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Lutetian *Schizaster* Fauna (Echinoidea, Spatangoida) from Sargaz Area, South of Kerman, Iran

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Abstract

The spatangoid genus *Schizaster* Agassiz is recorded, for the first time, from the Lutetian (Middle Eocene) deposits of Sargaz area, south of Kerman, Iran. The Lutetian sediments of Sargaz region contain a rich and divers echinoid fauna represented by Cidaridae, Conoclypeidae, Echinolampadidae, Toxopneustidae, Phymosomatidae and Schizasteridae. Schizasteroid echinoids are an important component of this fauna. Five Schizasteroid echinoids assigned to genus *Schizaster* are described and illustrated in the present paper. The *Schizaster* species are *Schizaster ambulacrum*, *S. archiaci*, *S. globulus*, *S. lucidus* and *S. spado*. The *Schizaster* specimens occur in association with a rich nummulitids and alveolinids fauna, and macro-invertebrates consisting of bivalves and gastropods, which suggest a Lutetian age for the sediment. Associated micro-macro fauna also indicate a warm and shallow water environment was prevailed during the deposition of the sediments.

Keywords: Schizasteroid echinoids; Middle Eocene; Lutetian; Kerman.

Introduction

Relatively few studies are carried out on the echinoids in Kerman province. Vaziri *et al*. [1] reported six species of the Late Albian-Early Cenomanian echinoids from Ekhtiar abad region, west of Kerman. Arab & Vaziri [2] described sexual dimorphism in a new species of Cassiduloid Echinoid, *Pygaulus baghinensis,* from the Aptian marls of the Baghin area. Vaziri & Arab [3] discussed morphological variations and paleoecology of a spatangoid echinoid, *Heteraster renngarteni* from the region. Similarly, they [4] identified three new species of *Tetragramma* from the Aptian sediments of the Basab area. The present work aims to provide a detail study of a spatangoid echinoid, genus *Schizaster*, from the Lutetian deposits in the Sargaz area, south of Kerman, Iran. Echinoids are among the most common members of the Lutetian fauna of Sargas area represented by Cidaridae, Conoclypeidae, Echinolampadidae, Toxopneustidae, Phymosomatidae and Schizasteridae. Spatangoid echinoids are characterized by their ovate or heart-shaped horizontal outline, modifided plates in the aboral portion of interambulacrum 5, forming a plastron and ambulacrum ш commonly differentiated from the paired ambulacra. According to Mortensen [5] the number of genital pores is of very great classifactory importance and a very practical means of distinguishing the genera of the Schizasteridae, *Schizaster* having only 2, *Paraster* 4. All

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species referrerd to *Schizaster* have a deep peripetalous fascioles and lateral fascioles that join the periperoct.

Geological Setting

Iranian plate is a part of Tethyan region. In other words, its geology, tectonic style and connection with other areas are directly influenced by the development and history of the region. According to Stocklin [6] and Berberian and King [7] the following major structural zones can be distinguished throughout the Iranian plate: Folded Zagros, High Zagros, Sanandaj-Sirjan Ranges, Central Iran, Alborz Mountains, Kopet Dagh, Lut Block, and East Iran/Markran Ranges. The Sargaz area is located at the Central Iranian zone.

The isolated outcrops of the fossiliferous middle Eocene (Lutetian) sediments in studied area are located west of Jiroft city. The dominant outcrops of this area consist of Jurassic rocks that include basic igneous rocks (andesite and basalt). Cretaceous sediments are formed of ophiolitic melange. The studied section is located near the Sargaz village and consists essentially of alternation of limestone and marl with relatively rich macrofossil content. Foraminifera and ostracods are present, as well as bivalves, gastropods and echinoids. The micro and macrofauna indicates a Lutetian age for the studied section The Lutetian deposits covers the Paleocene green conglomerate, while overlain by the Oligo-Miocene limestones.

