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INTEGRATED BIOSTRATIGRAPHY OF THE CENOMANIAN OF ROMANIA

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Abstract. In this papers, the first model with the Cenomanian intercorrelated biostratigraphy of Romania, elaborated by the authors on theirs concomitant studies, is improved by the new data and its detailed content is first reported for to be printed.

Keywords: Romania, Cenomanian, Intercorrelated biostratigraphy, Ammonites, Inoceramids, Planktonic foraminifera, Dinoflagellates, Pollen, Nannoplankton.

INTRODUCTION

Based on the biostratigraphic data obtained from numerous stratigraphic sections [from the East and South Carpathians, North Dobrogea (Babadag Basin) and South Dobrogea (outcropping deposits of the Moesian Platform)] studied by us, the first integrated biostratigraphic model us have elaborated for the Cenomania of Romania using the ammonites, inoceramids (L.S.), planktonic foraminifera (J.I.), dinoflagellates, pollen (E.A.) and calcareous nannoplankton (M.C. M.) (Ion *et al.*, l997a, l998, emended and completed in this paper)(Fig.1). The principal biostratigraphic data/sections for the Carpathian domain have been obtained from the basinal deposits of the Median Dacides major tectonic unit, preseved in the Hateg Basin, Banita Basin, Cheia Basin (Vanturarita-Cozia area) and Tara Barsei Basin. Only for the Lower Cenomanian the additional data given by the deposits of the Outer Dacides (Icovesti-Badeni area) and of norther part of the Moldavides. In the Carpathians our integrated biostratigraphic studies are based on the all fossil groups cited while in the Dobrogea olny on macrofauna, planktonic foraminifera and sometimes on calcareous nannoplankton. It is to note that the charts with the location into the Carpathian and North Dobrogea Cenomanian stratigraphic successions of the biostratigraphic sections there are in Ion & Szasz, 1994, Ion *et al.*, 1997b.

For this on six fossil groups Cenomanian integrated biostratigraphy of Romania, we have been published only: a table with this integrated biozonation and other one that displays the vertical distribution especially of the zonal species markers and with the chronological significance of the bioevents (Ion *et al.*, 1997a); a short report of the new and emended biozones separated in this integrated scale (Ion *et al.*, 1998). The detailed intercorrelated biostratigraphic data, the figures with the biostratigraphic key sections and some stages concerning the integrated biozonation are given in: with microfauna and microflora only, Antonescu *et al.*, 1978, Ion *et al.*, 1994 (for northern East Carpatrhians); planktonic foraminifera and macrofauna only, Ion, 1983 (Tara Barsei Basin); macrofauna and planktonic foraminifera, Szasz & Ion, 1988 (North Dobrogea), Szasz & Ion, 1984*, Ion & Szasz, 1989*, 1994 and Ion, 1993* (Carpathians and North Dobrogea); macrofauna, planktonic foraminifera and microflora, Ion *et al.,* 1987 (unpublished data; Carpathians and North Dobrogea) plus nannoflora, Szasz *et al.*, 1992 (unpublished data;Carpathians, North and South Dobrogea). Additional paleontological and/or biostratigraphical papers on the one fossil group: for the ammonites, Pop & Szasz, 1973* and Szasz, 1976* (for Hateg Basin), Szasz, 1982* (Babadag Basin), Szasz, 1982, 1983* (Carpathians and Dobrogea); nannoflora, Melinte,1997 (Carpathians).

Because of the limited space of paper, other previously literature and some from papers above cited (noted with *) or in the text, could be found into the papers from selected references here presented in the last part.

In present paper, our Cenomanian integrated biostratigraphy of Romania is revised and improved by new data and its detailed content is first reported for to be printed. According to the multiple boundary bioevents as concept, the primary, proxy and auxiliary bioevents that define in Romania the boundaries and the content of this stage and of its substages and of its biostratigraphic units respectively, are presented; are described some key sections/suuccessions with these data. From these bioevents are distinguished (Ion *et al.*, 1997a and new data and some

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emend. in this paper) and discuted three categories with regard to their chronological significance and correlation potential toward other portion of the Tethyan domain/of the world: the general (or global) bioevents (having an extent covering very large areas sometimes including the whole Tethys); the regional ones (are supposed to be valid for some portion of the Tethys); local ones (relevant for Romania but synchronous /complementary to some bioevents in the first two categories).

The majority of the chrono- and biostratigraphic subdivisions for the Cenomanian of Romania are defined by us based on the ammonite distribution/primary events but frequently associated with the inoceramid, planktonic foraminifera, microflora and nannoflora proxy and auxiliary events (Figures 1 and 2). Only the detailed biostratigraphic succession across the Albian-Cenomanian as well as the biostratigraphy of the upper part of the Upper Cenomanian are established just on the planktonic foraminifera, microflora and nannoflora events.

Based on the ammonite criteria the Cenomanian of Romania has been divided (Szasz, 1982) in three substages being identified almost all stratotype ammonite zones from West European Cenomanian standard zonation (of Anglo-Parisian Basin) of Wright *et al.*,1984* and Kennedy,1984*, 1986* (fide in Ion & Szasz, 1994); only the *Metoicoceras geslinianum* Zone and *Neocardioceras juddii* Zone have not been identified because the upper part of the Upper Cenomanian strata are without a significative macrofauna for biostratigraphy. These ammonite zones co-occur with the inoceramid, planktonic foraminifera, dinoflagellate, pollen and nannoplankton biostratigraphic units achieved by us: (i)The succession of the inoceramid assemblages for Romania (Szasz, 1997a and in this paper) is generaly as in the European scales of Keller, 1982* and Kaplan *et al.*, 1984* (fide in Ion *et al.*1997a). (ii)The planktonic foraminifera zonal scale elaborated by Ion (for a synthetical account/references: Ion, 1993*; Ion in Ion & Szasz, 1994; Ion in Ion et. al., 1998] contains: some local biozones (*Th. porthaulti* Sz., *W. paradubia* Sz.) but with the equivalent ones from other Tethyan areas; the majority are the biozones known in some zonal scales for Tethys but emended in the Cenomanian zonation for Romania; new local biozones defined by Ion in this paper (*Th. broteni*/*Th. globotruncanoides* and *Th. ticinensis* Assemblage Subzone, *Th. greenhornensis* Subzone, *Th. jaquesigali* Subzone). By the biozones in the first two category,this planktonic foraminifera zonal scale for Romania may be correlated with others from Tethys. (iii)The dinoflagellate and pollen zonal scales proposed by Antonescu for the Cenomanian contains only new zones (Antonescu in Ion *et al.*, 1997a,b, 1998) but that may be correlated with some microflora zones from the world (e.g.from Canada, England). (iv)The nannoplankton zonation (Melinte,1997; Melinte in Ion *et al.*, 1997a,b) is with cosmopolitan – tethyan features but with some primary events (the first occurrence of *Lithraphidites acutus* VERBECK & MANIVIt and of *Microrhabdulus decoratus* DEFLANDRE) more early in Romania as regards their chronological significance; it contains the zones known in the other zonal scales for the Tethys but one emend. (*Lt. acutus* Zone) and a new separated/defined zone (the *Corollithion signum* Zone).

