

## A MODIFIED PERISPINCTID ZONATION FOR THE MIDDLE OXFORDIAN OF SOUTHERN EUROPE, SUBMEDITERRANEAN PROVINCE

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### ABSTRACT

A new detailed biostratigraphic scheme for the Middle Oxfordian of western and southern Europe (Plicatilis and Transversarium Zones) is proposed, by means of perispinctids. It precises and slightly modifies the classical biozonations proposed during the last 25 years. The Plicatilis Zone is subdivided into the two classical subzones, Vertebralis and Antecedens. Within the Vertebralis Subzone, two successive horizons may be distinguished: Paturattensis, the lower, and Plicatilis (ex: Rotoides, as the species Per. rotoides RONCHADZE has been stratigraphically re-placed at the top of Transversarium Zone), the upper. The Transversarium Zone is subdivided into four subzones: Parandieri, Lucieformis (ex: Wartae Subzone, since the species Per. wartae BUKOWSKI has also been re-placed at the top of Transversarium Zone), Schilli, and Rotoides, nov. Within the Lucieformis Subzone two horizons are distinguished: Nectobrigensis, nov. nom. (=ex Wartae Horizon, see above), and Lucieformis Horizon, characterised by a whole of dense and finely ribbed, small-size Per. (Dichotomosphinctes). The Schilli Subzone, dominated by the mass occurrence of representatives of Larcheria, is subdivided into the two Schilli (lower) and Subschilli (upper) Horizons. The Rotoides Subzone, nov., is here individualized as a stratigraphical interval above the Schilli levels, and below the first record of Dichotomoceras beds. It is characterized by a set of forms showing features transitional towards Per. (Dichotomoceras), among them: Per. (Dichtes) rotoides RONCHADZE, Per. (Dichtes) ultimus ENAY, and Per. (Dichtes) wartae BUKOWSKI. This subzone has, up to the present, been identified in areas as far apart as Iberian Chain, Spain, Pitou area (France) and Swiss Jura.

## INTRODUCTION

The Middle Oxfordian of southern Europe has been classically subdivided into two zones since the formal zonal subdivision made by the Jurassic French Group (Cariou et al. 1971). This proposal included a detailed characterisation of Plicatilis and Transversarium Zones. The Bifurcatus Zone, first integrated in the Upper Oxfordian, was later moved into the Middle Oxfordian (see Meléndez et al., 1985), the boundary between Middle and Upper Oxfordian being definitively placed at the base of Bimammatum Zone.

A more detailed subdivision of these zones into subzones and horizons has been traditionally difficult and full of contradictions between the different authors. This is mainly due to two reasons (CALLOMON, 1988): (1) The presence of generalised gaps and nonsequences between the Upper Callovian and Middle Oxfordian throughout wide areas in southern Europe, and (2): The lack of an abundant and stratigraphically localized material of successive representatives of the genus Perisphinctes, a group characterized by its high morphological diversity and by the repeated occurrence of convergence phenomena, which make them extremely difficult to determine from isolated or stratigraphically uncertain specimens. A consequence of this would be the long list of morfo-specific names created for this genus during the last century.

The problems set by the question of the species concept within the subfamily Perisphinctinae are, undoubtedly, beyond the scope of this work. However, recent paleontological monographs and works carried out by the different authors since the classical study of Arkell (1935-48) on the "Corallian Beds" of England about this same stratigraphic interval, have led to the recognition of a series of homogeneous, successive ammonite assemblages, correlable throughout wide areas of southern Europe (CARIOU 1966; ENAY 1966; BROCHWICZ-LEWINSKI 1970, 1976, 1981; SEQUEIROS 1974; SAPUNOV 1977; BOURSEAU 1977; MALINOWSKA 1972, 1972 a; MELENDEZ 1984). It is also worth noting the progress made by some recent, more specifically biostratigraphical works which have much helped clarify the successions of Oxfordian ammonite assemblages and correlations within Tethys and between the Tethys and other areas (cfr. MELENDEZ et al. 1985; ENAY & MELENDEZ 1985 and references cited therein. See also the precisions recently made by CALLOMON, 1988).

Much progress has, therefore, been achieved in refining the biostratigraphic subdivisions of the classical Oxfordian zonal scheme and precisising the stratigraphical range of Oxfordian ammonite species, specially on what concerns the successive forms of the genus Perisphinctes. However, many difficulties and imprecisions in correlation still remain to be solved. This is mainly due to the sparse and fragmentary character of stratigraphic and paleontological record in most of southern Europe during Lower and Middle Oxfordian as well as to the large variability shown by the representatives of

		BIOZONE	SUBBIOZONE	BIOHORIZON
OXFORDIAN	UPPER	PLANULA	Galar	
			Planula	Praecursor
		BIMAMMATUM	Hauffianum	
			Bimammatum	
			Hypselum	
		BIFURCATUS	Grossouvrei	
	Stenocycloides			
	MIDDLE	TRANSVERSARIUM	Rotoides	
			Schilli	Subschilli Schilli
			Luciaeformis	Luciaeformis Nectobrigensis
			Parandieri	
		PLICATILIS	Antecedens	
	Vertebrale		Plicatilis Paturattensis	
	LOWER	CORDATUM	Cordatium	
			Costicardia	
			Claromontanus	
MARIAE				

TABLE 1 : The biostratigraphic zonal scheme for the Oxfordian of southern Europe, as proposed here.

subfamily Perisphinctinae during this interval, with the consequent taxonomic overload which makes the characterization of species in distant areas slow and difficult.

The comparative study of ammonite successions in the Poitou (N. Aquitaine) and Iberian Chain (eastern Spain) areas has led to the evidence of the close stratigraphical and paleontological relationships existing between both areas and to the recognition of a general Perisphinctes succession which can help fulfil and complement those already proposed by different authors for southern Europe (CARIOU 1966; BR.-LEWINSKI 1976; MELENDEZ 1984). The purpose of this paper is to propose a biostratigraphic subdivision in subzones and horizons for the Middle Oxfordian (Plicatilis and Transversarium Zones) of southern Europe within the general frame of the classical standard zonation (CARIOU et al. 1971) which has been widely recognised and accepted to-day. In this sense, the here proposed subdivision modifies the zonal scheme formerly assumed by one of the present authors (cfr. BROCHWICZ-LEWINSKI 1976; MELENDEZ et al. 1985).

## THE PERISPINTID SUCCESSION IN THE MIDDLE OXFORDIAN OF SOUTHERN EUROPE

### PLICATILIS ZONE

The Plicatilis Zone has been traditionally subdivided into two classical subzones: Vertebrale, lower, and Antecedens, upper. The Vertebrale Subzone has been generally difficult to characterize, specially in southern Europe (Submediterranean and, most of all, Mediterranean Province), due to the virtual absence of the type-species Cardioceras (Vertebriceras) vertebrale, as well as to the generalised existence of gaps and discontinuities or faunal non-sequences during this interval. The Antecedens Subzone has been characterised in many areas, from Great Britain, Aquitaine (Poitou), French Jura, SE. France, S. Germany, to Poland and Bulgaria. The recognition of successive ammonite associations and the distinction of horizons within these subzones still remains unfinished.

