Morphology And Wall Structure Of Some Turonian Rudists (Bivalvia, Hippuritoida) Of Gabal Yelleg, Northern Sinai, Egypt

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Abstract: The Turonian succession exposed at the northern extremity of Gabal Yelleg at Northern Sinai yields many rudists. Most of these rudists exhibit polymorphism. Identification, systematic, wall structure and the biostratigraphy of the rudists are made. Rudists encountered are found to belong to: family RADIOLITIDAE Gray, 1848 which includes species related to subfamily RADIOLITINAE Gray, 1948: *Radiolites* cf *polyconilites* Orbigny, *Radiolites peroni* (Choffat), *Radiolites sauvagesi* (d'Holmis-Firmas), *Gorjanovicia costata* Polsăk and *Praeradiolites biskraensis* (Coquand); subfamily BIRADIOLITINAE Douvillé: *Milovanovicia heraki* Polsăk 1968; Subfamily SAUVAGESIINAE Douville´: *Suvagesia sharpie* (Bayle), *Durania* gaensis (Dacque), *Suvagesia nicaisei* (Coquand), *Durania barakatensis* nov. sp, *Durania cornupastoris* (Des Moulins) and *Durania arnaudi* (Choffat) and subfamily LAPEIROUSIINAE Kühn: *Lapeirousella aumalensis* (Douville´). From the family HIPPURITIDAE Gray, 1948 only species *Hippurites (Hppuritella)* cf. *castroi* Vidal was identified. One species among the rudists of Gabal Yelleg is suggested as new species: *Durania barakatensis* nov. sp. Fourteen thin sections representing the described Turonian rudists were prepared to study the wall structure of rudists, and the evaluation of such structure in classification of the studied rudists is discussed.
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Key words: Turonian rudists, Bivalvia, Hippuritoida, Gabal yelleg.

1. Introduction:

General view:

Ghorab (1961) divided the Upper Cretaceous in Ras Gharib oil field into five formations, namely: Raha Fm., Abu Qada Fm, Wata Fm., Matulla Fm. And Sudr Chalk. Moon and Sadek (1921) studied the Cretaceous succession exposed at Gabal Yelleg starting from the Lower Cretaceous to the Campanian and Maastrichtian forming the ground of Gabal Yelleg.

Omran, A. M. (1997) divided the Upper Cretaceous succession of Wadi Um Said in the southeastern flank of Gabal Yelleg into Halal Fm. (Cenomanian), Wata Fm. (102.8m, Turonian), Matulla Fm. (63m, Coniacian- Santonian) and Sudr Chalk (77m, Campanian).The lower part of the latter formation, the Markha Member (40m) was assigned to Campanian and the upper part, the Abu Zenima Member (30.8m) was related by Omran to the Masstrichtian.

El-Sabbagh and El-Hedeny (2003) recorded seven radiolitids from the Upper Turonian of the Acteonella Series of Abu Roach. Theses are *Durania cornupastoris* (Des Moulins), *D. gaensis* (Dacque), *D. humei* (Douville´) *Lapeirousella aumalensis* (Douville') *Sauvagesia sharpei* (Bayle) and *S. toucasi* Pamouktchiev and *S. nicaisei* (Coquand).

Abdel-Gawad et al. (2004) recorded four species of rudists from Gebel Yelleg: *Praeradiolites irregularis* Douville´, *Durania arnaudi* (Choffat) and *Praeradiolites ponsianus* (d´,Archiac) from the Middle Turonian, Wata Formation, and *Eoradiolites liratus* (Conrad) from the Lower Cenomanian, Galala Formation).

Aly et al. (2005) identified 17 rudist species from the Cenomanian –Turonian rocks (Halal Fm. and Wata Fm.) of northern Sinai in sections of Gabal El-Minsherah, Gabal Yelleg and Gabal Maaza. These species belongs to genera: *Eoradiolites, Radiolites, Praeradiolites, Distefanella, Bournonia, Durania* and *Ichthyosarcolites.* The geological map of the Gabal Yelleg is given in (Fig. 1) after Omran, A. M. (1997).

In the present work a section was measured representing the topmost part of the Upper Cretaceous succession exposed at the northern flank of Gabal Yellig. A brief description of the measured section is given in (Fig.2):

Lithostratigraphy:

A section of about 130 meters of the Wata Formation was measured and divided into 18 beds. The lithology is mainly represented by marls and limestone and their intercalations. Marl and little shale, dominate the lower part of the section and limestone is the essential component all over the section. The limestone becomes gradually chalky toward the top of the section until it becomes entirely

chalk in the topmost part. Many rudist lisothsomes are encountered from which rudists are collected for this study. A bed of variegated sandstone attaining 3 meters in thickness found in the middle of the section is used as a marker bed. Accordingly, the section is tentatively divided into Lower Turonian and Upper Turonian. The top of the section consists of the chalk which probably related either to the Wata Formation or to the above formation.

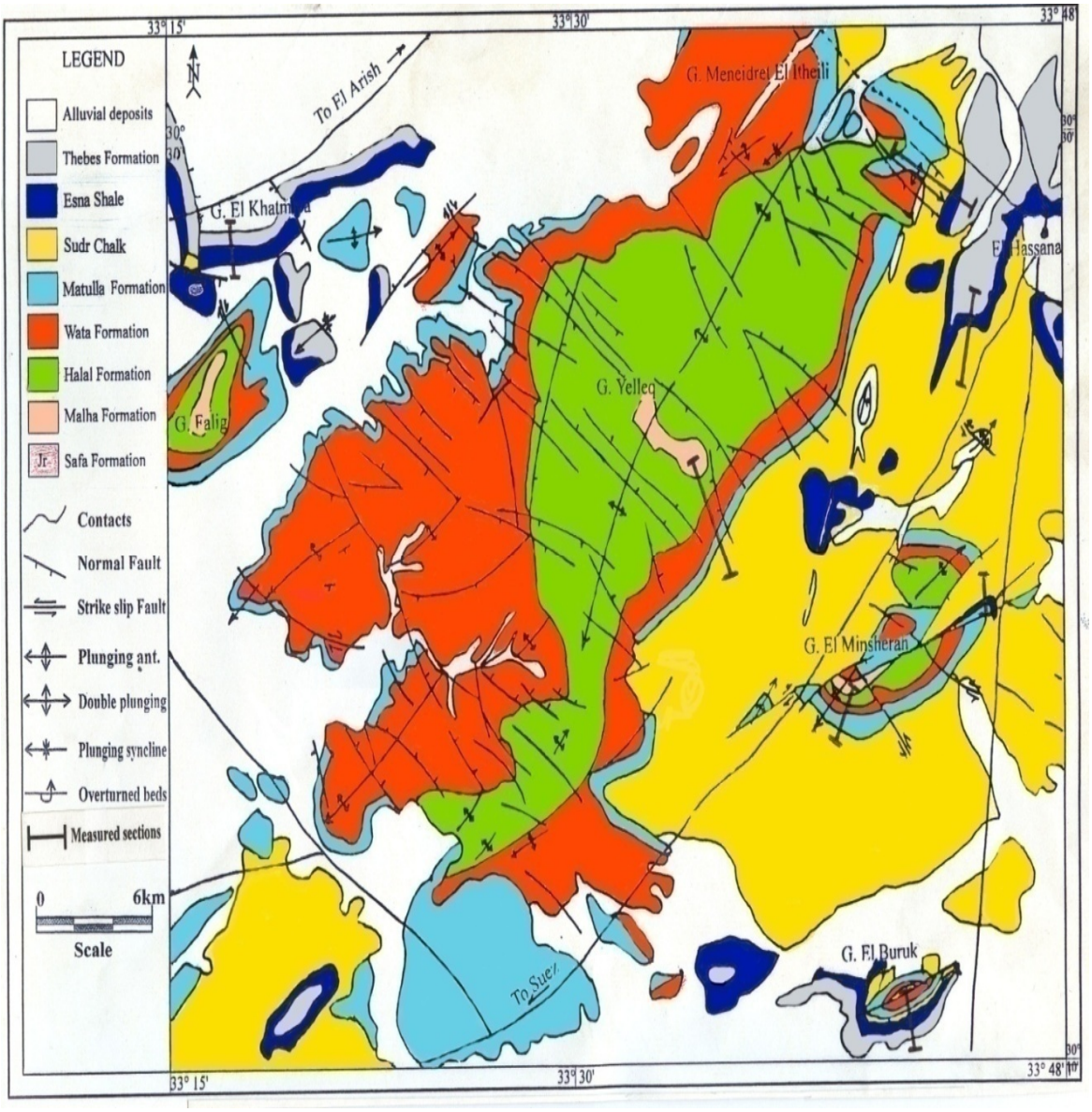

Fig (1): Geological map of Gabal Yelleg (After Omran, A. M. 1997)