LOWER CENOMANIAN

We admit that in Romania, - in accordance with the widely accepted view and the ammonite boundary markers from the Mont Risou (Hautes Alpes) Global Stratotype Section and Point (GSSP) for the Albian-Cenomanian boundary -, in ammonite terms, the Lower Cenomanian begins from the base of the *Mantelliceras mantelli* Zone (respective from the base of the *Neostlingoceras carcitanense* Subzone). The strata with *M. mantelli* Zone, known only in the South Dobrogea, are transgressively. But they contain in the bottom part the whole assemblage of the *N. carcitanense* Subzone from the Sarthe stratotype area and from NW Europe, situation that corroborated with other observations (in Avram *et al.*, 1988) suggests a short-term hiatus between Albian and Cenomanian and that the lowermost segment of the *M. mantelli* Zone is present here. As proxy markers for the Albian-Cenomanian boundary we proposed (some from they in this paper) the bioevents: (i)-for the planktonic foraminifera, the first occurrence (FO) of *Thalmanninella greenhornensis* (MORROW, 1934) (=the beginning of the *Th. greenhornensis* new Sz., Ion in this paper) and/or the last occurrence (LO) of *Th. ticinensis* (GANDOLFI, 1942) as bioevents of regional chronological significance in theTethys and situated into the assemblage (of the *Th. brotzeni*/*Th. globotruncanoides* Zone) with *Th. brotzeni*, *Th. globotruncanoides*, *Th. gandolfi*, *Th. appenninica*; (ii)- for the nannoplankton, the FO of *Lithraphidites acutus* VERBECK & MANIVIT,1971(=the beginning of the *Lt. acutus* Zone) and the LO of *Predicosphaera columnata* (STOVER, 1966) PERCH NIELSEN, 1984 and *Hayesites albiensis* MANIVIT, 1971, as bioevents of local chronological significance; (iii)-for dinoflagellates, the FO of *Palaeohystrichophora infusorioides* DEFLANDRE, 1935 and *Epelidosphaeridia spinosa* (COOKSON & HUGHES) DAVEY,1969, the LO of *Ovoidinium verrucosum* (COOKSON & HUGHES) DAVEY,1970, *O. scabrosum* (COOKSON & HUGHES) DAVEY and of *Endoceratium dettmanniae* (COOKSON & HUGHES) STOVER & EVITT (= the beginning of the *P. infusorioides* Zone), the all of general/global chronological significance; (iv)-for the pollen (only in the litoral and continental facies) the FO of the *Senectotetradites* and *Artiopollis* genera (=the beginning of the *Senectotetradites* and *Artiopollis* Zone) as bioevents of general chronological significance.

In the South Dobrogea, the first lowermost Cenomanian strata with the ammonites of the *M. mantelli* Zone (and of the *N. carcitanense* Subzone respectively), *Neohibolites ultimus* (d'ORBIGNY, 1845) and *Inoceramus crippsi* MANTELL, 1822 and reworking Albian macrofauna, contain (at Ivrinezul Mic and Sipote sections) the planktonic foraminifera assemblage (Ion, in this paper) with *Th. greenhornensis* and devoid of *Th. ticinensis* (of the *Th. greenhornensis* Subzone) and the nannoplankton assemblage with *Lt. acutus* and devoid of *P. columnata* and *H. albiensis*. In the North Dobrogea, where the Albian strata are devoid of macrofauna and for the Lower Cenomanian as macrofauna only rarely *N ultimus* and *I. crippsi* are known, the bottom Cenomanian foraminifera is of the *Th. greenhornensis* Subzone too.

In the South and East Carpathians there are the continuous successions across the Albian-Cenomanian, but here only the uppermost Albian(=Vraconian) macrofauna of *Stoliczkaia dispar* Zone and *aucellins* there are sometimes presents, for the lowermost Cenomanian a biostratigraphic meaninig macrofauna being absent/not found. In the South Carpathians (key sections: Cheia Valley in the Cheia Basin; Tocila Mica Valley in Postavarul Mountains; Icovesti-Badeni in Dambovita Valley) the planktonic foraminifera and the nannoplankton proxy markers proposed by us for the base of the Cenomanian are located in the first levels that immediately succeed the last levels with fauna of the *S. dispar* Zone. For here,a synthetic/ biostratigraphic data composite succession across the uppermost Albian-basal Cenomanian is the following: (i) – The approximate lower segment (approx. 20-25 m) of the strata with ammonites of the *S. dispar* Zone and with *aucellins*, contains the co-occurrence of *Ostlingoceras puzosianum* (d'ORBIGNY, 1842), *Mortoniceras* (*Durnovarites*) sp., *Aucellina* sp. (in Cheia Valley, Szasz in Ion *et al.*,1987 and in Szasz *et al.*, 1992) or *Paraturrilites bergeri* (BROGNIART, 1822), *Stomohamites charpenteri* PICTET & CAMPICHI, *Aucellina gryphaeoides* SOWERBY (in Tocila Valley, Kusko *et al.*, 1970) as macrofauna, the planctonic foraminifera zonal assemblage (of the *Th. appenninica* Zone) with *Th. appenninica*, *Th. gandolfi*, *Th. ticinensis* and the nannoplankton zonal assemblage (of the *P. columnata* Zone) with *P columnata, H. albiensis* and *Eiffelithus turriseiffelii* (DEFLANDRE, 1954) REINHART, 1965 ; (ii) – The uppermost segment (approx. 20-25 m) of the *S. dispar* strata includes *Stoliczkaia notha* (SEELEY), *O. puzosianum*, *Puzosia* sp., *Neohibolites* sp., *aucellins* (in Icovesti-Badeni section, Szasz in Ion *et al.*, 1987, Ion & Szasz 1994) or *Tetragonites*, *Aucellina* spp., *Gaudryceras* sp., *Scaphites* sp. (in Tocila Mica Valley "b" section, Ion 1983) as macrofauna and the same zonal nannoplankton assemblage as for the lower segment; in the planktonic foraminifera terms the beginning of this segment is marked by the concomitant FO of *Th. brotzeni* and *Th. globotruncanoides* (=the beginning of the *Th. brotzeni / Th. globotruncanoides* Zone and respective of the *Th. brotzeni / Th. globotruncanoides* and *Th. ticinensis* new Ass.Sz.) while the *Th. ticinensis*, *Th. appenninica* and *Th. gandolfi* persist; (iii) – The beginning of the immediately overlying devoid of macrofauna strata, assigned by us to the base of the Lower Cenomanian, is marked as microfauna events by the FO of *Th. greenhornensis* (=the beginning of the *Th. greenhornensis* new Sz.) and the LO of *Th. ticinensis* while as nannoplankton events there are the FO of *Lt. acutus* (=the beginning of the *Lt. acutus* Z.), the LO of *P. columnata* and of *H. albiensis*. These all concomitant bioevents of the "iii" point/level are located at 4-6m above the last uppermost Albian levels with fauna of the *S. dispar* Zone (at Icovesti-Badeni as the main key section; at Tocila Valley as auxiliary one).