#### I. Vertebrale Subzone

In Poitou this subzone is lenticular. The sediments form the infilling of some erosional "cavities" affecting the Callovian materials. A very similar situation has been detected in the Iberian Chain (MELENDEZ et al. 1983; MELENDEZ 1984). The most complete data besides southern England, come from the Polish Jura (BROCHWICZ-LEWINSKI 1976) and southeastern

MIDDLE OXFORDIAN							Subzones/ horizons	Ammonite species
PLICATILIS		TRANSVERSARIUM				BIFURC.		
Verteb.	Antec.	Parand.	Luciaeformis	Schilli	Rotoid.	Stenoc.		
Paturattensis	Plicatilis		Nectobrigensis	Luciaeformis	Schilli		Bifurcaloides	
	Tenuiserratum							Per. (Otosph.) paturattensis
	F2 (Carou)							Per. (Otosph.) montfalconensis
	?							Per. (Otosph.) episcopalis
	?							Per. (Otosph.) laisinensis
								Per. (Otosph.) ouatius
								Per. (Otosph.) magnouatius
								P. (A.) cotovui (in BOURSEAU)
								P. (A.) maximus (in BOURSEAU)
								P. (A.) pickeringius (in BOURSEAU)
								P. (A.) plicatilis (in BOURSEAU)
								P. (A.) cowleyi (in BOURSEAU)
								P. (Kr.) promiscuus (in BOURSEAU)
								P. (Kr.) bullingdon. (in BOURSEAU)
								Per. (Arisph.) ingens
								Per. (Arisph.) plicatilis
								Per. (Arisph.) cristatus
								Per. (Kranaosph.) kranaus
								Per. (Dichtes.) sp. (ex rotoides)
								Per. (Dichtes.) antecedens
								Per. (Arisph.) helenae
								Per. (Arisph.) orbigny
								Per. (Kranaosph.) trifidus
								Per. (Arisph.) pickeringius
								Passendorferia (m & M) sp. nov.
								Cardioceras tenuiserratum
								Neocampilites pamprouxense
								Neocampilites henrici
								Euaspidoceras submeriani
								Protoph. christoli
								Per. (Per.) parandieri
								Per. (Per.) andelotensis
								Per. (Dichtes) buckmani
								Proscaphites anar
								Taramelliceras dentostriatum
								Per. (Dichtes.) elisabethae
								Per. (Per.) aguilonensis

Table 2 (a) Stratigraphic distribution of the main species of ammonites in Southern Europe during the Middle Oxfordian (Plicatilis Zone).

France (BOURSEAU 1977). According to Arkell's interpretation (cfr. CALLOMON 1988) this subzone would correspond to an interval characterized by several classical forms of Perisphinctes (Arisphinctes), specially Per. (Arisph.) plicatilis (SOWERBY); Kranaosphinctes: Kr. promiscuus (BUKOWSKI); Kr. kranaus BUKMAN, and Dichotomosphinctes, mainly Per. (Dichtes.) rotoides, ARKELL (non Ronchadzé). This association has been recognised, with very little variation in many areas of Europe and has been regarded as the basic, characteristic assemblage for this subzone.

### Ia. Paturattensis Horizon

However, in many points, specially in southern Europe (Poland, Bulgary, southeastern France, Spain), a lower assemblage may be clearly distinguished sometimes, still associated to Cardioceras (Vert.) vertebrale (cfr. BOURSEAU 1977). It is characterized by the constant presence of Perisphinctes (Otosphinctes) of the paturattensis-montfalconensis DE LORIOI groups, hence making it possible to individualize it as a separate, Paturattensis Horizon. Some other typical forms of this interval are the so-called "Dichotomosphinctes" of the episcopalis-laisinensis DE LORIOI, groups and their corresponding macroconchs. All these elements seem to form a remarkably homogeneous assemblage characterized by the serpenticone, evolute coiling with subcircular somewhat massive to oval whorl section and fine and dense, proverse ribbing with prominent parabolic structures. This assemblage, first described by De Loriol (1902) was subsequently recognised by Brochwicz-Lewinski (1976), Bourseau (1977), Sapunov (1977) and Meléndez (1984; Meléndez et al. 1983, 1985).

### Ib. Plicatilis Horizon (=Rotoides Horizon, BR.-LEW. 1976)

It is characterized by the forms grouped around Perisphinctes sp. (=Per. rotoides, ARKELL, non RONCHADZE), and their corresponding macroconchs among which are some familiar forms of Perisphinctes (Arisphinctes) such as: Per. (Arisph.) plicatilis (SOWERBY), Per. (Arisph.) ingens (YOUNG & BIRD), as well as Kranaosphinctes, such as: Kr. kranaus BUCKMAN, Kr. promiscuus (BUKOWSKI) (cfr. CALLOMON 1988). This horizon was classically characterized by Arkell in Great Britain, and seems to be partly absent, or poorly represented in most of southern Europe. Some isolated elements that could be referred to this horizon, have been recognized. In the Iberian Chain, a specimen of Kranaosphinctes kranaus has been collected at the locality of Ariño, within the iron-oolitic level which marks the boundary between the Callovian and Oxfordian in the region.

The term "Rotoides Horizon" was first proposed by Brochwicz-Lewinski (1976) to designate stratigraphic interval with a similar ammonite association, and accepted as a basal horizon of the Antecedens Zone of the same author (cfr. MELENDEZ et al. 1985). However, the permanence of this name would be troublesome to-day, once the stratigraphic position of the nominal species, Per. rotoides RONCHADZE has been correctly recognized and replaced at the Uppermost Transversarium Zone levels. As a substitute, the type-species of the zone, Per. (Arisph.) plicatilis (SOWERBY) is here proposed as the type-species for the horizon, since it appears at this horizon and has been widely recognized throughout southern Europe (cfr. CALLOMON, 1988). A further species, such as Kranaosphinctes kranaus BUCKMAN, also recognized in most of southern Europe, including Iberian Chain, could serve as well as type-species.

## II. Antecedens Subzone

It corresponds to the stratigraphic interval integrated by middle to large size Dichotomosphinctes of the antecedens SALFELD group and their corresponding macroconchs, i. e. the group of Perisphinctes (Per.) chlorooliticus GUEMBEL, according to Callomon (1988).

The species Dichotomosphinctes antecedens SALFELD is characterized by its large size, the slow, evolute coiling with quadratic section, and the uniform, homogeneous ribbing with moderately thick, round primaries and thick secondaries, and point of furcation very high on the ventral margin. It shows a wide variability on what concerns the strenght of the ribbing, coiling, and whorl section, some evolute, more coarsely costate specimens having sometimes been described as Per. (Dichtes) buckmani ARKELL.