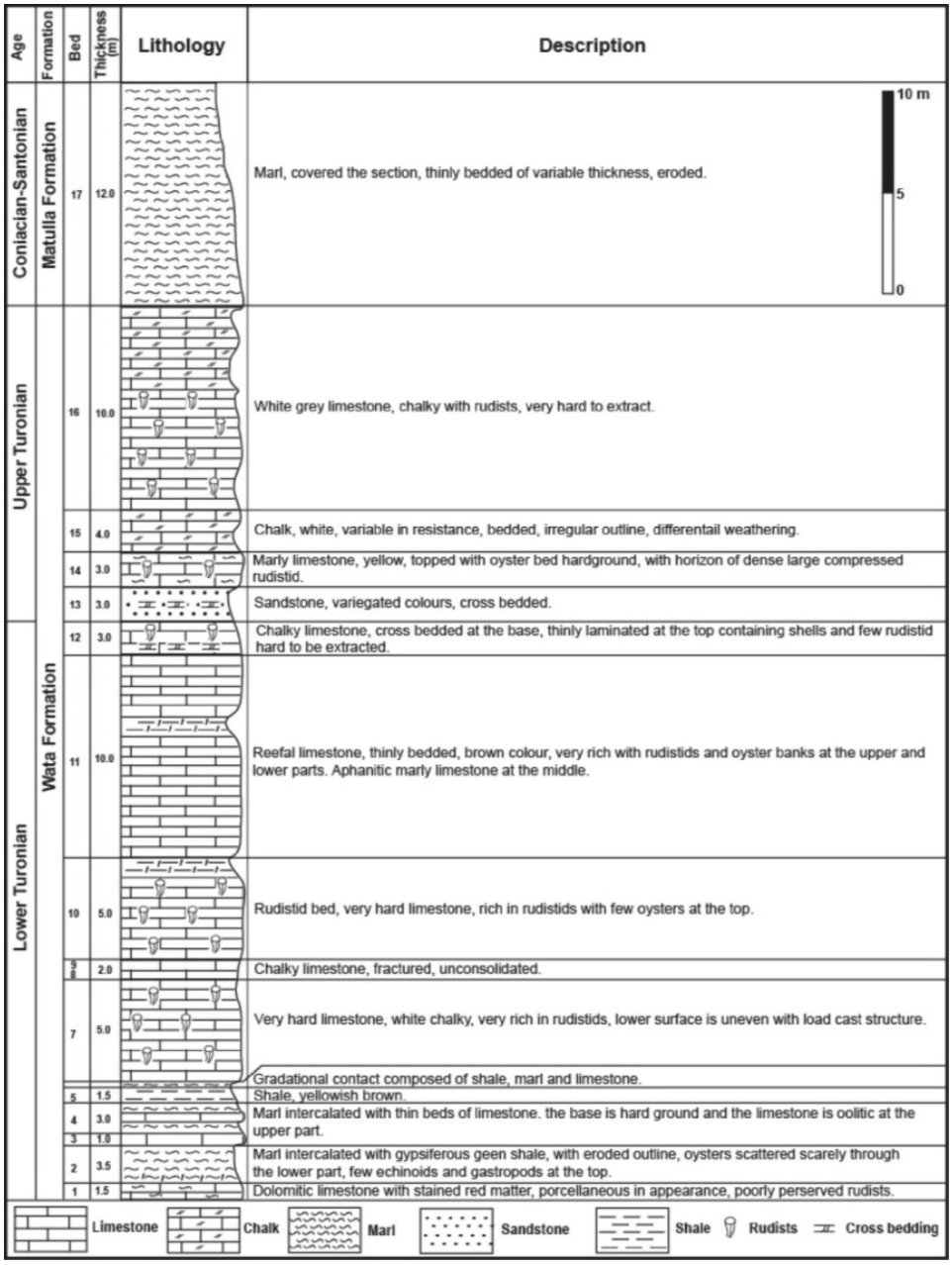

Fig (2): Stratigraphic column of Turonian succession at Gabal Yelleg, north Sinai, Egypt.

2. Materials and methods:

The shell of radiolitids consists of a hypostracum of aragonite and an ostracum of calcite (Zapfe 1937; Kennedy & Taylor 1968; Amico 1978; Cestari & Sartorio, 1995). In the attatched valve (AV) of most radiolitids, three outer layers of ostracum and an inner layer of hypostracum can be distinguished (Sanders, D. &Pons, J.M. 1995 & Sanders, 1999). Sanders recognized three layers in the wall of radiolitids: **(1)** an outermost ostracal layer of delicate calcite lamellae**, (2)** a thick layer of 'boxwork ostracum' built of radial funnel plates and cell walls, **(3)** a thin, inner 'ostracal layer **3'** of thick-walled boxwork, and **(4)** the hypostracum that formed the innermost shell layer (Fig. 3 after Sanders, 1999).

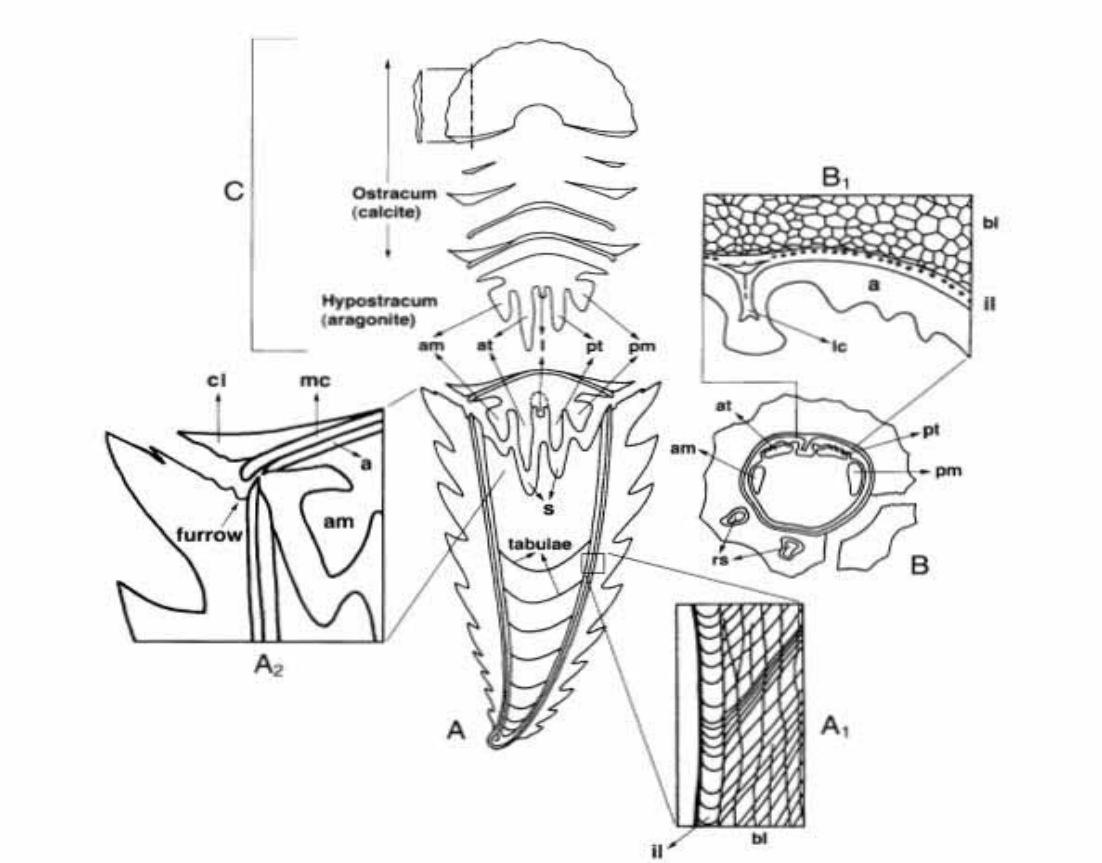

Fig (3): Main features of radiolitid shell (after Sanders, 1999) with some abbreviations: (s) socket; (am) anterior myophore; (pm) posterior myophore (at) anterior tooth; (pt) posterior tooth (L) ligament; (il) inner layer; (bl) thick outer layer of thin-walled boxwork; (a) the aragonitic hypostracum; (mc) layer of massive calcite; (rs) radial structures; ligamentary crest (lc).

The terminology used in description of rudistids in this paper is used after Moore (editor) in the Treatise on Invertebrate Paleontology- Mollusca, vol. 2, 1969, after Yanin, B.T. (1989).

Size: Concerning the size of the mature individuals, the scale proposed by Yanin was accepted, where:
Height (length) Small: up to 5cm; Medium: 6-10 cm, Large: 11-20 cm and Very large: 21-30cm. Bar in all text-figures equals 1mm.

Orientation**: AV:** attached valve**; FV:** free valve.

Ligamental Structures:

Ligamental groove**: (**Ligamental zone**,** LB**)** or furrow on the exterior of the shell on the lateral cardinal side of the lower valve.

Ligamental cavity**:** within the shell wall**.**

Ligamental ridge or pit on the interior of the shell.

L: Ligamental crest (truncated, small truncation and rounded).

Siphonal Structures (pillars, bands, pseudopillars, fossettes, and oscules):

Sp: first pillar

Ep: second pillar

Sb, **Eb**: siphonal bands (smooth, shallow depresses areas) in posterior-lateral side corresponding **S** and **E**.

Es and **Ss**: pseudopillars.

Myophore**:** am and pm, anterior and posterior myophore.

The material is deposited in the Geological Museum of Faculty of Science- Mansura University, Egypt.

SYSTEMATIC PALAEONTOLOGY

Class: BIVALVIA

Order: HIPPURITIDA Newell, 1965

Suborder: HIPPURITINA Newell, 1965

Superfamily: HIPPURITOIDEA Gray, 1848

Family: HIPPURITIDAE Gray, 1848

Genus *Hippurites* Lamarck, 1801

Type species: *Hippurites biloculata;* M

***Hippurites* (*Hppuritella*) aff. *castroi* Vidal (pl. 3, fig. 3)**

1960 aff. *Orbingnya vlasovi:* Bobkova, p. 117, pl. 25, fig.3

1977 *hippurites* (*Hppuritella*) *castroi* Vidal: Pons, pl. X

1989 aff. *Hippurites vlasovi* (Bobkova): Yanin, Pl. XIV, Fig S. 3-6.

Dimensions (mm)**:**				
Specimen no	Length	Width	Diameter opening	wall thickness
……29	61.50	25.40	30.30	?
…….. .30	72.00	22.10	22.10	7.50

Description:
Shell medium sized, LV curved cone to sub cylindrical form, wall thick; transverse section circular; surface covered with numerous longitudinal rounded smooth thin ribs, ribs regularly spaced forming network; anterodorsal aspect, growth laminae crowded in the lower part of the attached valve and widened near the commissure, at posterodorsal aspect four narrow concave siphonal bands and raised interbands having the same thickness as the bands.
Remarks: The described specimens has some affinity to *Hippurites vlasovi* (Bobkova, 1960), but the latter species is vey large and found in a higher stratigraphic level (Maastrichtian).
Locality: beds 15 & 16, Wata Formation, Upper Turonian, Gabal Yelleg.

Family: RADIOLITIDAE Gray, 1848
Subfamily RADIOLITINAE, Gray, 1848
Genus : *Radiolites* Lamarck. 1801
Type species: *Ostracites angeiodes* Picot De Lapeirouse, 1781

***Radiolites* cf. *polyconilites* Orbigny.**
(pl.1, fig.7)
1851: *Radiolites* cf. *polyconilites* Orbigny, pl.547, fig. 3 &4.
Material: one specimen of AV.

Dimensions:	Length (mm)	Width (mm)	commissural diameter	wall thickness
Specimen1.	87.82	22.22	36.50	?

Diagnosis: Horn-shaped AV, smooth with a triangular tooth and two coma shape sockets to receive the teeth of FV; concave radial bands and elevated ligamental ridge in between.
Locality: Gabal Yelleg, bed 1, Lower Turonian.
Geographic distribution: Cretaceous France; Cenomanian, Mexico.

