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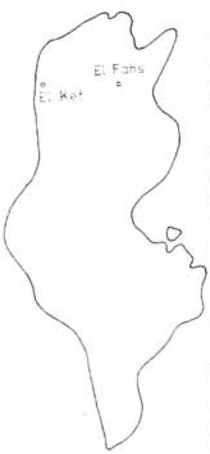
PROPOSITION OF TURONIAN BOUNDARIES OF THE TETHYAN REALM ON THE BASIS OF FORAMINIFERS

(Figs. 3, Pls. 4)



A b s t r a c t: From foraminifers extinction of rotalipores on the one hand and explosive development of dicarinells *(Dicarinella imbricata)* and whiteinells *(Whiteinella gigantea)* on the other hand represent the most distinct events in the Upper Cretaceous, which should be taken into a account also in the proposal for the definitive Cenomanian—Turonian boundary. This distinct microfaunistic change was taking place in the time the ammonite *Metoicoceras geslinianum/Euomphaloceras septemseriatum* Zone. For this reason this zone is necessary to consider as the basal Turonian zone, what would be in agreement with traditional understanding of the Cenomanian—Turonian boundary. The Turonian—Coniacian boundary would be determined by appearing of the species *Dicarinella concavata* (BROTZEN) and *Helvetoglobotruncana cachensis* (DOUGLAS). The species *Marginotruncana* ex gr. *renzi* (GANDOLFI), *Marginotruncana tarfayensis* (LEHMANN), *Marginotruncana sinuosa* PORTHAULT, considered as Coniacian only, are found throughout the Upper Turonian. Besides that, *Marthasterites furcatus* (DEFLANDRE) appears in close overlier of *Helvetoglobotruncana helvetica* T.R.Z. Regarding to the occurrence of this nannofossil in the Boreal region (NW Germany, England) in the underlier of the Upper Turonian *Subprionocyclus neptuni* Zone is evident, that the above mentioned planktic species should be put into relation with this ammonite zone and therefore it is not possible to count with them in determination of the Turonian—Coniacian boundary.

Р е з ю м е: Вымирание фораминифер типа *Rotalipora* с одной стороны и взрывчатое развитие типов *Dicarinella (Dicarinella imbricata)* и *Whiteinella (Whiteinella gigantea)* с другой стороны представляют самые особые явления верхнего мела, которые необходимо принимать во внимание также при предложении окончательной сеноманско—туронской границы. Это особое микрофаунистическое изменение происходило во время аммонитовой зоны *Metoicoceras geslinianum/Euomphaloceras septemseriatum*. Поэтому необходимо считать эту зону базальной туронской зоной, что будет в согласии с традиционным пониманием сеноманско—туронской границы. Туронско—коньякская граница будет определена появлением видов *Dicarinella concavata* (BROTZEN) и *Helvetoglobotruncana cachensis* (DOUGLAS). Виды *Marginotruncana* ex gr. *renzi* (GANDOLFI), *Marginotruncana tarfayensis* (LEHMANN), *Marginotruncana sinuosa* PORTHAULT, считаемые только коньякскими, встречаются в продолжение верхнего турона. Кроме того *Marthasterites furcatus* (DEFLANDRE) появляется непосредственно над зоной *Helvetoglobotruncana helvetica* (T. R. Z.). Ввиду появления этой наннофоссилии в бореальной области (СЗ Германия, Англия) внижележащей толще верхнетуронской зоны *Subpriono-*

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cyclus neptuni очевидно, что вышеприведенные планктонные виды необходимо соотносить с этой аммонитовой зоной и, поэтому, не является возможным принимать их во внимание при определении туронско—коньякской границы.

Introduction

In October 1983 in Copenhagen was a session of the Subcommission for Cretaceous Stratigraphy. The main objective of the session was to work out the criteria for determination of he boundaries of the individual Cretaceous stages and proposal of the stratotype localities defined best by fauna. Birkelund — Hancock — Hart — Rawson — Remane — Robaszynski — Schmid — Surlyk (1984) presented the views of the session participants taken into account as summary and provide several alternative proposals for definition of the boundaries of the individual Upper Cretaceous stages at several localities taken into consideration. For determination of the Cenomanian—Turonian and Turonian—Coniacian boundaries, besides the macrofauna, also foraminifers are taken into consideration, together with nannoplankton of the species *Marthasterites furcatus* (DEFLANDRE) should be used for determination of the Turonian—Coniacian boundary.

In the last time in Tunisia two profiles of the Upper Cretaceous (Djebel Fguira Salah and El Kef) were proposed as hypostratotypes by the author (Salaj, 1973; 1980), or stratotypes of the Upper Cretaceous stages for the Tethyan realm (Salaj, 1980; Salaj — Azzouz — Maamouri, 1976; Salaj — Maamouri, 1984) and the locatities (Hammam Mellègue and Kat ez Zerblia) near El Kef are suitable as stratotype localities for the Turonian — Coniacian and Campanian — Maastrichtian boundary (Birkelund et al. 1984). In the presented contribution the author wants to call attention to some knowledge, which should be taken into consideration with definitive determination of the Cenomanian—Turonian and Turonian—Coniacian boundaries.

Cenomanian — Turonian boundary

The question of the Cenomanian—Turonian boundary is largely discussed recently (Bengtson, 1983; Birkelund et al. 1984; Hancock, 1983, 1984; Cobban, 1983, 1984; Kennedy, 1984; Robaszynski et al. 1982; Robaszynski, 1984; Wright — Kennedy; 1981 Marks, 1984; Salaj — Samuel, 1977; Salaj — Gašpariková, 1983 and others).

The author of the contribution (Salaj, 1980, p. 81) is tending to the opinion that it is more correct to put the Cenomanian—Lower Turonian boundary to the base of the *Metoicoceras geslinianum/Euomphaloceras septemseriatum* Zone, as proposed as the first possible alternative by Hancock (1983, p. 60; 1984, p. 126), Birkelund et al. (1984, p. 12) and what would be also in agreement with the traditional Cenomanian—Turonian boundary (Ernst — Wood — Hilbrecht, 1984, p. 105) In the middle part of this zone is a distinct, sharp step of development among planktic foraminifers. On the one hand, it is extinction of rotalipores and on the other hand rapid explosive development of representatives of the genus *Dicarinella* PORTHAULT, 1970 and of the genus

