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Conclusions to the Colloquium on the Turonian stage: Integrated biostratigraphic charts and facies maps (France and adjacent areas)

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With 6 text figures

ABSTRACT

A Colloquium organized by the "Groupe Français du Crétacé" in Paris gave the opportunity to bring together recent data on biostratigraphy, sedimentology and palaeogeography of the Turonian of France and adjacent areas. Biostratigraphical results are synthesized on four charts that show the comparative vertical distribution of the main macrofossils: ammonites, inoceramids, echinoids, brachiopods, rudists and microfossils: planktonic and benthic foraminifera, nannoplankton, dinoflagellates and ostracods. A three-fold division based on ammonites is proposed for the stage. Palaeogeographical facies in France during the Early and Middle-Late Turonian are shown on two maps.

RÉSUMÉ

Un Colloque organisé par le Groupe Français du Crétacé au Muséum de Paris en 1981 a donné l'occasion de confronter les nouvelles données biostratigraphiques, sédimentologiques et paléogéographiques sur le Turonien de la France et des contrées limitrophes. Les résultats biostratigraphiques sont synthésisés dans quatre tableaux donnant les extensions verticales parallélisées des principales macrofaunes: ammonites, inocérames, échinides, brachiopodes, rudistes et des principaux microfossiles: foraminifères planctoniques et benthiques, nannoplancton, dinoflagellés et ostracodes. Une division tripartite de référence est proposée avec le groupe des ammonites. Deux aspects paléogéographiques de la France au Turonien inférieur et au Turonien moyen-supérieur sont ensuite présentés sur deux cartes.

KURZFASSUNG

Auf einem Kolloquium der „Groupe Français du Crétacé" in Paris 1981 wurden die neuesten Daten zur Biostratigraphie, Sedimentologie und Paläogeographie des Turon Frankreichs und angrenzender Gebiete vorgestellt. Die biostratigraphischen Resultate sind in 4 Tabellen synoptisch zusammengefaßt und zeigen die Reichweiten von Ammoniten, Inoceramen, Echiniden, Brachiopoden sowie von Mikrofossilien, wie planktonische und benthonische Foraminiferen, Nannoplankton, Dinoflagellaten und Ostrakoden. Eine Dreiteilung, die auf Ammoniten basiert, wird für das Turon vorgeschlagen. Zwei paläogeographische Karten zeigen die Faziesverteilung in Frankreich für das Unterturon und den Zeitabschnitt Mittel- bis Oberturon.

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INTRODUCTION

A Colloquium on the Turonian stage was held in the Muséum d'Histoire Naturelle de Paris in October 1981, organized under the auspices of the Groupe Français du Crétacé by G. Alcayde and myself. About fifty people, including members of the Albian to Coniacian working-group, attended the meeting where twenty-one lectures were given.

On the last day of the session, participants were invited to compare their data in order to draw up a multiple biostratigraphical chart for the Turonian with the main macro and microfossils.

Figures 1 to 4 contain the results of fruitful discussions for each fossil group, from data of F. Amedro, J. M. Hancock, W. J. Kennedy, J. Lauverjat, J. Sornay for ammonites; J. Sornay for inoceramids; M. Fouray, F. Amedro, F. Robaszynski for echinids; D. Gaspard for brachiopods, J. Phillip and M. Bilotte for rudists; M. Caron, M. B. Hart, M. Lamolda, Ch. Monciardini, F. Robaszynski for foraminifera; H. Manivit and J. C. Foucher respectively for calcareous nannoplankton and dinoflagellates; J. F. Babinot, J. P. Colin and R. Damotte for ostracods.