***Radiolites peroni* (Choffat, 1886)**
(pl.1, figs.1a-b & 2)
1886 *Spheriolites peroni*: Choffat, p.33, pl. V, fig. 1-8.
1974 *Radiolites peroni* (Choffat): Atabican & Babkova (in Atlas fauna Azerbaijan), p.220, pl. 116, fig.3.
1981 *Radiolites peroni* (Choffat): Tzankov, p. 183, pl. XCII.
Material: 8 well preserved specimens of AV.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no.2	70.00	37.00	35.00	5.30
……..…..3	50.60	23.00	26.60	9.00
……4	52.80	21.18	24.68	5.70

Diagnosis: conical and horn-shaped AV, deep growth layers, irregular polygonal and vermiform cells, siphonal fossetes structures.
Description: Av medium size, elongate, curved cone, wall very thick, transverse section globular; external surface covered with thick raised folds, zigzag wavy growth laminae; external surface ornamented with longitudinal interrupted sharp ribs; siphonal zones large wide bands. Siphonal furrows longitudinal shallow. Wall structure with compressed elongate vermiform and smaller granular cells and fasciculate aspect (fig.4a-c)
Remarks: the described specimens differ from those identified by Aly *et al.* (2005) as *Eoradiolites sinaiticus* Douvillé: (pl.1, figs. 1-3) by their small size, coarse ribbing and development of fossetes siphonal structures of the outer layer; however a similarity in wall structure is sometimes obvious**.**
Locality: Gabal Yelleg, Wata Formation, bed 7, Lower Turonian.
Geographic distribution: U. Cenomanian: Middle Asia, Portugal, Libya, Egypt, Syria, Azerbaijan, Tajikistan, Little Caucasus; U. Cenomanian - L. Turonian: South France, Albania, Tunisia, Egypt, Iran, Karakorum; U. Cenomanian and L. Turonian: Albania, Tunisia, Egypt, Iran, Little Caucasus; Lower Turonian: Portugal, Armenia, Azerbaijan; Turonian: Albania; U. Turonian: Bulgaria, Romania, Greece, Tunisia, Iran, West China. Upper Cenomanian and Lower Turonian Azerbaijan, Upper Cenomanian Tadzhikistan, Lower Turonian Portugal, Upper Cenomanian – Lower Turonian south France, Albania, Tunisia, Egypt, Iran, Karakorum.(Ali-Zade,1988).

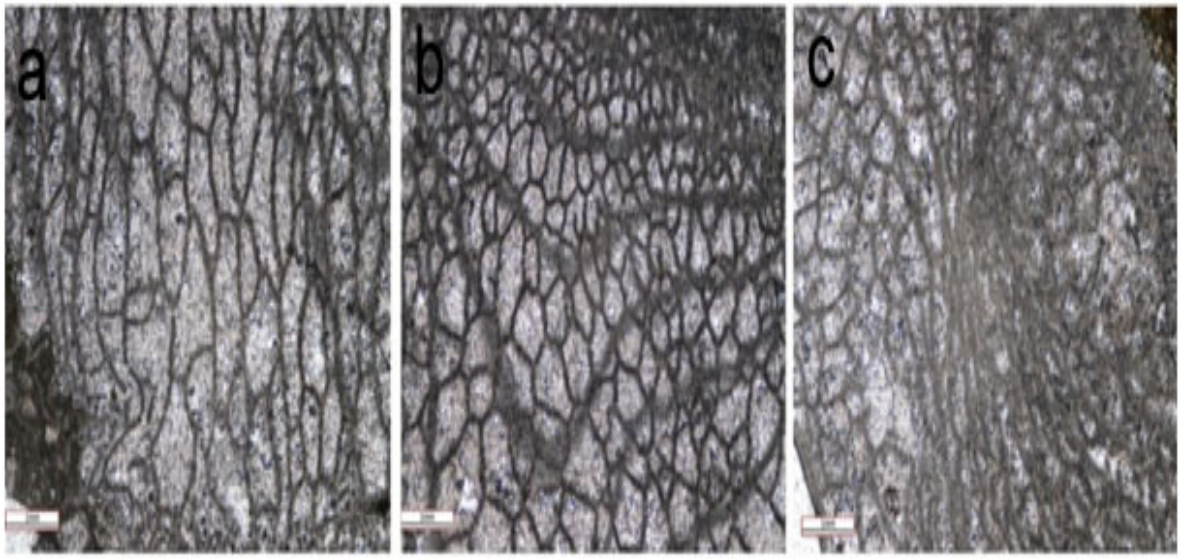

Fig (4) Transverse section in *Radiolites peroni* (Choffat, 1886): a- vermiform elongated cells; b- wavy plates and cellular polygons; c- siphonal fossetes structures. Bar equals 1mm.

Radiolites sauvagesi (d'Holmis – **Firmas, 1838)**

(Pl.1, figs. 3-5)

1851 *Radiolites sauvagesi* Orbigny: Orbigny, pl.553, fig.1-8.
1908 *Radiolites sauvagesi* (d ´Holmis - Firmas): Toucas, p.65, pl.12, fig 10.
1981 *Praeradiolites subtocasi* Toucas: Tzanov et al., p.189, pl. LXXV, fig.3.
2004 *Praeradiolites ponsianus* (d Archiac): Abdel-Gawad, p. 292, pl. 9, figs. 7 & 10.
2005 *Radiolites sauvagesi* (d´Holmis-Firmas): Aly, p. 263, pl.6, figs 4-5 & pl. 7, fig. 1a-b.
2009: *Radiolites sauvagesi* (d´Holmis - Firmas); Gil, *et al*., p.533, fig.6
Material: 10 specimens.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 5	99.70	39.22	39.22	11.20
…….6	5 0.40	39.60	39.60	12.30
……7	52.00	40.10	39.80	15.20

Diagnosis: dense growth laminae, horn and cylindrical shape, high amplitude wavy plates and closed funnels.
Description: Av medium size, conical and subcylindirical, thick recrystallized wall; transverse section circular; external surface covered with dense wavy zigzagged growth laminae; siphonal bands smooth, concave toward the commissure, Es and Eb well developed, Eb wider than Es., pentagonal cells and closed elliptical funnels of the outer shell layer (fig. 5).
Locality: Gabal Yelleg, Wata Formation, bed 7, lower Turonian.
Geographic distribution. The species was recorded from higher stratigraphic levels than the Turonian.

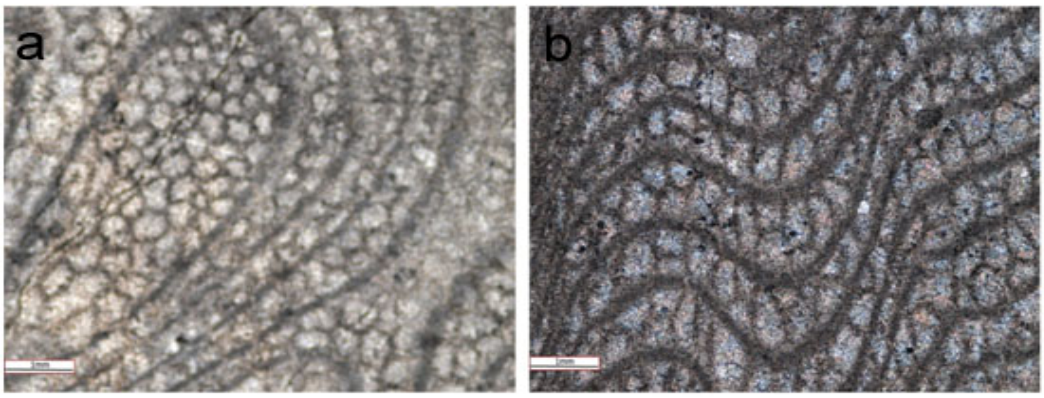

Fig (5) Transverse section of *Radiolites sauvagesi* (d´Holmis-Firmas): a- elliptical funnel plates; b- . ,nm, hz

Genus: *Gorjanovicia* Polsăk, 1968
Type species: *Gorjanovicia costata;* OD.
Gorjanovicia costata Polsăk, 1968
(pl.1, fig. 6)
1960: *Gorjanovicia costata* Polsak: Moore R.C. (ed.); Part N, vol. 2/3, Mollusca 6, N 808, fig E268-
Material: Tow well preserved specimens.
Dimensions: Length (89.66) Width (28.20), commissural diameter (20.50), wall thickness (8.30), specimen no 8.
Diagnostic feature: compressed subcylindirical Av, network of the outer shell layer composing of uniform rhombohedral cells, slightly undulation of plates.
Description: Av medium sized, thick-walled, elongate, cylindrical-conical, slender, slightly impressed with long dimension normal to the commissure and extending from the apex of the valve to commissure; longitudinal ribs salient, ribs thin and inter- ribs regularly spaced and relatively broad and deep, with fine zigzag growth layers, pointed upward; siphonal zones well developed Sb and Eb and Sb concave broader, both with dense flat laminae; ligamental groove in the exterior of the shell, very narrow pit on the interior of the shell; network of the outer shell layer composing of uniform rhombohedral cells; laminae with a definite pattern of arrangement of repetitions of two or three narrow spaced layers followed by fine distant layers crossed by muri; inner layer thin with fragments of disaggregate rod-like spines (fig. 6).
Remarks: The rhombs of the network differentiate the described specimen from the lamellar structure shown in *Sauvagesia nicaisei* (Coquand) figured by El-Sabbagh & El-Hedeny (2003, pl. 7, fig 2. Also the internal structure of *Praeradiolites* cf *irregularis* Douvillé described by Aly et al (2005) is similar to the present species; both are quite different morphology.
Locality: Gabal Yelleg, bed 11, Wata Formation, Lower Turonian
Italy, Yugoslavia and Turkey.

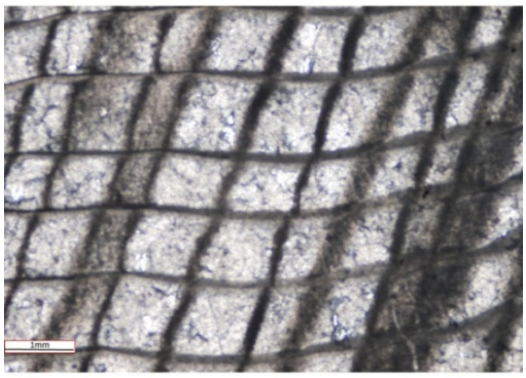

Fig (6) Transverse section of *Gorjanovicia costata*: compact rhombohedral network.

Praeradiolites Douvillé, 1902
Type species: *Radiolites fleuriaui* d´Orbigny, 1842
***Praeradiolites biskraensis* (Coquand, 1880)**
(pl. 3, fig. 1)
2004 *Praeradiolites biskraensis* (Coquand): Abdel-Gawad et al., p.292, pl.9, fig.1.
Material: one well preserved AV.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 9	88.82	47.66	44.52	9.52

Diagnosis: Strong longitudinal regular folds, concave bands and prominent ridge.