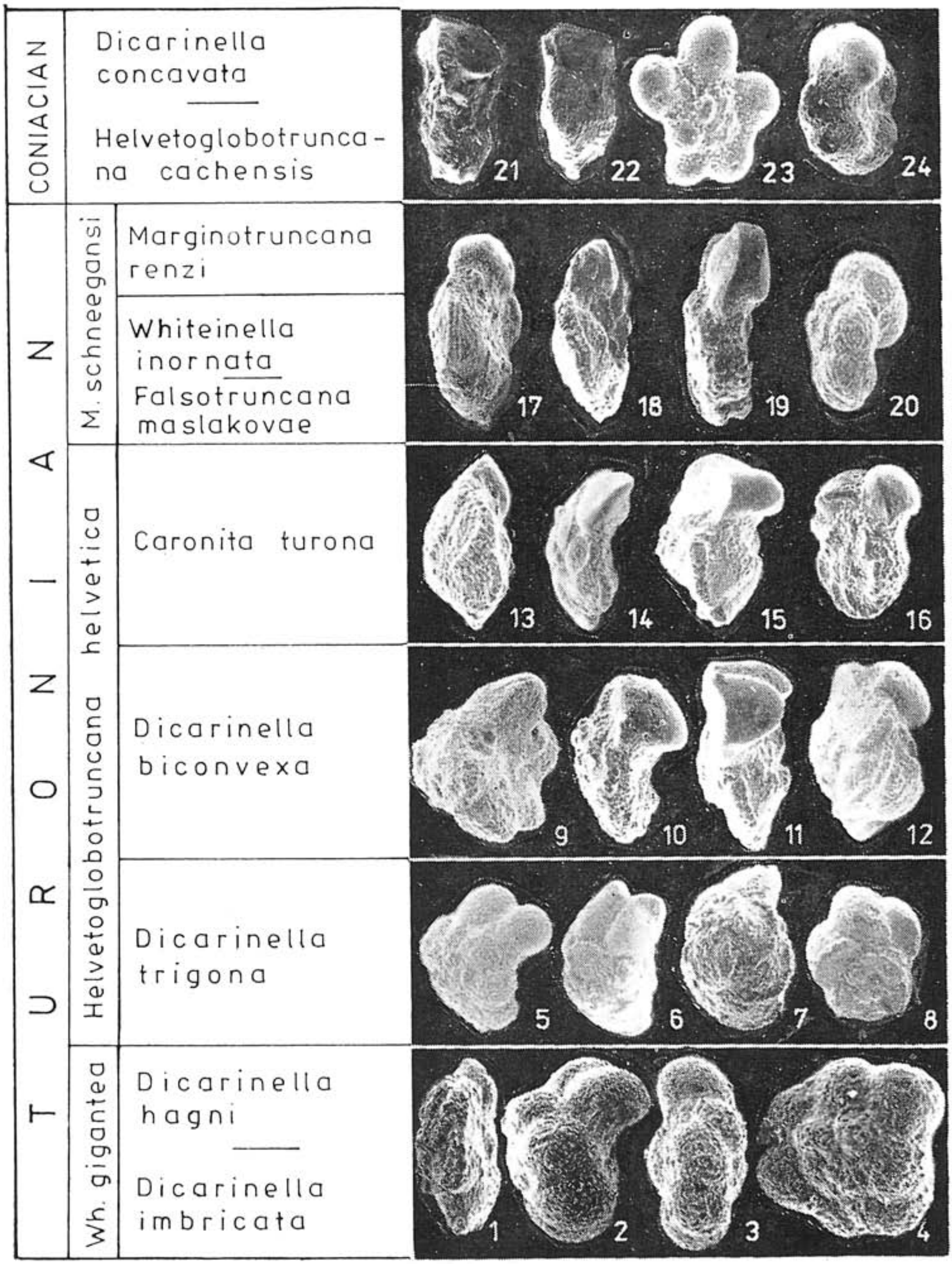
Whiteinella PESSAGNO, 1967 (Hagn — Zeil, 1945; Lehmann, 1962; Carter — Hart, 1977; Salaj — Samuel, 1977; Wright — Kennedy, 1981) within the *Whiteinella gigantea — Dicarinella imbricata* Zone (Salaj — Gašpariková, 1983), or *Dicarinella imbricata* Zone (Salaj — Samuel, 1966; 1977).

If we take into consideration a compromising solution that extinction of rotalipores and appearing of dicarinells was taking place throughout the basal Turonian (Salaj — Samuel, 1966; 1977, p. 73), or at the Cenomanian—Turonian boundary (Marks, 1984), then this solution would be most practical for current biostratigraphical practice. In both cases the Cenomanian—Turonian boundary should be established by the base of the *Metoicoceras geslinianum Euomphaloceras septemseriatum* Zone. So also d'Orbigny's opinion (1852), would be supported indirectly, that this ammonite zone in the area of Saumur, as indicated by Hancock (1983, p. 60) can be called also Turonian.

Equally from the palaeogeographical-tectonic and palaeoecological viewpoint it will be more correct when the whole *Metoicoceras geslinianum Eumphaloceras septemseriatum* Zone is in the Turonian, as at the Cenomania—Turonian boundary distinct changes were taking place in northwestern Europe. Stratigraphical hiatuses are frequent or at many places distinct condensation is taking place during sedimentation. Such a condensation was taking place in places in Tunisia, e.g. also in the area of El Fahs on a raised basement (haut fond), however, under conditions of pelagic sedimentation without supply of clastics. The Lower Turonian at the locality Djebel Fguira Salah, represented by the *Dicarinella imbricata — Whiteinella gigantea* Zone, is only 120 cm thick (Salaj, 1980), on the contrary, in the area of El Kef (Hammam Mellègue) this zone is of thickness about 30 m.

Other alternative proposals (Birkelund et al. 1984; Hancock, 1984) for definition of the stratotype boundary of the Turonian, i. e. the basal Turonian zone (base of the *Waticoceras coloradoense* Zone — see also Robaszynski, 1983; further, the base of the *Pseudospidoceras flexuosum* Zone) are met with some difficulties and problems (Hancock, 1984, p. 127), of which the most serious problem is that the individual ammonite zones at the proposed localities are not containing characteristic microfauna or are very poor in it. In addition, the above mentioned Cenomanian—Turonian boundary would not run not at the base of the developing typically Turonian association but higher, so that the typical foraminifer associations considered as Turonian so far would come to the Cenomanian. In this conception the Turonian base would be determined by appearig of the species *Helvetoglobotruncana helvetica* (BOLLI) together with *Mytiloides mytiloides* (MANTELL) and *Mytiloides* sp. (ERNST et al. 1984).

