

Ocular sinuses in some modern and fossil species of *Echinocythereis* (Ostracoda)

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ABSTRACT: Ocular sinuses were studied in some Cenozoic species of the ostracode genus *Echinocythereis*. Internal molds indicate that the sinus is elongate and stalklike. The distal portion is expanded, with a central or offset concavity and anterior and posterior convexities. The topography is the complement of the inner surface of the eyespot. The right sinus is the larger in a carapace; it has only one major opening, the ocular pit, whereas the left sinus has an additional hole formed by the anterior hinge socket. Interspecific variation is seen in the shapes of the ocular sinuses. Such variation is useful in taxonomic applications.

INTRODUCTION

In the past, the morphology of ocular sinuses of ostracodes was unknown. The area between the eyespot and the ocular pit was neglected by paleontologists, probably because of the difficulty in studying the portion encased by relatively thick shell material. Transmitted light and both scanning electron and transmission electron microscopy cannot be used to gain information about such enclosed structures.

The use of internal molds, however, can reveal the shapes and dimensions of ocular sinuses, and did so for the first time in the course of this study, for some species of *Echinocythereis*. To my knowledge, this is the first published study dealing with the morphology of the ostracode ocular sinus beyond the ocular pit.

METHODS AND MATERIALS

Internal molds of shells were produced using the common mounting medium Lakeside 70, which fills all cavities with diameters of at least 1 μm . Shells were filled with finely crushed Lakeside, heated on a glass slide at 150°C, allowed to cool, then dissolved in 5% HCl (Kontrovitz 1982). The resulting molds were mounted on stubs for scanning electron microscopy.

The following modern species were studied: *E. margaritifera* (Brady) and *E. spinireticulata* Kontrovitz from the Louisiana continental shelf and *E. sp. A* from off the Florida Keys. Fossil specimens were from *E. planibasalis* (Ulrich and Bassler), *E. okeechobiensis* (Swain), *E. jacksonensis* (Howe and Pyeatt), and an undescribed species herein designated *E. sp. B* (see table 1).

RESULTS

The descriptions that follow are of internal molds but can be applied to the ocular sinuses they fill. The molding technique produces forms of high fidelity, as is indicated by many replications and comparisons with thin and polished sections. Valves that have been subject to slight natural dissolution produce molds with rough surfaces that are useful for these purposes.

The molds from specimens of *E. margaritifera* show the ocular sinuses of adult right and left valves to be unequal in size and proportions. The sinus in the right valve appears to

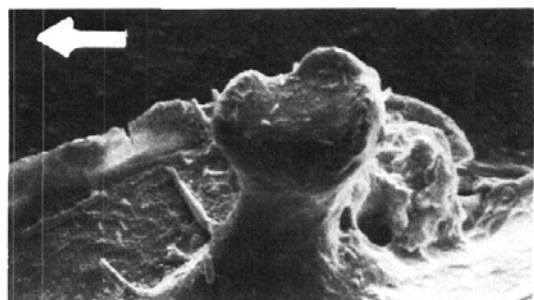
be a short, thick stalk; that of the left is thinner. The right sinus has a maximum diameter of about 65 μm and a length of about 82 μm while in the left valve, dimensions are about 55 and 75 μm , respectively. The right sinus is constricted at about one-third of its length from the proximal end, but on the left the constriction is at about one-half the length. The constriction in each sinus causes the diameter at that point to be about 60% of the maximum found at the distal end (pl. 1, figs. 1, 2).

In the right ocular sinus there is a single major opening, the ocular pit, whereas in the left there are two openings. The left has the pit and an additional orifice formed by an extension of the anterior hinge socket, as do all species in this study (see pl. 1, fig. 10; text-fig. 1).

