

Hemicidaroid Echinoids from Upper Cretaceous deposits in the Wadi Qena-area (eastern desert, Egypt)

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Abstract

A large number of regular echinoids has been collected by a German expedition in the Upper Cretaceous of Wadi Qena, Egypt. Five species belonging to the order Hemicidaroida are described and discussed in this paper. *Hemicidaris bandeli* is new.

Keywords : Echinoids - Cretaceous - Egypt - Taxonomy.

Résumé

Une expédition allemande a récolté un grand nombre d'échinides réguliers dans les dépôts du Crétacé supérieur du Wadi Qena, Egypte. Cinq espèces appartenant à l'ordre des Hemicidaroida sont décrites et discutées. *Hemicidaris bandeli* est une espèce nouvelle.

Mots-clés : Echinides - Crétacé - Egypte - Taxionomie.

1. Introduction

Wadi Qena is a wide and long, tectonically determined depression, bordered by faults, which are parallel to the coasts of the Red Sea. The valley has a gentle south-slope towards the Nile, in the vicinity of the town of Qena.

The geology and the stratigraphy of Wadi Qena was poorly understood, until it was unraveled and described by BANDEL, KUSS & MALCHUS (1987).

During their survey of the area, in 1985 BANDEL, KUSS and MALCHUS collected a large number of fossils. The present paper is a systematic description of a small part of these collections, and deals with regular echinoids belonging to the order of Hemicidaroida. Other groups of regular echinoids will be discussed in a forthcoming paper. The stratigraphical framework, set up by BANDEL, KUSS & MALCHUS (1987) is used throughout the present text. Useful toponyms are few and far apart in desert-areas, such as Wadi Qena. In this paper localities are therefore indicated as letters, which again refer to BANDEL, KUSS & MALCHUS (1987).

Hemicidaroid echinoids from the Cenomanian-Turonian of Egypt, have previously been described by GREGORY (1906), FOURTAU (1898, 1900, 1901, 1905, 1906, 1909, 1912, 1913, 1914) and STEFANINI (1918).

GREGORY (1906) mentioned only three species :

"Heterodiadema bigranulatum n. sp.

Acanthechinopsis humei n. gen., n. sp.

Thylechinus trigranulatus n. sp."

FOURTAU (1914) compiled the following list of species, from his earlier papers :

"Pseudodiadema Balli, FOURTAU, 1909

Pseudodiadema bigranulatum, GREGORY, 1906

Pseudodiadema Humei, FOURTAU, 1912

Pseudodiadema trigranulatum, GREGORY, 1906

Diplopodia Deshayesi, COTTEAU, 1864

Diplopodia marticensis, COTTEAU, 1864

Diplopodia variolaris, BRONGNIART, 1822

Heterodiadema libycum, DESOR, 1846

Pedinopsis sinaea, DESOR, 1847"

Three species from FOURTAU's records were mentioned again by STEFANINI (1918), who added a species and a new variety :

"Diplopodia variolaris (Brngn.)

Heterodiadema libycum Des.

Pedinopsis Desori (Coq.)

Pedinopsis sinaea Des.

Pedinopsis sinaea var. *Figarii*"

Since that time, very little has been published on fossil Cenomanian-Turonian echinoids from Egypt. Two species from the list of FOURTAU (1914) have been recorded again by EL-ARABI FAWZI (1963) :

"Pseudodiadema triangulatum, GREGORY, 1906 (= *P. trigranulatus*)

Heterodiadema libycum, DESOR sp. 1846".

Hence, until now, twelve different names have been used to describe Egyptian Cenomanian-Turonian Hemicidaroida. Three of these are valid names for species, found to be present in the Wadi Qena-area. Four names are junior synonyms of the latter three.

The Cenomanian-Turonian of Wadi Qena yielded five species of Hemicidaroida, one of which is new :

Hemicidaris bandeli n. sp.