Therefore, taking into consideration all the viewpoints, it will be most correct to tend to the opinion that the Cenomanian—Turonian boundary should be established on the basis of the ammonite *Metoicoceras geslinianum/Euomphaloceras septemseriatum* Zone or still more correctly in its middle part, i. e. from appearance of *Vascoceras cauvini* CHUDEAU, a typical Turonian Tethyan species. This species, as proved by LEWY—KENNEDY—CHANCELLOR (1984), is found together with *Metoicoceras geslinianum* (D'ORBIGNY) and further, the Lower Turonian *Vascoceras cauvini* Zone in Israel can be correlated with the Upper Cenomanian *Neocardioceras juddii* Zone in Texas (HOOK — COBBAN, 1981) indirectly, on the basis of the occurrence of *Pseudospidoceras pseudonodo-*


CONIACIAN
Dicarinella concavata
Helvetoglobotruncana cachensis
21
22
23
24
TURONIAN
M. schneegansi
Marginotruncana renzi
Whiteinella inornata
Falsotruncana maslakovae
17
18
19
20
Helvetoglobotruncana helvetica
Caronita turona
13
14
15
16
Dicarinella biconvexa
9
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11
12
Dicarinella trigona
5
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8
Wh. gigantea
Dicarinella hagni
Dicarinella imbricata
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soides (CHOFFAT) in both zones. Therefore we propose to understand the Upper Cenomanian *Metoicoceras geslinianum* Zone as a zone s.s. defined at the top by appearance of the species *Vascoceras cauvini* CHUDEAU. On the contrary, the Lower Turonian *Vascoceras cauvini* Zone, known from Israel (LEWY—KENNEDY—CHANCELLOR, 1984), would be understood as a zone s.l., the lower boundary of which would be determined by appearance of *Vascoceras cauvini* and would also include the upper part of the *Metoicoceras geslinianum* Zone s. l. and the whole *Neocardioceras juddii* Zone. So the base of the *Vascoceras cauvini* Zone would correspond more or less also to the base of the foraminifer *Whiteinella gigantea — Dicarinella imbricata* Zone.

Turonian

Zonal subdivision of the Turonian in Tunisia on the basis of planktic foraminifers is mentioned in Fig. 1. Appearing of individual species important for stratigraphic subdivision of the Turonian is shown in Fig. 2.

Zonal subdivision of the Turonian in Tunisia, which represents a typical Tethyan region, is partly different from the Turonian of the West Carpathians (Salaj — Samuel, 1977; 1979) belonging to the northern branch of the Tethyan realm (Salaj — Gašpariková, 1979). In the Turonian of the West Car-

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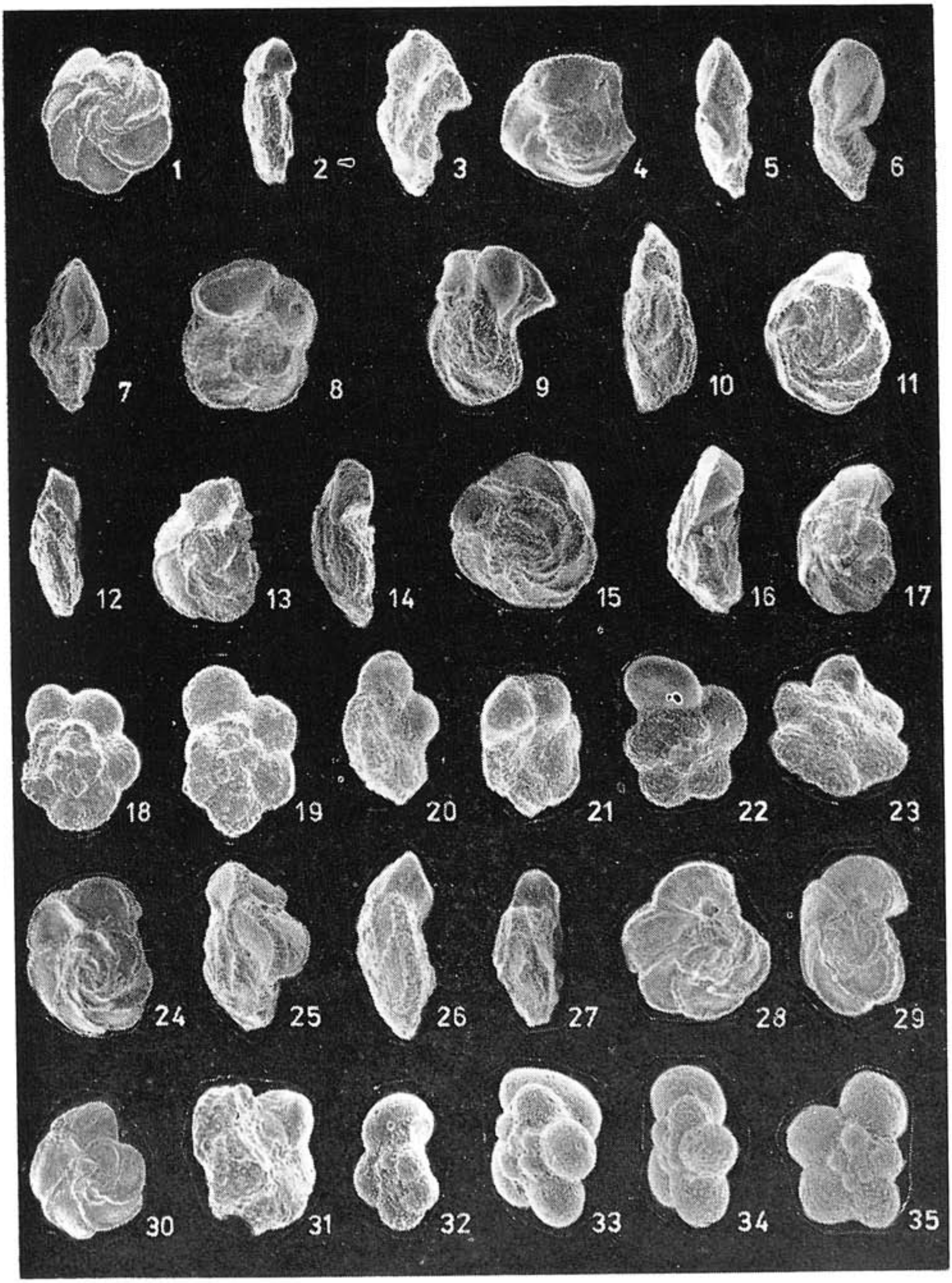
Fig. 1. The microbiostratigraphy of the Turonian in Tunisia.

