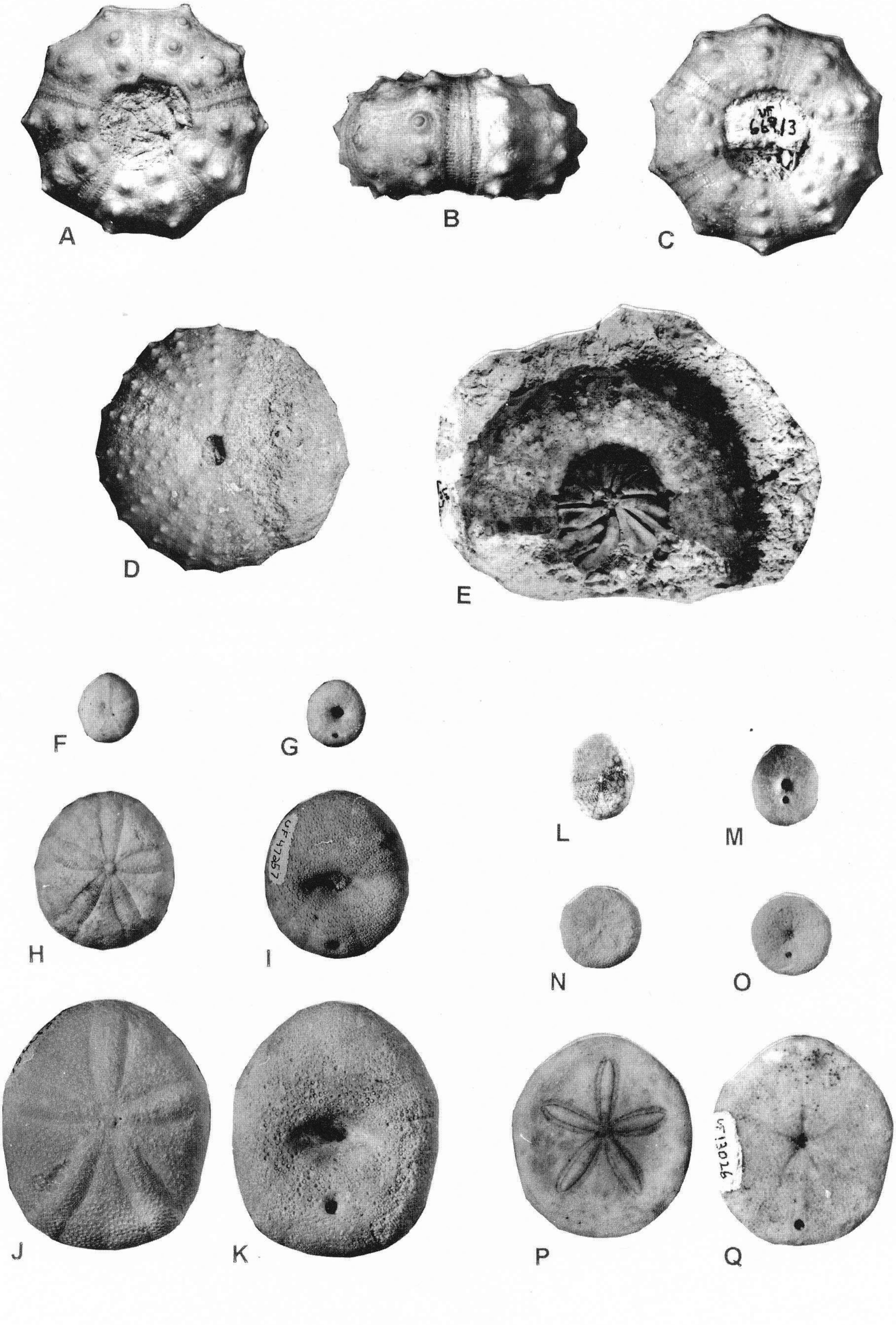

A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q

PLATE 2

A) Durhamella floridana (Twitchell, 1915); UF 3356; aboral view; 1x.

B) Durhamella floridana (Twitchell, 1915); UF 3356; adoral view; 1x.

C) Durhamella ocalana (Cooke, 1942); UF 3341; aboral view; 1x.

D) Durhamella ocalana (Cooke, 1942); UF 3341; adoral view; 1x.

E) Weisbordella cubae (Weisbord, 1934); UF 5846; aboral view; 1x.

F) Weisbordella cubae (Weisbord, 1934); UF 5846; adoral view; 1x.

G) Weisbordella johnsoni (Twitchell, 1915); UF 47957; aboral view; 1x.

H) Weisbordella johnsoni (Twitchell, 1915); UF 47957; adoral view; 1x.

