a

b

c

d

e

f

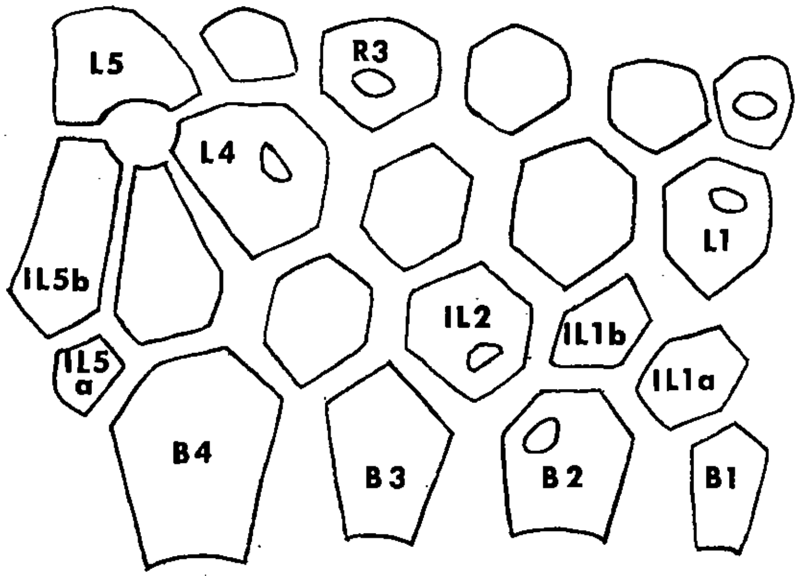

Figure 28
Plate diagram of Laosacystis monterey.

Thecal plate arrangement as shown in Figure 28. Four basals forming a closed circlet. Aboral edge of each basal plate bearing a circular groove for juncture with the stem. Base not indented. Infralateral circlet closed but irregular since IL1 and IL5 are represented by two plates each. Five laterals in a closed circlet. The five radial plates are protuberant and form an open circlet with L5 intercalated between R4 and R5. Orals largely covered by ambulacra. Plates ornamented by numerous and slightly irregular concentric ridges that parallel the plate edges. No ridges developed perpendicular to the plate edges.

Three disjunct pectinirhombs developed in the usual positions for callocystitids, across the suture between plates B2/IL2, L1/R5 and L4/R3. Half-rhombs set far back from the plate sutures. Half-rhombs IL2, L1 and L4 are semi-circular in outline, while adjacent half-rhombs B2, R5 and R3 are more oval. Half-rhombs contain at least five dichopore slits.

Periproct region surrounded by IL4, IL5b, L4 and L5. Periproctal plates not preserved. Gonopore and hydropore unknown. Stem not preserved except portions of proximal-most two columnals. Diameter of stem at juncture with theca 2 mm.

Discussion: In pore rhomb structure and plate arrangement, Laosacystis monterey resembles Jaekelocystis hartleyi. However, thecal shape and plate ornamentation clearly differentiate Laosacystis from any of the known species of Jaekelocystis. Of more fundamental importance, the ambulacra in Jaekelocystis are deeply entrenched in the theca and extend to the base, while in Laosacystis they are protuberant and largely confined to the apex. Although relative length of ambulacra may in many cases be a feature of maturity, an immature specimen of J. harleyi, only 8 mm. in height, was discovered with ambulacra extending fully one half the thecal length indicating Laosacystis cannot be an immature form of this species. On the basis of thecal shape, ornament, ambulacral structure and length, Laosacystis is separated from J. harleyi and other species of Jaekelocystis.

Laosacystis resembles Pseudocrinites and Tetracystis by nature of its protuberant ambulacra. Pseudocrinites, however, has only two ambulacra and a dissimilar plate arrangement and in addition has pore rhombs which are set close against and extend the entire length of the plate sutures. Half-rhombs of Laosacystis by contrast are short and set far back from the plate sutures. Tetracystis is similar to Laosacystis in having four unbranched and protuberant ambulacra but is differentiated by having a pore rhomb structure similar to Pseudocrinites and slightly different plate arrangement.

The writer considers the four unbranched and protuberant ambulacra of Laosacystis to be its most diagnostic feature. For this reason it is included in the subfamily Staurocystinae along with Pseudocrinites and Tetracystis.

D. Cystoid Assemblage - Lithofacies Associations

Preliminary investigation along the length of the outcrop belt suggested that cystoids were confined to a few closely associated lithofacies within the lower Keyser. Subsequent field work, refined in the laboratory, confirmed this initial observation and has, in addition, segregated the Keyser cystoids into distinct assemblages. Cystoid taxa were identified, with respect to stratigraphic occurrence and the associated invertebrate fauna, by disarticulated part studies (comparison of isolated ossicles with the corresponding element on the whole thecae) and by identification of whole thecae collected in the field. Previously published reports, although limited in number and generally imprecise in locating exact stratigraphic occurrences, were helpful and support my data.