Description: Attached valve (AV) medium size, conical shape, thick recrystallized wall, broad-rounded posterior margin and very narrow anterior margin; surface coarsely reticulate, ornamented with strong longitudinal regular folds, nearly 16 ribs pre diameter 20.5mm assuming bundle- shape of longitudinal digits, unequally spaced, condensed and sharp in early stage and large and divergent near commissure; growth laminae regularly spaced and crowded as growth proceeds ; growth laminae covered the surface, concave upwards at the ribs and convex downward in inter-ribs; siphonal furrow shallow longitudinal slit bounded by rounded raised prominent siphonal ridge; internal shell cavity narrow ellipse, anterior myophore (ma) large kidney- shaped tangent the inner wall, posterior myophore (mp) inclined at the inner wall.

Locality: Wata Formation, bed13, Upper Turonian, Gabal Yelleg.

Locality: Gabal Yelleg, Wata Formation, bed 7, Lower Turonian.

Subfamily SAUVAGESIINAE, Douvillé, 1908
Subfamily BIRADIOLITINAE Douvillé, 1902
Genus: ***Milovanovicia*** Polsăk, 1968

Type species: *Milovanovicia heraki;* OD.

***Milovanovicia heraki* Polsak 1968**
(PL. 2, figs. 1-5)

1969 *Milovanovicia heraki* Polsăk: Moore (editor), Mollusca 6. Bivalvia, p.N810, fig271, 1
2007 *Milovanovicia heraki* Polsăk: Bilal Sari & Sacit Ozer.

Material: 10 specimens.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 10	150.00	21, 60	59.62	8.13

Description: AV cylindo-conical to conical, very elongate, slightly curved. External ornamentation consists of few large massive, elongate folds separated by deep furrows; both with fine longitudinal striae; ligamental structure on the exterior of the shell very deep; siphonal bands smooth or finely costulate (fig. 7).

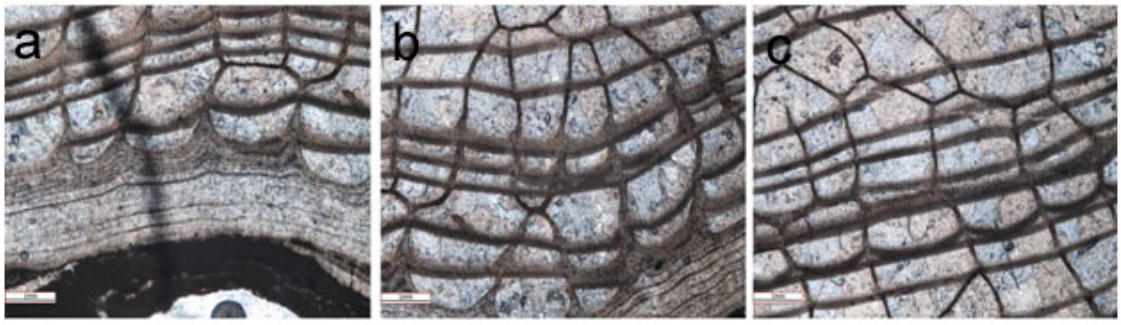

Fig (7) Transverse section of Radiolites *Milovanovicia heraki* Polsăk: a. of the exterior of the outer layer; b. tow radial bands (Eb, Es) and interband (ib); c. thin inner layer and irregular polygons of the outer layer.

Locality: Gabal Yelleg, Wata Formation, bed 16, Upper Turonian.

Geographic distribution: Middle Upper Turonian, Turkey; Turonian Yugoslavia; Upper Turonian.

Subfamily SAUVAGESIINAE Douvillé, 1908
***Suvagesia* Choffat, 1886**
***Suvagesia sharpei* (Bayle, 1857)**
(Pl.2, fig.6)

1886 *Suvagesia sharpei* Bayle: Choffat, p.29, pl.29, pl. 4, fig. 1.
1902 *Suvagesia sharpei* (Bayle): Choffat, p.171, pl.8, fig. 14.
1969: *Vautrinia Syriaca* (Vautrin): Moore R.C. (ed.); Part N, vol. 2/3, Mollusca 6, N777, pl. 243 , fig. 5-6 and N815, pl. 274, fig. 2.
1974 *Vautrinia Syriaca* (Vautrin, 1933): Atabican , A.A and Babkova, H. H., P.221, Pl. 117, fig. 1-2, pl. 118, fig.1-2.
1977 *Hippurites* (*Orbigny*) *radiosus* Des Moulins: Jose Maria Pons, pl. XXX, fig. 1-2.
2003 *Suvagesia sharpei* (Bayle): El-Sabbagh & El-Hedeny, p.252, pl.3, figs. 2-4.

Materials: Two fragments of AV.

Dimensions: length of AV = 70.20mm, commissure diameter = 59.60.mm, specimen no 15.

Diagnosis: cylindrical Av, regular ribbing and growth laminae and network of uniform polygons**.**
Description: AV very large, cylindrical, wall very thick; surface covered by thin rectilinear ribs with nearly equal spaces between them, thin regular growth layers concave toward the commissure; siphonal bands large and flat finely costulate, Eb broader than Es. Cellular structure consists of rectangular polygons forming with the parallel muri a net work of uniform polygons. Siphonal bands consist of well developed funnels (fig. 8).
Locality: Locality: Occurrence: Bed 13, Wata Formation, Upper Turonian, Gabal Yelleg.

Geographic distribution: Upper Cretaceous, Syria, Turkey, Iran, Azerbaijan and Egypt.

***Suvagesia nicaisei* (Coquand, 1826)**
Pl. 2, figs 7-8)
1862 *Suvagesia nicaisei:* Coquand, p. 223, pl, 17, fig. 12.
2003 *Suvagesia nicaisei* (Coquand): El-Sabbagh & El-Hedeny, p.251, pl. 2, figs. 5-6.
Material: 6 specimens of AV.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 16	111.2O	?	63. 00	52.00
……17	130.00	?	56.0	12.00

Diagnosis: Long and large AV, conical shape, deep narrow smooth radial costulate bands, well developed ligamental cavity, sloping wide growth laminae
Description: Av conical with broad commissure, ornament with radial thin ribs, inter-ribs regularly spaced; growth layers broad and regularly spaced; siphonal bands slightly concave finely costulate folds, interbands narrow.
Locality: Gabal Yelleg, Wata Formation, bed 16, Upper Turonian.

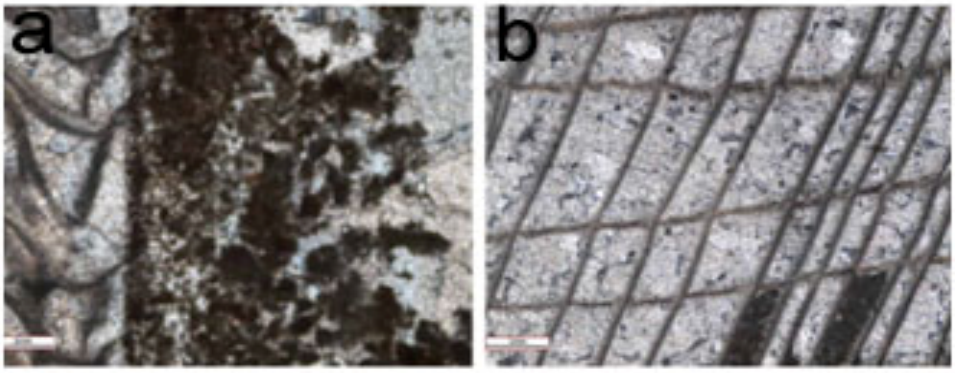

Fig (8) Transverse section of *Suvagesia sharpei* (Bayle): a. radial band with funnel shaped laminae; b. radial rectangular cells and parallel muri, sample no 15.

Genus: ***Durania*** Douvillé, 1908
Type species: *Hippurites cornupastoris* Des Moulins, 1827, p. 288; OD

***Durania barakatensis* nov. sp.**
(pl. 3, fig. 2a-c)
Derivation of name: on the honor of Gabir Barakat, professor of Paleontology, Cairo University.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 18	83.10	41.10	50.60	9.70
…… 19	87.00	49.30	48.10	6.48

Description: AV vase-shaped, short cone, medium size, expanding upward rapidly; surface ornamented with folded laminae and sharp radial ribs, inter-ribs wide and slightly concave; radial bands narrow deeply concave, with one sharp rib carrying chevrons pointing downward; interbands wider than bands, ridge with growth layers concave upward; wall relatively thick; transverse section subcircular to quadrate; inner layer thin composing of 7 wavy laminae divided by pillars; cells of the outer layer increase in size toward the periphery, polygons rounded near the inner layer and becoming rectangular toward the commissure; rod-like bearing bifurcated feather-like structure (fig. 9).
Locality: Beds 11 & 13, Gabal Yelleg, Wata Formation, Upper Turonian.

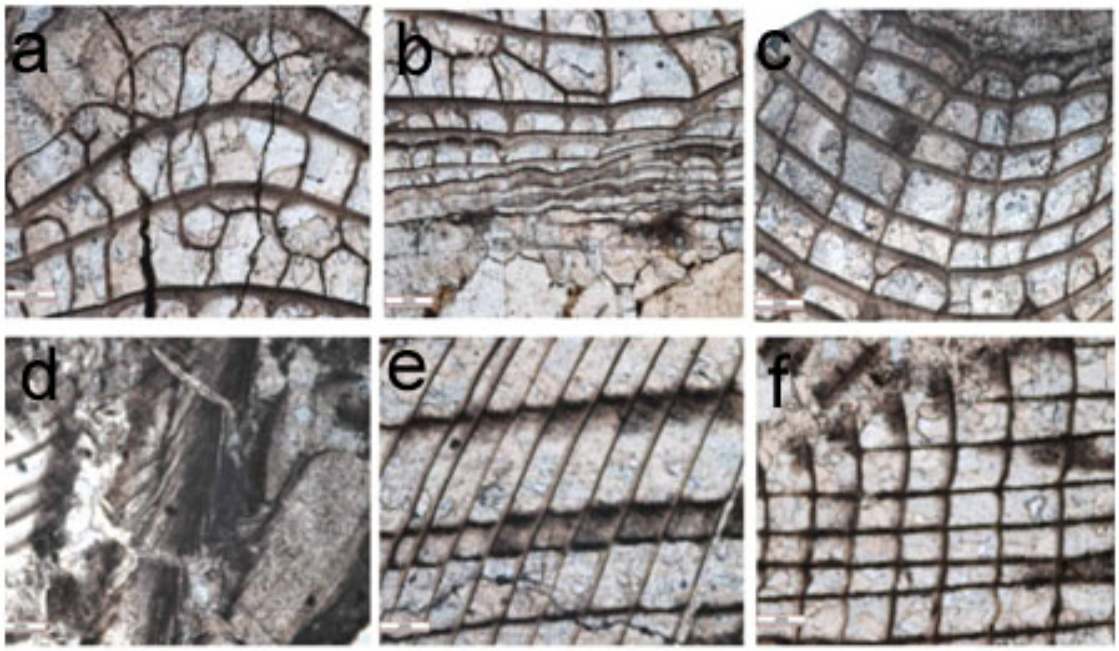

Fig (9): Transverse section of *Durania barakatensis* nov. sp. showing irregular polygonal muri, laminated inner layer, regular semi-quadrate polygons, branching funnels, network of elongated and quadrate cells from a to f respectively.