According to the data from the Mont Risou (Hautes Alpes) GSSP for the Albian-Cenomanian boundary (Gale *et al.*, 1995 in Troger & Kennedy 1996) the FO of *Rotalipora globotruncanoides* (with *R. brotzeni* as synonime) was chosen as global marker of the Albian-Cenomanian boundary; here the FO of *Mantelliceras mantelli* is the ammonite marker of this boundary too. In Romania, according to the South Carpathian data the FO of the *brotzeni* and *globotruncanoides* cannot be the marker events for the base of the Lower Cenomanian, here these concomitant bioevents being situated approximately into the median part of the strata (40-50 m thickness) with *S. dispar* Zone, at least 25 m below last levels with this ammonite fauna (the both species being with rare or moderate frequence in the *S. dispar* strata as well as in the basal Lower Cenomanian); while the LO of *ticinensis* and the FO of *greenhornensis* there are only at 0-4 m on an average above the last levels with fauna of *S. dispar* Zone. But it is to remark that excepting the first presence of *greenhornensis* in Romania and the presence of the *tehamaensis* in Mont Risou section, the same *Rotalipora sensu lato* assemblage devoid of *ticinensis* characterises in both cases the base of the Cenomanian.

Regarding the dinoflagellate event markers listed for the Vraconian-Cenomanin boundary, according to the data from the several key sections from the East Carpathians (Antonescu in: Antonescu *et al.*, 1978; Ion *et al.*, 1994) we know that in Romania as well as in other areas from the world they are located together in the same lithological level (i.e. in the base of the Varriegated Clays from the Corlateni Valley section in the Audia Nappe and in the base of the Maguricea Valley Varriegated Clays from the Tiganului Valley section in the Tarcau Nappe), or as very close succession e.g. across 1,5-2 m beds (i.e. in the base of the Maguricea Valley Varriegated Clays from the Maguricea Valley section scale 1, Tarcau Nappe) as follows (from oldest to youngest): (i) – a zonal assemblage (of the *O. verrucosum* Zone) with *O. verrucosum*, *O. scabrosum*, *E. dettmanniae*, etc., in the 7-8 m of strata from the terminal segment of the Glauconitic Silicated Sandstones (of the Black Shales Formation) and in the first levels of the Maguricea Valley Varriegated Clays; (ii) – the FO of the *P. infusorioides* and the LO of *O. scabrosum* at 1 m above, into the base of the Maguricea Valley Varriegated Clays; (iii) – the LO of *O. verrucosum* and *E. dettmanniae*, at 1 m above; (iv) – the FO of *E. spinosa,* at 0,5 m above; (v) – the zonal assemblage with *P. infusorioides* and *E. spinosa* continued in the imediately overlying 5-6 m of beds from Maguricea Valley Member and below the apparition of *Rotalipora gr. cushmani-turonica* (as marker of the base of the Middle Cenomanian). Across this decribed succession the pollen assemblage is of the *Camerozonosporites insignis* Zone (Upper Albian- Middle Cenomanian).

In ammonite terms two parts distinguish for the Lower Cenomanian of Romania (Szasz, 1982): a lower part with/correlated with the *Mantelliceras mantelli* Zone (correlated with the *Neostlingoceras carcitanense* Subzone plus the *Mantelliceras saxbii* Subzone, the both from Juignet & Kennedy,1976, zonation, fide in Szasz, 1982); a upper part with/correlated with *Mantelliceras dixoni* Zone. This zonation is in accordance with those recognized by Wright *et al.*,1984 and Kennedy, 1986 (fide in Ion & Szasz, 1994) as standard one for Western Europe.

The lower part of the Lower Cenomanian

The lower part of the Lower Cenomanian is represented in Romania by the co-occurrence of: as macrofauna, the ammonites of the *Mantellicers mantelli* Zone associated with *Neohibolites ultimus* (d'ORBIGNY, 1845) and *Inoceramus crippsi* reported to the *I.crippsi* Assemblage (in South Dobrogea) or is reported only the pointed occurrence of *I. crippsi* together with *N. ultimus* and sometimes with *aucellins* (in the North Dobrogea and Carpathians); the planktonic foraminifera of the greatest portion (separated in this paper as *Thalmanninella greenhornensis* new Sz.) of the *Thalmanninella brotzeni/Th. globotruncanoides* Zone (that starts from the middle of the Vraconian *S. dispar* Zone); the greatest portion of the *Lithraphidites acutus* nannoplankton Zone; the microflora of the lower segment of the *Palaeohystrichophora infusorioides* dinoflagellate Zone and of the *Senectotetradites* and *Artiopollis* pollen Zone as well as a segment from the *Camerozono-sporites insignis* pollen Zone.

As bioevents for the Lower Cenomanian, except those for the Albian-Cenomanian boundary already listed, the FO of planktonic foraminifera *Thalmanninella micheli* (SACAL & DEBOURLE, 1957), *Th. marchigiana* (BORSETTI, 1962), *Rotalipora montsalvensis* and of others (listed in Ion, 1993, Ion & Szasz, 1994) have been documented in the lowermost part of the Lower Cenomanian from Carpathians. In the Dobrogea domains these taxa start from the upper part of the Lower Cenomanian (when in the Carpathians they have a bigger frequency).

The *M. mantelli* Zone, known only in South Dobrogea (Szasz, 1982, 1983, Szasz in Avram *et al.*, 1988, revised by Szasz in this paper), is represented by two succeding assemblages: the first assemblage (of the transgressive Lower Cenomanian basal conglomerate 'a "litho-stratigraphic unit) including *M. mantelli, M. cantianum* (SPATH, 1920), *N. carcitanense*, *Mariella cenomanense* (SCHLUTER, 1876), *Hypoturrilites tuberculatus* (BOSC, 1801); the second assemblage (of the "c" unit and in the lower segment of the "d "unit) with the species cited for the first assemblage plus *Mantelliceras saxbii* (SHARPE, 1857), *M. couloni* (d'ORBIGNY, 1850), *M. picteti* (HYATT), *Hypoturrilites gravisianus* (d'ORBIGNY, 1842), *Hypoturrilites mantelli* (SHARPE, 1857), *Hyphoplites spp.*, *Stoliczkaia (Leymeriella) sanctaecatherinae* WRIGHT & KENNEDY, 1978. The both assemblages co-occur with *I. crippsi* and *N. ultimus,* the latter taxon with bloom during the first assemblage.

The upper part of the Lower Cenomanian

This time interval as macrofauna is represented in Romania by the co-occurrence of : some ammonite fauna (*Turrilites sp., Mantelliceras sp., Phylloceras sp., Stomohamites aff. duplicatus* PICTET & CAMPICHI, *M. dixoni* SPATH, 1926 and *M. couloni*, as pointed occurrence in South Carpathians; *M. dixoni* and *Turrilites costatus* LAMARCK, 1801, as pointed occurrence in South Dobrogea) reported to the *M. dixoni* Zone and the bivalve *Inoceramus virgatus* SCHLUTER reported to the *I. virgatus* Assemblage. The lower segment of the *M. dixoni* Zone and of the *I. vir*gatus Ass. is associated with: the planktonic foraminifera of the uppermost segment (separated as *Th jaquesigali* new Subzone) of the *Th. brotzeni/Th. globotruncanoides* Zone and with the bloom of the *R. montsalvensis*; the nannoplankton of the uppermost segment [characterized by the absence of *Microstaurus chiastus* (WORSLEY, 1971) GRUN in Grun & Allemann,1975)] of the *Lt. acutus* Zone. The upper segment of the *M. dixoni* Zone and of the *I. virgatus* Ass. is associated/simultaneusly with: the entire *Thalmanninella porthaulti* planktonic foraminifera Subzone and the nannoplankton of the lowermost segment of the *Corollithion signum* Zone. In both segment the microflora is the same as for the lower Lower Cenomanian.