BIOSTRATIGRAPHICAL DATA

AMMONITES

Cenomanian-Turonian boundary

The upper part of the Cenomanian is marked in most areas in the world by the occurence of *Metoicoceras geslinianum* (d'Orbigny). Furthermore, it seems convenient to place the base of the Turonian at the appearance of the genus *Watinoceras* known in Europe, Africa, the Soviet Union and the U.S.A. Between *Metoicoceras* and *Watinoceras* is inserted a fauna with *Neocardioceras juddii* (Barrois & Guerne) which could be considered very high Cenomanian. This opinion has to be carefully discussed because of its implications: in the Tethyan realm most Vascoceratids, such as *Thomasites, Nigericeras, Gombeoceras,* were considered as Turonian till Berthou and Lauverjat found high Cenomanian *Vascoceras* in Portugal.

Turonian-Coniacian boundary

According to Hancock and Kennedy (1981) the first ammonite found at the base of the Coniacian in its type area is *Reesideoceras petrocoriense* (Coquand) (= *Barroisiceras haberfellneri* [Hauer] sensu de Grossouvre). Species of the genus *Peroniceras* which are commonly cited by authors appear above the lowest *Reesideoceras* and do not indicate the basal part of the Coniacian, as Arnaud demonstrated more than a century ago. We should note that the important changes in fauna used by d'Orbigny to separate his Cretaceous stages are situated at levels where hard-grounds and gaps of sedimentation are numerous. For example, near the Cenomanian-Turonian boundary it is possible that about one million years separate the *Metoicoceras* and *Watinoceras* zones and it could be the same between Turonian and Coniacian.

Divisions of the Turonian

A tripartition into Lower, Middle and Upper Turonian from the work of Amedro & al. is shown in fig. 1.

The appearance of *Collignoceras woollgari* (Mantell) ends the Lower Turonian which is divided in two zones: *Watinoceras coloradoense* (Henderson) and *Mammites nodosoides* (Schlüter) – or three if the *juddii* zone be included in the Turonian. Two opinions hang in the balance for the boundary between Middle and Upper Turonian:

- in the first, Amedro & al. place the base of the Upper Turonian at the appearance of *Romaniceras deverianum* (d'Orbigny):
- in the second, Hancock, Kennedy and Wright use the appearance of *Subprionocyclus neptuni* (Geinitz) to mark the base of the Upper Turonian.

The first solution may have the advantage of appreciably reducing the duration of a very long *C. woollgari* zone, whereas the second emphasizes the more cosmopolitan character of *S. neptuni.* Amedro & al. have recorded *Subprionocyclus neptuni* and *Collignoniceras woollgari* together in Troyes, but it is not known where *S. neptuni* appears. At Uchaux, Devalque & al. have recorded *Romaniceras deverianum* immediately below *S. neptuni,* but *C. woollgari* is unknown there. In fact, there are no modern records from Europe of *R. deverianum* being found with a collignoniceratid, either *Collignoniceras* or *Subprionocyclus.* In the U.S.A. *Romaniceras* cf. *deverianum* has been collected with a collignoniceratid above the highest *Collignoniceras* there, but it is a *Prionocyclus, Subprionocyclus* being unknown in the western interior of the U.S.A. It may be that the appearances of *Romaniceras deverianum* and *Subprionocyclus neptuni* coincide, and there is no real difference between the two opinions. In fig. 1 the first view is used.

INOCERAMIDS

In the present state of knowledge, inoceramids still do not give such accurate divisions as ammonites but their frequent occurence, or even abundance, makes the group a good and reliable stratigraphical tool when cephalopods are lacking. Three divisions can be recognised but they do not coincide with the ammonite ones.

A lower division is characterized by forms of the group *I. mytiloides* Mantell – *I. labiatus* Schlotheim – *I. hercynicus* Petrascheck. *I. mytiloides* first appears, immediately followed by *I. hercynicus.* The three species extend into the basal part of the Middle Turonian.

A middle division is marked by the development of the *I. lamarcki* Parkinson group where *I. brongniarti* Mantell and *I. cuvieri* Sowerby are frequent.