***Durania gaensis* (Dacque, 1903)**
(Pl. 4. Fig.1a-c)

1903 Radiolites *gaensis* Dacque: Dacqué, p. 374, pl. 35, figs. 7-9.
1903 *Praeradiolites boucheroni*: Toucas, p. 32, pl. 3, fig. 10-12
1977 *Hippurites* (*Orbignya*) *toucasianus* d' Orbigny: Jose Maria Pons, pl. XL, fig. 1.
2003 *Durania gaensis* (Dacqué): El-Sabbagh & El-Hedeny, p.284, pl.1, figs. 5-6)
2004 *Durania gaensis* (Dacqué): Abdel-Gawad *et al.*, p. 292, pl.9, fig.6.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 20	88.82	47.66	44.52	9.52
……21	75.80	38.40	45.20	10.90
…….. …..22	77.10	31.4	48.90	14.20

Description: AV vase shape, conical to subcylindirical, shell beginning very narrow, after that increases by continuous accretion gradually during growth; radial bands deeply concave, very narrow, with fine chevrons, 5 in number, interband bud-shaped, broader than the bands; external surface ornamented with folded branching laminae; thick of regular polygons,, radial bands mostly with hexagonal polygons, ligamental pit in the interior of the shell (fig. 10)
Locality: Gabal Yelleg, bed 11, Wata Formation.

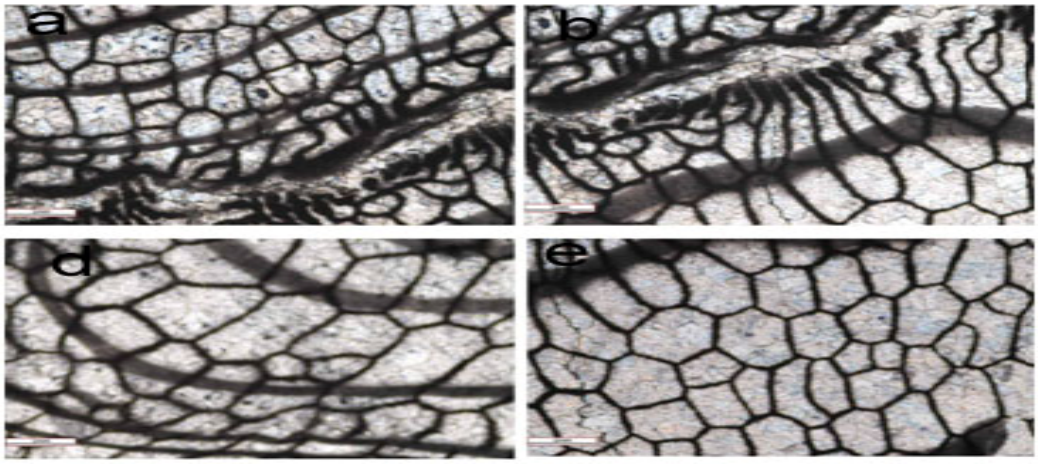

Fig (10): transverse section of *Durania gaensis* (Dacqu`) showing free muri (a &b) ending in subcircular bores, pentagonal, hexagonal or more faces and curved laminae (c & d).

Durania cornupastoris (Des Moulins)
(pl.3, fig. 3a-c)

Material: One good preserved specimen of AV.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 23	82.20	16.20	34.80	9.4019

1969: ***Durania cornupastoris (***Des Moulins): Moore (editor), Mollusca 6, N.813, fig. E 272, 4.
2003: ***Durania cornupastoris (***Des Moulins): El-Sabbagh & El-Hedeny, pl.1, fig. 1-4.
Description: AV conical, curved, medium sized; transverse section oval; external wall ornamented with fine widely spaced ribs, inter ribs flat to slightly concaved; growth layers zigzagged with chevrons in the inter ribs and inverted chevrons across costae; ribs coarse in the ventral aspect; Siphonal bands Sb and Eb finely costulate, cells hexagonal in siphonal bands, normal the commissure, laminae folded (8 crenulations) in the outer part of the outer layer (fig. 11)
. **Locality**: Gabal Yelleg, Wata Formation bed 14, Upper Turonian.
Geographic distribution: Upper Turonian in the Tethyan Province.

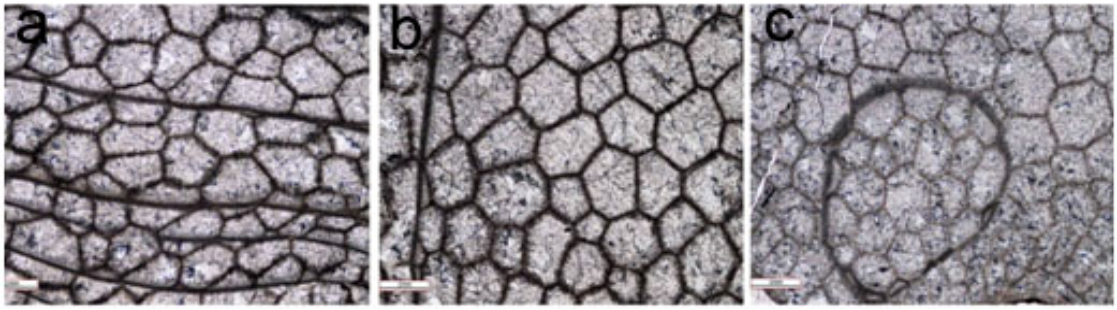

Fig (11): Transverse section of *Durania cornupastoris (*Des Moulins) showing: a-shell outer layer and superposed lamellae, b- one siphonal band with compact polygons (6-7 faces), c- ligamental pit.

Durania arnaudi (Choffat, 1891)
(pl.4, figs. 3-8 & 10-11)

1891 *Durania arnaudi:* Choffat, pp.203, 210 and 211.
1901 *Biradiolites arnaudi*: (Choffat); p. 138, pl. VI & pl. VII.
2004 *Durania arnaudi* (Choffat), Abdel-Gawad et al. p.289, pl 9, figs 4-5.
2005 *Durania arnaudi* (Choffat), Aly et al., p. 273, p. 10, Fig. 9.

Material: Ten complete and fragments of AV.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 24	30.00	24.00	24.00	0.80
……25	26.00	25.oo	25.00	0.80
…… 26	55. 70	20.20	22.00	0.50
…… 27	71.90	30.00	38.00	0.70

Description: Shell medium sized, according shape three forms are presented: typical cylindrical, conical with curved anterior part and rounded commissure, conical with elliptical commissure; surface covered with sharp fine rounded radial uniform ribs with flat to slightly concave smooth inter-ribs; wall relatively thick, crystallized with finger print – like; ligamental cavity within the shell wall and ligamental ridge in the interior of the third mentioned form (fig. 12) and (pl. 4, fig.7b); siphonal structures with well developed Eb and Sb bands, the bands deeply concave separated by raised interband (ib).

Remarks: The conical form with broad commissure is similar to *Durania cornupastoris* (Des Moulins) described by El-Sabbagh & El-Hedeny (2003) in plate1, fig 2&4 from the Upper Turonian of el-Hassana Dome in Abu Roach area, but our mature shells are smaller in size. On the other hand, the typical cylindrical form is a typical the same species figured by Abdel-Gawad *et al.*, (2004) from the Middle Turonian of Gebel Yelleg and those of Aly *et al.* (2005) from the Turonian of the same locality.

Locality: Gable Yelleg, bed 11, Wata Formation, Lower Turonian.

Geographic distribution: Tethyan Province.

***Durania humei* Douvillé 1913**

(Fig. 13)

1913 *Durania humei*: Douville, p.254, pl.16, figs. 3-5

2003 *Durania humei* Douville: El-Sabbagh & El-Hedeny, p.248, pl. 2, figs. 1-2.

2004 *Durania arnaudi* (Choffat, 1891): Abdel-Gawad et al., p292, p. 9, fig.4-5.

Material: Two specimen of AV.

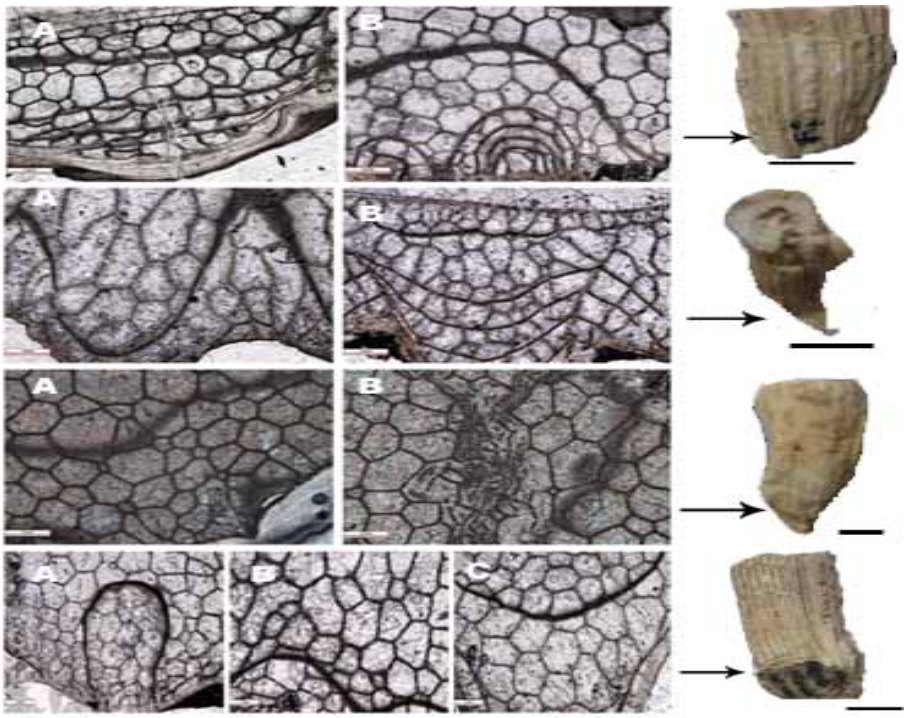

Fig (12) Transverse sections of *Durania arnaudi* (Choffat, 1891): first row- typical cylindrical form with radial structure (rs) in the outermost ostracal layer; second row- conical form showing the sockets for the teeth of the FV and ligament in between; third row-conical form with elliptical commissure showing relic shell by sapling of the ostracal layer; fourth row- typical cylindrical form showing the ligamentary crest (lc), with the hypostracal, aragonitic shell layer (a) indicated.