In summary, the interval with/of the *M. dixoni* Zone and/or with the *I. virgatus* Assemblage is marked by co-occurrence of the followig bioevents (the best calibrated in the South Carpathians and South Dobrogea). (I) – The beginning of this time interval is marked by: in the South Carpathians, the FO of the *Turrilites* ammonite genus (=the beginning of the *M. dixoni* Zone) as primary marker of general chronological significance for Tethys, associated with the FO of the bivalve *I. virgatus* (=the beginning of the *I. virgatus* Assemblage) as proxy marker possible of regional chronological significance, while in South Dobrogea is known only the FO of *I. virgatus*; in the planktonic foraminifera terms, the FO of *Thalmanninella jaquesigali* ION, 1977 (=the beginning of the *T. jaquesigali* new Subzone) and of other *Rotalipora s.l.* [*Thalmanninella caroni, Th. runcui, Th. oresti* and *Th. acuta* (the all of ION, 1977), *Rotalipora thomei* (HAGN & ZEIL, 1954)], as local bioevents, as well as the beginning of the *Rotalipora montsalvensis* MORNOD, 1950 bloom as of regional chronological significance event; in the nannoplankton terms, the LO of *Microstaurus chiastus* (into the *Lt. acutus* Zone) as bioevent of regional chronological significance. (ii) – Into the middle of this time interval there is the FO of the planktonic foraminifera *Thalmanninella porthaulti* ION,1983 (=the beginning of the *Th. porthaulti* Subzone) as bioevent of regional chronological significance, simultaneous with the FO of the nannoplankton *Corollithion signum* STRADNER,1963 (=the beginning of the *C. signum* Zone), *Ahmuellerella regularis* and *Chiastozygus amphipons* (BRAMLETTE & MARTINI, 1964) GARTNER, 1968.

In the South Carpathians a synthetical account concerning the intercorrelated biostratigraphic data/events for the interval with the *M. dixoni* Zone and *I. virgatus* Assemblage (estimated from 10 to 35 m; the Icovesti – Badeni key section from Dambovita Valley; the Tocila Mica Valley, the Negilla Valley and section 2c, as key sections from Tara Barsei Basin) records: (i) – The basal segment (situated above some Lower Cenomanian strata devoid of macrofauna but including the planktonic foraminifera of the *Th. greenhornensis* new Sz.) is represented by the first pile of strata with the first *I. virgatus* or *Turrilites,* the both taxa being associated with the first planktonic foraminifera *Th. jaquesigali, Th. caroni, Th. runcui,* Th. *oresti*, *Th. acuta*, *Th. aff. brotzeni*, *R. thomei* and the beginning of the *R. montsalvensis* bloom. As macrofauna also contain (Ion, 1983) *Mariella dorsetensis* (SPATH, 1926), *Mantelliceras sp., Phyloceras sp., aucellins* and *Stomohamites aff. duplicatus*. (ii) – Higher (at 3m in the Icovesti-Badeni and Tocila Mica Valley sections; at 30 m in the Negilla Valley section) towards the median segment of the *M. dixoni* Zone the planktonic foraminifera *Th. porthaulti* has the FO. (iii) – Higher (at 3-4 m in Icovesti-Badeni section), towards the upper segment, there are specimens of *M. dixoni, M. aff. couloni, I. virgatus* (acc. Szasz, 1983) associated with the planktonic foraminifera of the *Th. porthaulti* Subzone that persists up of this macrofaunal level to (iv) – the FO of *Thalmanninella reicheli* (MORNOD,1950) as marker of the base of the Middle Cenomania that in some section (i.e. Tocila Mica Valley) there is below (at 2-3m) of the last specimens of *I. virgatus*.

In South Dobrogea the interval of the *M. dixoni* Zone and the *I. virgatus* Assemblage (estimated at 10-12 m thickness according the Ivrinezu Mic and Sipote sections) is demonstred by the following intercorrelated biostratigraphic data (lithostratigraphy acc. Avram *et al.*, 1988): (i)-A Lower Cenomanian pile of strata (3-4 m, of "c" lithostratigraphic unit) with the second assemblage of the *M. mantelli* Zone (see its content in the "lower part of the Lower Cenomanian chapter'), *I. crippsi, N. ultimus* (at Ivrinezu Mic, Amzalia Hill and Sarapcikulac in Pestera Valley; at Sipote) together with the planktonic foraminifera of the *Th. greenhornensis* Subzone and the nannoplankton of the *Lt. acutus* Zone (at Ivrinezu Mic and Sipote). (ii)-The same microfauna and microflora persist above in the 4m pile of beds (of the "d" lithostratigrphic unit) devoid of macrofauna (at Ivrinezu Mic and Sipote). (iii)-Follows (at Ivrinezu Mic and Sipote) the first upper Lower Cenomanian levels they including the FO of the planktonic foraminifera *Th. jaquesigali*, *Th. caroni* and *Th. runcui* (bioevent that in South Carpathians is located in the levels with the FO of *Turrilites* and *I. virgatus*) while the nannoplankton *Microstaurus chiastus* has the LO. (iv)-At approximate 0,6m above, there is a level with *Mantelliceras sp.*, *I. crippsi* and the first *I. virgatus* (at Ivrinezu Mic). (v)-At 4m above, the nannoplankton *Corollithion signum*, *Ahmuellerella regularis* and *Chiastozygus amphipons* have the FO and simultaneously (at Ivrinezu Mic) or at 0,20m above (at Sipote) the planktonic foraminifera *Th. porthaulti* has the FO too. (vi)-Little above (at 1,50m at Sipote) are known the specimens of *M. gr. dixoni* and of *Turrilites costatus* (acc. to Chiriac, 1981 fide in Avram *et al.*,1988)) while the microfauna of the *Th. porthaulti* Subzone persists it being known upwards at 6m above the FO of its nominal species (at Ivrinezu Mic).

The all upper Lower Cenomanian planktonic foraminifera events calibrated in the Carpathians and South Dobrogea have been also identified in North Dobrogea (i.e. at Ciucurova) across the upper Lower Cenomanian beds devoid of macrofauna but situated immediately below the first levels with the FO of *Th. reicheli* as marker of the base of the Middle Cenomanian.