Explanations 1 — *Dicarinella aff. imbrcata* (MORNOD) (×35, sample Z 122b, loc.: Dj. Fguira Salah, El Fahs, Tunisia (see documentation Salaj, p. 77, Fig. 28, Pl. 43); 2 — *Whiteinella paradubia* (SIGAL) (×35), sample Z 122; 3 — *Whiteinella aprica* (LOEBLICH — TAPPAN) (×40), sample Z 122 b; 4 — *Whiteinella gigantea* (LEHMANN) (×35), sample Z 122b; 5 — *Whiteinella oumalensis* (SIGAL) (×35), sample Z 123, loc.: Dj. Fguira Salah; 6 — *Dicarinella trigona* (SCHEIBNEROVÁ) ×40, sample E 16, loc.: Dj. Abid (seee documentation Salaj, 1970, p. 375, Tab. 1); 7 — *Dicarinella oraviensis* (SCHEIBNEROVÁ) (×40), sample Z 123; 8 — *Helvetoglobotruncana helvetica* (BOLLI) (×40), sample Z 1312, loc.: Thuburbo Majus (see documentation Salaj, 1980; p. 50, Fig. 21); 9 — *Dicarinella turbinata* (REICHEL) (×40), sample Z 133, loc.: Dj Fguira Salah; 10 — *Dicarinella biconvexa* (SAMUEL — SALAJ) (×30), sample Be 300, loc.: Béja, Tunisie; 11 — *Dicarinella fusani* (SALAJ — SAMUEL) (×30), sample Z 131, loc.: Dj. Fguira Salah; 12 — *Dicarinella fusani* (SALAJ — SAMUEL) (×40), sample Z 1312, loc.: Thuburbo Majus; 13 — *Caronita sigali* (REICHEL) ×35, sample Z 1312; 14 — *Caronita turona* (OLBERTZ) (×30), sample Be 300; 15 — *Caronita marianosti* (DOUGLAS) (×30), sample Be 300; 16 — *Dicarinella carpathica* (SCHEIBNEROVÁ) (×40), sample Z 132h, loc.: Dj. Fguira Salah; 17 — *Marginotruncana schneegansi* (SIGAL) emend. SALAJ (×40), sample Z 1992, loc.: Dj Fguira Salah; 18 — *Dicarinella schneegansii* (SIGAL) emend. (CARON) ×35, sample Z 1992; 19 — *Falsotruncana maslakovae* CARON (×45), sample Z 184, loc.: Dj. Fguira Salah; 20 — *Helvetoglobotruncana inornata* (BOLLI) (×50), sample Z 184; 21 — *Marginotruncana renzi* (GANDOLFI) (×40), sample Z 2004, loc.: Dj. Fguria Salah (see documentation Salaj 1980, p. 86, Fig. 30, Pl. 46); 22 — *Dicarinella primitiva* (DALBIEZ) (×30), sample Z 2004; 23 — *Clavihedbergella subdigitata* (Carman) (×70), sample Z 2004; 24 — *Helvetoglobotruncana cachensis* (DOUGLAS) (×50), sample Z 2004.

The microphotos, the negatives of which were made by the operator Mr. K. Šebor, were prepared by aid of scanning microscope stereoscan JSM — U_3 at the Dionýz Štúr Institute of Geology in Bratislava.

Plate 1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pathians Lower to Middle Turonian representatives of the genus *Whiteinella* PESSAGNO, 1967, are missing. On the contrary, in the Turonian of Tunisia the species *Marginotruncana marginata* (REUSS), a typical Boreal species, is missing, which in the West Carpathians is also found sporadically only. Appearing of the species *Helvetoglobotruncana helvetica* (BOLLI) and so also the base of the zone of equal name is in the higher part of the Lower Turonian in the sense of knowledge of ROBASZYNSKI—CARON (1979). The upper part of this T. R. Z. is already in the Upper Turonian, in the basal part of the *Romaniceras deverianum* Zone, what is in agreement with knowledge of SALAJ — SAMUEL (1966, 1977, 1984), SALAJ—BELLIER (1978), BILLOTE—CALANDRA (1981) and other.

Mutual detailed parallelization of the Turonian of both the mentioned regions is carried out in the work by Salaj—Samuel (1979), to which we also refer.

From palaeogeographical viewpoint it is necessary to stress that the area of northwestern Tunisia, as also the area of El Kef — Les Salines represented maximum deepening-upper bathyal (Tunisian Trough, Burollet, 1967) with distinct pelagic sedimentation and typical facies of euxinic black limestones and marls in the Middle Cretaceous and mainly the Upper Cenomanian and Turomian. The influence of the considerably distant continent of the African shield as source area was shown very insignificantly in the uppermost Albian—Lower Cenomanian and Uppermost Cenomanian—Lower Turonian. It was the supply of very fine aleuritic quartz, which was taking part in formation of thin-fissionable, bituminous, intrabiomicrite black limestones and marlstones.

As to the Tunisian Trough, it is necessary to stress that is was continuation of

Plate 1

Figs. 1—2. *Marginotruncana coronata* (BOLLI) (×30), sample Z 190, loc.: Djebel Fguira Salah, Late Turonian, *Marginotruncana renzi* Subzone; Figs. 3—4. *Marginotruncana sinuosa* PORTHAULT (×35, ×40), sample Z 190; Fig. 5. *Marginotruncana schneegansi* SIGAL, emend. CARON (×30), sample Z 1994, loc.: Djebel Fguira Salah, Late Turonian, *Marginotruncana renzi* Subzone; Fig. 6. *Marginotruncana tarfayensis* (LEHMANN) (×30), sample Z 1994; Figs. 7—8. *Marginotruncana coldreriensis* (GANDOLFI) (×30),sample Z 1994; Fig. 9 *Marginotruncana renzi* (GANDOLFI) (×30), sample Z 1994; Fig. 10. *Marginotruncana pseudolinneiana* PESSAGNO (×30), sample Z 1994; Fig. 11. *Marginotruncana coldreriensis* (GANDOLFI) (×30), sample 1994; Fig. 12—13. *Marginotruncana schneegansi* (SIGAL) emend. CARON (×25), sample 1994; Fig. 14. *Marginotruncana coronata* (BOLLI) (×35), sample Z 190; Fig. 15. *Marginotruncana coldreriensis* (GANDOLFI) (×30), sample Z 1994; Fig. 16—17. *Marginotruncana coldreriesis* (GANDOLFI) (×30, ×35), sample Z 190; Figs. 18—19. *Marginotruncana* aff. *marginata* (REUSS) (×40, ×60,) sample Z 190; Figs. 20—21. *Marginotruncana coldreriensis* (GANDOLFI) (×40, ×30,) sample Z 1994; Figs. 22—23. *Marginotruncana schneegansi* (SIGAL) emend. SALAJ (×40. ×35), sample Z 190; Figs. 24—25. *Marginotruncana renzi* (GANDOLFI) (×25, ×30), sample Z 1994; Fig. 26. *Marginotruncana schneegansi* (SIGAL) emend. CARON (×40), sample Z 1994; Fig. 27. *Marginotruncana coldreriensis* (GANDOLFI) (×25), sample Z 1994; Figs. 28—29. *Marginotruncana coronata* (BOLLI) (×30), sample Z 1994; Fig. 30. *Marginotruncana coronata* (BOLLI) (×30), sample Z 190; Fig. 31. *Falsotruncana cf. maslakovae* CARON (×70), sample Z 190; Fig. 32. *Helvetoglobotruncana inornata* (BOLLI) (×35), sample Z 1994; Fig. 33. *Helvetoglobotruncana inornata* (BOLLI) (×60), sample Z 190; Figs. 34—35. *Helvetoglobotruncana inornata* (BOLLI) (×45, ×40), sample Z 1994.

