Schriftenreihe der Erdwissenschaftlichen Kommissionen, Band 5, Seiten 287—294

Veröffentlichung des Österreichischen Nationalkomitees für das International Geological Correlation Programme Project Nr. 73/I/4. Triassic of the Tethys Realm

Some Observations on the Triassic of the Iberian Peninsula

CARMINA VIRGILI, ALFONSO SOPEÑA, ALFREDO ARCHE, AMPARO RAMOS and SANTIAGO HERNANDO *)

2 Figs.

I. Introduction

The Triassic of the Iberian Peninsula forms the westernmost border of the Tethys and, for this reason, offers important changes in facies from the easternmost end, where the marine influence is greater, to the center of the Peninsula, where there are only continental series.

The working-group in Spain concerned with I. G. C. P. Project 4 "Triassic of Tethys Realm", has devoted special attention to the correlation between the marine and continental series in order to discover the significance of the changes in facies and the evolution of the basin.

Special attention has also been given to the beginning of the Mesozoic cycle and to the problem of defining the boundary between the Triassic and the Permian. This has revealed that the beginning of the sedimentary cycle does not exactly coincide with the commencement of the Secondary Era.

Tardihercinic tectonics have a considerable influence on the evolution of the basin. At the beginning of Buntsandstein sedimentation, there is a particularly energetic relief in the center of the Peninsula, which becomes less important in the eastern sectors. Some of the faults bordering it remained active until the middle of the Triassic, and played an important role in the distribution and the facies of the sediments.

2. The Mediterranean Triassic, the Iberian Triassic and the Hesperian Triassic

The variations in facies existing in the Iberian Peninsula make it possible to distinguish three areas with different characteristics which (SOPEÑA et al., 1980) have been named Mediterranean Triassic, Iberian Triassic and Hesperian Triassic. They are distinguished by their greater or lesser marine influence which is revealed by the greater or lesser importance of the carbonatic series in relation to the detritals.

It must be pointed out that in this report, as well as in its other research work, the Spanish Working-group of Project 4 has limited itself to the study of the stable platforms and the intermediate mountain ranges, thereby excluding the Pyrenees and Betic mountains. The Triassic stratigraphy and paleography of these mountain ranges have a somewhat different problem and, above all, as to present knowledge, it is difficult to establish stratigraphic correlations and palaeographic relations with the areas of stable platforms and intermediate mountain ranges.

---

*) Departamento de Estratigrafía. Facultad de Ciencias Geologicas. Universidad Complutense, Madrid (Spain). Instituto de Geologia Economica C. S. I. C.

The Mediterranean Triassic (VIRGILI et al., 1977a) includes the Triassic of the Catalanides and the eastern part of the Iberian Range. It is characterized by having a greater marine influence and well developed carbonatic levels in the Muschelkalk. Just as happens in most of the Triassic in the W. of France and Germany, here five very distinct lithologic units are found: a typical Buntsandstein, a Lower calcareous dolomitic Muschelkalk, a red evaporitic Middle Muschelkalk and a calcareous dolomitic Upper Muschelkalk. The Keuper has a typical facies throughout whole Europe.

The biofacies of this material has an important Alpine influence which has made it possible to trace some time lines and to define chronostratigraphic units. Generally speaking, the Buntsandstein corresponds to the Lower Triassic, although the Scythian has not been palaeontologically characterized because, up to the present moment, the Mediterranean Triassic Buntsandstein has been found sterile; however, the lowest levels of the Muschelkalk correspond to a rather low Anisian. Nevertheless, the Buntsandstein-Muschelkalk boundary is somewhat above the Anisian base.