The stratigraphic succession of the studied area is illustrated in Figure 1. The studied material was

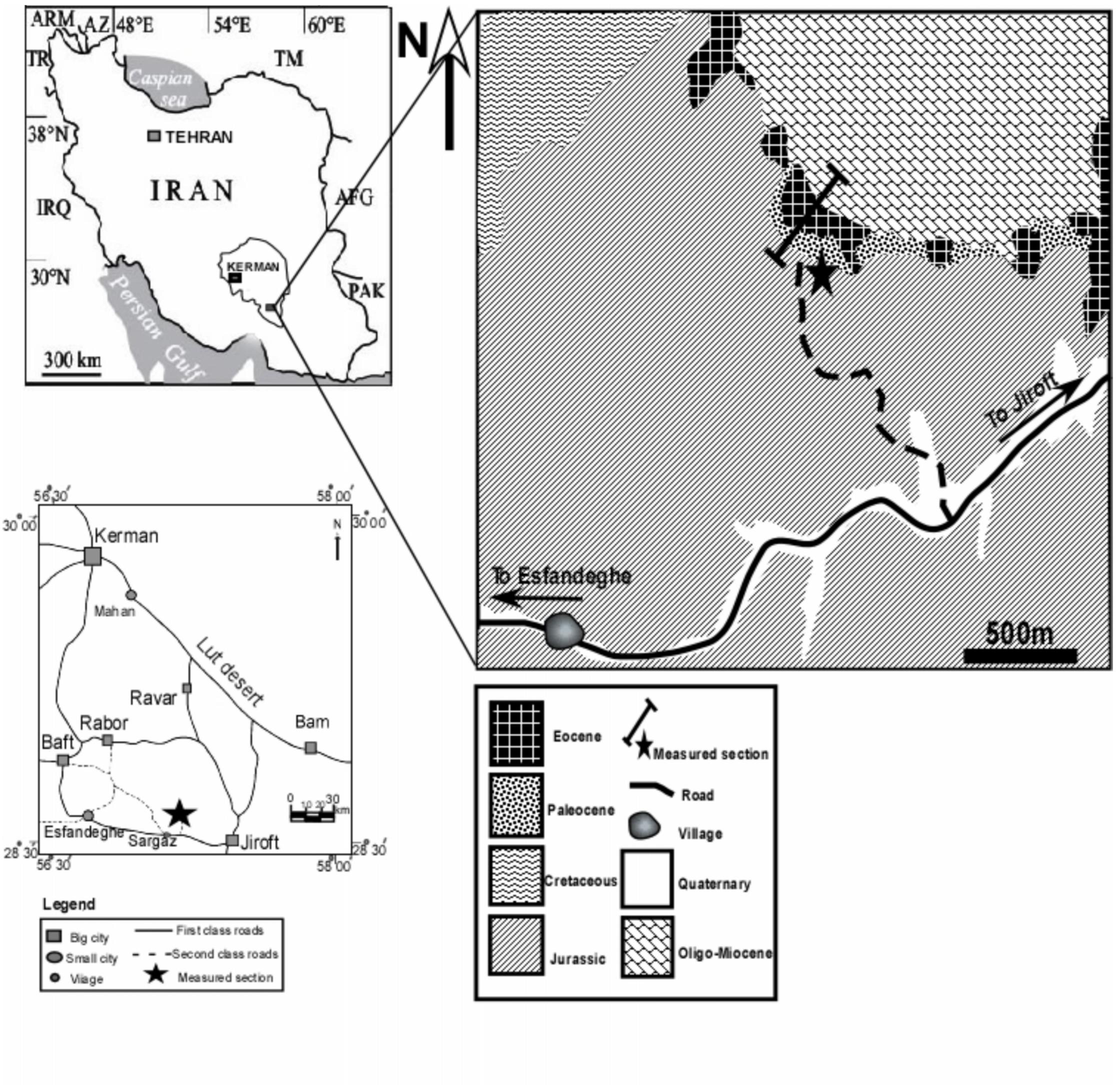

Figure 1. Simplified geological and road map of Sargaz area and location of the logged section near the Jiroft city.