This subzone has been widely recognized throughout western and southern Europe, from Great Britain (ARKELL 1935-48) to Franconia in Sengenthal (CALLOMON 1988), French Jura (ENAY 1966), SE. France (BOURSEAU 1977), Polish Jura (BROCHWICZ-LEWINSKI 1976). In Poitou it has been recognised in the section of Rom, by a rich assemblage of undoubtful Per. (Dichtes) antecedens SALFELD. In the Iberian Chain Spain, it seems to be absent or partly condensed (MELENDEZ 1984). In more typically mediterranean areas, in the Betic Chain and in Northern Italy, Verona, it has been characterized by some several forms of the genus Tornquistes (see: SEQUEIROS 1974; BENETTI & PEZZONI, 1985).

## TRANSVERSARIUM ZONE

Biostratigraphic subdivision of this zone into subzones and horizons has been traditionally difficult to work out, despite of the fossiliferous richness of these sediments, leading in many cases to divergent results. This is mainly due to the incomplete character of stratigraphic series in the different parts of Europe, which makes ammonite successions from distant areas hard to correlate. The lower part, (=Parandieri Subzone), is better developed in the northern and west Central French and northwestern part of the European Platform (ern), whilst the upper part appears well developed in more southerly areas (Aquitaine, Iberian Chain, where Lower Transversarium Zone is generally missing), up to the Polish Jura. This polarity in development has been linked to the presumable tectonic "Tilt" of the European Platform during the Middle Oxfordian (CALLOMON 1964).

A first subdivision of this zone into two subzones, Parandieri and Schilli was proposed by CARIOU et al. (1971). An intermediate "wartae assemblage" between these two subzones was, however, soon recognized by several authors, so that a proposition of a Wartae Subzone below Schilli Subzone has been repeatedly made (TINTANT 1958, MALINOWSKA 1972), although its demarcation from Parandieri Subzone was not precisely shown. A proposition of a Buckmani Horizon, or Subzone, partly equivalent to Parandieri Subzone, was subsequently made by Brochwicz-Lewinski (1976) as an upper subdivision of his Antecedens Zone. The author established the Wartae Subzone as the basal subdivision of Transversarium Zone. This acception was subsequently assumed by one of the present authors (MELENDEZ 1984, MELENDEZ et al. 1985) since it seemed more adequate to the observed perisphinctid succession in some Southern areas. However, both the reasons of stability and the wide acception of the former subdivisions of Transversarium Zone make it more advisable to retain the classical scheme, maintaining Parandieri Subzone as the basal subzone for Transversarium Zone.

### III. PARANDIERI SUBZONE

This lower subzone of Transversarium Zone has been recognized from England, French Jura, S. Germany, up to Swiss Jura and Poland. It is mainly characterized by the association of Per. parandieri (M) DE LORIOU and Per. (Dichtes) buckmani (m) ARKELL, as well as by some other large to giant forms of Perisphinctes showing evolute serpentine coiling with rounded whorl section and strong, somewhat sharp ribbing on inner whorls. Although proposed long ago as the basal subzone of Transversarium Zone, its demarcation from Wartae Subzone is, however, recent (see above). In the

MIDDLE OXFORDIAN							Subzones/ Horizons	Ammonite species
PLICATILIS		TRANSVERSARIUM			BIFURC.	Stenoc.		
Verteb.	Antec.	Parand.	Luciaeformis	Schilli	Rotoid.			
Paturatensis	Plicatilis	(F2 Carou)	Nectobrigensis	Luciaeformis	Schilli	Subschilli	Bifurcatoides	
								Per. (Otosph.) nectobrigensis
								Subdiscosphinctes kreutzii
								Subdiscosphinctes richei
								Per. (Dichtes.) wartae, (AUCT.)
								Per. (Otosph.) vermicularis
								Per. (Dichtes.) luciaeformis
								Neomorphoceras collini/chapuisi
								Per. (Dichtes.) luciae
								Per. (Dichtes.) marnesiaie
								Pass. (Enay.) bimensdorfensis
								Pass. (Pass.) ziegleri
								Sequeir. (Gemm.) trichoplocus
								Euaspidoceras tenuispinatum
								Larcheria schilli
								Larcheria ibérica
								Larcheria subschilli
								Larcheria latumbilicata
								Per. (Otosph.) sorlinensis
								Pass. aff. bimensdorf. (m & M)
								Euaspidoceras oegir
								Subdiscosphinctes divionensis
								Subdiscosphinctes richei
								Per. rotoides RONCHADZE
								Per. (Dichtes.) wartae BUKOW.
								Perisphinctes kiliani
								Perisphinctes jelskii
								Per. (Dichtes.) ultimus
								Sequeirosia sp. (m & M)
								Subdiscosphinctes aff. kreutzii
								Proscaphites colleti
								Per. (Dichceras.) bifurcatoides
								Per. (Dichceras.) stenocycloides

Table 2 (b) Stratigraphic distribution of the main species of ammonites in Southern Europe during the Middle Oxfordian (Transversarium Zone).

Poitou area this subzone was not specifically individualized (see Cariou, 1966). However, it might correspond to the "Horizon a Alligaticeras doublieri" wherefrom some specimens of Per. (Per.) andelotensis ENAY, regarded as a small-size variant of Per. parandieri DE LORIO, and some forms close to Per. (Dichtes) buckmani ARKELL have been recently recognized.

As far as more southerly areas is concerned this interval is normally poorly represented to totally absent, with the exception of the Polish Jura. In the Iberian Chain this subzone appears almost totally missing within the generalized gap between the Fe-oolitic level and the sponge limestone series, or localized at the base of this last unit, as it is the case in the section of Ricla.

#### **IV. LUCIAEFORMIS SUBZONE (=WARTAE SUBZONE, Auctt.)**

The individualization of this subzone, as well as the convenience of its definition as a separate unit at the middle part of Transversarium Zone, have already been remarked (see above). Its paleontological characterization, made by Cariou (1966 =Collini Horizon) by Brochwicz-Lewinski (1976) and by Meléndez (1984) and Meléndez et al. (1985), has been recently synthesized by Callomon (1988). According to this author it would comprise a highly variable, although relatively homogeneous assemblage characterized by a moderately evolute to involute coiling, with fine and dense ribbing in the inner whorls. The shell morphology shows a large variability, from moderately evolute serpenticones with rounded to oval section (e. g. Per. gr. wartae auctt., non BUKOWSKI) to flattened, compressed involute platycones to oxycones (= Subdiscosphinctes, of the kreuzi-richei-mindowe groups).

#### **On the stratigraphic position of typical Per. wartae BUKOWSKI**

The precise interpretation of Per. wartae BUKOWSKI could be to-day the matter of discussion. The sediments of Transversarium Zone in the region of Czestochowa, whence comes the type specimen of Bukowski's species are formed by a monotonous succession of limestone banks in which a continuous series of representatives of the subgenus Per. (Dichotomosphinctes) is recorded, from early representatives of Per. (Dichtes) buckmani ARKELL up to early representatives of Per. (Dichotomoceras), at the base of Bifurcatus Zone.