The basal levels of the Lower Muschelkalk (VIRGILI, 1958) contain *Mentzelia mentzeli* DUNK. of the Middle Anisian and an abundant fauna of *Paraceratites*, *P. hispanicum* (KUTASSY), *P. flexuosiformis* (TORN.), *P. evolutospinosus* (TORN.) of the Upper Anisian. The Middle Muschelkalk is azoic but it must correspond to the Anisian-Ladinian boundary as the Upper Muschelkalk contains: *Daonella lommelli, var. hispanica* WISS., *Protrachyceras hispanicum* MOJS, *P. ibericum* MOJS., *P. villonovae* D'ARCH., among other species characteristic of the Upper Ladinian, as well as *Epigondolella mungoensis* BOGAARD (HIRSCH, 1977) of the same age. The highest levels of this Upper Muschelkalk (VIRGILI, 1958) contain: *Cassianella decussata* MÜNST., *C. tenuistriata* MÜNST., *Myophoria goldfussi* ZEIL., *M. vestita* LB., which indicate an Upper Ladinian-Lower Karnian age.

The Keuper is not well characterized as it only contains (VIRGILI, 1958) *Myophoriopis Keuperina* QUENST., a not very significant species which has been attributed to the Karnian (CASTILLO, 1974). The different palynologic associations found in drill cores which were made in the Ebro basin (Ballovar), yield, among other species, *Camerosporites secatus* LESCHIK., *Ovallipollis* sp. *Enzonalasporites tenuis* LESCHIK., *Ellipsovelatisporites velatus* KLAUS, which would indicate a Karnian age.

The majority of the outcrops of the Iberian Range and its juncture with the Prebetic correspond to the Iberian Triassic. A less important marine influence and development of the carbonate levels characterize it and distinguish it from the Mediterranean Triassic. There is a typical Buntsandstein with varying thickness, only one carbonate level in the Muschelkalk and a Keuper which is relatively similar to that of the Mediterranean Triassic.

The fauna is scarce but the discovery of palynologic associations reveals the temporal significance of these lithostratigraphic units. The Buntsandstein, the beginning of which is very heterochronous, represents not only the Lower Triassic, but also the majority of the Middle Triassic and, perhaps, in the westernmost sectors, even part of the Upper Triassic. The only carbonatic section of the Muschelkalk found here corresponds to the Upper Muschelkalk of Catalonia and dates from the Ladinian-Karnian age, since the further West we go, the higher the age. Therefore, in Molina de Aragon (Guadalajara) a palynologic association from the Ladinian (RAMOS, 1979) was found, characterized by bisaccated pollen grains, among which was the genus *Triadispora*. The area near the edge of the Central Mountain Range (Riba de Santiuste) contains a palynologic association from the Karnian (SOPEÑA, 1979), which is characterized by abundant grains of the circum-polles type and, above all, *Camerosporites secatus*, LESCHIK.

The greater part of the Upper Triassic is represented by the Keuper with lithologic characteristics and an age quite similar to those of the Mediterranean area. According to the palynologic data contributed by BOULOUARD and VIALLARD (1981), in the area of Cuenca, the lower part would be of Karnian age. In the Ayllón-Atienza area (HERNANDO et al., 1977), there is a microflora corresponding to the Norian in the highest part of the evaporitic areas. The calcareous dolomitic levels that appear in sedimentary persistence have been considered either Upper Norian or Rhaetian (GOY et al., 1976), although there are no palaeontological proofs available.

The Hesperian Triassic (SOPEÑA et al., 1980) includes all the outcrops situated on the Hesperian Massif that forms the border facies. Calcareous series which could correspond to the Muschelkalk are lacking and the whole is formed by a red detrital series. The lower part of the series is a Buntsandstein that is analogous to the other sectors; but, on the other hand, the Keuper (HERNANDO, 1977) offers peculiar characteristics, mainly due to a greater detrital influence. The presence of pollen has made it possible to characterize the Ladinian, Karnian and Norian (HERNANDO et al., 1977), all of them in red detrital facies.

3. The Significance of Buntsandstein and the Boundary between the Permian and the Triassic

When Buntsandstein overlies Autunian or Saxonian, it does so by means of an unconformity, and in the base of the same, the existence of palaeoalterations can be seen (VIRGILI et al., 1977). Some times, this unconformity surpasses 40° (Atienza and Pálmaces de Jadraque, on the border of the Central Range) (SOPEÑA, 1979; HERNANDO, 1977b), while at other times, it is only cartographic (Molina de Aragón in the Iberian Range) (RAMOS, 1979), but it is always unquestionable. It also indicates an important change in the lithologic composition of the material and in the geometry of the basins.