Dimensions LV (mm):				
Specimen no 29	Length	Width	commissural diameter	wall thickness
	62.00	40.5o	42.50	36.00

Diagnosis: Ligamental groove, deep narrow siphonal bands and different number in faces of polygons.
Description: Av conical shape, wall thick; surface covered with dense thin radial ribs; siphonal bands deep and narrow, Eb slightly deeper , interband broad, raised and broader than bands; presence of ligamental groove, pentagonal-hexagonal and pentagonal polygons, some cells oblique and normal to axial radial lamminae and the others parallel to lamminae (fig. 13).
Locality: bed 7, Wata Formation, Lower Turonian, Gabal Yelleg.

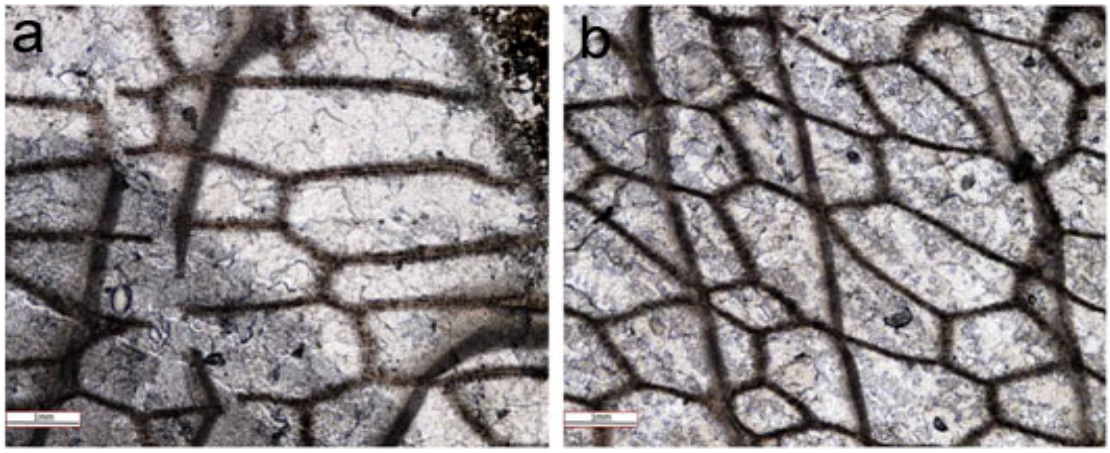

Fig (13): Transverse section of *Durania humei* Douvillé showing: a- elongated polygonal cells; b- polygons oblique to the siphonal bands.

Subfamily LAPEIROUSIINAE Kühn, 1932
Lapeirousella Milanovanović, 1938
***Lapeirousella aumalensis* (Douvillé, 1915)**
(pl. 4, fig. 9)
1915 *Lapeirousia aumalensis*: Douvillé, p. 26, text-fig. 1.
1988? *Durania bertholoni* Yanin**:** Yanin, (in Cretaceous fauna Azerbaijan: editor, Ali-Zad et al.), p.288, pl. XVII, fig. 6; pl. XVIII, fig.1-3, pl. XIX, FIG.1.
1989? *Durania bertholoni* Yanin**:** Yanin, P.288, pl. XIV, fig. 1-2
2003 *Lapeirousella aumalensis* (Douvillé):El-Sabbagh & El-Hedeny, p. 250, pl. 2, figs. 3-4.
Material: 10 specimens deformed perpendicular to commissure.

Dimensions:	Length	Width	commissural diameter	wall thickness
Specimen no 30	90.00	50.00	50.00	10.00

Diagnosis: conical to subcylindrica with more or less regular longitudinal ribs, outer layer with braided and structure surrounding cavities, pseudopillar giving rise to ropy structure.
Description: AV medium to large size, elongate, subcylindrical, slender, deformed; transverse section elliptical shape, narrow squeezed; surface of the attached valve covered on the dorsal side with radial straight thin dense similar, longitudinal ribs strong and raised between bands on the ventral aspect; Sb and Eb shallow depressed separated by terraces which covered by radial costae, Eb wider than Sb (fig. 14).
Remarks: the described specimens have some affinity to *Durania bertholoni* Yanin which identified from the Upper Cretaceous of Azerbaijan.(1988, p. 288, pl. XVII, fig. 6, pl. XVIII, fig. 1-3 and pl. XIV, figs. 1-2)
Locality: Gabal Yelleg, Wata Formation, bed 14, Upper Turonian.
Geographic distribution: ? Upper Coniacian of Caucasus, Coniacian of Tunisia, and Turonian of Egypt.

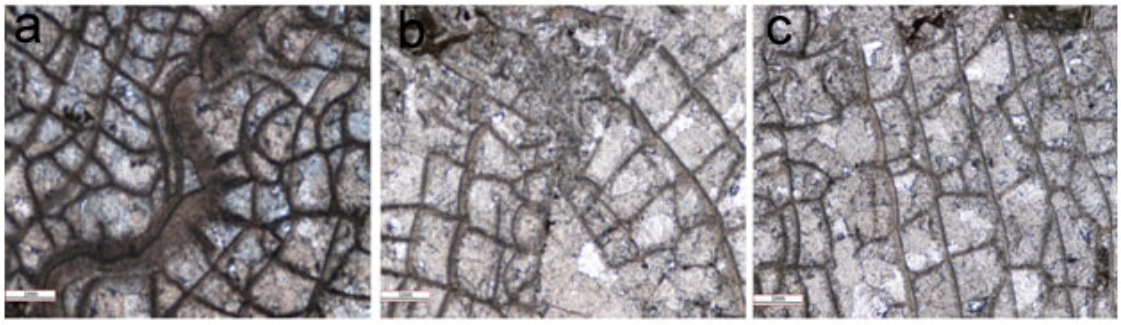

Fig **(14):** Transverse section of wall of ***Lapeirousella aumalensis*** **(Douvillé) showing: a- pseudopillar and longitudinal layers; b & c braided structure surrounding ligamental cavity parallel to commissure.**

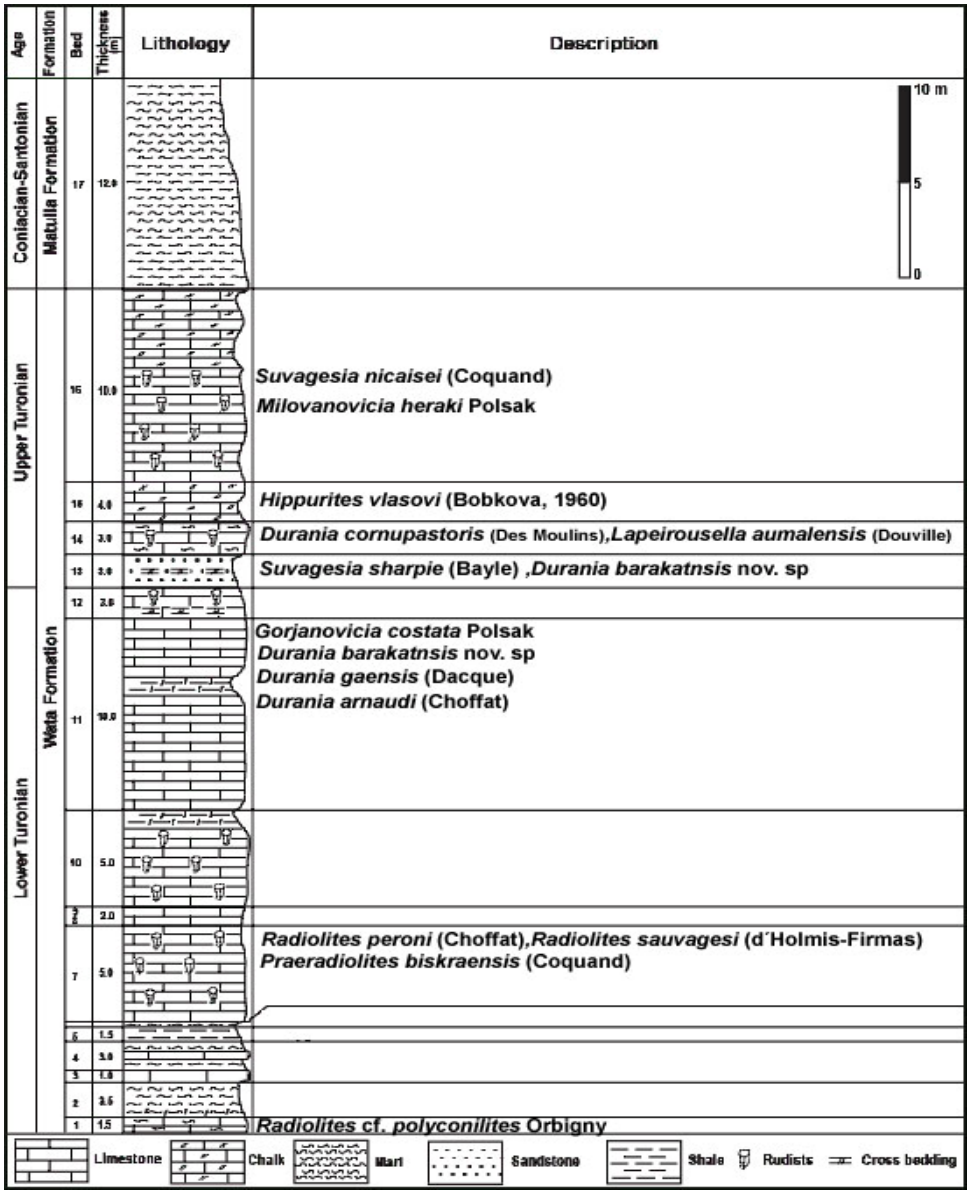

Fig (15): Distribution of the identified rudists though The Turonian rocks of Gabal Yelleg, North Sinai.

MORPHOLOGIAL VARIABILITY AND SIGNIFICANCE OF WALL STRUCTURE

Cretaceous rudist formations have long been studied with respect to paleontology, sedimentology and diagenesis (e.g. Toucas 1903; Zapfe 1937; Kühn 1967; Skelton 1976, Skelton *et al.* 1995; Bebout &Loucks 1977; Pons 1977, 1982; Enos 1988; Minero 1988; Köch et *al.* 1989; Ross & Skelton 1993; Sanders 1998a; Sanders & Baron-Szabo 1997; Sanders ***et*** *al.* 1997; Sanders & Pons 1999.