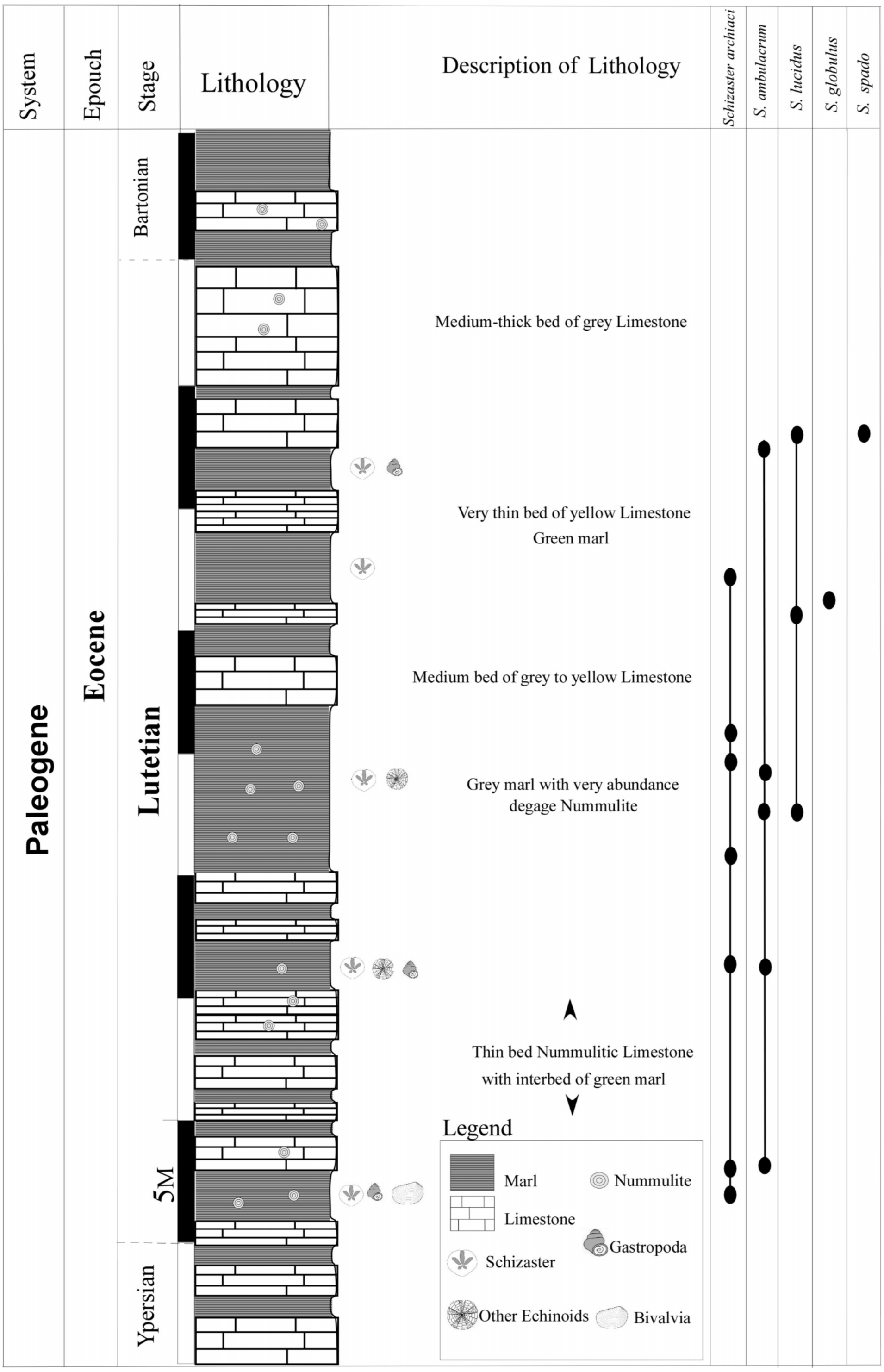

Figure 2. Schematic lithological and Biostratigraphy succession of Lutetian strata and location of *Shizaster* fauna in Sargaz area.

collected from several horizons, shown in the Figure 2.

Materials and Methods

An adequate number of individuals from the genus *Schizaster* was collected from the fossiliferous marls which are characterized by the predominance of the large benthic foraminifera *Nummulites* and Alveolinids. The preservation state of most of the studied specimens was good enough, however the material included some distorted, crushed, imperfect, or weathered individuals as well. Well-preserved specimens were cleaned, using a mild detergent and whenever necessary by using an ultrasonic vibrator and a preparation needle. Measurements were made of test length; maximum test width; maximum test height; centre of apical system to anterior ambitus; width of aboral ambulacrum III; length and width of anterior petals; length and width of posterior petals; width and length of peristome; width and length of periproct; length from anterior of peristome to anterior ambitus; maximum width of plastron. Furthermore, counts were made of the number of gonopores and number of pore pairs in ambulacra I, II and III aborally. The collection here described is housed in the paleontology laboratory of Shahid Bahonar University of Kerman.