Heterodiadema libycum (AGASSIZ & DESOR, 1846)

Pedinopsis sp. ind.

Pseudodiadema bigranulatum (GREGORY, 1906)

Tetragramma variolare (BRONGNIART, 1822)

The stratigraphical distribution of these species is given in table I.

Table I.

	<i>Hemicid. bandeli</i>	<i>Heterodiad. lybicum</i>	<i>Pedinop. sp. ind.</i>	<i>Pseudo-diad. bigranul.</i>	<i>Tetragram. variolare</i>
Tarfa Fm.					
upp. mb.	-	-	-	-	-
low. mb.	-	-	-	2	1
Atrash Fm.					
upp. mb.	1	2	1	-	30
low. mb.	-	5	-	-	2
unknown	-	-	-	-	4

2. Systematic descriptions

Order HEMICIDAROIDA BEURLIN, 1937

Family HEMICIDARIDAE WRIGHT, 1857

Genus *Hemicidaris* AGASSIZ, 1838

TYPE-SPECIES

Cidarites crenularis LAMARCK, 1816; subsequent designation by GOLDFUSS, 1836.

Hemicidaris bandeli sp. nov.

Plate 1, Figs. 1-4

Derivatio nominis :

Dedicated to Prof. Dr. Klaus BANDEL.

Locus typicus :

Locality F (sample F122/43), Wadi Qena, Eastern Desert, Egypt.

Stratum typicum :

Upper member of Atrash Formation, Cenomanian-Turonian.

Holotype :

IST 10483, KBIN-collections (the only known specimen).

Dimensions :

Ambital diameter (D) 30.9 mm; height (h) 14.5 mm; diameter of peristome (dp) 10.9 mm; h/D-ratio 0.47; dp/D-ratio 0.36.

Description

Medium sized *Hemicidaris*, with flattened, conical shape. The plates of the apical system are not preserved in our specimen.

The peristome is deeply sunken, moderately large and circular. Ten shallow gill slits are present. The specimen is filled with hard matrix, completely hiding the perignathic girdle.

Ambulacra are straight and narrow, their width at the ambitus corresponding to arcs of 22° each (360° being the complete circumference of the test). They are "bottle-shaped", showing a wide adoral and a narrow adapical sector. The adoral part of the ambulacra extends slightly above the ambitus and consists of 8 or 9 compound, trigeminate plates. Each of these plates carries a crenulate and perforate primary tubercle, surrounded by a smooth, conical scrobicule. The scrobicules are not confluent, but separated by one or two very narrow strings of tiny granules. Scrobicular rings are incomplete and open towards the poriferous zones. In the adapical sector of the ambulacra, simple plates alternate with bigeminate plates. The former show a very small primary tubercle each; the primary tubercles on the latter are slightly larger. All tubercles are much smaller than those on the adoral sectors. The transition between both sectors is fairly abrupt. Poriferous zones are simple and very slightly sinuous. They widen a little in the immediate vicinity of the peristome. The pore-pairs show a very slight inclination.

Interambulacra are more than twice as wide as ambulacra and correspond to arcs of 50°. They consist of vertical series of 10 plates each. Perforate and crenulate primary tubercles are well developed on all these plates. Scrobicules are conical, but their elevation is small. Scrobicular tubercles are very small and hardly larger than the granules, covering the extrascrobicular surfaces. Scrobicules are confluent at the ambitus. Secondary tubercles are absent. Interradial extrascrobicular surfaces are fairly large and coarsely granulated.

Diagnostic features

1. Deeply sunken peristome.
2. Ambulacral plates alternating simple and bigeminate adapically, with alternating smaller and larger tubercles.
3. Scrobicules confluent at the ambitus; scrobicular rings poorly developed.
4. Interradial extrascrobicular surfaces wide and granulated.