MIDDLE CENOMANIAN

Concerning the lower boundary of the Middle Cenomanian in Romania, despite that the *A. rhotomagense* Zone known only in the North Dobrogea is with not outcropping lowermost portion, we admit that this boundary would be marked by the base of the *A. rhotomagense* Zone [the appearance of the *Acanthoceras* genus and respective of *A. rhotomagense* (BRONGNIART,1822)] as in the West European zonation of Kennedy, 1986, and Wright et al, 1984 (fide in Ion & Szasz, 1994) and in other ones.The FO of *Cunningtoniceras* genus and respective of *C. inerme* (PERVINQUIERE,1907) as primary marker of this limit (of the *C. inerme* Zone as the first Middle Cenomanian ammonite zone) accepted in the conclusions of the Brussels Symposium (Troger & Kennedy, 1996) is not feasible in Romania, here the first species of *Cunningtoniceras*, as well as of *Calycocers s.s.*, being intercepted into the *A. jukesbrownei* Zone. As proxy markers for this boundary we have chosen: the LO of *Inoceramus virgatus* (documented in South Carpathians; e.g. in the Tocila Mica Valley-Tara Barsei Basin is located at 2-3 m above the FO of Th. reicheli); the presence of *I. tenuis* MANTELL and *I. conicus* GUERANGER (=the beginning of the *I. tenuis* and *I. conicus* Assemblage) should be the indices for the Middle Cenomanian (documented in North Dobrogea); calibrated in South Carpathians (see the biostratigraphic data succession in the upper Lower Cenomanian chapter) and North Dobrogea (its bottom range is across the *A. rhotomagense* Zone), the FO of *Thalmanninella reicheli* MORNOD, 1950 (=the beginning of the *Th. reicheli* Subzone) as the most important proxy marker of global chronological significance (Troger & Kennedy, 1996); possible the LO of the *Senectotetradites* and *Artiopollis* pollen genera (in the litoral and continental facies; docun\mented in the Carpathians); possible the LO of the nannoplankton *Lithraphidites acutus* (documented in the Dobrogea). The FO of *Inoceramus schoendorfi* HEINZ as proxy marker of the base of the Middle Cenomanian (Troger & Kennedy, 1996) cannot be recognized in Romania, here this species being reported (at Albesti in the South Carpathians) only as isolated specimens with uncertain stratigraphic position.

In ammonite terms we admit (Szasz, 1982) for the Middle Cenomanian of Romania as in the West European zonation proposed by Amedro *et al.* 1978 (in Szasz, 1982): a lower part represented by *Acanthoceras rhotomagense* Zone; a upper one represented by the *Acanthoceras jukesbrownei* Zone. But these two zones there are in two far regions, in the North Dobrogea the former biozone, in the South Carpathians the latter one.

The lower part of the Middle Cenomanian

For this time interval, in macrofaunistic terms the *A. rhotomagense* Zone associated with the *I. conicus* and *I.tenuis* Assemblage including also *I. crippsi* are known in North Dobrogea (in the Caraburun Hill section, Szasz, 1982, Szasz in Szasz & Ion, 1988). In the South Carpathians are known only pointed presence of the last specimens of *I. virgatus* in the base and *Scaphites obliquus* SOWERBY, 1965, *Phylloceras sp.*, *Inoceramus spp.* and *aucellins* in the uppermost part of the lower Middle Cenomanian (Tocila Mica Valley from Tara Barsei Basin, Ion 1983); a Cenomanian succession with ammonites from Cisnadioara, in which at least the *A. rhotomagense* Zone should exist (Todirita collection revised by Szasz), is not studied. This all macrofauna is associated with: the entire *Thalmanninella reicheli* Subzone (documented in the South Carpathians and in North Dobrogea at Caraburun Hill and a Ciucurova); as nannoplankton, the greatest part of the *Corollithion signum* Zone fallows by the lowermost segment of the *Microrhabdulus decoratus* Zone (documented in North Dobrogea, at Caraburun Hill). The microflora of this time interval, calibrated on the microfauna (i.e. at Largu and Gainesti areas, Tarcau Nappe from northern East Carpathians) and also on macrofauna (in Ohaba Ponor Valley from Hateg Basin), is of the *P. infusorioides* dinoflagellate Zone and *C. insignis* pollen Zone as in the Lower Cenomanian and upper Middle Cenomanian.

The *A. rhotomagense* Zone (4-5m) from North Dobrogea contains: *A. rhotomagense sussexiense* (MANTELL, 1970), *A. rhotomagense confusum* (GUERANGER, 1970), *A. ex. gr. rhotomagense*), *Calycoceras (Newboldiceras) assiaticum spinosum* (KOSSMAT, 1898), *Mesogaudryceras leptonema* (SHARPE, 1855), *Anagaudryceras vertebratum* (KOSSMAT, 1895), *Schloenbachia aff. coupei* (BRONGNIART), *Scaphites obliquus*, *S. dailyi* WRIGHT, 1977, *Protacanthoceras sp.*, *Phylloceras sp.*, *Tetragonites sp., Puzosia sp.* and *Scipanoceras baculoide* (MANTELL, 1959) that occurs (and with the great frequency) only in the lower part of this zone. The entire zone is rich in specimens of *Turrilites costatus* LAMARCK, 1971 and includes also transitive forms to *Turrilites acutus* PASSY,1832. But undoubted specimens of *T. acutus* are not identified, although the upper part of the *A. rhotomagense* strata is entire (the immediately overlying levels are with the first *Th. deeckei* that in Ohaba Ponor Valley starts from the base of the *A. jukesbrownei* Zone). Consequently the *T. costatus* and respective the *T. acutus* zones/subzones of Juignet *et al.*, 1978 (in Szasz, 1982) here not exist.

As planktonic foraminifera calibrated events during the *Th. reicheli* Subzone are to note: (i)-into its basal part there is only in the North Dobrogea the early appearance of *Praeglobotruncana gibba* KLAUS, 1960 associated with the first presence of *Th. reicheli*; (ii)-in its uppermost segmen, there is only in North Dobrogea a early (but very rarely) first presence o some specimens probable of *Helvetoglobotruncana praehelvetica* (TRUJILLO, 1960) (=probable the first presence of the *Helvetoglobotruncana* genus) while in the Carpathians there is a later FO of *P. gibba*.Concerning the nannoplankton, is to note that *Microrhabdulus decoratus* DEFLANDRE, 1959 in Romania has a early FO (in the A. *rhotomagense* Zone) in comparison with its distribution in some West European biozonal scales (i.e of Manivit, 1977, Sissingh, 1977, Premoli Silva & Sliter, 1994 - fide in Melinte 1997) where it occurs beginning from the Upper Cenomanian (i.e. from *Calycoceras naviculare* Zone).

The upper part of the Middle Cenomanian

This time interval is represented by coexistence of: as macrofauna, in the South Carpathians there is the *Acanthoceras jukesbrownei* Zone (known in Hateg Basin) or only the pointed presence of a assemblage with *Inoceramus gr. pictus* SOWERBY (by *I. pictus concentricondulatus*) and *I. crippsi* located in the topmost part/around the upper boundary of the Middle Cenomanian (documented in Tara Barsei Basin), while in the North Dobrogea (at Ciucurova) is known a equivalent ammonite fauna associated with *Inoceramus flavus* Assemblage; the entire *Thalmanninella deeckei* planctonic foraminifera Subzone, in the Carpathian and Dobrogea domains; the microflora and the nannoflora are the same as for the lower Middle Cenomanian (documented in Ohaba Ponor Valley section).