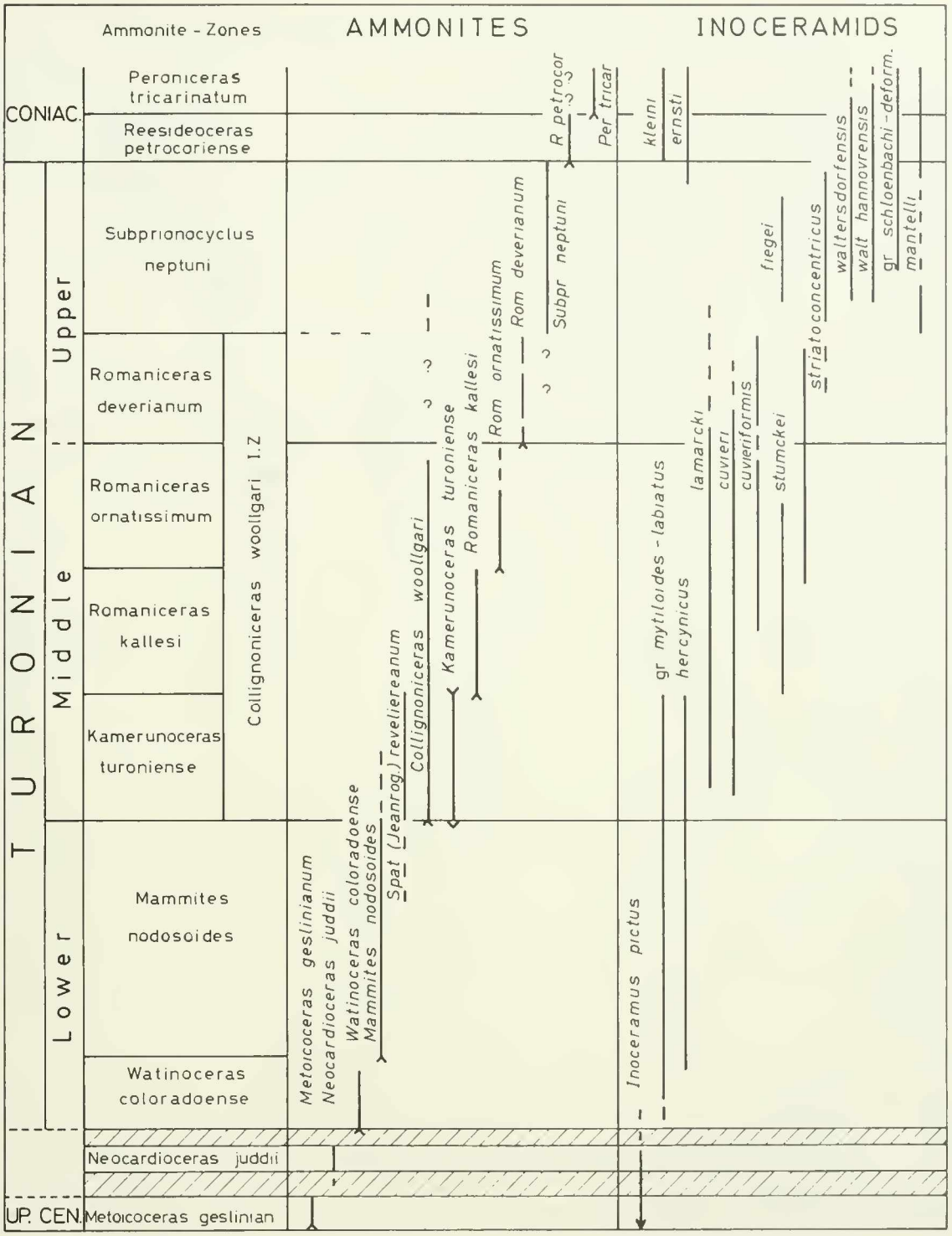

Fig. 1. Distribution of main species of ammonites and inoceramids in the Turonian of France and adjacent areas. Ammonite zonation partly from AMEDRO & al., 1982.