Within this succession the exact level of the type-specimen of Perisphinctes wartae BUKOWSKI "should be treated as impossible to precise" (Brochwicz-Lewinski, personal communication). According to this author (1980), representatives of this species should be regarded as transitional between the subgenera Dichotomosphinctes and Dichotomoceras, on account of their ontogenetic development and of the rib curve and style of ribbing. More recent evidence has come from Poitou (col. E. Cariou) where some

specimens, appearing extremely close to the type of this species have been collected at the top horizon of Transversarium Zone (=Colleti Horizon, Cariou 1966 =Rotoides Subzone nov.), at the uppermost part of Schilli Subzone, above the levels with Larcheria schilli (OPPEL). This would raise the possibility that the Bukowski's species could, in fact, be a last or "final" stage of Dichotomosphinctes line, coming from a clearly higher stratigraphic level than previously assumed. Specimens from Poitou are characterized by their evolute coiling, slow growth, with subquadrate to rectangular section, and flat sides; sharp, fine ribbing and secondaries describing a forward sweep at the ventral region. Some of these features would place them close to early representatives of Dichotomoceras. However, they must be classified as Dichotomosphinctes on account of the rib curve, ascendent in its initial part, and of the particular design of the suture line, with a long retracted suspensive lobe, of Dichotomosphinctes-type.

Most of these features are also displayed by the type specimen of Bukowski's species. So, it is not excluded that this species occupies a stratigraphical position at the uppermost part of Transversarium Zone. If this is the case, other specimens classically assigned by different authors to this species (Enay 1966, Malinowska 1972, Meléndez 1984, Callomon et al. 1988, etc.), characterized by their moderately evolute coiling, fine, dense ribbing and oval elevate section with convex sides, should be rather interpreted as successive links or "transients" within this continuous Dichotomosphinctes line. An exception could, perhaps, be the specimen figured by Enay (1966), Fig.147, p.487, Coll.Fac.Sc. Dijon, from the type locality (Czenstochau), which could actually correspond to a true representative of Per.wartae BUKOWSKI. In the same way, some specimens coming from top of the Schilli Subzone in the Iberian Chain, and figured as Per. (Dichotomosphinctes) ultimus ENAY by Meléndez (1984, lam. 48 fig. 1-2 ; lam. 49, fig. 1-3) could perhaps, be more properly placed within Per. (Dichtes) wartae BUKOWSKI. In the same way, among the specimens figured by Meléndez as Per.wartae in 1984 and 1990, that from lam. 44, fig 1a-b (non fig.2) could, actually be regarded as a true representative of this species, and all the rest be rather included in Per. luciaeformis ENAY.

## BIOSTRATIGRAPHIC SUBDIVISIONS

Difficulties hitherto found in recognizing horizons within this subzone are primarily due to the strong homogeneity of the Perisphinctes assemblage within this interval and, also, to the existence of large collections of specimens, but poorly localized within the stratigraphic succession. Two main subdivisions, as bio-horizons, were first proposed in Poitou by Cariou (1966), corresponding to the horizons: F. 3 and F. 4 of Pamproux section. In the Iberian Chain two main assemblages have been characterized in this

stratigraphic interval (Meléndez, 1984) and named respectively as *Wartae* and *Luciaeformis* Horizons. Some difficulties in correlating the successions from both areas are connected with the still scarce and incomplete record of Perisphinctes. On the other hand it seems that a new name should be proposed for the *Wartae* Horizon, on account of the recent knowledge of the stratigraphical position of the nominal species, Per. wartae BUKOWSKI. The situation, therefore, may be summarized as follows:

**IV. a: NECTOBRIGENSIS HORIZON, nom. nov. (= Hz. *Wartae* MELENDEZ 1984)**

**Type-species:** Perisphinctes (Otosphinctes) nectobrigensis MELENDEZ 1984

**Type-locality:** Ricla, Iberian Chain, Spain, SW from Zaragoza (see Meléndez 1984).

The proposal of a *Wartae* Horizon was made by Meléndez (1984) for this interval characterized by the whole set of large-size perisphinctids close to the "*wartae*" group (auctt.), showing a moderately evolute to involute coiling, elevata, compressed oval whorl section and fine, dense ribbing, specially on inner whorls. These are the forms grouped under the names Per. (Dichtes) wartae, auctt. (non BUKOWSKI); Subdiscosphinctes (Subdiscosphinctes) of the kreutzi-mindowe, groups SIEMIRADZKI 1891, and all their corresponding macroconchs: Perisphinctes (Per.) martelli (OPPEL 1863); Per. (Per.) aguilonensis MELENDEZ 1984; Per. (Per.) densecostatus ENAY 1966; Subdiscosphinctes (Aureimontanites) borealis MALINOWSKA 1972. Any of these names could be accepted as nominal species for this bio-horizon. However, the systematic revision of this group as well as the precise biostratigraphic position of the different forms remains still largely unclear. It seems, therefore, advisable to look for a well-known and biostratigraphically localised form as nominal species. Per. (Otosphinctes) nectobrigensis MELENDEZ has been widely recognized throughout Iberian Chain, as well as in southeastern France and Poitou, and it occupies this precise biostratigraphic position just above Parandieri levels. Its corresponding macroconch is a middle-size Kranaosphinctes showing slight variocostation on outer whorl and depressed section, figured by Meléndez (1984) as Kranaosphinctes sp. n. A, Pl. 22, fig. 2 and, perhaps, also the form figured by the same author as Per. (Arisphinctes) helenae DE RIAZ (loc. cit., Pl. 24 fig. 1).

IV. b: LUCIAEFORMIS HORIZON Meléndez 1984 (Collini Hz. Cariou 1966)

The corresponding assemblage to this horizon comprises the set of forms localized around Per. (Dichtes) luciaeformis ENAY, mainly Per. (Dichtes) luciae DE RIAZ and, probably, Per. (Dichtes) marnesiae DE LORIOLO. All these forms are characterized by their important reduction in size, in relation to the average of the forms from the lower, Nectobrigensis Horizon; the fine and dense ribbing, with numerous single ribs, and the involute coiling, although there exists a wide variability on that point. The holotype of Per. (Dichtes) luciaeformis ENAY is an evolute, crassicostate form with rounded section becoming ovate on outer whorls. Other topotypes, however, as well as the specimens from other areas (Poitou, SE France, Iberian Chain) show a more involute coiling and fine, dense style of ribbing.

This clear reduction of adult size and the umbilicus from the first to the second assemblage may be also remarked within the representatives of Per. (Otosphinctes); i. e. from P. (O.) nectobrigensis MELENDEZ, characterized by its evolute coiling, wide umbilicus and rounded to compressed whorl section, to P. (O.) vermicularis LEE at Luciaeformis Horizon, characterized by its rather involute coiling, narrower umbilicus, smaller adult size, and rounded to depressed whorl section.