the oceanic Rif/Tell basin. According to Thurow — Kuhnt — Wiedmann (1982) in this basin coastal upwelling is the principal mechanism of development of these peculiar sedimentary types in a rather differen palaeogeographic and palaeobathymetric frame.

AGE	ZONATION		
LOWER CONIACIAN	Dicarinella concavata	Helvetoglobotruncana cachensis Marginotruncana angusticarinata	D. concavata, D. asymetrica, H. cachensis entry
TURONIAN	Marginotruncana schneegansi	Marginotruncana renzi	Dicarinella primitiva entry M. renzi, M. tarfayensis entry
		Whiteinella inornata Falsotruncana maslakovae	M. sinuosa, M. coldreriensis M. schneegansi, W. inornata entry
	Helvetoglobotruncana helvetica	Caronita turona	H. helvetica, Caronita div. sp. exit Caronita marianosi entry C. turona, C. sigali entry
		Dicarinella biconvexa	Dicarinella fusani, D. carpathica entry D. biconvexa, D. gigantea entry
		Dicarinella trigona	H. helvetica, D. trigona entry
	Whiteinella gigantea	Dicarinella hagni	D. hagni, D. turonica entry
		Dicarinella imbricata	W. gigantea, W. aprica, D. imbricata entry
Cn^3	Rotalipora cushmani		Rotalipora div. sp. exit

Fig. 2. Planktic foraminiferal events related to the Turonian.

Regarding to the equal subsidential sedimentation during the Turonian in the Tunisian Trough, we propose the profile Hamman Mellègue (El Kef area) as standard one for considerations about the age diapason of the individual planktonic zones. According to Odin — Kennedy (1982) the absolute age of the Turonian is estimated to 3 mil. y. With a thickness of 300 m of Turonian sediments in this area the rate of sedimentation is shown as 10 m/10^3y (Fig. 3).

The study of thickness of the individual zones permits us to conclude on tectonic processes, which caused the paleogeographic changes not only in the configuration of continents but also distinct changes in morphology of the sea floor in the course of sedimentation (inversion of relief). As an example we mention the area of Dj. Fguira Salah where a distinct condensed sedimentation (only 1.20 m of sediments) was taking place during the Lower Turo-

time in my	stage	PLANKTIC FORAMINIFERAL ZONES AND SUBZONES		TUNISIAN TROUGH: Northwestern part – Hammam Mellègue (El Kef) standard profile					TUNISIAN TROUGH: Eastern part – Dj. Fguira Salah (El Fahs) hypostratotype				PELAGIAN BLOCK: Northern part – Dj. Abid (Enficaville) parastratotype			
				thickness		sed. rate 10^3 y	estimated time in my		thickness		sedimentation rate 10^3 y		thickness		sedimentation rate 10^3 y	
93,200 – 94,400	TURONIAN	Marginotruncana schneegansi	Marginotruncana renzi	120 m	300 m	10 cm	2,020.000	1,200.000	26 m	70 m (reduction 4,285 : 1; in the relation to the standard profile)	4,615 : 1	2,166 cm	11 m	67,5 m (reduction 4,444 : 1; in the relation to the standard profile)	10,9 : 1	0,916 cm
94,400 – 95,220			Whiteinella inornata / Falsotruncana maslakovae	82 m				820.000	38 m		2 157 : 1	4,634 cm	20 m		4,1 : 1	2,439 cm
95,220 – 95,430		Helvetoglobotruncana helvetica	Caronita turona	21 m			570.000	210.000	0,5 m		42 : 1	0,238 cm	4 m		5,25 : 1	1,904 cm
95,430 – 95,630			Dicarinella biconvexa	20 m				200.000	2,1 m		9,523 : 1	0,105 cm	17,5 m		1,142 : 1	8,75 cm
95,630 – 95,790			Dicarinella oraviensis trigona	16 m				160.000	2,2 m		7,272 : 1	0,137 cm	7 m		2,285 : 1	4,375 cm
95,790 – 95,[illegible]		Whiteinella gigantea	Dicarinella hagni	21 m			410.000	210.000	0,6 m		35 : 1	0,028 cm	4 m		5,25 : 1	1,904 cm
95,[illegible] – 96,200			Dicarinella imbricata	20 m				200.000	0,6 m		33,33 : 1	0,030 cm	4 m		5 : 1	2,0 cm

Fig. 3. Estimated time, relationship and correlation of Turonian planktic zones in Tunisia

nian (*Whiteinella gigantea* Zone), this a rate of sedimentation 0.030 cm/10^3y only.