In general radiolitids demonstrate wide intraspecific morphological variability (Gill, *et al.*, 2009; Senders, 1999; El-Sabbagh and El-Hedeny, 2003). Such variability markedly appears in rich assemblage, as the number of species and individuals increase the variability is well demonstrated. Concerning the studied specimens the some remarks of the variability in form and ornament are observed in the following species:

1- *Radiolites peroni* (Choffat, 1886): Two forms are recorded: horn and conical form with well developed concave tabulae and branched muri. The outermost ostracal layer is not preserved, it may be disintegrated. A thick layer of 'boxwork ostracum' is built of radial funnel plates and cell walls. The cells take two forms: cellular structure of pentagonal and hexagonal polygons and vermiform structure of elongated polygons with 2mm diameter. Very characteristic is the presence of siphonal fossetes structures (fig. 4).

2- *Radiolites sauvagesi* d'Holmis – Firmas, 1838): There are two forms, horn and cylindrical. Radial funnel plates are well developed, closed funnel is a characteristic feature for this species (fig. 5).

3- *Gorjanovicia costata* Pols˘ak, 1968: A profound feature of this radiolitids is network of the radial bands composing of rhombs of calcite and the narrow interbands (fig. 6).

4- *Milovanovicia heraki* Polsăk 1968: It is very large among all the studied specimens. Its wall is characterized by (a) an outermost thick ostracal layer of delicate calcite lamellae and the ligamental crests (lc). The latter penetrate the inner hypostracum that form the thin inner layer (il). The thick outer layer (bl) has a well developed radial band (rb) and interband (ib). Muri form what look-like ropy structure and the polygons are irregular hexagonal (fig. 7)

5- *Suvagesia sharpei* (Bayle): The cylindrical form is the only recorded form in this species. The Lamellar network and a well defined funnels are well developed (fig. 8).

6- *Durania barakatensis* nov. sp.: It is one of the large species in the rudist assemblage. The main features of the wall are highly laminated hypostracum with ligamental crests, rhombs of calcite, radial lamellae, branching muri, thick outer layer and branching funnels (fig. 9).

7- *Durania gaensis* (Dacqué,1903): The characteristic features of such species include a typical honey bee cellular structure of the inner layer, free muri ending in a vesicular pores and curved radial laminae(fig. 10)

8- *Durania cornupastoris* (Des Moulins): It has broad radial bands of hexagonal polygon and vesicular pore (fig. 11).

9- *Durania arnaudi* (Choffat, 1891): This species exhibits highest variability in form among the identified rudists. Three forms are recognized including conical form with rounded commissure, conical form with elliptical commissure and typical cylindrical form. The aspects include disintegrated laminae in the inner layer (fig, 12)

10-*Durania humei Douvillé* 1913: The large, oblique polygons and the developed radial bands are very characteristic features of the species (fig.13)

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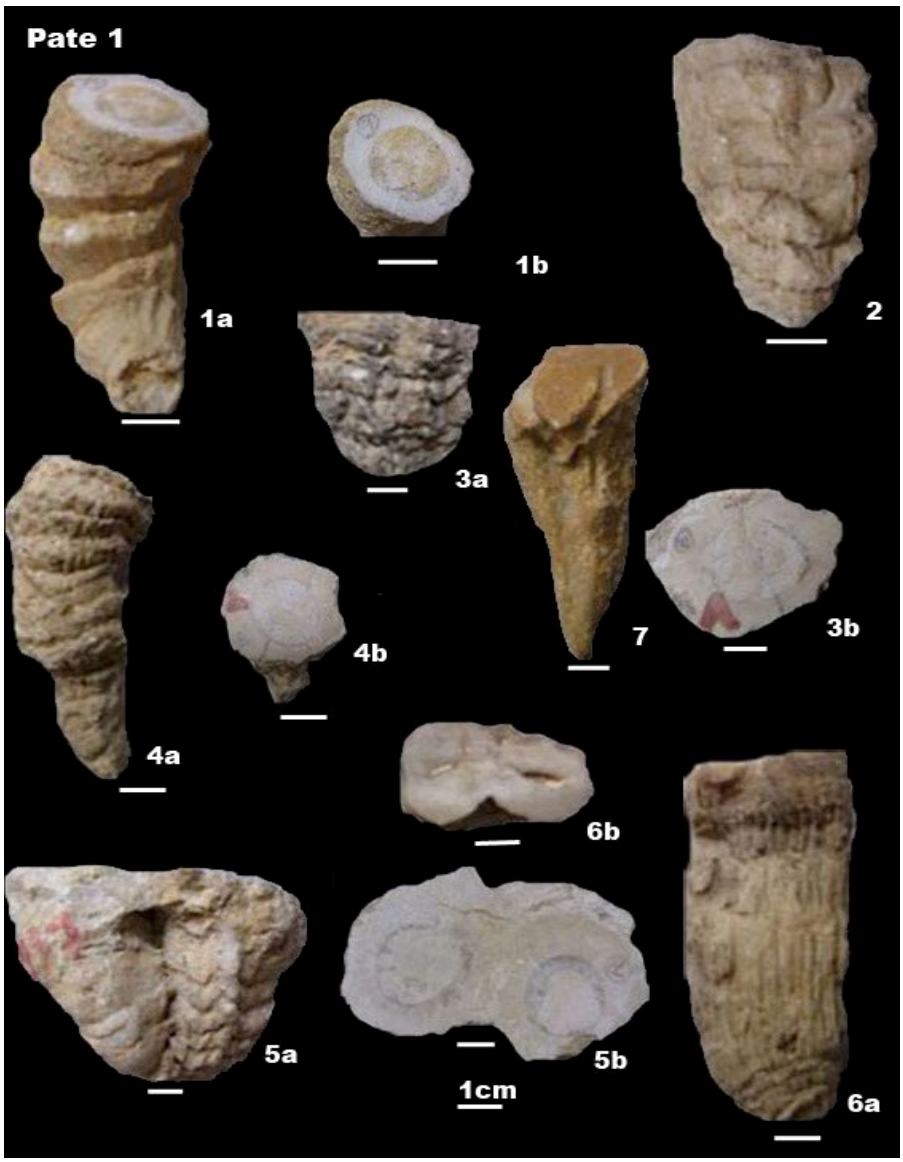


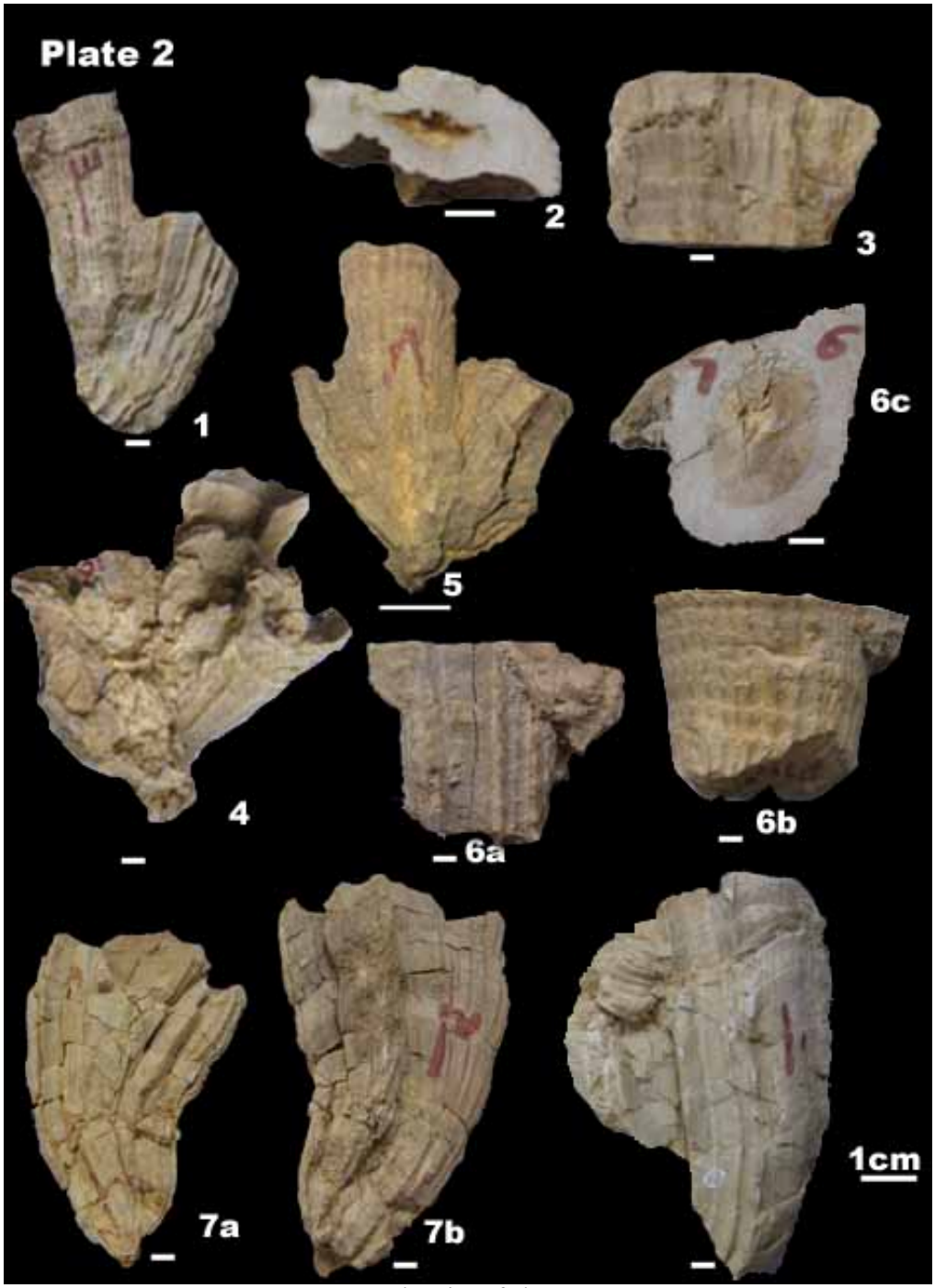
Explanation of plate 1

Figs. 1-2- *Radiolites peroni* (Choffat): 1a. Posterodorsal aspect; 1b. Adapical view, specimen no 2; 2. anterodorsal aspect, specimen no 3. Wata Formation, bed no 7, Lower Turonian, Gabal Yelleg.

Figs. 3-5- *Radiolites sauvagesi* (d´Holmis-Firmas): 3a. Dorsal aspect shows dense wavy growth lamellae, specimen no; 3b. Transverse section showing thick wall, specimen no 6; 4a. dorsal aspect, 4b. transverse section. specimen no 5, 4b. Transverse section of AV, 5a. Anterodorsal and posterodorsal aspects of two coagulate individuals, 5b. Transverse section of AV, specimen no 7 (length = 52mm). bed no 7, Wata Formation, Lower Turonian, Gabal Yelleg.