Representatives of subgenus Per. (Dichotomosphinctes) from this horizon, i.e. P. (D.) luciae DE RIAZ; P. (D) luciaeformis ENAY; P. (D) marnesiae DE LORIOLO have been reported by the different authors from these same levels, or slightly above, with the first representatives of the genus Larcheria. However, in the Iberian Chain this set of forms is clearly individualized below the Larcheria assemblage and above the large size Dichotomosphinctes of the preceding subzone (= D. wartae Auctt., non BUKOWSKI). On what concerns the representatives of subfamily Passendorferiinae it may be remarked that the species Passendorferia (Enayites) birmensdorfensis (MOESCH) and its presumable macroconch: Passendorferia (Pass.) of the zieglerei group (BROCHWICZ-LEWINSKI) and related forms, appears represented in these levels and in the lower part of the subsequent, Schilli Subzone.

Up to the present, these two separate assemblages have been identified, besides the Iberian Chain, in the Poitou area, in SE France, Castellane region and in the Polish Jura (A. Wierzbowski, personal comm.). In the French Jura, the general species succession described by Enay (1966) shows that this horizon is also identified. In Aquitaine, Poitou, this horizon is equivalent to the Collini Horizon of Cariou (1966), characterized by the local abundance of representatives of small size Neomorphoceras, of the collini (OPPEL) and chapuisi (OPPEL) groups, and a similar Perisphinctes association. Such species of Neomorphoceras have also been recorded at the same levels in the Iberian Chain.

## V. SCHILLI SUBZONE

The introduction of an interval characterized by the generalized presence of Perisphinctes schilli (OPPEL), subsequently Larcheria schilli, was first due to Boone (1922), and to Cariou (1966). (=Schilli Horizon, in Poitou). The proposition of a true Schilli Subzone, as understood nowadays, is due to Enay et al. (1971) and to Cariou et al. (1971). This subzone has been widely recognized and characterized thereafter throughout SW and S. Europe (Aquitaine, Paris basin, Iberian Chain, French Jura, Argovian Jura), up to the Polish Jura Chain, where this assemblage has been identified, at the Zawodzie section, by Brochwicz-Lewinski (1970, p. 240, level 23), together with some other forms typical of this interval. The species Larcheria latumbilicata TINTANT was described and figured by this author (1972, p. 487, Pl. 13).

The characteristic assemblage for this subzone in SW Europe comprises the different species of the genus Larcheria and a group of small-sized Perisphinctes referable to Per. (Otosphinctes) the late representatives of Per. (Otosphinctes) vermicularis LEE, whit the early records of Per. (Otosphinctes) sorlinensis DE LORIOI, more abundant, showing an even narrower umbilicus and rounded "massive", depressed whorl section. Their corresponding macroconchs are some still poorly known small size Kranaosphinctes, close to that Kranaosphinctes n. sp. A, in Meléndez (1984), Pl. 22 fig. 2). Some elements, close to Per. jelskii SIEMIRADZKI, characterized by its moderately evolute coiling, compressed whorl section and irregular parabolic ribbing, are also common. It is also remarkable the record of numerous representatives of genus Passendorferia, close to the Pass. birmensdorfensis group (MOESCH), but slightly more coarsely ribbed.

The geographic distribution of the genus Larcheria might make the identification of the Schilli Subzone difficult outside western Europe. As stated by Callomon (1988), the genus seems to have been endemic in this region. In more eastern areas within the european platform, (eastwards from Swiss Jura, Gygi, 1973, 1986) it appears extremely scarce, besides the single specimen figured by Brochwicz-Lewinski and a single figured specimen by Collignon as Discosphinctes aff. schilli (OPPEL) (1959, pl. 76, fig. 318). In these areas, it is recorded a more or less continuous succession of representatives of Dichotomosphinctes of the "wartae" groups (s. l.) and related forms, showing a morphological transition to Dichotomoceras (see Brochwicz-Lewinski, 1980). Conversely, in western Europe areas, this Dichotomosphinctes succession is not recorded, or very incomplete. This separate distribution of both taxa, probably due to biogeographic factors, has traditionally made biostratigraphic subdivisions and correlations of upper part of Transversarium Zone hard to work out and imprecise.

## BIOSTRATIGRAPHIC SUBDIVISIONS

The observed succession of the different species of Larcheria within this interval in the Iberian Chain has made it possible to distinguish, locally, two successive horizons at least:

### **V.a: SCHILLI HORIZON (Cariou, 1966; Meléndez, 1984)**

In the Iberian Chain, in all the localities where the Larcheria assemblage appears well developed, representatives of Larcheria schilli (OPPEL) are usually concentrated in the lower levels, allowing the distinction of a well-defined lower horizon. Representatives of this species in the Iberian Chain are characterized by their involute coiling, and by the ribbing fine and proverse, and by a smaller adult size and more compressed whorl section than the holotype.

Some other common forms from this interval are: Perisphinctes (Otosphinctes) vermicularis LEE (late forms) and P. (O.) sorlinensis DE LORIO, and some representatives of subfamily Passendorferiinae, Pass. (Enayites) aff. birmensdorfensis (MOESCH), a form more sharply ribbed than the typical forms of this species; and Sequeirosia (Gemmellarites) close to trichoplocus group (GEMMELLARO). It is also worth noting, in the Iberian Chain, the mass occurrence in these levels of Trimarginites of the stenorhynchus-arolicus groups (OPPEL).

### **V.b: SUBSCHILLI HORIZON (Meléndez, 1984)**

The ammonite assemblage characterizing this second, upper horizon, is basically the same as for the first one, but the representatives of the genus Larcheria are dominated by representatives of Larcheria close to the L.Subschilli group (LEE), i. e. these forms of larger size, showing more evolute coiling and compressed whorl section, wider umbilicus and coarser ribs than those from the lower assemblage.

The distinction of this horizon is not always evident. In some sections both assemblages may partly overlap and both forms may be recorded together. However, in those sections where a complete succession, with abundant material is found, both assemblages may be easily recognized.

Besides the representatives of the genus Larcheria, it is also typical the "late" representative of subgenus Otosphinctes: Per. (Otosph.) sorlinensis DE LORIO, quite common, and characterized by its small size, involute coiling and depressed section, in relation to its earlier representatives from lower horizons. Both oppeliids and Passendorferiinae are common, as in the former

horizon.

In Aquitaine, Poitou, this horizon has not yet been precisely characterized. In other western Europe areas, such as the Paris basin or Swiss Jura, it is undoubtedly represented, although it has not yet been precisely delimited. In the Polish Jura it could correspond to the assemblage of level 23 from Zawodzie section (Brochwicz-Lewinski, 1970).