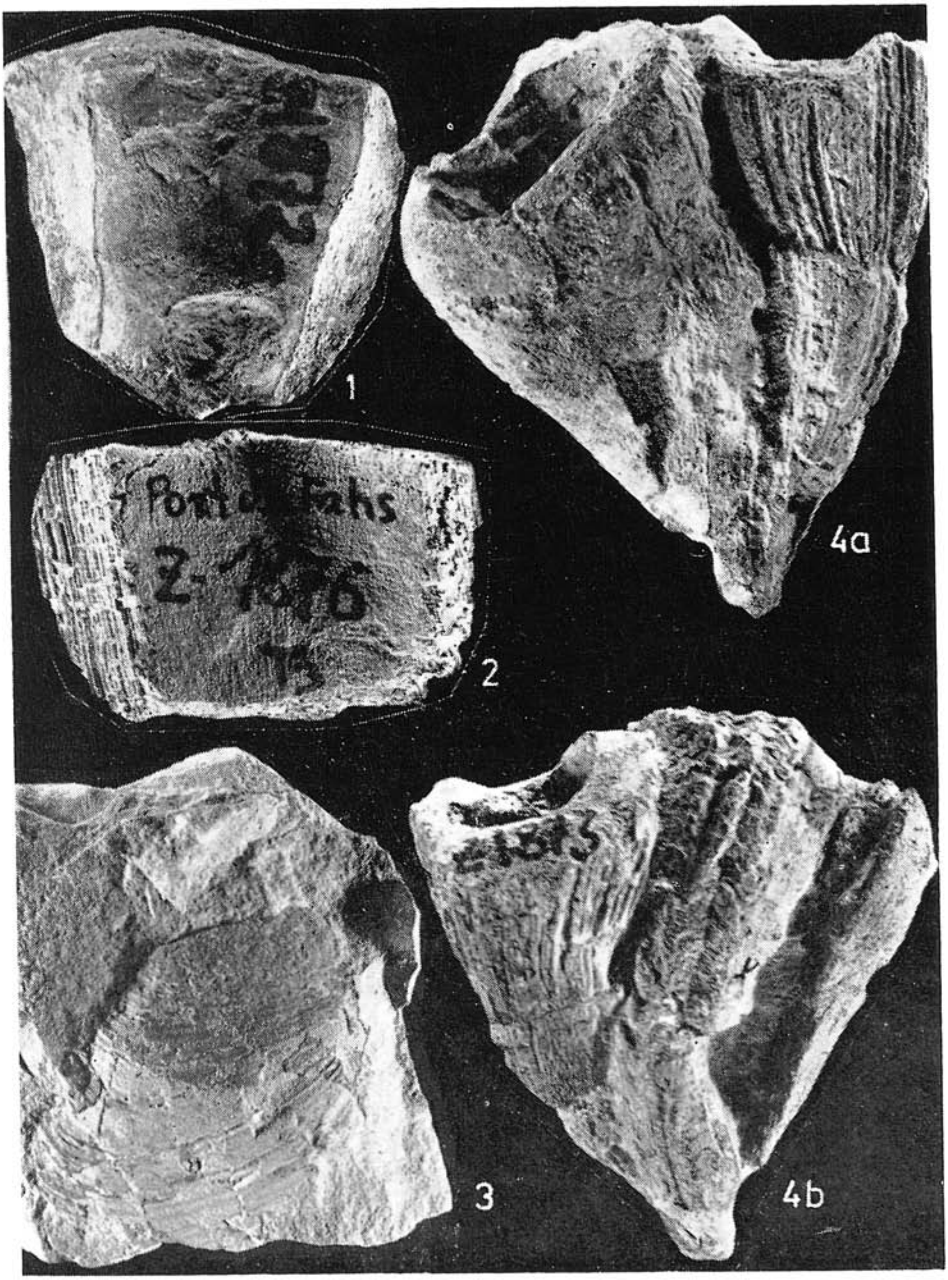
The second maximum of condensed sedimentation (0.5 m) was taking place to the end of the Middle Turonian *(Caronita turona Subzone)*. The rate of sedimentation is 0.338 cm/10^3y.

When also there was deepening and deposition of 64 m of sediments in the Upper Turonian in the area of Dj. Fguira Salah, the rate of sedimentation is slower here in relation to the El Kef area, in the ratio about 3 : 1.

The knowledge of the estimated age of the individual planktonic Turonian zones may be applied fully also in the West Carpathians. In the Kysuca trough thickness of Turonian sediments of the type profile of the Kysuca succession is 285 m. In relation to the standard El Kef profile the following values result for the individual Turonian zones of the Kysuca succession with equal range of age as for Tunisia:

For completeness we remark that in Upper Turonian turbidite sediments of the Kysuca succession coarse—grained exotic conglomerates are not present. Although these are present in the Turonian and Coniacian in the road cut near Považský Chlm, but this succession cannot be considered as the Kysuca succession, but as the Klape succession. This confirms a different facies development and, moreover — the Middle Turonian and Upper Cenomanian are in flysch development in this profile S a l a j, 1985.

Plate 2



Turonian—Coniacian boundary

A further problem is the question of solving of the Turonian—Coniacian boundary. Marks (1984, pp. 165—166) recommends that appearing of the species *Marginotruncana* ex gr. *sinuosa* PORTHAULT, *Dicarinella primitiva* (DALBIEZ), *Marginotruncana* ex gr. *renzi* (GANDOLFI) and *Marginotruncana tarfayensis* (LEHMANN) should serve as provisional criterion of determination of the Turonian—Coniacian boundary, equally as appearing of the nannoplankton species *Marthasterites furcatus* (DEFLANDRE), as would be also in agreement with observations of Thierstein (1976), Sissingh (1977; 1978), Verbeek (1976; 1977), Perch-Nielsen (1979; 1983). When also Birkelund et al. (1984, p. 13) consider one of the possibilities of determination of the Turonian—Coniacian boundary on the basis of appearing of the species *Marthasterites furcatus* (DEFLANDRE), they mention the counter-argument that in the Boreal region in England (Bailey—Gale—Mortimore—Swiecicki—Wood, 1984, pp. 32—33) and in northwestern Germany (Wood—Ernst—Rasemann, 1984, p. 235) this species is proved from the lower part of the Upper Turonian *Subprionocyclus neptuni* Zone.

For this reason the first note of the occurrence of the species *Marthasterites furcatus* (DEFLANDRE) from the Upper Turonian also of the Tethyan realm (Tunisia) mentioned by Crux (1982) and Salaj—Gašpariková (1983) should not be surprising. This species comes from the sample (Z 1318) taken from the basal part of the Upper Turonian sequence of the *Marginotruncana schneegansi* Zone with *Hippurites requiemi* (Salaj, 1980, p. 117, Fig. 28; Salaj—Bellier, 1978), situated in close overlier of the *Helvetoglobotruncana helvetica* Zone. The uppermost part of the *Helvetoglobotruncana helvetica Zone* is formed by an about 1 m thick thick-banked biomicrite limestone layer rich in inocerams. These were originally determined by Salaj (Salaj, 1970, 1980; Salaj—Bellier, 1978) as *Inoceramus (Cremnoceramus) schloenbachi* (BÖHM). These inocerams, however, after revision belong to the species *Mytiloides fiegei mytiloidiformis* (TRÖGER) (Pl. 2, Fig. 3).