Three basic cystoid assemblage-lithofacies associations are recognized. These are as follows:

Assemblage	Cystoid Genera	Lithofacies
1	<u>Lepocrinites</u>	well sorted calcarenite (biosparudite and biosparite
2	<u>Lepocrinites</u> <u>Pseudocrinites</u> <u>Jaekelocystis</u>	poorly sorted biosparite with interbedded calcareous shale
3	<u>Lepocrinites</u> <u>Pseudocrinites</u> <u>Jaekelocystis</u> <u>Spaerocystites</u> <u>Laosacystis</u>	open shelf calcisiltite

In previous sections of this study these three cystoid bearing lithofacies have been discussed in terms of their relative stratigraphic and geographic occurrences and they have been interpreted environmentally and paleogeographically. For the central portion of the outcrop belt, representing the central portion of the basin, they have been shown to represent a contemporaneous sequence of nearshore to offshore marine environments with transitional boundaries whose distribution was primarily influenced by the distribution of hydraulic energy over an exceedingly low slope carbonate shelf.

E. Associated Fauna

Each of the three cystoid assemblages is found to be associated with a diverse community, dominated by microphagous benthonic invertebrates (tables 4, 5, 6). Overall taxonomic diversity increases seaward; from assemblage 1 through assemblage 3.

Assemblage 1 (Lepocrinites) is found with an abundance of crinoids, encrusting and ramose bryozoa and a few brachiopod species (table 4). The fauna associated with assemblages 1 and 2 corresponds to the Pentamerus community position of other writers (see Ziegler 1965; Anderson, 1971b). Assemblage 2 is distinguished by a predominance of pelmatozoans (crinoids and cystoids), ramose and encrusting bryozoans and moderately diverse brachiopods including large globose pentamerids. Assemblage 3, characterized by its diverse cystoids, is associated with crinoids and a diversity of bryozoan colonial forms (table 6). This fauna has an equivalent environmental position to the Striklandia community position discussed by Ziegler 1965; Epstein, 1971 and Anderson, 1974.

Species of each community show a high propensity to occur together, and therefore are recurrent both as cycles in vertical sections and from outcrop to outcrop. More broadly tolerant species are found in more than one community. Community boundaries, like lithofacies boundaries, are gradational in vertical succession as well as in contem-

Table 4. Faunal list, well sorted calcarenite.

Brachiopoda

Stenochisma deckerenis (Stroph.)
Eccentricosta jerseyensis (Chonetid)
Cupularostrum convexorous (Rhyn.)
Protathris minuta (Atrypa)
Howellella modesta (Spir.)

Anthozoa

Favosites helderbergiae
Cladopora rectilineata

Bryozoa

Lioclema subramosum (encrusting to ramose)
Fistuliporella cumulata (encrusting to ramose)
Batostomella interporosa (ramose)
Orthopora rhombifera (ramose)
Cyphotrypa corrugata (encrusting - hemispherical)

Echinodermata

Crinoidea (more abundant than cystoids)
Cystoidea
Lepocrinites manlius

Table 5. Faunal list, poorly sorted biosparite.

Brachiopoda

<u>Cupularostrum convexorous</u> (Rhyn.)
<u>Machaeraria whittingtoni</u> (Rhyn)
<u>Cupularostrum gordoni</u> (Rhyn.)
<u>Cupularostrum lichfieldensis</u> (Rhyn.)
<u>Rhynchotreta hancockensis</u> (Rhyn.)
<u>Atrypa reticularis</u> (Atrypa)
<u>Dolerothis marylandica</u> (Orthid.)
<u>Dalejina emarginate</u> (Orthid.)
<u>Nucleospira ventricosta</u> (Spir.)
<u>Howellelia modesta</u> (Spira.)
<u>Leptostrophia bipartita</u> (Stroph.)
<u>Schuchertella deckerensis</u> (Stroph.)
<u>Eccentricosta jerseyensis</u> (Chonetid)
<u>Gypidula prognostica</u> (Pentam.)

Bryozoa

<u>Stenopora encrustans</u> (encrusting)
<u>Fistuliporella marylandica</u> (encrusting)
<u>Batostomella interporosa</u> (ramose)
<u>Orthopora rhombifera</u> (ramose)
<u>Cyphotrypa corrugata</u> (encrusting)
<u>Lioclema subramosan</u> (encrusting to ramose)

Anthozoa

<u>Aulopora sp.</u>
<u>Cladopora rectinilineata</u>

Echinodermata

Crinoidea (more abundant than cystoids)
Cystoidea
<u>Lepocrinites manlius</u>
<u>Pseudocrinites gordoni</u>
<u>Pseudocrinites stellatus</u>
<u>Jaekelocystis hartleyi</u>
<u>Jaekelocystis avellana</u>

Table 6. Faunal list, open shelf calcisiltite.