Fig. 6 - *Gorjanovicia costata* Pols˘ak,: 6a. Dorsal aspect, 6b, Transverse section of AV of a pair of *G. Costata,* specimen no 8. Wata Formation, bed no11, Lower Turonian, Gabal Yelleg.

Fig.7- Radiolites cf. *polyconilites* Orbigny, specimen no 1. Bed no 1, Wata Formation, L. Turonian, Gabal Yelleg.

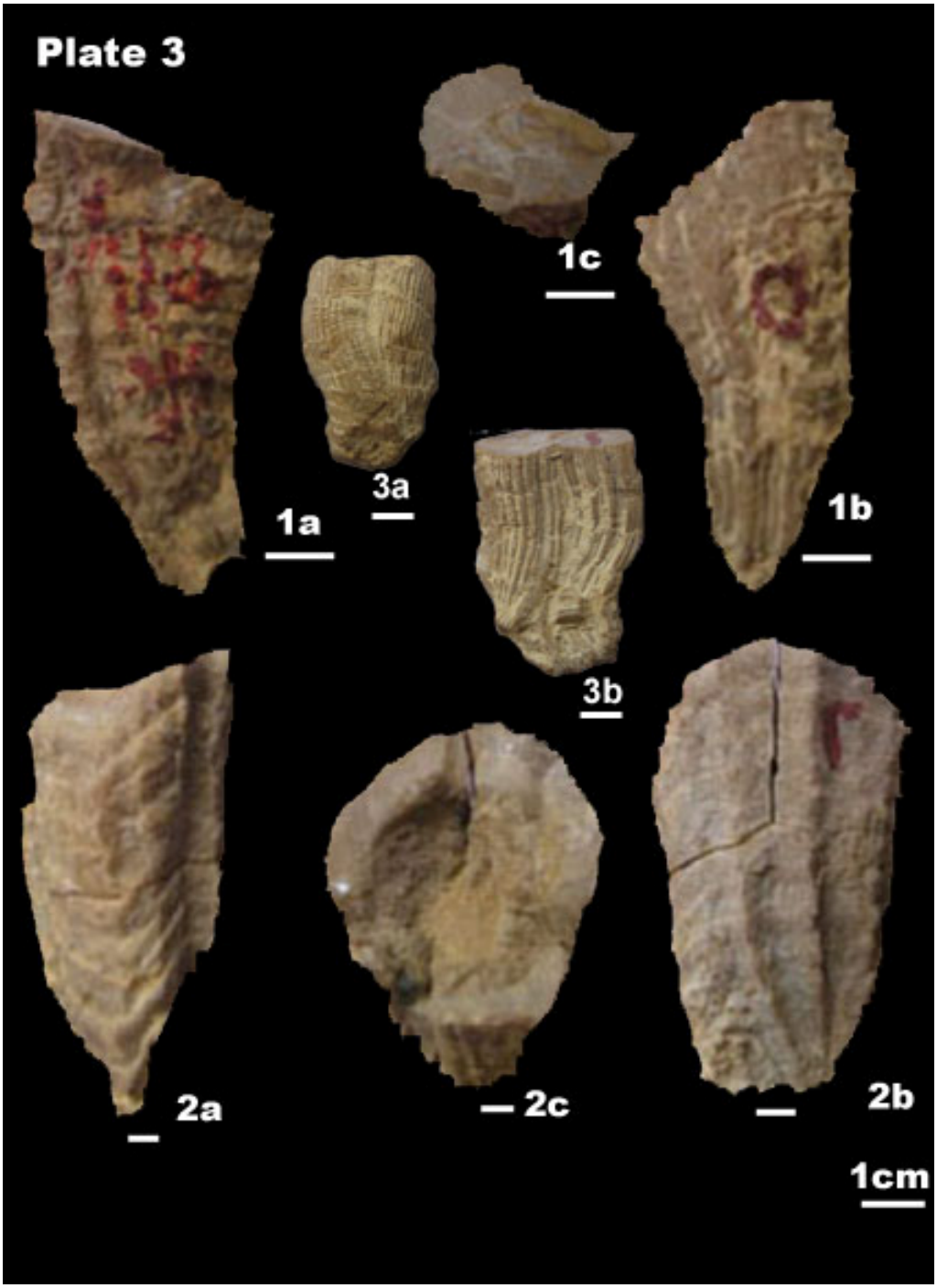


Explanation of plate 2

Figs. 1-5: *Milovanovicia heraki* Pols˘ak, side view, specimen no 10. Bed 16, Wata Formation, Upper Turonian, Gabal Yelleg.

Fig. 6a-c: *Suvagesia sharpei* (Bayle): 6a.dorsal aspect showing normal thin ribs interrupted by regularly spaced growth layer; 6b. Radial bands (Eb wider) with ligamental furrow; 6c.transverse section showing thick wall and ligamental pillar, specimen no 15, bed no 13, Wata Formation, Upper Turonian, Gabal Yelleg. .

Figs. 7-8: *Suvagesia nicaisei* (Coquand): 7 a & b. posteroventral & dorsal aspects, with radial costulate and flat bands, specimen no 16; 8 dorsal aspect, specimen17. Bed no 16, Wata Formation, Upper Turonian, Gabal Yelleg.

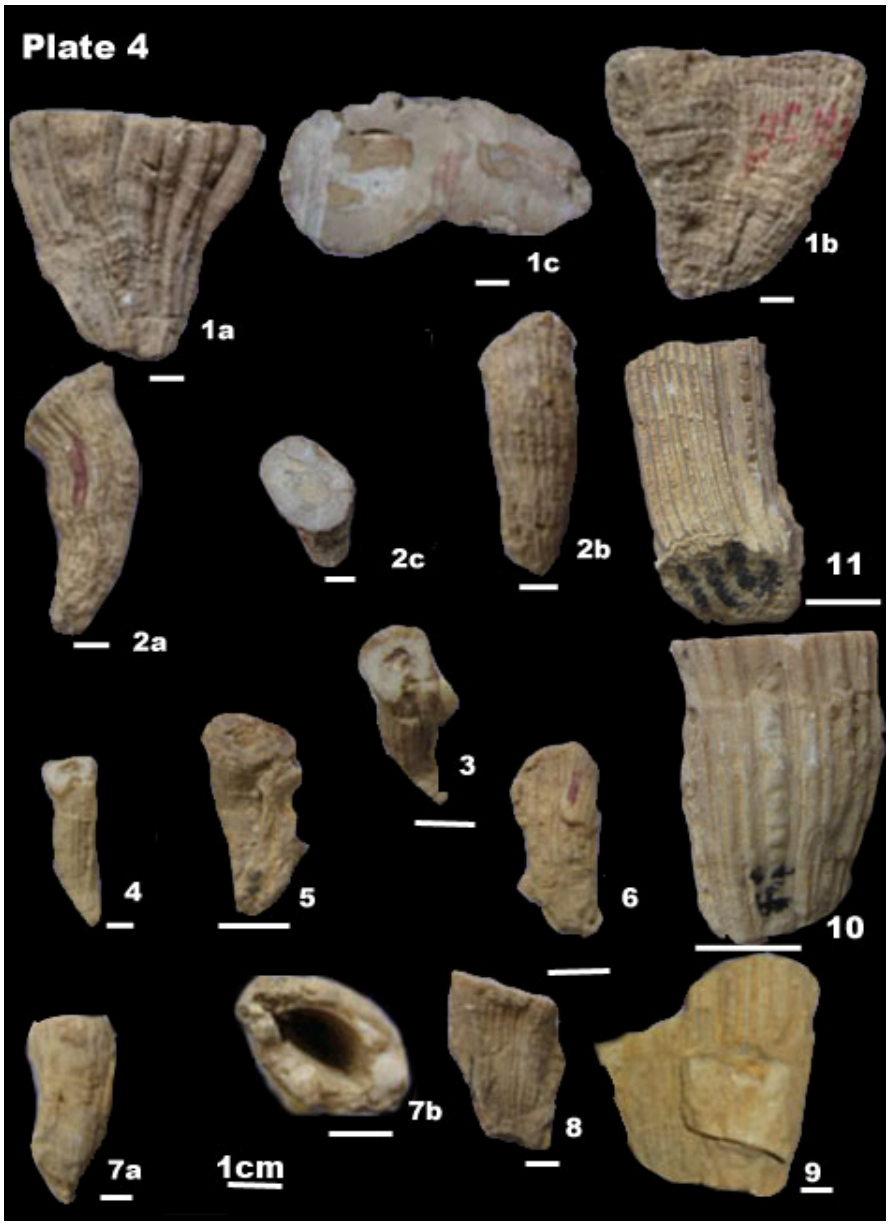


Explanation of plate 3

Fig.1a-c: *Praeradiolites biskraensis* (Coquand): 1a. Posteroventral aspect with concave siphonal band ligamental furrow; 1b. ornament with divergent radial folds, specimen no 9. Bed 7, Wata Formation, Lower Turonian, Gabal Yelleg.

Fig. 2a-c: *Durania* barakatensis nov. sp.: 2a. Concave siphonal bands and raised interband with concave growth laminae; 2b. Adapical view of AV; 2c. sharp ribs and wide inter-ribs, specimens no 18&19, Beds 11&13, Wata Formation, Upper Turonian, Gabal Yelleg.

Fig. 3a-b: *Hippurites (Hppuritella)* aff. *castroi* Vidal, specimens 29&30, beds 15 & 16, Wata Formation, Upper Turonian, Gabal Yelleg.



Explanation of plate 4

Fig. 1a-c: *Durania gaensis* (Dacque): 1a. Posteroventral aspect showing radial bands deeply, and plicate interbands; 1b. longitudinal and growth laminae; 1c. Transverse section, specimen no 20, bed 11, Wata Formation, Upper Turonian Gabal Yelleg., .

Fig. 2a-c: *Durania cornupastoris (*Des Moulins): 2a. Ventral with siphonal bands; 2b. dorsal aspect, 2c. transverse section, specimen no 23. Bed 14, Upper Turonian, Gabal Yelleg.

Fig. 3-8 & 10-11: *Durania arnaudi* (Choffat). 3-6: conical form (fig. 4 = specimen 26);7-8: conical form with broad commissure (fig. 7 = specimen 27), 10-11: cylindrical form (specimen no 24 & 25 , sample no 24-27. Bed 11, Wata Formation, Lower Turonian, Gabal Yelleg..

Fig. 9: *Lapeirousella aumalensis* (Douville), ventral view showing band and interbands, specimen no 30, bed 14, Upper Turonian, Gabal Yelleg.

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