Discussion

The acme of the genus *Hemicidaris* was during the Jurassic. Very few species are known from the Cretaceous, the vast majority of these being described from Lower Cretaceous strata. Until now, a mere two species have been described from the Upper Cretaceous: *H. ghazirensis*, DE LORIO, 1897, from the Lebanon, and *H. palmirensis*, SANCHEZ-ROIG, 1949, from Cuba. Both were discovered in deposits of Cenomanian age. The species discussed has been found in strata of Upper Cenomanian - Lower Turonian age. It is the youngest species of this genus on record. The only other species from the Tethyan Cenomanian, *H. ghazirensis*, cannot be confused with the new species. The shape of the former is much higher (h/D 0.65) than that of *H. bandeli*. Interambulacral tubercles are less high in the new species. Interradial extrascrobicular surfaces are much wider in *H. bandeli* than in *H. ghazirensis*.

Genus *Heterodiadema* COTTEAU, 1864

TYPE-SPECIES

Hemicidaris lybica AGASSIZ & DESOR, 1846, by subsequent designation of LAMBERT & THIERY, 1910.

Heterodiadema lybicum (AGASSIZ & DESOR, 1846)
Plate 1, Figs. 5-6.

- v.1980 *Heterodiadema lybicum*, GEYS, pp. 445-451, pl. 8.
v.1985 *Heterodiadema lybicum*, BANDEL & GEYS, p. 106, pl. 4, figs. 6-7, pl. 5, figs. 1-2.
v.1987 *Heterodiadema lybicum*, GEYS in BANDEL, KUSS & MALCHUS, pl. 5, fig. 5a,b.
(extensive synonymy see GEYS, 1980)

Locus typicus :

Unknown locality in Egypt.

Stratum typicum :

"Terrain crétacé", probably Cenomanian.

Specimens studied

Locality W (sample W3), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 2 specimens (one of them figured herein, KBIN-coll. n° IST 10157).

Locality W (sample W2A); Wadi Qena, Egypt; lower member of Atrash Formation, Cenomanian : 5 specimens.

Dimensions (D, h, ds & dp in mm)

	D	h	ds	dp	h/D	ds/D	dp/D
W3 IST							
10157	51.5	20.8	13.4	14.0	0.40	0.26	0.27
W3	40.3	18.8	-	-	0.45	-	-
W2	24.1	11.1	8.0	9.3	0.46	0.33	0.38
W2	16.0	7.8	-	-	0.49	-	-
W2	23.9	11.0	8.9	-	0.46	0.37	-
W2	20.3	9.0	-	7.2	0.44	-	0.35
W2	21.5	9.9	-	-	0.46	-	-
mean	28.2	12.6	10.1	10.1	0.45	0.32	0.33

Description

The species has been described by GEYS (1980).

Discussion

This is a very common species in Cenomanian and Turonian strata of the Tethys-area, being found from Portugal to Pakistan. Confusion with other species is hardly possible.

H. lybicum seems to become larger during its evolution.

FOURTAU (1914) stated that Cenomanian specimens are considerably smaller than those from Turonian strata. Similar observations were made by BANDEL & GEYS (1985) on specimens from Jordan. Although the number of specimens from Wadi Qena is limited and hardly large enough to yield statistically significant results, we can observe that specimens from the upper member of the Atrash Formation are almost twice as large as those from the lower member.

Family PSEUDODIADEMATIDAE POMEL, 1883
Genus *Pedinopsis* COTTEAU, 1863

TYPE-SPECIES

Pedinopsis meridianensis COTTEAU, 1863, by original designation.

Pedinopsis sp. ind.

Plate 1, Figs. 7-8.

Specimen studied

Locality C (sample CII), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen (KBIN-collections IST 10494).

Dimensions (D, h, ds & dp in mm)

	D	h	ds	dp	h/D	ds/D	dp/D
CII (IST							
10494	27.3	13.0	-	-	0.48	-	-

Description

Medium sized *Pedinopsis* with circular, hemispherical test. The apical system is caducous. Its plates are absent in our specimen. Its shape cannot be determined either, the hole being completely covered with hard matrix.