It is evident from the mentioned comparison that the marlstone — limestone sequence of the *Marginotruncana schneegansi* Zone with *Mytiloides fiegei mytiloidiformis* (TRÖGER), *Hemiaster* aff. *latigrunda* PERVINQUIÉRE et GAUTHIER, *Hemiaster verneuili* DESOR, *Holaster (Holasteropsis)* aff. *latissimus* (ROEMER) (Pl. 4, Figs. 1—4), *Hippurites requieni* MATHERON and *Marthasterites furcatus* (DEFLANDRE) overlying the foraminifer *Helvetoglobotrun-*

Plate 2

Fig. 1. *Durania* sp. (×1.2), sample Z 1872, loc.: Djebel Fguira Salah, El Falhs, Lower Coniacian.
Fig. 2. *Durania* cf. *gaensis* DACQUI (×1.2), sample Z 1876, loc.: Djebel Fguira Salah, El Fahs, Lower Coniacian.
Fig. 3. *Mytiloides fiegei mytiloidiformis* (TRÖGER) (×1.2), sample Z 1317, loc.: Djebel Fguira Salah, El Fahs. Top of the *Helvetoglobotrucana helvetica* Zone, base of the Upper Turonian.
Fig. 4 a, b. *Biradiolites* aff. *lumbricalis* D'ORBIGNY (×1.4, ×1.2) sample Z 1873, loc.: Djevel Fguira Salah, El Fahs, Lower Coniacian.

The negatives of the macrofossils (Pls. 2—4) were made by Mrs. H. Jendeková.

Plate 3

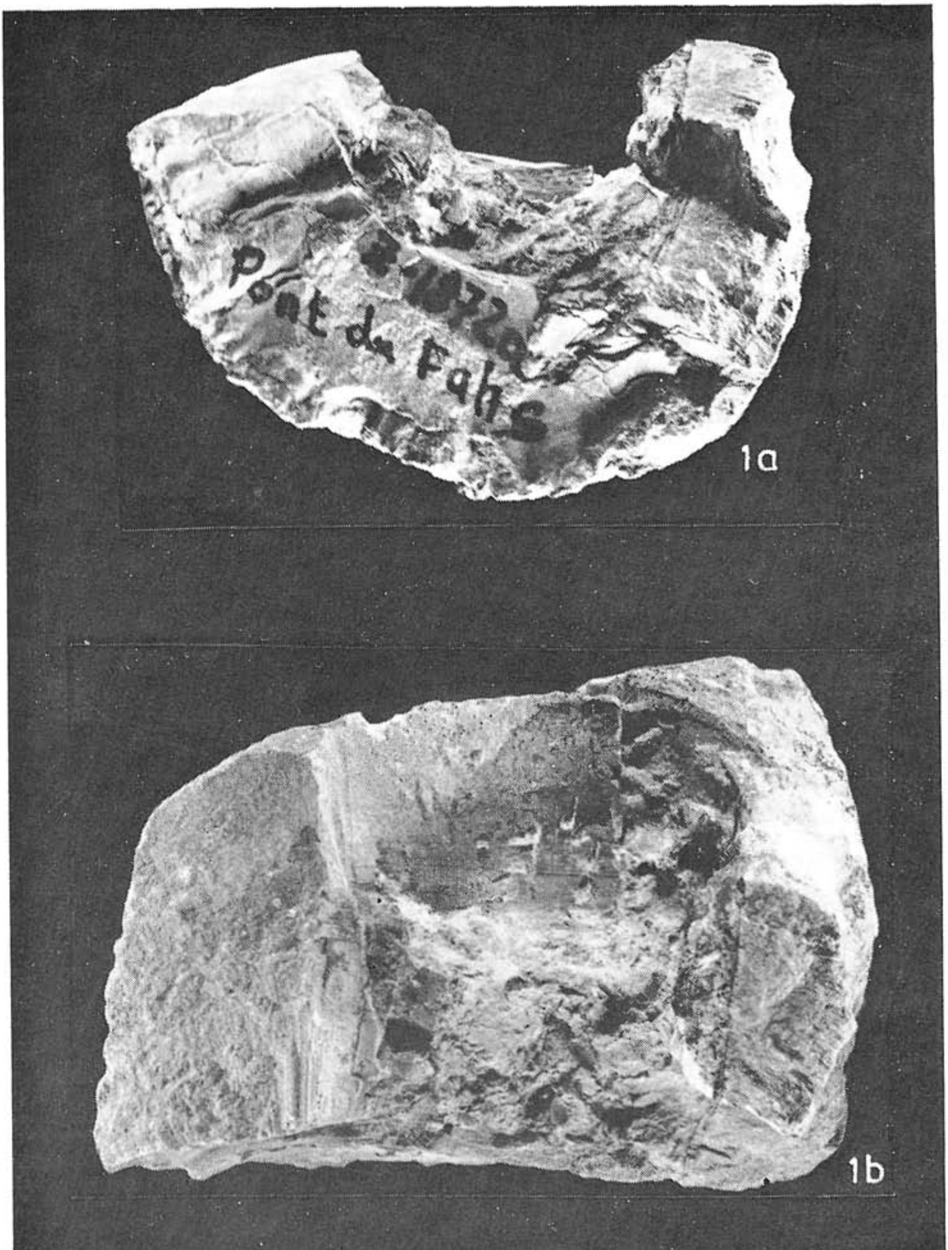


Fig. 1 a, b. *Eoradiolites* cf. *lyratus* CONRAD (×1.2; ×1.4), sample Z 1872, loc.: Djebel Fguira Salah, El Fahs (= sample Z 1177, see Salaj 1980, p. 86, Fig. 30), Lower Coniacian.)

cana helvetica Zone corresponds to nearly the upper part of Upper Turonian and is correlable with the *Subprionocyclus neptuni* Zone.

In connection with first appearing of the species *Marthasterites furcatus* (DEFLANDRE) already in the Late Turonian at the profile Djebel Fguira Salah at the same time also the question of appearing of significant planktic Tethyan foraminifers may be solved at this profile, which, as already mentioned above (Marks, 1984; Bellier, 1983), are put into relation with the Turonian—Coniacian boundary.

The species *Marginotruncana renzi* (GANDOLFI) — with straight dorsal side (Salaj—Samuel, 1966; 1984), *Marginotruncana coldreriensis* (GANDOLFI), *Marginotruncana sinuosa* PORTHAULT and *Marginotruncana tarfayensis* (LEHMANN) begin to appear in the middle part of the *Marginotruncana schneegansi* Zone (from sample No. 22 and 1180, Salaj, 1980, p. 77, Fig. 28; Lamolda, 1983, p. 101). The species *Dicarinella primitiva* (DALBIEZ) was considered by the author (Salaj, 1980) as Coniacian only, however, its morphotypes related with *Marginotruncana renzi* (GANDOLFI) are also found in the uppermost Turonian.

The boundary between the Turonian—Coniacian hypostratotypes, as also established in the field (Salaj, 1973, 1980; Salaj—Bellier, 1978; Salaj—Gašpariková, 1983) is determined by appearing of the species *Dicarinella concavata* (BROTZEN), *Helvetoglobotruncana cachensis* (DOUGLAS) and the species *Marginotruncana angusticarinata* (GANDOLFI). The last named species determines the Coniacian base in the West Carpathians (Salaj—Samuel, 1966; 1984), also in Israel (Flexer—Honigstein, 1983, p. 50, Pl. 1).