For this reason, Buntsandstein has traditionally been considered the basis of the Triassic, that is, the beginning of the Mesozoic cycle. However, it is not easy to have an exact knowledge of the Buntstandstein age because, until recently, the datations available close to the base correspond to high levels and are Upper Anisian-Lower Ladinian. Moreover, taking into consideration that they overlie a very important palaeorelief, the Buntsandstein sedimentation obviously does not begin everywhere at the same time. In a mudstone level in the Buntsandstein basal conglomerate, overlying the Saxonian unconformably, recently (RAMOS and DOUBINGER, 1979; RAMOS, 1979) appeared an important, characteristic Thuringian microflora: *Lueckisporites wirkkiae*, POT. & KLAUS; *Nuskoiporites dulhunty*, POT. & KLAUS; *Jugasporites delasaucei*, LESCHIK; *Falcisporites schaubergeri* (POT. & KLAUS).

This reveals that at this site, even though the Buntsandstein sedimentation starts the Alpine cycle, the latter does not coincide with the beginning of the Mesozoic but rather still belongs to the end of the Permian.

In several outcrops of the central part of the Iberian Range (Landete, Henarejos, Talayuelas) (VIRGILI et al., 1980a; VIRGILI et al., 1980b), a lower, red

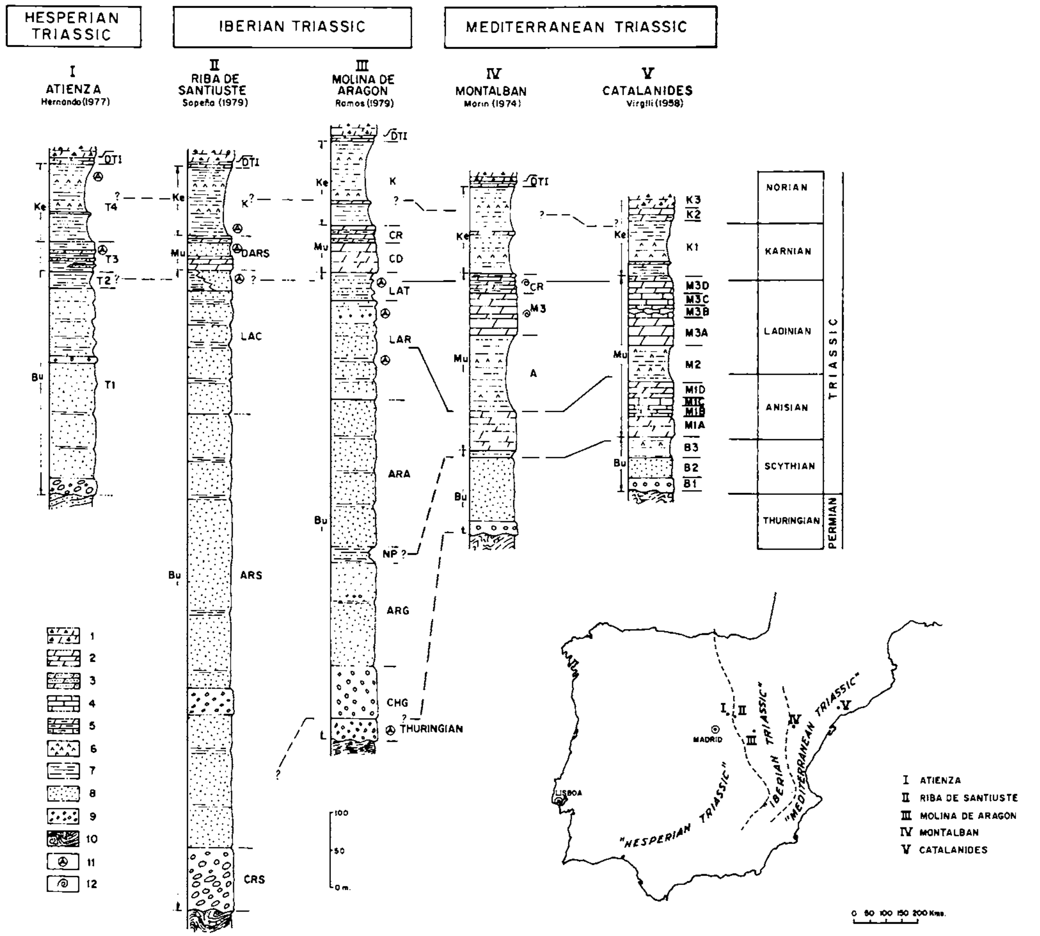

Fig. 1
Essay of Triassic correlation

DTI	Imon slabed dolostones (GOY, GOMEZ y YEBENES, 1976)	
CR	Royuela beds	(HINKELBEIN, 1965)
CD	Dolomitic beds	(HINKELBEIN, 1965)
LAT	Torete mudstones and sandstones	(RAMOS, 1979)
LAR	Rillo mudstones and sandstones	(RAMOS, 1979)
ARA	Arandilla River sandstones	(RAMOS, 1979)
NP	Prados Level	(RAMOS, 1979)
ARG	Rillo de Gallo Sandstones	(RAMOS, 1979)
CHG	Hoz del Gallo Conglomerates	(RAMOS, 1979)
DARS	Riba de Santiuste Dolostones and Sandstones	(SOPEÑA, 1979)
LAC	Cercadillo Mudstones and Sandstones	(SOPEÑA, 1979)
ARS	Riba de Santiuste Sandstone	(SOPEÑA, 1979)
CRS	Riba de Santiuste Conglomerates	(SOPEÑA, 1979)
KE	Keuper	
MU	Muschelkalk	
BU	Buntsandstein	

1. "Carniolas"