An upper division is defined by *I. striatoconcentricus* GÜMBEL and contains the first *I. schloenbachi* J. BR. and *I. waltersdorfensis* AND. with its subspecies *I. w. hannovrensis* HEINZ.

ECHINOIDS

The genus *Micraster* AGASSIZ includes numerous morphospecies which were and are always used for biostratigraphical needs. The study of several successive populations in the Normandy Chalk demonstrated the existence of variants linked by intermediate forms as shown by M. FOURAY (1981). The most prominent aspect which allows one to follow the evolution of *Micraster* is the development of ornamentation on the test. The five types observed by ROWE (1899), in addition to the terminology for periplastronal areas proposed by FOURAY, constitute a base for the definition of three morphotypes very useful for the stratigraphy of the Upper Turonian-Coniacian.

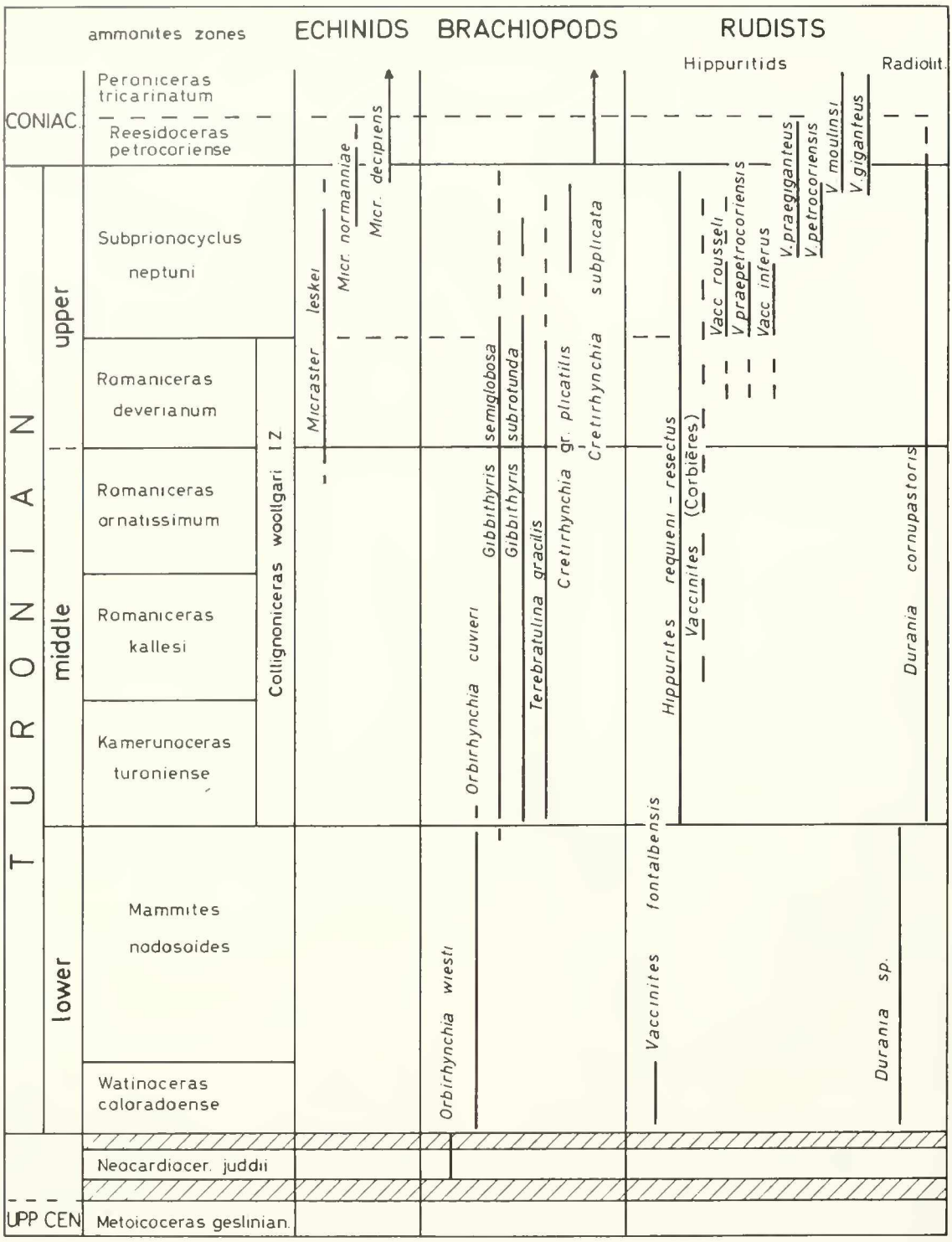

Fig. 2. Distribution of main species of micrasters, rudists and brachiopods in the Turonian of France.

1. *M. leskei* Des Moulins (alias *M. breviporus* Agassiz, nomen nudum) has interporiferous areas that are smooth or sutured, periplastronal areas punctuated, the peristome far from the anterior edge and not covered by a prominent labrum. *M. corbovis* Forbes belongs to the *leskei* group but is larger and has a thinner test.

First representatives of the group generally appear high in the Middle Turonian but some specimens of *M.* cf. *corbovis* have been found with *I. labiatus* at the base of the substage, or even in the upper part of the Lower Turonian in England. Typical forms of the *leskei* group run through the whole of the Upper Turonian.

2. *M. normanniae* Buccaile appears high in the *Subprionocyclus neptuni* zone and extends into the basal part of the Coniacian. It differs from *M. leskei* by its interporiferous areas being inflated and sometimes subdivided, the peripla-