The start of the upper Middle Cenomanian is marked by the several intercorrelated bioevents: the FO of the ammonite from *jukesbrownei* and *whitei* group respective the FO of *A. jukesbrownei* (SPATH, 1926) and *A. whitei* MATSUMOTO, 1959 (=the beginning of the *A. jukesbrownei* Zone) as primary markers possible of general cronological significance for Tethys, bioevents documented in South Carpathians (Ohaba Ponor Valley key section); the FO of *Th. deeckei* (FRANKE, 1925)(=the beginning of the *Th.deeckei* Subzone) as the proxy marker of regional chronological significance for Tethys, documented in South Carpathians (in Ohaba Ponor Valley is located at the base of *A. jukesbrownei* Zone) and North Dobrogea (is located at 1m above the *A. rhotomagense* Zone in the Caraburun Hill, at 4-5 m bellow the strata with a upper Middle Cenomanian fauna at Ciucurova); the FO of *I. flavus* (=the beginning of the I. *flavus* Assemblage) as auxiliary proxy marker, documented in North Dobrogea (at Ciucurova is located in the basal segment of strata with the upper Middle Cenomanian ammonite and above the FO of *Th. deeckei*).

Into the upper Middle Cenomanian, as the most importan bioevents there are: (i)-only in the Carpathians, in the uppermost segment (in Ohaba Ponor Valley key section, in the uppermost part of the *A. jukesbrownei* Zone), the early FO of *Dicarinella algeriana* (CARON, 1966) and *Marginotruncana aff. renzi* (of PORTHAULT, 1974) and respective the early appearance of the *Dicarinella* and *Marginotruncana genera*; (ii)-in the topmost/around the upper boundary of the Middle Cenomanian there is in the South Carpathians (documented in the section 2c in the Rasnoava Valley area, Tara Barsei Basin), in the levels with the assemblage of the *Th. deeckei* Sz., the last specimens of *I. crippsi* and the first of *I. gr. pictus* (here represented by *I. pictus concentricondulatus*).

The *A. jukesbrownei* zonal assemblage from Hateg Basin contains (Szasz in Pop & Szasz, 1973 fide in Szasz, 1982, 1983 completed and revised): *Acanthoceras aff. jukesbrownei*, *A. whitei*, *Calycoceras (Newboldiceras) cf.vergonsense* COLLIGNON, *C. (N.) assiaticum assiaticum* (JIMBO, 1894), *C.(N.) assiaticum spinosum* (KOSSMAT) (the last two being the most frequently), *Callycoceras paucinodatum* (CRICK), *Protacanthoceras aff. judaicum* (TAUBENHAUS), *Forbesiceras bicarinatum* (SZASZ, 1976) (the all in the Ohaba Ponor Valley section); *C.(N.) cf. assiaticum hunter*, *A. whitei, Austiniceras austini* (SHARPE) (from Varatec Valley at Gruzoni). The upper Middle Cenomanian ammonite assemblage from North Dobrogea (at Ciucurova, Szasz in Szasz & Ion, 1988) includes: *Cunningtoniceras aff. kunningtoni* (SHARPE, 1855), *Turrilites scheuzerianus* BOSC, 1801, *T.costatus*, *Mesogaudryceras leptonema* (SHARPE, 1855), *Schloenbachia coupei* (BRONGNIART).

UPPER CENOMANIAN

The base of the Upper Cenomanian in Romania may be defined by the following primary and proxy intercorrelated bioevents: in ammonite terms,the FO of *Eucalycocers* genus respective the FO of *E. pentagonum* (JUKES-BROWN,1896) (=the beginning of the *E. pentagonum* Zone) as primary boundary marker (of regional chronological significance for Tethys), as well as the first presence of the *Calycoceras* (*Lotzeites*) subgenus [by the FO of *C. (L.) lotzei* WIEDMANN, 1961], *Pseudocalycoceras* genus and of *Forbesicers obtectum* (SHARPE, 1853) as proxy/auxiliary boundary markers; as bivalves, the FO of *Inoceramus gr. pictus* (=the beginning of the *I. gr. pictus* Assemblage) and the LO of *I. crippsi*, the former event possible of general significance boundary marker (fide inTroger & Kennedy, 1996), the second one of regional significance proxy marker; the FO of the planktonic foraminifera *Rotalipora gr. cusmani-turonica* (=the beginning of the *R. gr. cushmani-turonica* Zone) respective the FO of *R. cushmani* (MORROW, 1936), *R. turonica* BROTZEN, 1942, *R. expansa* CARBONNIER, 1952, as proxy boundary markers (of regional chronological significance for Tethys); the FO of the *Ascodinium* genus by the FO of *A. dacicus n.sp.* (Antonescu,in press) and *A. ovatum* (=the beginning of the *A. dacicus* Zone) as dinoflagellate proxy markers (the first of local significance, the second of regional chronological significance);documented in the Carpathians, the FO of the *Atlantopollis* and *Complexiopollis* genera, respective the FO of *A. microreticulatus* KRUTZSCH,1967 and *C. complicatus* GOCZAN, 1964 (=the beginning of the *A. microreticulatus* Zone) as the pollen proxy boundary markers of general chronological significance as genera and regional cronological significance as species; in nannoplankton terms, a undoubtely event marker for the base of the Upper Cenomanian is not known in Romania, the FO of *Gartnerego obliquum* (STRADNER, 1963) NOEL, 1973 or REINHARDT, 1970 being only possible situated at the lower limit of the Upper Cenomanian or proximity above it.

The choice of the *E. pentagonum* as primary marker of the base of the Upper Cenomanian in Romania (Szasz in Pop & Szasz, 1973 and Szasz, 1976 fide in Szasz, 1982) is in accordance with: the proposals of Juignet & Kennedy, 1976 (fide in Szasz, 1982) defining the *E. pentagonum* Zone as the first ammonite zone of the Upper Cenomanian; this ammonite event together with the FO of *I. pictus* and other bioevents (fide in Troger & Kennedy, 1996) were proposed for the researchs for to chose a possible global marker for this boundary.

Excepting the inoceramid markers, the all above listed markers for the base of the Upper Cenomanian have been documented in the South Carpathians continuous succession from the Hateg Basin (Ohaba Ponor-Magura Hill key section; for datailed data see in the lower Upper Cenomanian chapter). Concerning the inoceramid boundary markers the data proceed from theTara Barsei Basin (detailed data in the upper Middle Cenomanian chapter). In the North Dobrogea, for this time interval a macrofauna is not known, while the microflora and nannoflora are not investigated. But the FO of *R.cushmani*, *R. turonica* and *R. expansa* in the base of the Upper Cenomanian is also demonstred: this datum level is situated immediately above the strata with a upper Middle Cenomanian ammonite fauna, the *I. flavus* Assemblage (at Ciucurova) and/or the *Th. deeckei* planktonic foraminifera Subzone (at Ciucurova, Caraburun Hill, General Praporgescu and in other sections).