2. Dolostones
3. Sandy dolostone
4. Limestone
5. Marls
6. Gypsum
7. Mudstones
8. Sandstones
9. Conglomerates
10. Indifferentiated Palaeozoic
11. Microflora
12. Fauna

detrital series appears with mudstones, conglomerates and sandstones, in continuity with the dated Triassic (Ladinian). The basal sections display fine grey intercalations with Thuringian microflora. In areas where the Thuringian overlies the Stephanian no Lower Permian exists.

This fact has also been pointed out in other parts of Europe where the boundary, found by means of lithologic or tectonic criteria, does not seem to correspond with the flora boundaries (VISSCHER, 1971; GEIGER & HOPPING, 1968). In his study of the Permian of central and western Europe, KOZUR recently (1980) studied this phenomenon on a general scale and also reached the conclusion that the Palatinic unconformity does not separate the Triassic from the Permian, but is instead intrapermian, since the Zechstein and even a part of the Upper Rotliegendes would be following above it.

4. Marine and Continental Facies

The correlation between the different series of the Mediterranean, Iberian and Hesperian Triassic reveals the heterochrony of the lithostratigraphic units throughout the Peninsula (VIRGILI et al. 1977a; VIRGILI 1977), as the time lines are completely oblique to the lithologic changes. This is particularly noticeable in the Middle Triassic.

The marine invasion, which is especially clear in the Muschelkalk deposit, started in the easternmost part of the Peninsula at the beginning of the Anisian and did not reach the central part of the Iberian Mountain Massif until the Ladinian-Karnian. The marine episode in the center of the Peninsula is not only younger but also more short-lived. It must be pointed out that the marine sedimentation in the center of the Peninsula is basically clastic and not carbonatic, like in the Mediterranean Triassic. There is no trace of it in the westernmost outcrops, which we have named Hesperian Triassic.