Also the peristome is hidden by covering hard limestone. Ambulacra are straight and moderately wide. At the ambitus their width corresponds to an arc of 24°. The plates are quadrigeminate throughout and biserial from the margins of the apical system down to the adoral hemisphere. Below the ambitus, the pore-pairs gradually merge into a single series. Pore-pairs are almost horizontal. Tubercles are well developed, crenulate and perforate. They are arranged in two straight series, one tubercle on every plate. The specimen being badly weathered, finer surface structures, such as scrobicular rings and extrascrobicular granulation, cannot be seen.

Interambulacra are twice as wide as ambulacra and correspond to arcs of 48°. Tubercles are well developed, crenulate and perforate. They are arranged in four regular, vertical series, so that all the plates (except those closest to the peristome and to the apical system) carry two of them.

The secondary tubercles are only slightly smaller than the primaries. A series of very small granules, or tubercles, is present near the adradial suture. Fine sculptural features, such as scrobicular rings and extrascrobicular granulation, have been destroyed by erosion and cannot be described.

Diagnostic features

1. Interambulacra twice as wide as ambulacra.
2. Ambulacra quadrigeminate.
3. Poriferous zones biserial on adapical surface and on upper half of adoral surface.
4. Interambulacral tubercles in 4 vertical series.

Discussion

The most common species of *Pedinopsis* in the Cenomanian of the Tethys-area is *P. sinaica* (Agassiz & Desor, 1847) (= *P. sinaea* FOURTAU, 1914). The species under discussion does not correspond exactly to the description of the above mentioned taxa. The arrangement of its tubercles in ambulacra and interambulacra seems different from that in *P. sinaica*. In the specimen from Wadi Qena, only four series of interambulacral tubercles are present. Of these, the two interrarial series persist up to the apical system, while the two adradial ones quickly diminish in size, before vanishing adapically. The granules close to the adradial suture are so small, that they can hardly be considered as "tubercles". In the descriptions of *P. sinaica* and its synonyms, the interambulacral tubercles are arranged in six vertical series, of which the second and the fifth are the most persistent.

No trace is found of perradial secondary tubercles in the ambulacra of the Wadi Qena specimen. Such tubercles should be present in *P. sinaica*.

Yet, the Wadi Qena species is very similar to *P. sinaica*. Having only a single, poorly preserved specimen at my disposal, I am reluctant to consider it a new species and naming it as such.

Genus *Pseudodiadema* DESOR, 1855

TYPE-SPECIES

Cidarites pseudodiadema LAMARCK, 1816; by original designation.

Pseudodiadema bigranulatum (GREGORY, 1906) Plate 1, Figs. 11-13.

- *.1906 *Heterodiadema bigranulatum*, GREGORY, p. 218, pl. 10, fig. 1.
- *.1909 *Pseudodiadema Balli*, FOURTAU, p. 97, pl. 6, figs. 4-7.
- *.1912 *Pseudodiadema Humei*, FOURTAU, p. 139, pl. 1, fig. 1.
- .1914 *Pseudodiadema Balli*, FOURTAU, pp. 11-12.
- .1914 *Pseudodiadema bigranulatum*, FOURTAU, p. 12.
- .1914 *Pseudodiadema Humei*, FOURTAU, pp. 12-13.

Loci typici

- P. bigranulatum*: Jebel Gunneh, Sinai, Egypt.
- P. balli*: Bir Abou el Messad, Libyan Desert, Egypt.
- P. humei*: Wadi Hawachieh, Eastern Desert, Egypt.

Strata typica

- P. bigranulatum*: Cenomanian.
- P. balli*: Cenomanian.
- P. humei*: Cenomanian.

Specimens studied

Locality M (sample M15/2), Wadi Qena, Egypt; lower member of Tarfa Formation, Turonian; 2 specimens (KBIN-collections nrs. IST 10485 & 10486).