In macrofaunistic and microfaunistic terms, the Upper Cenomanian in Romania contains two parts: a lower part represented concomitantly by the *E. pentagonum* Zone, *I. pictus* Assemblage (the both identified only in South Carpathians) and/or the *Rotalipora gr. cusmani-turonica* Zone (in Carpathians and North Dobrogea); a upper part without a macrofauna for biostratigraphy but well characterised (in Carpathians and North Dobrogea) by the planktonic foraminifera biostratigraphy, respective by the *Whiteinella paradubia* Zone and the lower part of the *Dicarinella imbricata* Zone. According to the data from Carpathians, these all Upper Cenomanian macro- and microfauna co-occur/are simultaneously with the entire *Ascodinium dacicus* dinoflagellate Zone, the entire *Atlantopollis microreticulatus* pollen Zone as well as with the upper part of the *Microrhabdulus decoratus* nannoplankton Zone.The *E. pentagonum* Zone from Romania is correlated with the *Calycoceras guerangeri* Zone from the western European zonation of Wright *et al.*, 1984, Kennedy, 1984, 1986 (fide in Ion & Szasz, 1994); the upper part of the Upper Cenomanian, devoid of macrofauna, is correlated with the *Metoicoceras geslinianum* Zone plus the *Neocardioceras juddii* Zone from the same zonation. The *W. paradubia* Zone is correlated with approximate lower part of the *M. geslinianum* Zone, while the Upper Cenomanian part of the *D. imbricata* Zone is correlated with the approximate upper part of the *M. geslinianum* Zone and plus the *N. juddii* Zone.

Lower part of the Upper Cenomanian

The Ohaba Ponor-Magura Hill key section from Hateg Basin shows the entire lower Upper Cenomanian strata with *E. pentagonum* Zone (approx. 100 m) and all the general biostratigraphic characteristics on the fossil group studied by us. Here these strata cover in continuity of sedimentation the upper Middle Cenomania ones (approx. 35 m) with *A. jukesbrownei* ammonite Zone in co-occurrence with *Th. deeckei* Subzone, the upper part of the *P. infusorioides* Zone and of *C. insignis* Zone, as well as with the lowermost segment of the *M. decoratus* Zone. Through these *E. pentagonum* Strata us have been identified the following intercorrelated biostrastigraphic data/events: (i)- immediately above of the *A. jukesbrownei* Strata follow the first Upper Cenomanian levels including the all ammonite and planktonic foraminifera events already listed for the Upper Cenomanian lower boundary, but it is to note also the presence of ammonite *Cimatoceras cenomanense*; (ii)-at 1-1,5 m above, *Th. appenninica* has the LO and (iii)- in entire lowermost segment (approx. of 20 m) of these *E. pentagonum* Strata there are the ammonite cited in its first levels, the microfauna of the *R. gr. cushmani–turonica* Zone but without *Th. appenninica*, the first microflora identified including *Complexiopollis*, *Atlantopollis* and *Ascodinium* genera cited for the base of Upper Cenomanian (=the beginning of the *A. microreticulatus* pollen Zone and of the *A. dacicus* dinoflagellate Zone), the nannoplankton of the *M. decoratus* Zone as in the *A. jukesbrownei* Strata; (iv)-into the approximate median segment, are known specimens of *E. pentagonum* only and the same planktonic foraminifera, microflora and nannoflora as in the underlying segment; (v)-in the subsequent uppermost segment (approx. 25 m, exposed in Magura Hill) the specimens of *E. pentagonum* associated with *E. gothicum* (KOSSMAT), *Forbesiceras bicarinatum* SZASZ, 1976, *Schloenbachia sp.* and the first *Calycoceras naviculare* (MANTELL, 1822) there are as the ammonite of the *E. pentagonum* Zone, while the planktonic foraminifera, microflora and nannoflora are not changed.

The integrated biostratigraphy during the uppermost segment of the *E. pentagonum* Zone is completed by the data from Banita Basin (well documented in the afluent left tributary to Daljii Valley). Here there is a lower Upper Cenomanian succession (100 m) that in the last 25 m of beds includes, from oldest to youngest: (i)-A sequence(of 8-10 m) with *Scaphites yonekurai* (YABE, 1910) and *Turrilites costatus* as fauna of the *E. pentagonum* Zone. In the bottom levels of this sequence this fauna is associated with the dinoflagellate of the *A. dacicus* Zone, the pollen of the *A. microreticulatus* Zone, the planktonic foraminifera assemblage (including *R.turonica*, *R. cushmani*, *R. montsalvensis*, *Th. deeckei*) of the *R. gr. cushmani-turonica* Zone. In the topmost part of this sequence, the presence (? FO) of *Whiteinella baltica* DOUGLAS & RANKIN, 1964 and the FO of *W. aprica* (LOEBLICH & TAPPAN, 1961) added to the assemblage of the uppermost segment of the *R. gr. cushmani-turonica* Zone. (ii)-Follows a second sequence without macrofauna (12m), including rare specimens of *Th. micheli* (SACAL & DEBOURLE, 1957) and *Th. brotzeni*. At 6 m above, *Whiteinella paradubia* (SIGAL, 1952) has the FO (=the beginning of the *W.paradubia* Zone) and the microflora is as in the first sequence.

For the biostratigraphy of the lower segment of the Upper Cenomanian, in the Hateg Basin and Banita Basin are also known several pointed/isolated fauna of the *E. pentagonum* Zone: *Pseudocalycoceras thomeli* SZASZ, 1976 (in Daljii Valley, Banita B,), *E. pentagonum* (in Lunca Ohabei V. and in Federi locality from Hateg B., Barusorul V. from Banita B.), *Thomelites sornayi* (Dumbravita V. from Hateg. B.), *T. sornayi* and *E. gothicum* (Dreptului V. from Hateg B.). The all these isolated presences are located into the strata with the *R. gr. cushmani-turonica* planktonic foraminifera Zone and with the nannoplankton of the *M. decoratus* Zone has from the Ohaba Ponor-Magura Hill section but without *Megadiscus asper* and including in plus the *Ahmuellerella octoradiata* (GORKA, 1957) REINHARDT, 1964 and *Gartnerego obliquum*] (Ion *et al.*, 1987, completed and revised in this paper).

The co-occurrence of the lower part of the *A. dacicus* Zone and of the *A. microreticulatus* Zone with the *R. gr. cushmani-turonica* Zone is also well demonstrated in the Tara Barsei Basin (Brebina Valley-Barsa Valley key section).

In summary, in Romania the zonal assemblage of the *E. pentagonum* includes: *E. pentagonum, C.(L.) lotzei, F.obtectum, Ps. thomeli, E. gothicum, C. naviculare and F. bicarinatum,* the last three species occurring in its uppermost segment.