Brachiopoda

Atrypa reticularis (Atrypa)
Cupularostrum convexorous (Rhyn.)
Eccentricosta jerseyensis (Chonetic)
Leptostrophia bipartita (Stroph.)
Dalejina emarginata (Orthid.)
Howellella modesta (Spir.)

Anthozoa

Cladopora rectilineata
Aulopora sp.

Bryozoa

Fenestella cumberlandica (fenestrate)
Fenestella altidorsata (fenestrate)
Fenestella helderbergii (fenestrate
Semicoscinium planum (fenestrate)
Batostomella interporosa (ramose)
Orthopora rhombifera (ramose)
Eridotrypa parvulipora (ramose)
Fistuliporella marylandica (encrusting to ramose)
Lioclema subramosum (encrusting to ramose)
Fistuliporella cumulata (encrusing to ramose)
Stromatatotrypa globularus (encrusting - globular)
Diplostemopora siluriana

Echinodermata

Crinoidea
Edrioasteroidea (rare)
Cystoidea (more abundant than crinoids
Sphaerocystites multifasciatus
Sphaerocystites globularis
Lepocrinites manlius
Jaekelocystis hartleyi
Jaekelocystis avellana
Jaekelocystis papillatus
Tetracystis chrysalis
Pseudocrinites gordoni
Pseudocrinites stellatus
Pseudocrinites claypolei
Pseudocrinites clarki
Pseudocrinites perdewi
Pseudocrinites subquadratus
Laosacystis monterey

Trilobita

Calymane camerata

Gastropoda

Platystoma niagarense

poraneous nearshore to offshore deposits in the central basin region. To the south, the influence of terrigenous clastics reduces cystoid diversity and abundance. Although a detailed faunal analysis of that portion of the basin is not within the scope of this thesis, reconnaisance work suggests that diversity decreases through loss of organisms intolerant of high sedimentation rates or muddy bottoms.

F. Conclusions and Paleoecologic Summary

Stratigraphic and paleoecologic study of cystoids and other Crinoidea is hindered by the scarcity of fairly complete thecae, usually needed for identification. Identification of genera and in many cases species through a sequence of beds may be practically approached by disarticulated part studies (comparison of isolated ossicles with the corresponsing element on whole thecae of known taxa). This technique enables the segregation of distinct assemblages usually not possible when one has to rely on complete thecae and will also provide estimates of relative abundances. Disarticulated part studies, when used in conjunction with independent paleoenvironmental-paleogeographic analysis of the same beds and functional analysis of the fossils, will produce a detailed and integrated paleoecologic interpretation.

The cystoid fauna of the Keyser Formation is comprised of a diverse but closely related group of the Callocystitidae. Within the lower Keyser, which represents a locus of major epeiric sea environments from supratidal through offshore shelf, below wave base, the cystoids had a restricted distribution, preferring current agitated skeletal sands and silts on the open shelf. Cystoids occurred in three discrete assemblages, associated with three distinct lithofacies: well sorted calcarenite, poorly sorted biosparite and open shelf calcisiltite. The cystoids reached greatest diversity in the calcisiltite and decreased in coarser shoreward calcarenites. Assemblages existed contemporaneously and approximately paralleled the ancient shoreline. The following factors influenced their distribution:

Depth of water. Comparison to inferred water depths for analagous epeiric sea environments in the New York State Helderberg Group assigns an upper depth limit of 65 to 100 feet for the open shelf calcisiltite lithofacies (see Laporte, 1967; Head, 1969). Lithofacies which occupied more shoreward positions (biosparudite and biosparites) were probably deposited at depths not shallower than 20 feet.

Sedimentation and turbidity. Keyser cystoids were confined to areas characterized by clear water and were intolerant of even short periods of high sedimentation rate or turbidity. The ambulacral grooves and in particular, the pectinirhombs were highly susceptible to sediment clogging.

Water agitation. Water agitation must have been persistent and of sufficient strength to provide continual replenishment of suspended nutrients.

Substrate Keyser cystoids preferred firm substrates of poorly sorted biosparite and calcisiltite and were intolerant of both higher energy well sorted calcarenite and of mud bottoms, where crinoids were relatively more abundant. Crinoids, by means of well developed root structures (cirri and radicular cirri) were more capable of achieving stability on high energy sand and inform mud bottoms. For this reason crinoids appear to have enjoyed greater substrate felxibility than cystoids. *Lepocrinites* had greater substrate flexibility than other Keyser cystoids by nature of its peculiar ballast stem and resultant free living mode of life.

Depth of water, ultimately controlled by bottom slope, is considered to be the most important of these factors. Water depth controls the distribution of hydraulic energy (water agitation) which in turn determines the nature of the substrate and the supply of nutrients. In combination these factors created the open shelf environments in which the cystoids thrived.

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