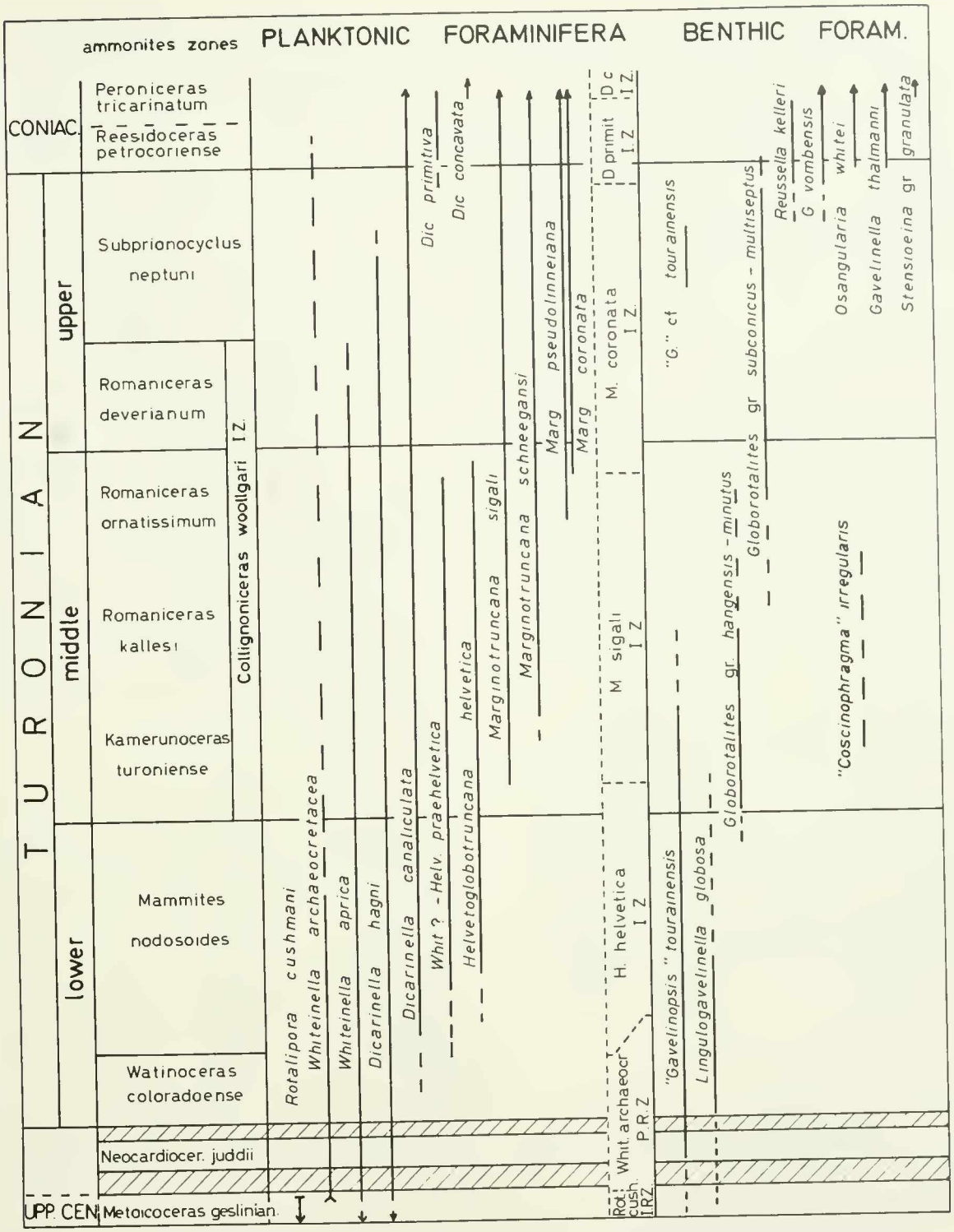

Fig. 3. Distribution of main species of planktonic and benthic foraminifera in the Turonian of France.

stronal areas chained ("caténulé") to verrucose, the peristome rather distant from the anterior edge and half covered by a labrum.

3. *M. decipiens* Bayle shows subdivided interporiferous areas and evenly divided, periplastronal areas typically verrucose, the peristome close to the anterior edge and covered by a labrum. The morphotype appears in the uppermost part of the *S. neptuni* zone but characterizes the Coniacian.

BRACHIOPODS

Amongst rhynchonellids, *Orbirhynchia cuvieri* (d'Orbigny) and *O. heberti* Pettit are common in the Lower Turonian.

Terebratulids are frequent in the Middle and Upper Turonian: *Gibbithyris semiglobosa* (Sowerby), *G. subrotundus* (Sow.) and *Terebratulina gracilis* d'Orbigny (? = *T. lata* in