Excepting the bioevent markers for the base of the Upper Cenomanian/base of the *E. pentagonum* Zone and the first presence of *C. naviculare* already listed by us, in the uppermost segment of this zone, across the lower Upper Cenomanian time interval from Carpathians and North Dobrogea are also reported several planktonic foraminifera events (listed by Ion, 1993) from which as the most importantly are: (i)-at the base, the FO of the *Pseudorotalipora* genus {by the FO of *Ps. praemontsalvensis praemontsalvensis*, *Ps. pr. altispira*, *Ps. pr. lobata* (of ION, 1976)]; (ii)- into the base (with the *E. pentagonum* Zone), *Th. appenninica* and *Th. gandolfi* has the LO; (iii)- into the lowermost segment, the *Whiteinella* genus (by *W. aumalensis*) has the FO and only in the North Dobrogea the *Dicarinella* genus (by *D.algeriana*) has a later FO (while in Carpathians from this level is begins to be more frequently);(iv)- in the middle of the *E. pentagonum* Zone, *W. baltica* has the FO and only in North Dobrogea the *Marginotruncana* genus (by *M. aff. renzi* of Porthault, 1974) has a later FO (and in the Carpathians it begins to be more frequently);(v)-towards the uppermost segment, *Whiteinella kingi* (TRUJILLO, 1960), *W. inornata* (BOLLI, 1957), *M. renzi* (RENZI, 1942)–with convex profil and the undoubted specimens of *H.praehelvetica* have the FO; (vi)- towards the top of this interval, *W. aprica* and the specimens of *Rotalipora s.l.* with angularity-lobat contour [*Th. aff. micheli* and *Th. aff. marchigiana* of ION, 1983;*Th. acuta* (ION, 1978)] have the FO.

The upper part of the Upper Cenomanian

In Romania, this time interval extended between the lower Upper Cenomanian *E. pentagonum* Zone/the concomitant *R. gr. cuhmani-turonica* Zone and the basal Lower Turonian [correlated by us with the *Watinoceras devonense* ammonite Zone or the upper part of the *Myliloides hattini* inoceramid Zone from the Rock Canyon Anticline (West of Puebblo Colorado) GSSP for the Cenomanian-Turonian boundary (Bengston *et al.*, 1996)] marked by the several planktonic foraminifera events and microflora ones choised by us as potential proxy markers. The integrated biostratigraphic data for this time interval are from the Carpathians and North Dobrogea.

In summary, for this time interval in Romania we have been identified only the planktonic foraminifera and microflora events, as follows: (i)-The beginnig of the upper Upper Cenomanian is marked by the FO of the planktonic foraminifera *W. paradubia* (=the beginning of the *W. paradubia* Zone) as bioevent of general chronological significance (in Romania is located above the last levels with fauna of the *E. pentagonum* Zone/and or the microfauna of the *R.* gr. *cushmani-turonica* Zone; detailed data in the lower Upper Cenomanian chapter). (ii)-Into its lower segment, only in the Carpathians (Daljii V. and Ghimbavului V. sections) there are (as rare and little specimens) the earlier FO of the *Praeglobotruncana biconvexa biconvexa* (SAMUEL & SALAJ, 1962) and *Pr. gr. oraviensis* SCHEIBNEROVA 1960 planktonic foraminifera. (iii)-Approximate in the middle of the upper Upper Cenomania interval, the dinoflagellate *Camarozonosporites insignis* has the LO (documented in the Carpathians) and little higher (iv)-the planktonic foraminifera *Whiteinella archaeocretacea* PESSAGNO, 1967, only in North Dobrogea has a earlier FO. (v)-Follows in the upper segmen, the simultaneous FO of the planktonic foraminifera *Dicarinella imbricata* (MORNOD, 1950) (=the beginning of the *D. imbricata* Zone), *D. hagni* (SCHEIBNEROVA, 1962), *D. canaliculata* (REUSS, 1854) and *Archaeoglobigerina cretacea* (d'ORBIGNY,1840) in both domains, - as of regional chronological signifficance events (known in some areas of the Tethys in the *Metoicoceras geslinianum* Zone)- and only in North Dobrogea there is a later FO of *P. gr. oraviensis* (comparative with in the Carpathians); (vi)-little higher, *Falsotruncana* [by *F. loeblichae* (DOUGLAS, 1969)] has the FO in both domains, *D. biconvexa gigantea* (SAMUEL & SALAJ, 1962) has a earlier FO only in the Carpathians. (vii)-Higher, the base of the Lower Turonian would be marked by the concomitant FO of the dinoflagellate *Subtilisphaera pontis-marie* (=the beginning of the S. *pontis-marie* Zone) and *Xenascus ceratioides* (DEFLANDRE) LENTIN & WILLIAMS, 1973 (=the beginning of the *X. ceratioides* Zone) as proxy markers of local chronological significance, the FO of the pollen *Complexiopollis christae* (VAN AMERON, 1965) KEDVES, 1980 (=the beginning of the *C. christae* Zone) as proxy event of regional chronological significance for Tethys, while as planktonic foraminifera events there are (into the *D. imbricata* Zone) the FO of *Marginotruncana elenae* ION, 1983 (of local significance event) and the LO of *Th. greenhornensis*, *Th. brotzeni*, *Th. globotruncanoides* (as of regional chronological significance event for Tethys) and of other *Rotalipora s.l.* (as *jaquesigali, porthaulti*). It is to note: in Romania as in the other Tethyan areas, some *Rotalipora s.l.* (as *cushmani, turonica, reicheli*) persit to in the Lower Turonian (in the *Helvetoglobotruncana helvetica* Zone); this situation and the inconstant FO of of *W. archaeocretacea* are the reasons for not using the Interval /or Partial *W. archaeocretacea* Zone (from West European scales) in Romania.

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APPENDIX: NEW PLANKTONIC FORAMINIFERA SUBZONES DEFINED IN THE UPPERMOST ALBIAN-LOWER CENOMANIAN OF ROMANIA (Jana ION). Into the *Thalmanninella brotzeni/Th. globotruncanoides* Zone (acc. definition J. Sandulescu, 1969 emend. J. Ion, 1983) from Romania three new subzones are defined/separated: (1) *Th. brotzeni/Th. globotruncanoides* and *Th. ticinensis* new Assemblage Subzone. Age: uppermost Albian. Author: J. Ion. Definition: from the FO of *Th. brotzeni* and/or *Th. globotruncanoides* (in the middle of the strata with *St. dispar* Zone) to the FO of *Th. greenhornensis* (immediately above the strata with *St. dispar* Zone). Remarks: at the upper boundary , *Th. ticinensis* has the LO; the subzonal assemblage is with *Th. ticinensis*, *Th. brotzeni*, *Th. globotruncanoides*, *Th. appenninica*, *Th. gandolfi*, *Planomalina buxtorfi*. (2) *Thalmanninella greenhornensis* new Subzone. Age: lower Lower Cenomanian. Author: J. Ion. Definition: from the FO of *Th. greenhornensis* (immediately above the strata with *St. dispar* Zone) to the FO of *Th. jaquesigali* (in the first levels with *Turrilites* and/or *Inoceramus virgatus*, respective at the base of the *M. dixoni* Zone and/or *I. virgatus* Assemblage). Remarks: at the lower boundary, *Th. ticinensis* has the LO; at the upper boundary, *Th.caroni, Th. runcui, Th. oresti, Th. acuta, Rotalipora thomei* have the FO too and begins the bloom of *R. montsalvensis*. (3) *Thalmanninella jaquesigali* new Subzone. Age: a part of the upper Lower Cenomanian. Author: J. Ion. Definition: from thr FO of the nominale species (at the base of the *M. dixoni* Zone and/or of the *I. virgatus* Assemblage) to the FO of *Th. porthaulti* (in the middle of the *M. dixoni* Zone and/or of the *I. virgatus* Assemblage). Remarks: at the lower boundary there are also other several bioevents listed at the upper boundary of the *Th. greenhornesis* Subzone.

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