I) Wythella eldridgei (Twitchell, 1915); UF 5803; aboral view; 1x.

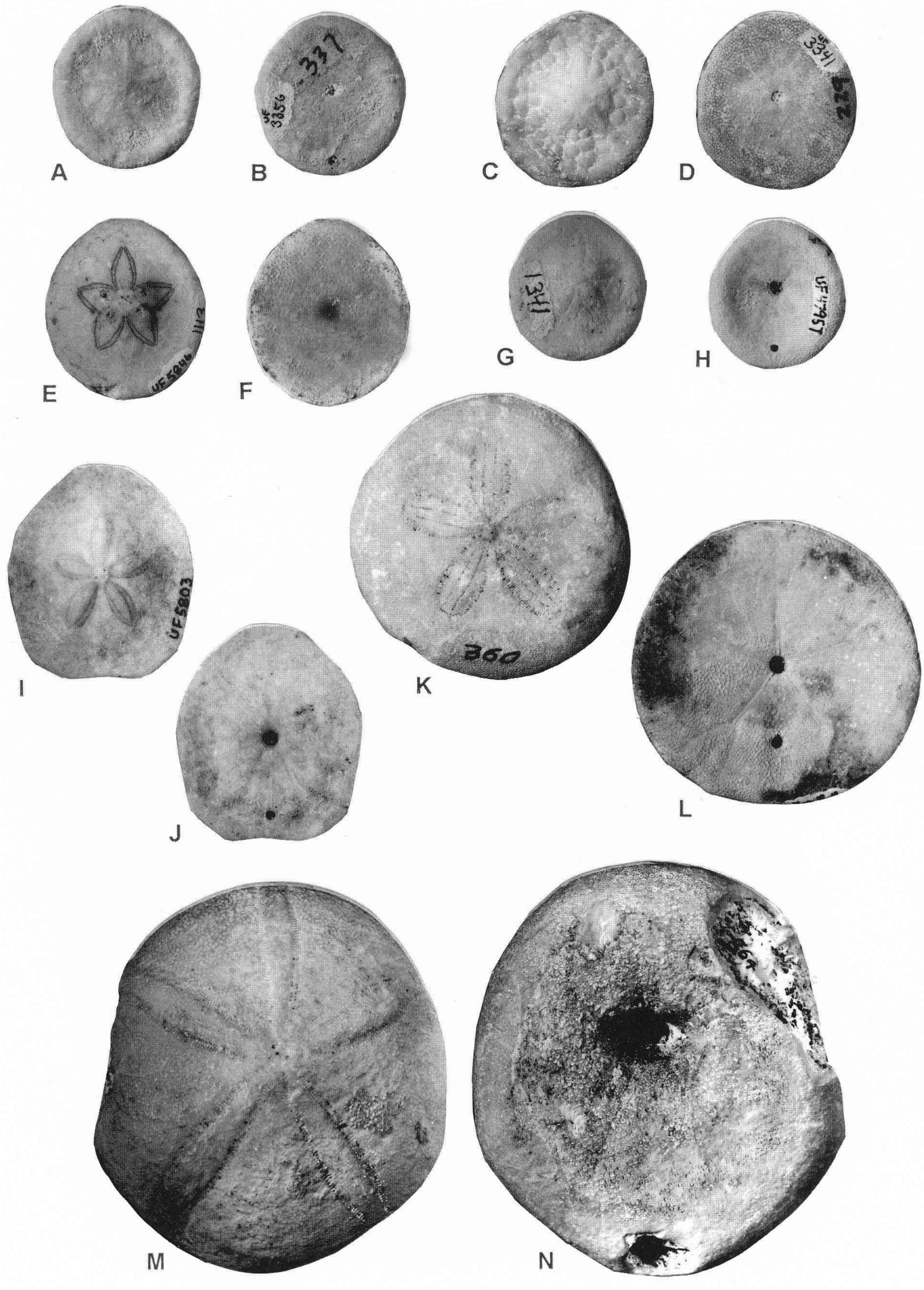
J) Wythella eldridgei (Twitchell, 1915); UF 5803; adoral view; 1x.

K) Mortonella quinquefaria (Say, 1825); UF 2202a; aboral view; 1x.

L) Mortonella quinquefaria (Say, 1825); UF 2202b; adoral view; 1x.

M) Echinolampas tanypetalis Harper and Shaak, 1974; UF 5385; aboral view of partial test; 1x.

N) Echinolampas tanypetalis Harper and Shaak, 1974; UF 5385; adoral view of partial test; 1x.


A
B
C
D
E
F
G
H
I
J
K
L
M
N