The eastern part of the Paris basin is a major overlapping area for representatives of taxa Dichotomosphinctes and Larcheria both assemblages being represented at the same levels and the species Larcheria latumbilicata TINTANT being well represented by its typical assemblages. However, neither the Larcheria nor the Per. (Dichotomosphinctes) elements from this association are clearly comparable, at the present state of knowledge, with that characteristic of this Subschilli Horizon. It could probably correspond to a somewhat higher horizon.

**VI. ROTOIDES SUBZONE** nom. nov. (non Brochwicz-Lewinski 1976), neq. Meléndez et al., 1985), =Colleti Horizon, Cariou, 1966).

**Type-species:** Perisphinctes (Dichtes) rotoides RONCHADZE (non Arkell 1935-48; Enay 1966; Brochwicz-Lewinski 1976).

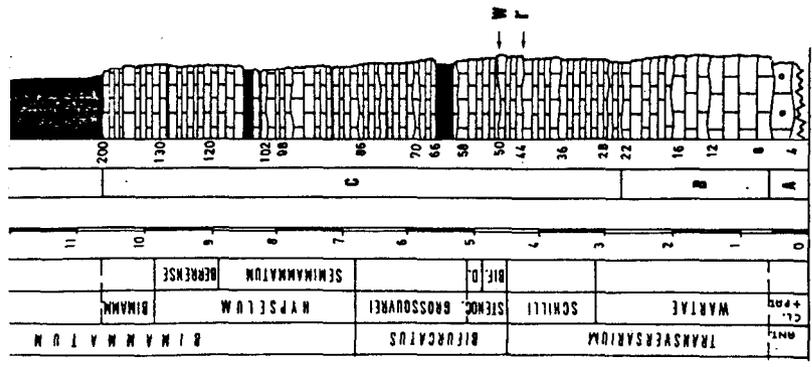
**Type-section:** French Jura, Dpt. Ain.- Reference Sections: Chézery, Swiss Jura, Canton Aargau. (Ronchadzé 1917; Gygi & Persoz, 1986).

## REMARKS

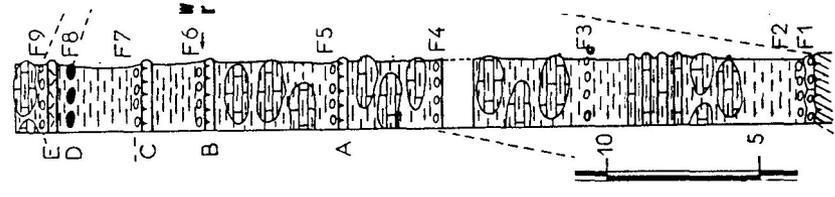
The individualization of this stratigraphic interval as a separate, uppermost subzone within Transversarium Zone is justified by the recent recognition, within quite distant areas in western Europe, such as Iberian Chain, Poitou and Swiss Jura, of a well defined stratigraphical interval above the Schilli levels and below the first typical assemblage of the Dichotomoceras bifurcatoides stenocycloides group (fig. 3). This assemblage is characterized by some species of middle to large size Per. (Dichotomosphinctes) showing intermediate features towards Dichotomoceras, such as Per. (Dichtes) wartae BUKOWSKI (non auctt.); Per. (Dichtes) rotoides RONCHADZE (non Arkell, and Auctt.), once this species has been correctly interpreted and re-placed stratigraphically by Gygi (1984).

As far as the nominal species for this subzone is concerned it seems advisable to propose Per. (Dichtes) rotoides RONCHADZE rather than Per. (Dichtes) wartae BUKOWSKI, in order to avoid confusion with the classical Wartae Subzone hitherto admitted by all authors, at the middle part of Transversarium Zone. Furthermore, unlike the species Per. (Dichtes) rotoides RONCHADZE, the precise stratigraphical position of the type of Per. (Dichtes) wartae BUKOWSKI at its type locality is still unknown (see above).

Moscardon (Iberian Chain)  
Meléndez, 1984



Pamproux (Poitou, SW France)  
Cariou, 1966



RG, 276, Holderbank, kt. Aargau (Switzerland)  
Gygi et al, 1979

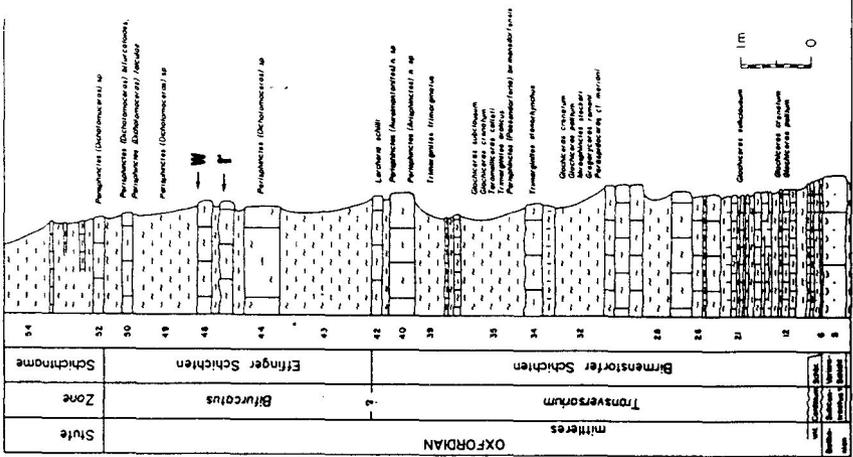


Figure 1: A general stratigraphic succession of the Middle Oxfordian Sediments in Iberian Chain, E. Spain (Moscardón) Poitou, SW. France (Pamproux), and Aargau, Switzerland. The arrows point the stratigraphic level where Per. rotoides RONCHADZE has been found. In Moscardón, the Upper arrow shows the levels containing typical Per wartae BUKOWSKI. The lower arrow indicates the levels with Per cf. rotoides RONCHADZE.

## THE ROTOIDES ASSEMBLAGE

### a. Problematics and diagnostic features

The characterization of this perisphinctid assemblage has traditionally been difficult and confusing. This is mainly due, on one side, to the intermediate morphological status between Dichotomosphinctes and Dichotomoceras displayed by its components, such as sharp ribbing; slight ventral projection of secondaries, initial part of the rib curve flat or even descendant, and to the erroneous interpretation traditionally given to both species, P. (D.) rotoides and P. (D.) wartae BUKOWSKI. Furthermore, it should be taken into account the existence, throughout wide areas of southern Europe of a generalized discontinuity between Transversarium and Bifurcatus Zone, which partly affects both zones, from Schilli to Stenocycloides Subzone (Gabilly et al. 1985). As a consequence, this assemblage has been regarded as a primitive Dichotomoceras assemblage by some authors and placed at the base of Bifurcatus Zone, Stenocycloides Subzone (e. g. Gygi & Persoz, 1986, for Per. rotoides RONCHADZÉ; Brochwicz-Lewinski, 1980, Pl. 3, fig. 1-2; etc.) for some elements figured as Per. (Dichceras) cf. crassus ENAY). However, all these elements, on account of their evolute coiling, the style of ribbing and the suture line, with a long, retracted suspensive lobe with several auxiliaries, should be rather assigned to the subgenus Dichotomosphinctes, despite of the fact that some scarce elements showing early Dichotomoceras features might be found within this assemblage.