Dimensions (D, h, ds & dp in mm)

	D	h	ds	dp	h/D	ds/D	dp/D
M15/2							
(10485)	19.9	10.2	-	7.8	0.51	-	0.39
(10486)	22.2	11.8	10.0	-	0.53	0.45	-
mean	21.0	11.0	-	-	0.52	-	-

Description

Small to medium sized *Pseudodiadema* with circular, hemispherical test.

The apical system cannot be observed, being destroyed in both specimens. In one of the specimens it leaves a large, pentagonal hole.

The peristome is moderately large, circular and not sunken. Gill slits are moderately deep. The perignatic girdle is hidden by hard rock in both specimens.

Ambulacra are straight and moderately wide. At the ambitus, their width corresponds to an arc of 27°. The plates are trigeminate and diadematoid throughout, without demiplates. The sutures between the components are sometimes visible as thin, dirt-filled cracks. Each ambulacral series consists of 12 or 13 compound plates. Poriferous zones are straight, narrow and simple throughout, not widening, neither at the peristome, nor adapically. Pore-pairs are slightly inclined, forming angles of about 20° with the ambital plane. Each plate carries a perforate and crenulate primary tubercle, which is surrounded by a smooth conical scrobicule. The sutures between the components of the plates are sometimes visible on the scrobicules, as narrow, dirt-filled grooves. Scrobicular rings are complete and consist of numerous, very small scrobicular tubercles. Hence, the scrobicules are not confluent. Perradial extrascrobicular surfaces are very narrow, the scrobicular rings of adjacent plates touching each other.

Interambulacra are wider than ambulacra and correspond to arcs of 45° at the ambitus. They consist of vertical series

of 12 or 13 plates. All these plates show well developed perforate and crenulate primary tubercles. Scrobicules are smooth, slightly conical, but only lightly elevated. Scrobicular rings are open adorally and adapically, so that scrobicules are confluent, or at most separated by a few scattered, tiny granules. Scrobicular tubercles are very small and can hardly be distinguished from the granules, which cover the extrascrobicular surfaces. Interradial extrascrobicular surfaces are narrow and densely granulated. They widen slightly towards the apex. Adradially, narrow, granulated zones are present. Secondary tubercles are absent.

Diagnostic features

1. Peristome not sunken.
2. Poriferous zones simple throughout, not widening adorally or adapically.
3. Interambulacral scrobicules confluent.
4. Interradial and perradial extrascrobicular surfaces narrow and densely granulated.

Discussion

FOURTAU (1914) listed four species of *Pseudodiadema*, from the Cenomanian of Egypt. *P. trigranulatum* (GREGORY, 1906) is characterized by well developed secondary tubercles on the interambulacral plates. The remaining three taxa, *P. balli* FOURTAU, 1909, *P. bigranulatum* GREGORY, 1906 and *P. humei* FOURTAU, 1912 seem to be very closely related, judging by their descriptions and illustrations. FOURTAU (1914) emphasised mainly differences in width of the interambulacral extrascrobicular surfaces and differences in the characteristics of the interambulacral scrobicules. Comparing the figures of the three taxa involved, I cannot see any consistent difference between miliary zones called "large" (*P. bigranulatum*), "assez étroite" (*P. humei*) and "qui s'élargit" (*P. balli*). The interambulacral scrobicules of the same three taxa are described "tangents" (*P. balli*), "pas tangents" (*P. granulatum*) and "confluents" (*P. humei*). Again, no significant and consistent differences can be seen on the figures. The three taxa fit the description of GREGORY (1906): "... not confluent, but occasionally the scrobicular circles become very thin and the granules somewhat scanty".

The apical system of the three taxa have a similar, large size, which is unusual in *Pseudodiadema*.