Systematic Paleontology

Subphylum: Echinozoa Haeckel in Zittel, 1895
Cohort: Irregularia Letreille, 1825
Class: Echinoidea Laske, 1778
Subclass: Euechinoidea Bronn, 1860
Superorder: Atelostomata Zittel, 1879
Order: Spatangoida Claus, 1876
Suborder: Hemiastrina Fischer, 1960
Family: Schizasteridae Lambert, 1905
Genus: *Schizaster* AGASSIZ, 1836

Schizaster ambulacrum **Deshayas, 1831**

(Fig. 3: A-D & Fig. 8: a-d)

Material: Five specimens.

Description: Test large and clearly cordiform, greatest width just behind the apical system. Anterior ambulacrum III not petaloid, in very deep groove from apical system to peristome. Apical system slightly posterior. Anterior petals extending two-thirds distance from the apical system to marginal. Posterior petals extending one-half from apical system to margin. Petals curve slightly anteriorly. Periproct high, located on slightly overhanging posterior truncation, visible from below. Peristome is near the anterior margin. Traces of prepetalous fasciole preserved.

Schizaster archiaci **Cotteau, 1868**

(Fig. 4: A-D & Fig. 8: e-h)

Material: Seven specimens.

Description: Test suboval. Anterior ambulacrum III not petaloid, in very deep groove from apical system to peristome. Apical system posterior. Anterior petals flexuous, extending two-thirds distance from the apical system to marginal. Posterior petals short and straight. Periproct high, located on slightly overhanging posterior truncation, visible from below. Apical system posterior.

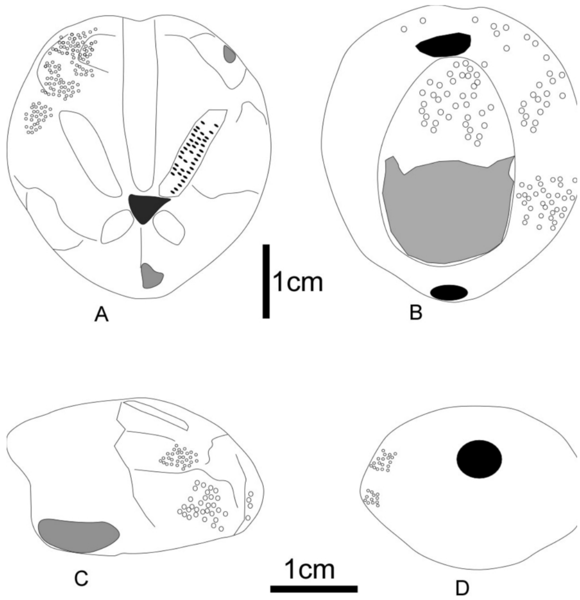

Figure 3. Camera lucida drawings of *Schizaster ambulacrum*

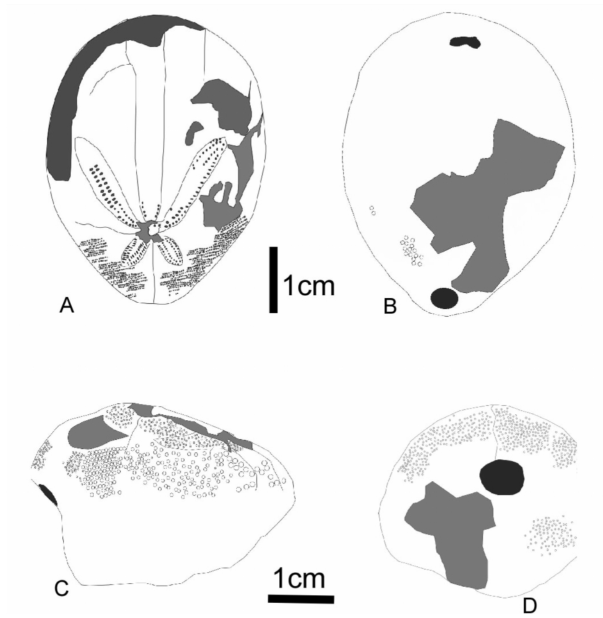

Figure 4. Camera lucida drawings of *Schizaster archiaci*

Peristome is near the anterior margin in a shallow depression. Only short portions of prepetalous fasciole preserved.