### b. Main components of the assemblage

Among the main representatives of this assemblage there should be mentioned these classical forms hitherto misinterpreted; such as Per. (Dichtes) rotoides RONCHADZÉ. Some elements of this species, or very close, have been figured by Meléndez (1984) as Per. (Dichtes) n. sp. A (p. 614 Pl. 50, fig. 1-7). Their corresponding macroconchs have also been figured (Meléndez, loc. cit. p. 476, Pl. 28, fig. 1-4) as Perisphinctes (Perisph.) sp. ex gr. panthieri ENAY.

Per. (Dichtes) wartae BUKOWSKI, as interpreted here, appears as a late representative of subgenus Dichotomosphinctes at the top of Transversarium Zone, and should be best interpreted as transitional to Dichotomoceras (cfr. Brochwicz-Lewinski 1980), in the same way as Per. rotoides RONCHADZÉ, as interpreted here. It is characterized by its large size (up to, or even larger than 200 mm. diameter); evolute coiling, sharp ribbing, with forward sweep of secondaries at the ventral margin, the rib curve showing an ascendent to flat initial part, and suture line with a long, retracted and branching suspensive lobe. Specimens assigned to this species from the

Iberian Chain (Meléndez, 1984) come, most of them, from the middle part of Transversarium Zone and are probable misidentifications, being better referred to Per. (Dichtes) close to the luciaeformis group ENAY. However, the specimen nr. WAr. 1/117/1, figured in Pl. 44, fig. 1, from the locality of Ariño, where the sediments of Transversarium Zone are partly condensed, and collected in, or even above the Larcheria levels could, actually, belong to this species.

Perisphinctes ultimus ENAY is a large size Perisphinctes, microconch, from this same interval, characterized by its rapid growth somewhat involute coiling Meléndez (1984), and dense ribbing, with numerous single ribs. On account of all these features it could be referred both to Per. (Dichotomosphinctes) and to Subdiscosphinctes. Its corresponding macroconch is still unclear although, according to Enay (1981) it could correspond to Per. (Perisphinctes) swidzinskii MALINOWSKA. Specimens from the Iberian Chain assigned to this species (Meléndez, 1984) are too scarce and poorly preserved to add any further evidence. Some of them could even be regarded as fragments of outer whorls of Per. (Dichtes) wartae BUKOWSKI.

Some other typical representatives of Perisphinctinae from this interval, identified up to the present in the Poitou area are certain specimens characterized by their small to middle size, moderately evolute coiling and fine and dense ribbing on the inner whorls, with numerous deep constrictions, very close to Per. kiliani RONCHADZÉ (non De Riaz), 1917, pl. IV, fig. 35. Elements belonging perhaps to the genus Larcheria are present as well in these levels, by some involute specimens showing compressed whorl section and dense, strong and oblique ribbing, with numerous deep constrictions, very close in the inner whorls to the form figured as Perisphinctes kreutzii SIEMIRADZKI by Ronchadzé (1917, Pl. IV, fig. 3).

## CONCLUSIONS

The detailed biostratigraphic analysis shows the good possibilities of perisphinctids for establishing biostratigraphic subdivisions within this Middle Oxfordian interval. Much progress has been achieved in this sense, a whole of six subzones and seven biohorizons having been characterized or defined, according to the successive perisphinctid assemblages identified in the classical Plicatilis and Transversarium Zones in this part of western Europe. By a reason of consistency, the names of classical zones and subzones have been maintained as far as possible. However, in the case of some horizons and subzones, when the nominal species has been re-placed in a different stratigraphical position, it appears more advisable to propose, as new index, the name of a stratigraphically well localized species. This is the case of the

Luciaeformis Subzone (ex: Wartae Subzone), as well as the Plicatilis Horizon (ex: Rotoides Horizon), and Nectobrigensis Horizon (ex: Wartae Horizon MELENDEZ 1984). In the case of the newly proposed Rotoides Subzone nov., at the top of Transversarium Zone, the election of Ronchadzé's form as the nominal species seems adequate as this species is now well stratigraphically localized, and the "Rotoides assemblage", as studied and described by Ronchadzé has been identified in such distant areas as Iberian Chain, Spain; Aquitaine, Poitou area, and Swiss Jura. Much work of correlation and comparison of assemblages with other european and extra-tethyan areas still remains to be done.

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### REFERENCES

- ARKELL, W. J. (1934-48).- A monograph on the Ammonites of the English Corallian beds. Palaentographical Society, London. Vol LXXXVIII, XC-XCI, XCIII-CII; part. I-XIV, 420 pp. 138 fig. 84 Pl. (A-F; I-LXXVIII).
- BENETTI, A., PEZZONI, N. (1985).- Proposta di una Zonazione per L'Oxfordiano dei Lessini. Studi lab. pal. inv. mus. Foss. Lessinia, n. 2, pp. 15, 2 figs.
- BOURSEAU, J. P. (1977).- L'Oxfordien moyen à Nodules des "Terres Noires" de Beauvoisin (Drome). (Ammonitina de la zone à Plicatilis, paléontologie et biostratigraphie; milieu de sédimentation et genèse des nodules carbonatés). Nouv Arch. Mus. Hist. nat. Lyon, fasc. 15, 116pp., 31 figs., 54 tabl., 12 pl., Lyon 1977.
- BROCHWICZ LEWINSKI, W. (1970).- Biostratigraphy of Oxfordian limestones from the Zawodzie quarries in Czestochowa, Polish Jura Chain. Bull. de l'Academie Polonaise des Sciences. Série des Sciences Géologiques et Géographiques, vol. XVIII, n° 4, 237-245.
- BROCHWICZ LEWINSKI, W. (1972).- Middle Oxfordian representatives of the genera Lithacoceras HYATT, 1900, and Liosphinctes BUCKMAN, 1925, from the Polish Jura Chain. Acta Geologica Polonica, vol. 22, n° 3 pp. 473-497, pl. I-XVI.