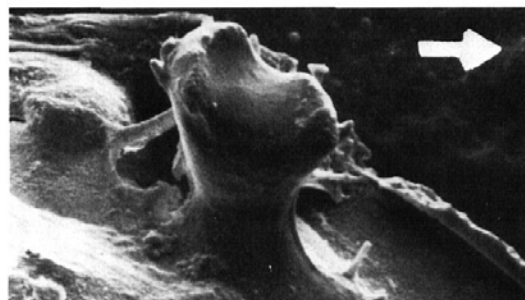
The distal portion of each of the right and left sinuses is expanded markedly compared to the remainder. While other areas have circular cross sections, the distal expanded area does not. It is bulbous, with modifications including a well-developed concavity near its center. The anterior has a rounded lobe that extends some 7 to 10 μm above the concavity. At the posterior there is a rimlike ridge, often divided into two lobes that are a few micrometers higher than the anterior lobe. All the described shapes and proportions of the distal features are presumed to be the complement of the interior surface of the eyespot (Kontrovitz and Myers 1984). Thus, the whole mold of the sinus has the appearance of a stalked eye, whose long axis is oriented upward and outward at about a 45° angle from the plane of commissure of the carapace.

Early molts (juveniles) have sinuses that are unlike those of adults. In the early stages, the sinus is a low, truncated cone dominated by the central concavity. Late juveniles display lobation of the anterior and posterior portions and greater elevation of the sinus, giving a stalked appearance (pl. 1, fig. 3).

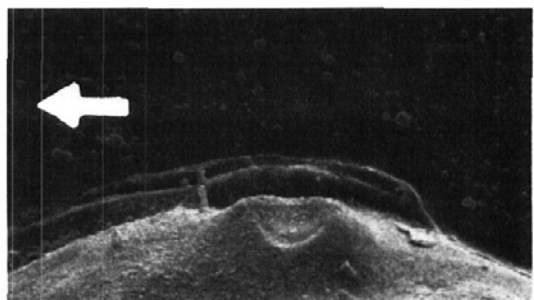
Interspecific variation was noted among the modern and fossil species. The ocular sinus of *E. spinireticulata* appears to be slightly thicker than that of *E. margaritifera*, is tilted more toward the anterior, and has the distal concavity situated more toward the outside of the stalk. In a third species, *E. sp. A* from off the Florida Keys, the anterior lobe at the distal end is proportionally larger than that in either of the