Schizaster lucidus **Laube, 1868**

(Fig. 5: A-D & Fig. 8: i-l)

Material*:* Three specimens.

Description: Test large and cordiform. Anerior ambulacrum III not petaloid. The anterior groove is wide and deep, extended to the mouth, its deepest and

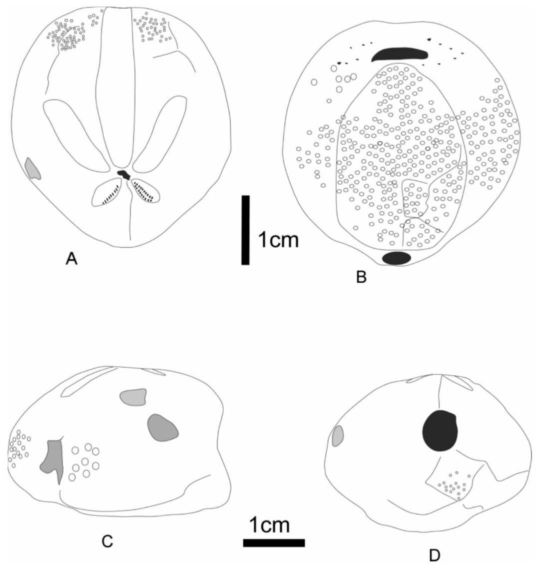

Figure 5. Camera lucida drawings of *Schizaster lucidus*

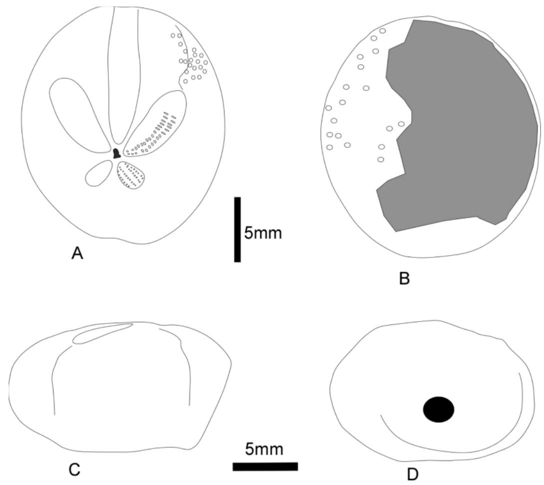

Figure 6. Camera lucida drawings of *Schizaster globulus*

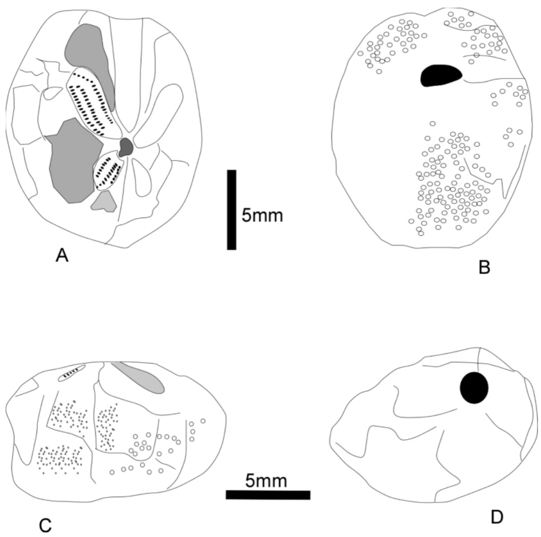

Figure 7. Camera lucida drawings of *Schizaster spado*

widest midway between apical system and test margin. Apical system posterior. Anterior petals extending approximately two-thirds distance from apical system to margin. Posterior petals short, straight, extending more than half distance from apical distance to margin. Periproct high, located on slightly overhanging posterior truncation, visible from below. Peristome is near the anterior margin. Only short portions of prepetalous fasciole preserved.

Schizaster globulus **Women, 1872**

(Fig. 6: A-D & Fig. 8: m-p)

Material: one specimen.