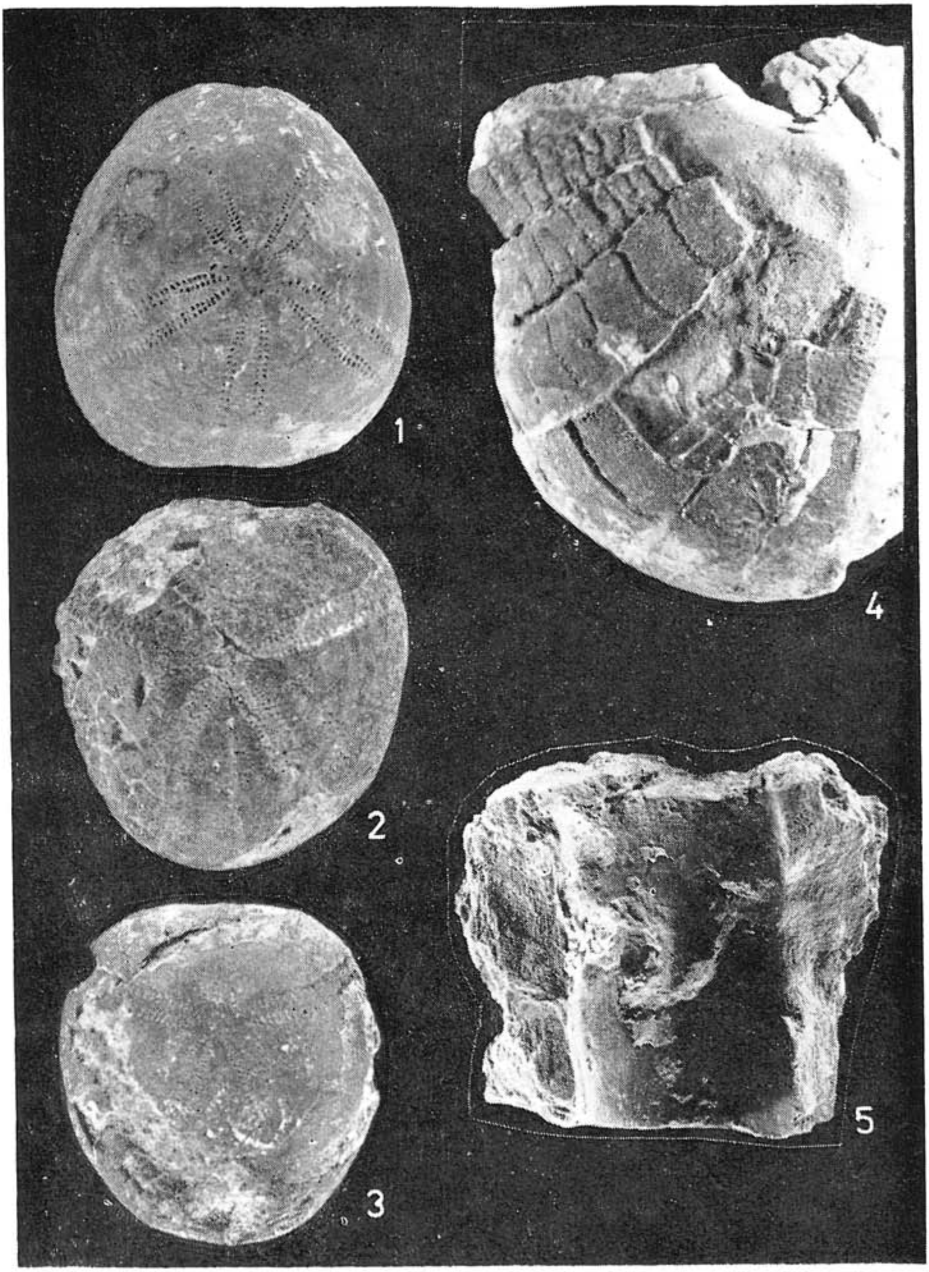
This opinion of first appearence of the above mentioned foraminifer species in the Coniacian is also confirmed by macrofauna. In the basal part of the Coniacian hypostratotype at the profile Djebel Fguira Salah rudists are found represented by the species: *Biradiolites lumbricalis* D'ORBIGNY (Pl. 2, Fig. 4a, b), *Eoradiolites* cf. *lyratus* CONRAD (Pl. 3) and echinoids, from which mainly the species *Holaster descloiseauxi* COQUAND is present.

Conclusion

Closing it may be stated that equal microbiostratigraphical conditions at the Turonian—Coniacian boundary as at the locality Djebel Fguira Salah are at many other localities in Tunisia. We mention from them the locality Thuburbo Majus (Salaj, 1980, p. 58, Fig. 21) and the locality Hammam Mellègue, mainly studies by Dalbiez (1955), Burollet (1956) and Salaj (1970). The last named profile with the Turonian part and the Turonian—Coniacian boundary are cropping out in the cut of the river Oued Mellègue. The Middle to Upper Turonian in the facies of black limestones and marls as well as the Coniacian mainly represented by grey marls and limestones are rich in inoceram fauna.

On the contrary, the above mentioned area (Djebel Fguira Salah, Thuburbo Majus) represented in the Turonian and Coniacian zone, in which sedimentation was taking place under conditions of raised basement (presence of abundant rudists). This distinctly uplifted zone of north-southern direction separated NW Tunisia with relatively deep-sea sedimentation (Tunisian Trough,

Plate 4



Burollet, 1967) from eastern Tunisia already belonging to other paleogeographical zone, represented by the Pelagian block (Burollet, 1967; Salaj, 1980).

Translated by J. Pevný

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Plate 4

Fig. 1. *Hemiaster verneuili DESOR* (×1.2), sample Z 83, loc.: Dj. Fguira Salah, El Fahs. Uppermost Turonian.

Fig. 2. *Hemiaster* aff. *latigrunda* PERVINQUIÈRE et GAUTHIER (×1.2), sample Z 83.

Fig. 3. *Hemiaster* aff. *latigrunda* PERVINQUIÈRE et GAUTHIER (×1.2), sample Z 83.

Fig. 4. *Holaster (Holastreropsis)* aff. *latissimus* (ROEMER) (×1.5), sample Z 83.

Fig. 5. *Durania* sp. (×1.2), sample Z 1872, loc.: Dj. Fguira Salah, El Fahs. Lower Coniacian.

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