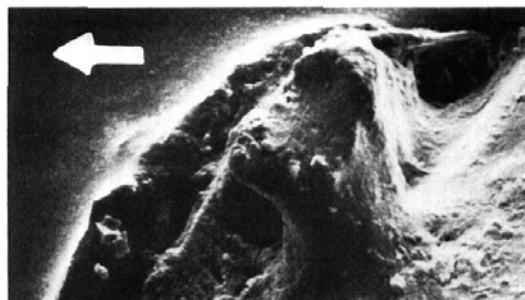
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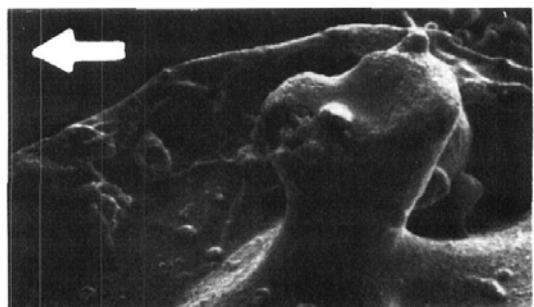
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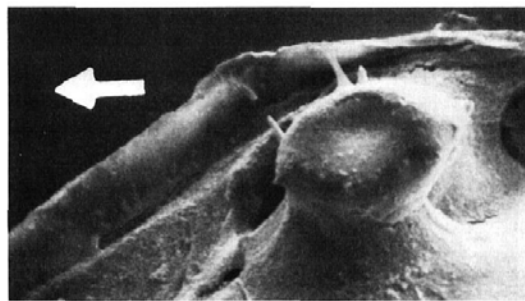
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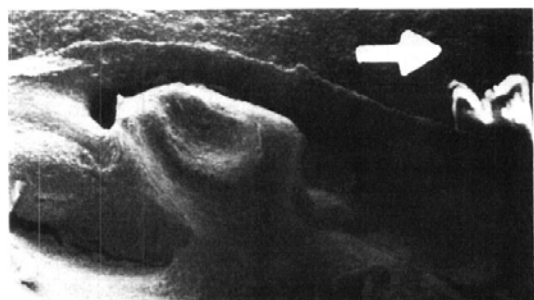
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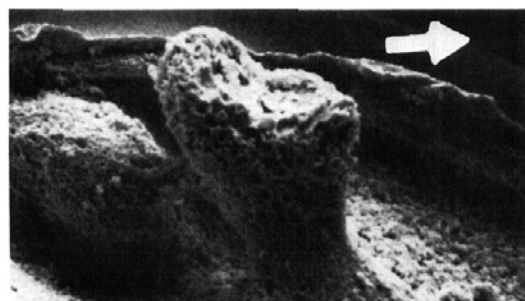
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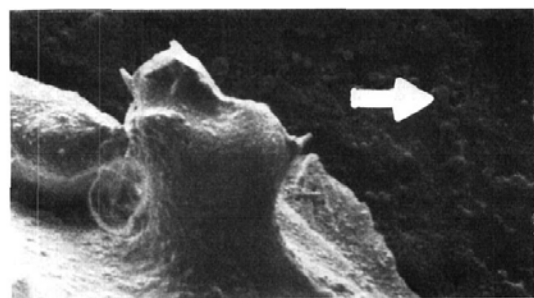
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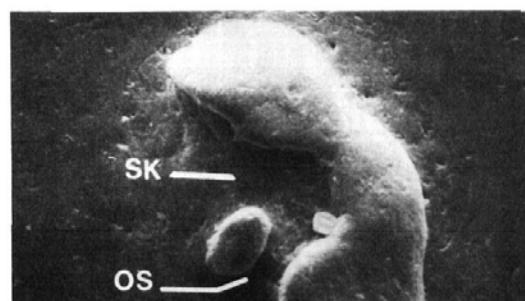
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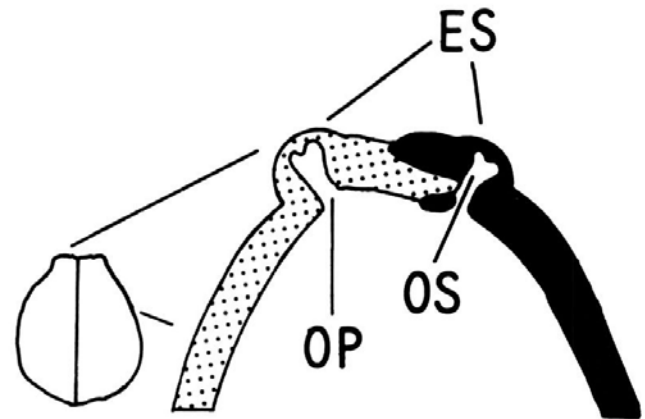
TABLE 1

The species used to make internal molds, their age, and the localities from which they were collected.

Species	Age of material	Locality
<i>Echinocythereis margaritifera</i> (Brady 1870)	Modern	Louisiana Continental Shelf, 28°48.6'N, 91°45.6'W
<i>Echinocythereis spinireticulata</i> Kontrovitz 1971	Modern	Louisiana Continental Shelf, 28°40.0'N, 86°50.1'W
<i>Echinocythereis</i> sp. A	Modern	Off Florida Keys, 24°56.4'N, 80°11.5'W
<i>Echinocythereis planibasis</i> (Ulrich and Bassler 1904)	Pleistocene	Atlantic Margin Coring Project (AMCOR), site 6010, 39°03.7'N, 73°05.7'W Core 7, Section 4, 40–60 cm
<i>Echinocythereis</i> sp. B	Oligocene, Vicksburg Group	Byram Formation, Locality 1/9 of Hazel et al. (1980)
<i>Echinocythereis okeechobiensis</i> (Swain 1946)	Eocene, Ocala Group	Crystal River Formation, Marion County, Florida, locality PM-2 of Puri (1953)
<i>Echinocythereis jacksonensis</i> (Howe and Pyeatt 1935)	Eocene, Jackson Group	Moodys Branch Formation, "fossil gulch" locality of Huff (1970)

other two modern forms. The posterior rim is larger and more rounded while the central concavity is more evenly rounded (pl. 1, figs. 4, 5).