- BROCHWICZ LEWINSKI, W. (1976).- Oxfordian of the Czeszochowa area. I. Biostratigraphy. Bull. Acad. Polon. Sciences, (Sc. Terre), vol. XXIV, n° 1, pp. 37-46, Pl. I-X.
- BROCHWICZ LEWINSKI, W. (1980).- Perisphinctids Proper (Ammonoidea) of the Czeszochowa Oxfordian. I. Subgenus Perisphinctes WAAGEN, 1869. Bull. Acad. Pol. Sc. (Sc. Terre), XXVII, 3-4, 1979, pp. 193-203, 1 Text-Fig; Tabl. I-II; Pl. 1-6.
- BROCHWICZ LEWINSKI, W. (1980).- Perisphinctids Proper (Ammonoidea) of the Czeszochowa Oxfordian. II Subgenera Dichotomosphinctes BUCKMAN 1926 and Dichotomoceras BUCKMAN, 1919. Bull. Acad. Pol. Sc. (Sc. Terre), XXVII, 3-4, pp. 205-218, 3 Text-Figs; Tabl. I, IV; Pl. 1-4.
- BROCHWICZ LEWINSKI, W. (1981).- Early Oxfordian Perisphinctids of the Czeszochowa Area; Their Stratigraphic value. Bull. Acad. Pol. Sc. (Sc. Terre), XXVIII, 4, pp. 233-242, 1 Text-Fig; Tabl. I-IV; pl. 1-4.
- CALLOMON, J. H. (1964).- Notes on the Callovian and Oxfordian Stages. Coll. Jurass. Luxembourg, 1962, C.R. et Mém. Inst. Gd. Duc. Sect. Sc. Nat. Phys. et Math., Luxembourg, pp. 269-291.
- CALLOMON, J. H. (1988).- The ammonite successions and subzones of the Transversarium Zone in the Submediterranean Middle Oxfordian. Proc. 2nd. Int. Symposium on Jurassic Stratigraphy, Lisboa, 1987, pp. 433-444.
- CALLOMON, J. H., DIETL, G., GALACZ, A., GRANDL, H., NIEDERHOFER, H. J., ZEISS, A. (1988).- On the Stratigraphy of Middle and early Upper Jurassic at Sengenthal, near Neumarkt/Opf (Franconian Alb). Stuttg. Beitr. Naturk. (B) 132, 53 pp. 5 pl.
- CARIOU, E. (1966).- Les faunes d'Ammonites et la sédimentation rythmique dans l'Oxfordien supérieur du seuil du Poitou. Trav. Inst. Géol. Anthr. Préhistorique Fac. Sc. Poitiers Tome VII 1966, pp. 47-67, 2 figs.
- CARIOU, E., ENAY, R., TINTANT, H. (1971).- Oxfordien. (Province Subméditerranéenne). In: Mouterde, R. et al. (eds.). Les Zones des Jurassique en France". C. R. Seances, Soc. Géol. France 1971, F. G, pp. 18-21.
- ENAY, R. (1966).- L'Oxfordien dans la moitié sud du Jura Français. I. Etude Stratigraphique. II. Etude Paléontologique. Nouv. Arch. Mus. Hist. Nat. Lyon, 624 pp. 40 pl. 178 figs.

- ENAY, R., BOULLIER, A. (1981).- L'Age du complexe récifal des côtes de meuse entre Verdun et Commercy et la Stratigraphie de l'Oxfordien dans l'est du Bassin de Paris. Géobios, 14, 6, pp. 727-771, 11 figs., 6 tabl., Pl. 1-6.
- ENAY, R., MELENDEZ, G. (1985).- Report of the Oxfordian Working Group. O. Michelsen & A. Zeiss (eds.): I. International Symposium on Jurassic Stratigraphy, Erlangen, 1984, Symposium vol. I, 87-103.
- ENAY, R., TINTANT, H., CARIOU, E. (1971).- Les faunes Oxfordiennes d'Europe méridionale. Essai de zonation. Coll. Jur. Luxembourg 1967 Mém. BRGM n. 75, (1971), pp. 635-664, 4 figs., 1 Tabl.
- GABILLY, J., CARIOU, E., HANTZPERGUE, P. (1985).- Les grandes discontinuités stratigraphiques au Jurassique: témoins d'événements eustatiques et sédimentaires. Bull. Soc. Géol. France, 1985, (8), I, 3, pp. 391-401, 6 figs., 1 tab.
- GYGI, A., PERSOZ, F. (1986).- Mineralostratigraphy, Litho and Biostratigraphy combined in correlation of the Oxfordian (Late Jurassic) formations of the Swiss Jura range. Eclogae Geol. Helv. Vol. 79, 2, pp. 385-454, 15 figs., 1 pl.
- LORIOL, P. (1902-1904).- Etude sur les mollusques et Brachiopodes de l'Oxfordien supérieur du Jura lédonien. Mém. Soc. Paléont. Suisse, vol. XXIX-XXX, 298 pp., XXVII pl.
- MALINOWSKA, L. (1972).- The Middle Oxfordian Perisphinctidae of Zawodzie near Czestochowa (Poland). Acta Palaeontologica Polonica, t. XVII, 2 pp. 167-242, pl. I-XXX.
- MALINOWSKA, L. (1972).- Middle and Upper Oxfordian in the north-west part of the Czestochowa Jurassic. Inst. Geol. Biul. 233, 1972, pp. 57-68, 8 Figs., 14 pl.
- MELENDEZ, G. (1984).- El Oxfordiense en el sector central de la Cordillera Ibérica. I. Bioestratigrafía; II. Paleontología (Perisphinctidae, Ammonoidea). Tesis Doct. Univ. Compl. Madrid, 825 pp. 75 figs., 62 láms.
- MELENDEZ, G., SEQUEIROS, L., BROCHWICZ LEWINSKI, W. (1983).- Lower Oxfordian in the Iberian Chain, Spain; Part I: Biostratigraphy and Nature of Gaps. II. Ammonite Fauna. Bull. Ac. Pol. Sc.; (Sc.Terre), XXX, 3-4, pp. 157-173; 173-180, Text-Figs. 1-3; pl. I-IV.
- MELENDEZ, G., SEQUEIROS, L., BROCHWICZ LEWINSKI, W. (1985).- Tentative biostratigraphic subdivision for the Oxfordian of the Submediterranean Province on the base of Perisphinctids. O. Michelsen & A. Zeiss (eds.): Proc. Int. Symp. Jur. Str., Erlangen 1984, (II), pp. 481-502.

- RONCHADZE (1917).- Perisphinctes de l'Argovien de Chézerie et de la Faucille. Thèse de la Faculté de Sciences de l'Université de Genève, n° 590. 70 pp; 6 pl.
- SAPUNOV, G. (1976).- Ammonite stratigraphy of the Upper Jurassic in Bulgaria. II. Oxfordian: Substages, Zones and Subzones. Geologica Balcanica, 6, 4; Sofia, Decemb. 1976, pp. 19-36
- SEQUEIROS, L. (1974).- Paleobiogeografía del Calloviense y Oxfordense en el sector central de la Zona Subbética. Tesis Doctorales de la Univ. Granada, n° 65 t. I: Bioestratigrafía, 275 pp. 122 figs., t. II: Estudio Paleontológico, 359 pp. 140 figs. XXXII láms.
- TINTANT, H. (1958).- Sur la stratigraphie de l'Oxfordien supérieur aux environs de Dijon (Côte d'Or). C. R. Acad. Sc. Paris, t. 246, pp. 2504-2507