Description: Test small and globular shape. Anterior ambulacrun not petaloid, in groove from apical system to peristome. Apical system nearly central. Anterior petals nearly straight, club-shaped. Posterior petals short, straight extending approximately one-thirds from apical system to margin. Periperoct transversely oval, located slightly lower than mid-height of tall oblique posterior truncation. Peristome not preserved. Traces of prepetalous fasciole preserved.

Schizaster spado **Lambert, 1902**

(Fig. 8: A-D & Fig. 8: q-t)

Material: one specimen.

Description: Test medium-sized and nearly hexagonal in shape. Anterior ambulacrun not petaloid, in groove from apical system to peristome. Apical system central. Anterior petals flexuous, with greatest width distal. Posterior petals short, extending nearly one-third distance from apical system to margin, curving slightly inward anterior. Periproct high, located on slightly overhanging posterior truncation. Peristome is relatively near the anterior margin. Traces of prepetalous fasciole preserved.

Results and Discussion

Representatives of five families have been found in Lutetian sediments of Sargaz area: Cidaridae, Conoclypeidae, Echinolampadidae, Toxopneustidae, Phymosomatidae and Schizasteridae. In comparison to crinoid, ophiuroid and asteroid skeletons, which after death, rapidly disintegrate, echinoid tests are mostly preserved more or less whole. This is true especially for burrowing species such as all spatangoids [8]. According to Kier [9] irregular echinoids are more likely to be fossilized especially those having burrowing habit like schizasterids. Therefore The Sargaz material may reflects only part of fauna living in the Middle Eocene in the area.