Taking into account the very small number of specimens examined by FOURTAU (1909, 1912, 1914) (1 sp. of *P. balli*, 2 sp. of *P. bigranulatum* and 2 sp. of *P. humei*), the significance of the subtle differences described, is further reduced. In my opinion, *P. balli* and *P. humei* are junior synonyms of *P. bigranulatum*.

The species has never been recorded previously in post-Cenomanian strata.

Genus *Tetragramma* AGASSIZ, 1840

TYPE-SPECIES

Cidarites variolare BRONGNIART, 1822; subsequent designation by LAMBERT & THIERY, 1910.

Tetragramma variolare (BRONGNIART, 1822)

Plate 1, Figs. 9-10.

- *.1864 *Pseudodiadema Marticense*, COTTEAU, pp. 507-509, pl. 1122.
- .1887 *Diplopodia Marticensis*, LORIOL, p. 41, pl. 7, figs. 1-5.
- 1901 *Diplopodia marticensis*, FOURTAU, p. 39.
- 1914 *Diplopodia marticensis*, FOURTAU, p. 15.
- .1914 *Diplopodia variolaris*, FOURTAU, pp. 15-16.
- v.1985 *Tetragramma* cf. *variolare*, BANDEL & GEYS, p. 107, pl. 5, figs. 3-4.
- v.1985 *Tetragramma variolare*, GEYS, p. 135, pl. 2, figs. 7-8. (extensive synonymy in GEYS, 1985)

Loci typici

T. variolare : Le Havre, Seine-Maritime, France.

P. marticense : Martigues, Bouches-du-Rhône, France.

Strata typica

T. variolare : "Craie chloritée", Cenomanian.

P. marticense : "Zone du *Janira inaequicostata*", Turonian.

Specimens studied

Locality B (sample B 1/2), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality B (Sample B 2-3), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality D, Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 2 specimens.

Locality E (sample E 1/3), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality E (sample E 4), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 5 specimens.

Locality F (sample F 119/83), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality F (sample F 120/83), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality F (sample F 1230/83), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality K (sample K 3), Wadi Qena, Egypt; lower member of Tarfa Formation, Turonian : 2 specimens.

Locality L (sample L 1), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 1 specimen.

Locality M (sample M 7), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 12 specimens (one of these is IST 10484).

Locality M (sample M 10), Wadi Qena, Egypt; upper member of Atrash Formation, Cenomanian-Turonian : 6 specimens.

Locality M (sample M 5/2), Wadi Qena, Egypt; lower member of Tarfa Formation, Turonian : 1 specimen.