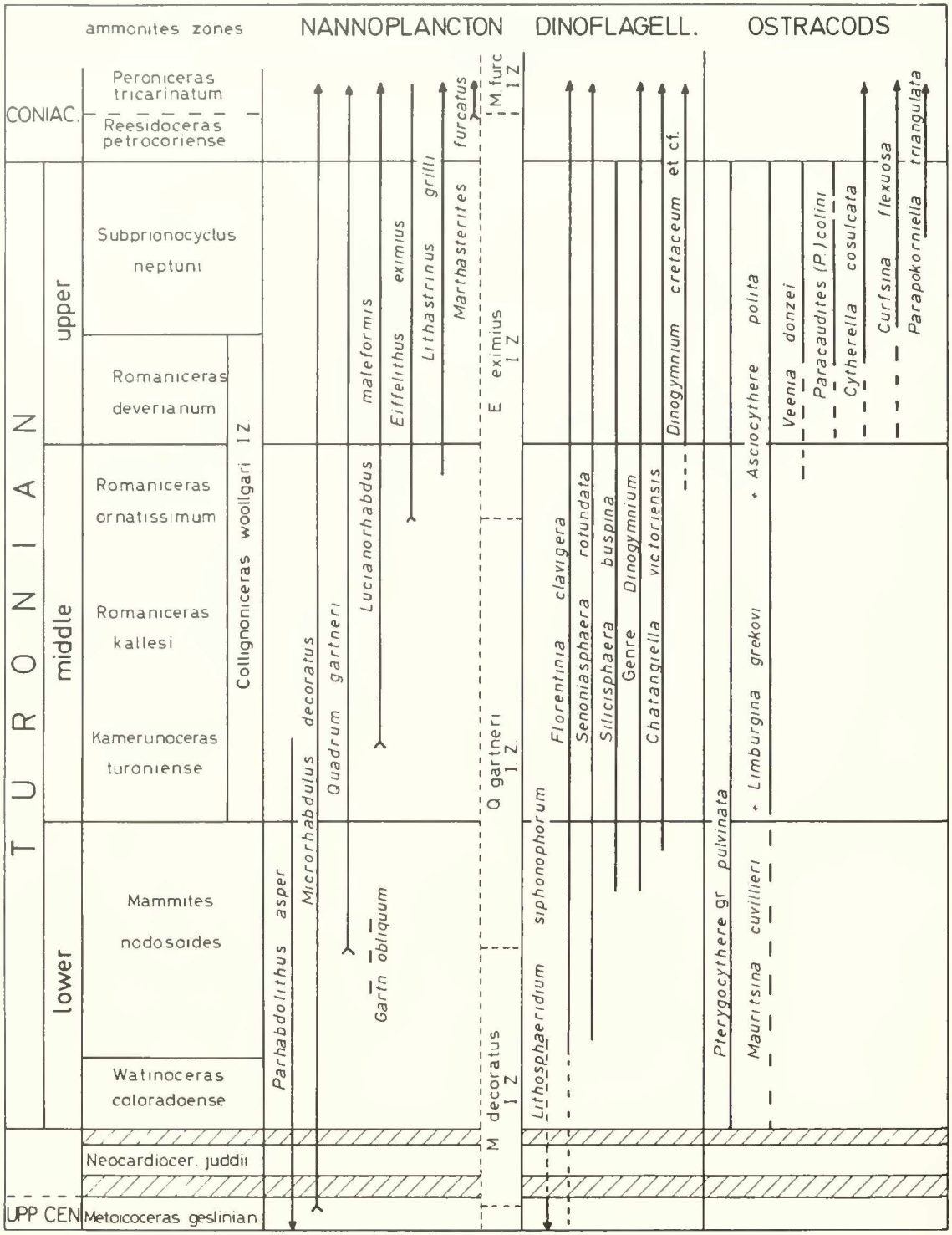

Fig. 4. Distribution of main species of nannoplankton, dinoflagellates and ostracods in the Turonian of France.

England). The Upper Turonian is marked by the appearance of *Cretirhynchia plicatilis* (Sow.) and the Coniacian by *C. subplicata* (Mantell).

RUDISTS

A phyletic zonation can be defined using the Hippuritidae which are a homogenous group with a rapid evolutionary rate and a wide geographical distribution. In Provence, *Vaccinites fontalbensis* Philip is characteristic of the basal Turonian. After an absence due to palaeogeographical changes, rudists return in the Middle Turonian (Provence and Pyrénées) with *Hippurites* gr. *requieni* Math. – *resectus* Defr. In the Massif d'Uchaux (Rhône Valley), two Assemblage-Zones can be distinguished in the Upper Turonian: A.–Z. with *Vaccinites rousseli* (Douville) and *V. praepetrocoriensis* Toucas, and A.–Z. with *V. petrocoriensis* (Douville). The first was correlated with the *S. neptuni* ammonite zone (Devalque & al., 1982).

The last rudistid assemblage is recorded from the upper part of the Turonian and below the *Peroniceras* zone. It includes Turonian forms *(V. praegiganteus)* and some representatives of species which will develop during the Coniacian *(V. moulinsi* and *V. giganteus)*.

PLANKTONIC FORAMINIFERA

Globotruncanid genera

All species of *Rotalipora* disappear before the end of the Cenomanian and that corresponds with the development of two other genera: *Whiteinella* and *Dicarinella*. The Lower Turonian is marked by the appearance of *Helvetoglobotruncana,* followed in the Middle Turonian by *Marginotruncana*. The *genus Globotruncana* does not occur below the Coniacian.