According to Kier and Grant [10] the major factor

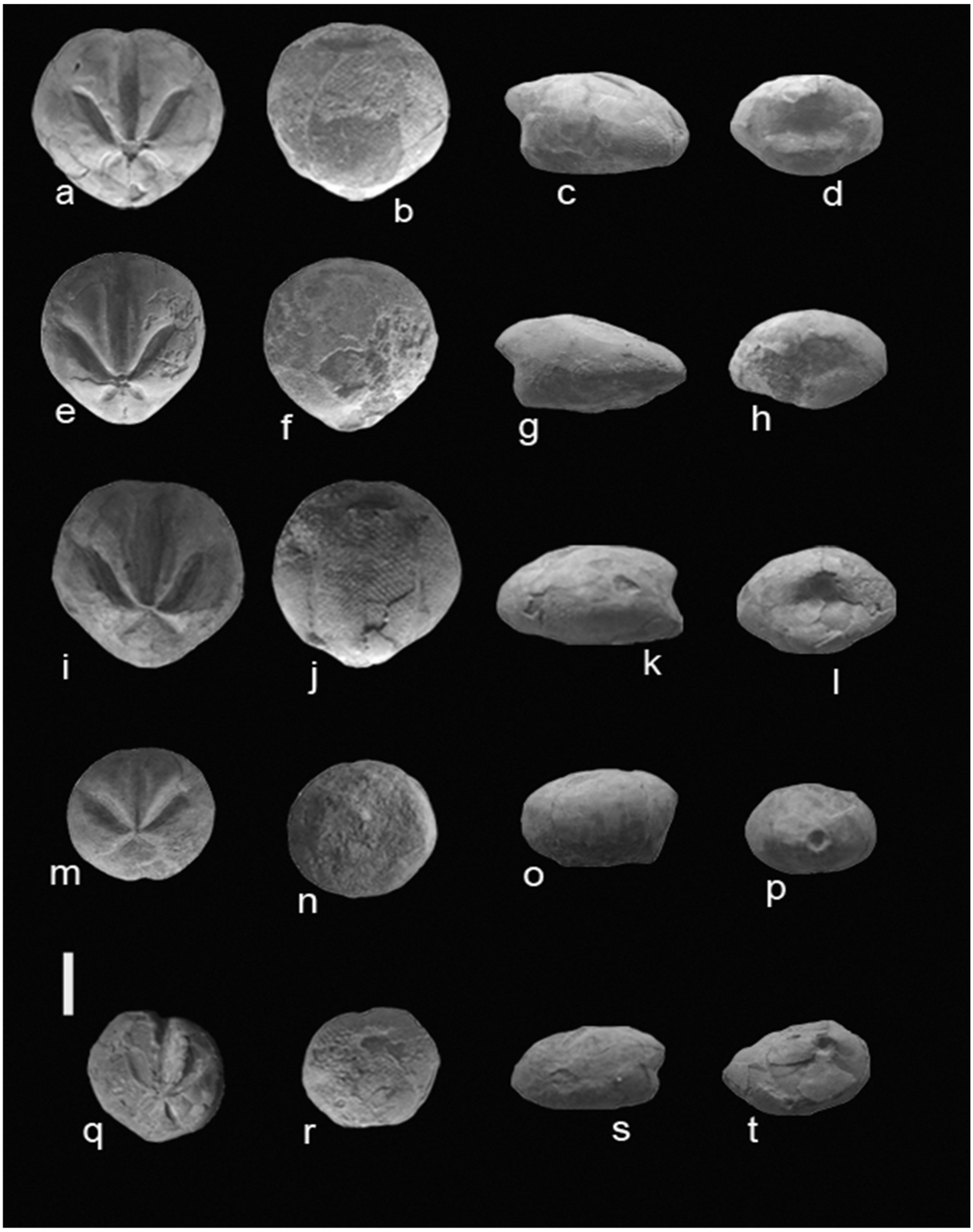

Figure 8. a-d, *Schizaster ambulacrum* Deshayas, KUIC 1912; apical, oral, lateral and posterior views. e-h, *Schizaster archiaci* Cotteau, KUIC 1918; apical, oral, lateral and posterior views.i-l, *Schizaster lucidus* Laube, KUIC 1928; apical, oral, lateral and posterior views.m-p, *Schizaster globulus* Women, KUIC 1931; apical, oral, lateral and posterior views.q-t, *Schizaster spado* Lambert, 1937; apical, oral, lateral and posterior views.Scale bar represents 1cm.

influencing echinoid distribution is water depth/shore distance. Spatangoid echinoids live in littoral to bathyal zones, burrowing to various depths in different types of sediments. They have a wide variety of test shapes with a complex arrangement of functionally and morphologically distinct spines [11,12,13,14]. The diverse assemblage of Sargaz area is composed of algivores (regular echinoids), bulk sediment swallowers (cassidoloids), suspension feeders (sand dollars) and spatangoids, which are selective deposit-feeding infaunal echinoids. The two former groups are at their most diverse today in shallow shelf platform environments and decrease in abundance dramatically in water depths greater than about 50 m [15]. Thus the assemblage suggests a shallow water condition. This is confirmed also by associated fauna includes numerous Nummulites, alveolinids, snails, bivalves and corals which show shallow water. The important age diagnostic foraminifers of this area is *Nummulites perforatus* (Samanta, 1968). This species is widely distributed in the middle Eocene (Lutetian) successions of the Tethyan belt, corresponding to zones SBZ15 of the Shallow Benthic Zonation [16].

The studied Schizaster specimens have relatively developed petals, in common, and can be an indication that water temperature was relatively high. The presence of genus Conoclypus with its massive skeleton, enabling the animal to resist strong water currents, shows a high energy environment as well [17].

According to [18], the H/L index is an expression of the flattening of the test and indicates the sediment penetration depth. More flattened forms penetrate deeper than more conical ones. However, concludes that, among modern spatangoids, tests with globular profile reach the deepest level in the substratum. This is especially true for sandy substrata, where the maintenance of the burrow's shape is an essential issue. As far as muddy substrata are concerned, a low test profile is probably advantageous when burrowing because of the decrease in the cross-sectional area of the test [19].

The presence of five different species of deposit-feeding echinoids in the same habitat can be explained by their different burrowing depths. *Schizaster ambulacrum* and *Schizaster archiaci* are interpreted here as a deep-burrowing deposit feeder due to their wedge shaped test and deep frontal ambulacrum. Furthermore, a posterior-situated apical system, a high keel in interambulacrum 5, long curved anterior-paired petals and short posterior-paired petals were interpreted as an adaptation to deeper burrowing by McNamara and Philip [20]. *Schizaster spado* is a species that does not seem to be well adapted to deep burrowing. This echinoid has rather high profile, with the apical system lying nearly centrally. It is interpreted here as a shallow-burrowing form. *Schizaster lucidus* was shallow to moderately deep burrowing forms, while *Schizaster golobolus* with high profile and centrally positioned of apical system most probably ploughed the sediment surface.

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