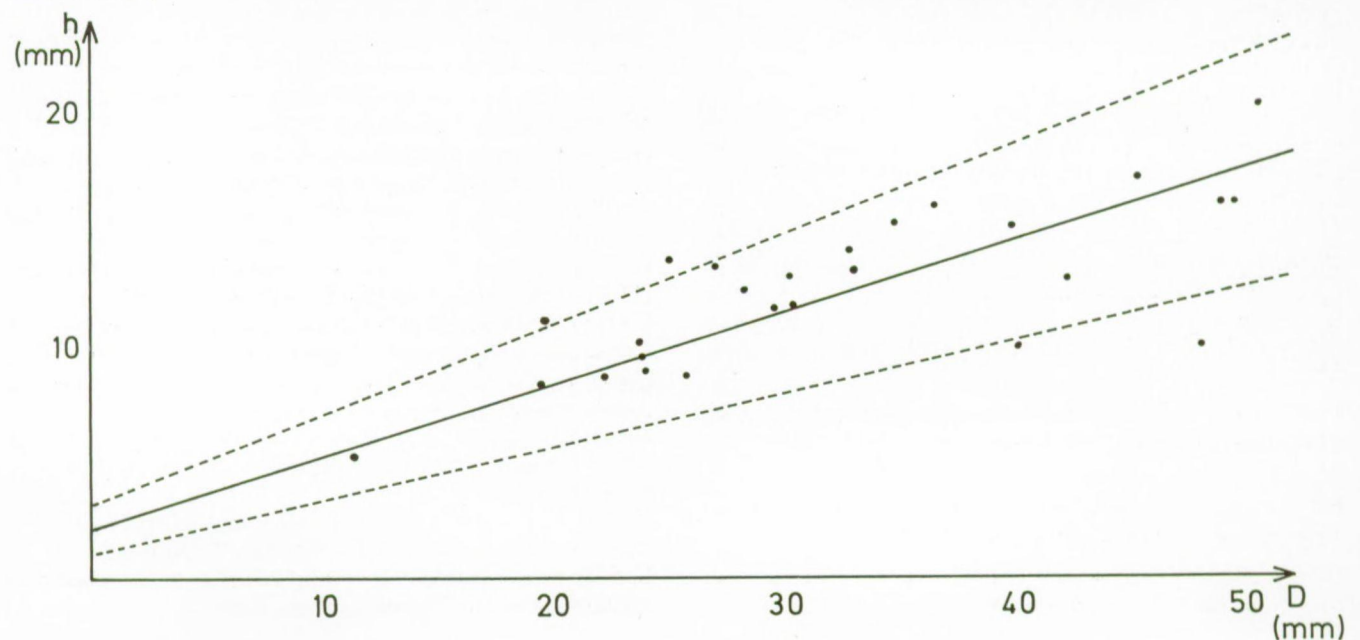
Locality W (sample W 2 A), Wadi Qena, Egypt; lower member of Atrash Formation, Cenomanian : 2 specimens.

El Riz, Bahariya-Oasis, Egypt; El-Riz Member of Bahariya Formation, Upper Cenomanian : 2 specimens.

Dimensions (D, h, ds & dp in mm)

	D	h	ds	dp	h/D	ds/D	dp/D
BI2	23.7	10.1	10.5	9.3	0.43	0.44	0.39
BII-3	27.0	13.3	12.0	11.2	0.49	0.44	0.41
E 1/3	11.4	5.2	-	4.8	0.46	-	0.42
E 4	39.8	15.0	-	15.5	0.38	-	0.39
	29.2	12.3	-	-	0.42	-	-
	19.5	8.3	-	8.3	0.42	-	0.42
	24.0	8.9	-	10.8	0.37	-	0.45
F119/83	22.2	8.6	9.2	9.4	0.39	0.41	0.42
F120/83	29.5	11.5	-	-	0.39	-	-
F1230/83	36.5	15.9	-	-	0.44	-	-
M7 IST							
10484	42.2	12.8	15.4	15.4	0.30	0.36	0.36
M7	40.1	9.9	-	15.7	0.24	-	0.39
	45.2	17.1	-	-	0.38	-	-
	49.4	16.0	-	-	0.32	-	-
	50.4	20.2	-	-	0.40	-	-
	33.0	13.1	-	-	0.40	-	-
	48.0	9.9	-	-	0.20	-	-
	48.8	16.0	-	17.0	0.33	-	0.35
M10	25.0	13.6	9.3	-	0.54	0.37	-
	19.6	11.0	8.3	-	0.56	0.42	-
	23.8	9.5	-	-	0.40	-	-
	30.3	11.6	11.7	10.8	0.38	0.39	0.36
	32.8	14.0	10.6	11.9	0.43	0.32	0.36
M15/2	34.7	15.2	-	11.6	0.44	-	0.33
W2A	30.2	12.9	-	11.5	0.43	-	0.38
	25.7	8.6	-	-	0.33	-	-
mean	31.0	11.7	10.9	10.7	0.38	0.39	0.39

(other specimens are too poorly preserved to yield significant measurements)



Description

The species has been described by GEYS (1985b).

Discussion

Tetragramma variolare is a fairly common species in Cenomanian deposits of the Tethys-area. It has been recorded from southern France, Spain, Portugal, Hungary, Algeria, Tunisia, Egypt, Syria, the Lebanon, Jordan and Israel. In sediments of the same age in the Boreal realm, the species is less common. Yet it has been found in northern France, Germany, England, Poland and Belgium.