Comments on some Globotruncanid index species

The Lower Turonian shows the blossoming of numerous *Whiteinella: W. brittonensis* (Loeblich & Tappan), *W. archaeocretacea* Pessagno, *W. aprica* (Loeblich & Tappan) whose association is known in the literature as "grosses globigérines". Within the Lower Turonian *Helvetoglobotruncana helvetica* (Bolli) appears just preceded by ? *W. praehelvetica* (Trujillo), but is possible that bathymetrical conditions control the individualization of the two morphotypes. On the other hand the extinction of *H. helvetica* marks a clear level just below the base of the Upper Turonian ammonite-zone of *Romaniceras deverianum*. *Marginotruncana sigali* (Reichel) and *M. schneegansi* (Sigal) arise just above the base of the Middle Turonian and, near the top of the substage, *M. pseudolinneiana* Pessagno and *M. coronata* (Bolli) appear.

The summary of the distribution of the main species cited here corresponds to that given in the "Atlas of Mid Cretaceous Planktonic Foraminifera" (Robaszynski, Caron and European Working Group on Planktonic Foraminifera, 1979).

NANNOPLANKTON, DINOFLAGELLATES AND OSTRACODS

The index species, selected from about one hundred forms found in the Turonian, are listed in fig. 4. Details and comments are given in Robaszynski & al. (1982). It should be emphasised that calcareous nannoplankton and dinoflagellates are two groups frequently represented in shallow as well as in oceanic environments. Although their zones are longer than those of other fossil groups, it has become apparent that they are very useful for global correlation between continental and oceanic sections.

FACIES MAPS FOR THE TURONIAN

The distribution of palaeogeographical facies in France and adjacent areas during the Turonian were built up with documents coming from twenty-two contributors. We chose to represent generalised facies for two intervals: the Early and Late Turonian, and their comparison led to several conclusions:

- Most french regions are affected by the Early Turonian transgression, whereas the Late Turonian is characterized by a regressive phase beginning in the Middle Turonian.
- A relatively strong rise of sea-level during the Early Turonian is revealed by the development of pelagic facies that indicate the eustatic nature of the transgression. However, this transgression is moderated by epeirogenic movements, local or regional, as in north Spain, northern subalpine chains and in NW France.
- The reconstruction of sedimentary events in pyrenean and alpine areas is more difficult on account of orogenic movements.
- Communications between Cornwall and Armorica or through the Poitou allowed faunal transfers between the Tethyan and Boreal provinces (for example: vascoceratids, planktonic microfossils and ostracods).

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Fig. 5. Facies of the Early Turonian.

Facies legend:
1. actual boundary of old massifs; 2. erosion boundary; 3. area without deposits; 4. fault; 5. anticlinal area during sedimentation; 6. breccia; 7. volcanic breccia; 8. volcanism; 9. sands, sandstones, conglomerates; 10. marly clay; 11. marl; 12. carbonate marl; 13. chalk (two lines: disturbed sedimentation); 14. tuffeau; 15. nodular chalk; 16. alpine sea; 17. limestones; 18. flysch; 19. transgressivity; 20. direction of detrital deposits; 21. sand; 22. clay; 23. glauconite; 24. flint, chert; 25. bioclasts; 26. lignite; 27. rudists; 28. echinoids; 29. oysters; 30. corals; 31. algal laminations; 32. pithonels.

Abbreviations:

AB: Bilbao anticlinorium; AL: Losas fault; AM: Merlerault axis; BD: Durance bending; FN: Nimes fault; FNP: North Pyrenean Front; FV: Villefranche fault; SB: Burgos gate; SD: Douro gate; SP: Pedroza gate;

Fig. 6. Facies of the Late Turonian. (Facies legend and abbreviations see Fig. 5.)

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