In the fossil species *E. planibasis*, there is a thick, short sinus with anterior and posterior lobes or rims. The sinus forms a large angle (60°) with the plane of commissure. A shallow central concavity is at the distal end (pl. 1, fig. 6). In *Echinocythereis* sp. B, the sinus is short, with a distal



TEXT-FIGURE 1

Schematic drawing ($\times 280$) of a section through the ocular region of *Echinocythereis*. Anterior view, with the left valve shown in black and the right valve stippled. Smaller drawing at left shows area of carapace in the section. ES = eyespot; OS = ocular sinus; OP = ocular pit.

portion elongated in an anterior-posterior direction (pl. 1, fig. 7). The posterior rim is divided into two small lobes, and the central concavity is narrow and situated near the outside margin of the stalk. The Eocene form, *E. okeechobiensis*, has a stalked sinus similar to that of *E. sp. B*, but the concavity is more centrally situated (pl. 1, fig. 8).

The ocular sinus of *E. jacksonensis* is distinct in being short and thick, with little constriction at any portion of its length. Furthermore, it has a rounded, low anterior lobe and two unequal but narrow and sharp posterior lobes. The central concavity is long and narrow and intersects the posterior margin of the stalk (pl. 1, fig. 9).

SUMMARY AND DISCUSSION

The ocular sinuses are stalked with enlarged distal areas that contain the portion of the eye with the lens cells, retinal cells and rhabdoms (Andersson and Nilsson 1981). There is al-

PLATE 1

All figures are $\times 400$ and are internal molds of ocular sinuses, unless otherwise indicated. Arrows point toward anterior.

- 1–3 *Echinocythereis margaritifera* (Brady)
1, left valve; 2, right valve; 3, juvenile, left valve. Modern.
- 4 *Echinocythereis spinireticulata* Kontrovitz
Left valve; modern.
- 5 *Echinocythereis* sp. A
Left valve; modern.
- 6 *Echinocythereis planibasis* (Ulrich and Bassler)
Left valve; Pleistocene.
- 7 *Echinocythereis* sp. B
Right valve; Oligocene, Vicksburg Group.
- 8 *Echinocythereis okeechobiensis* (Swain)
Right valve; Eocene, Ocala Group.
- 9 *Echinocythereis jacksonensis* (Howe and Pyeatt)
Right valve; Eocene, Jackson Group.
- 10 *Echinocythereis* sp. B
Polished section, left valve, anterior view, through ocular sinus (OS) and anterior hinge socket (SK).

ways a central or offset concavity that is the complement of the corresponding convexity of the inner eyespot surface. The sinuses each have distal anterior and posterior lobes or rims that also fit into negative surface features of the eyespot. In all cases, the posterior of these is higher than the anterior. All such topographic features of the sinuses can be used to interpret the inner topography of the eyespots. This precludes the need for the difficult and tedious task of isolating individual eyespots for examination (Kontrovitz and Myers 1984).

Interspecific variation in *Echinocythereis* is such that the shapes of sinuses are distinct and can be used as one more character for purposes of taxonomy, if the worker is willing to destroy the specimen. Moreover, ontogeny of the internal sinuses can be described for both modern and fossil forms where a series of molts is available.

No evolutionary trends were interpreted from size and shape of the sinus, but at least two points should be considered. First, more species from the entire stratigraphic range of the genus are needed to determine if such trends occurred. Second, if the eye represents an adaptation to light, and if light intensities affect the size and the shape of ocular structures (Benson 1976), it may be difficult to determine which features result from evolutionary trends and which represent differences caused by environmental factors. If environmental factors can be defined as they control morphology, then the sinus shapes and sizes should be useful in interpreting paleoenvironment.

This kind of study can be repeated for any ostracode group with ocular sinuses. Preliminary work with other genera, including *Actinocythereis*, *Radimella*, *Puriana*, and *Loxiconcha*, indicates that each is different.

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