Acanthechinopsis humei GREGORY, 1906 from the Cenomanian of the Sinai is a junior synonym of *T. variolare*. The description and figures of *A. humei* in GREGORY (1906) fit *T. variolare* perfectly.

Diplopodia marticensis (COTTEAU, 1864) has been mentioned by FOURTAU (1901, 1914) from the Cenomanian of Egypt. Although he was well aware of the great similarity between *D. marticensis* and *T. variolare*, COTTEAU thought it was wise to separate them. Yet, the differences between both species are small and subtle. In my opinion they are well within the range of intraspecific variability of *T. variolare*. Therefore I feel that *D. marticensis* is merely a junior synonym of *T. variolare*.

Specimens described by COTTEAU (1864) as *P. marticense*, were the only ones ever recorded from Turonian strata. Therefore, the discovery of *T. variolare* in the lower member of the Tarfa Formation, which is presumably of Lower Turonian age, is significant. It illustrates the survival of the species beyond fini-Cenomanian times. Although the

Figure 1. - Height (h) plotted against diameter (D) for *Tetragramma variolare* (BRONGNIART, 1822); reduced major axis line (full line) and its 95% confidence bands (dashed lines) are shown.

species seems to be largely confined to the Cenomanian, its occurrence in the Turonian, however rare, is confirmed by the specimen from the Tarfa Formation.

Height (h) and diameter (D) were plotted in a graph; the reduced major axis line, as well as the confidence intervals of its slope and intercept, were computed, using the formulae given by TILL (1974).

$$h = 2.20 (\pm 1.04) + 0.31 (\pm 0.08) D$$

The graph, its cloud of dots, the reduced major axis line and its confidence band, are shown in Figure 1.

Correlation between h and D is moderate ($r = 0.75$). This is probably partly due to taphonomical factors. Some of the specimens are indeed badly crushed and damaged. The origin of the graph is not included in the 95 % confidence

band of axis line. This means that the h/D-ratio is significantly larger in small (= young) specimens, than in large (= old) ones. In other words: the test of *T. variolare* becomes more and more flattened during growth.

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PLATE 1

- Figure 1. – *Hemicidaris bandeli* sp. nov.; upper member of Atrash Formation; Wadi Qena, Egypt; coll. KBIN IST 10483 (holotype); adapical view; $\times 1.5$.
- Figure 2. – The same; adoral view; $\times 1.5$.
- Figure 3. – The same; detail of ambitus; $\times 7$.
- Figure 4. – The same; lateral view; $\times 1.5$.
- Figure 5. – *Heterodiadema lybicum* (AGASSIZ & DESOR, 1846); upper member of Atrash Formation; Wadi Qena, Egypt; coll. KBIN IST 10157; adapical view; $\times 1$.
- Figure 6. – The same; adoral view; $\times 1$.
- Figure 7. – *Pedinopsis* sp. ind.; upper member of Atrash Formation; Wadi Qena, Egypt; coll. KBIN IST 10494; lateral view; $\times 1.8$.
- Figure 8. – The same; adapical view; $\times 1.8$.
- Figure 9. – *Tetragramma variolare* (BRONGNIART, 1822); upper member of Atrash Formation; Wadi Qena, Egypt; coll. KBIN IST 10484; adapical view; $\times 1.25$.
- Figure 10. – The same; adoral view; $\times 1.25$.
- Figure 11. – *Pseudodiadema bigranulatum* (GREGORY, 1906); upper member of Atrash Formation; Wadi Qena, Egypt; coll. KBIN IST 10485; lateral view; $\times 2.5$.
- Figure 12. – Same species; same locality; coll. KBIN IST 10486; adapical view; $\times 2.5$.
- Figure 13. – The same as 11; adoral view; $\times 2.5$.