The marine invasion occurred in two stages. The first and less important was in the Anisian and only covered the area we have named Mediterranean Triassic. At this time, the carbonate section of the Lower Muschelkalk was deposited. The second marine stage took place in the Ladinian-Karnian and is of far greater importance, as it affects the entire eastern half of the Peninsula (Mediterranean Triassic and Iberian Triassic). This fact not only applies to the Iberian Peninsula, but can be observed as well in the Tethys transgression over the French central mountain massif (DURAN, 1978; COUREL, 1976).

It is still difficult to determinate the causes; nevertheless, the influence of the tectonic evolution of the basins which were still active during the Lower and Middle Triassic, is obvious. It was only after the Ladinian that some areas, already more stabilized and filled up by previous sediments, allowed a more extensive invasion of a shallow sea and later the special conditions that prevailed during the Keuper sedimentation.

5. Basin Evolution: Tectonics and Sedimentation

The nature and situation of Permian material in the Iberian Peninsula reveals that it was deposited in small, isolated basins, situated at the foot of important reliefs (VIRGILI et al. 1980). The morphogenesis of the latter is connected with the existence of Tardihercynic fractures forming two main systems: some having a NW—SE dextral nature and others, a NNE-SSW and NE-SW sinistral one. At times, these fractures bear a relation to important volcanic emissions from the Permian, as in the case of Atienza (Guadalajara) (HERNANDO et al. 1978; HERNANDO 1977). The thick coarsening upwards sequences which almost always filled these basins, can be considered (SOPEÑA, 1979) the result of the rapid fracturing and subsidence movement of these basins.

The beginning of Buntsandstein sedimentation marked an important change in the style of the deposits and in the geometry and evolution of the sedimentary basins. There is a greater stability, and sedimentation is generalized and regularized. Nevertheless, it is not quite correct to affirm that sedimentation is produced on a peneplain, as was originally supposed, or on a surface where irregularities have been filled up. Buntsandstein sedimentation began on a basement displaying a certain palaeorelief and tectonic mobility which disappeared only at the end of the Triassic, accentuating the existing reliefs even more (SOPEÑA, 1979; SOPEÑA et al., 1980; HERNANDO, 1977).

These paleoreliefs existing throughout the Peninsula, are particularly important and active in the center of the Peninsula. They produce important variations in the Buntsandstein thickness and influence the lithofacies of the same. Important alluvial fans (SOPEÑA, 1979) have thereby been characterized in connection with some of the most important and active faults.

These palaeoreliefs also exist in the eastern part of the Peninsula (MARZO 1980), but they are much less important and active. This is, without any doubt, due to their greater distance from the area of Atlantic rifting.

A very important result of this is that the thickness of the Buntsandstein is extraordinarily variable and its beginning is very heterochronous (SOPEÑA, 1979; RAMOS, 1979). Evidence shows that it began to be deposited during the Thuringian at several points of the Iberian Ranges; while, at others, it probably began in the Ladinian. When we have a complete stratigraphic and sedimentologic study available on the Buntsandstein of the Iberian Peninsula, we shall have important data on its tardihercynic evolution.

Summary

The main results of the Spanish working-group for the I.G.C.P. Project n°4 "Triassic of the Tethys Realm" can be summarized into the following points:

1. — It is now possible to distinguish the types of Triassic deposits in Spain (excluding Pyrenees and Betic zone) according to the marine influence and the presence or absence of calcareous material of the Muschelkalk: Mediterranean type (two calcareous levels), Iberian type (one calcareous level) and Hesperian type (no calcareous level).

2. — According to palynological data the basal Buntsandstein has an Upper Permian (Thuringian) age in several points of the Iberian Ranges.

3. — Sedimentation and tectonics are clearly related because Triassic basins are limited by active faults related to the Hercynian and older fault systems, reactivated in these times. Some evidence has been obtained as to these faults having been active until Ladinian times because only Muschelkalk facies of Karnian age cover them without being affected.

4. — Sedimentological research has shown many different environments, from alluvial fan facies in the proximal Hesperic and Iberian Triassic to several transitional and marine facies in the Mediterranean Triassic.

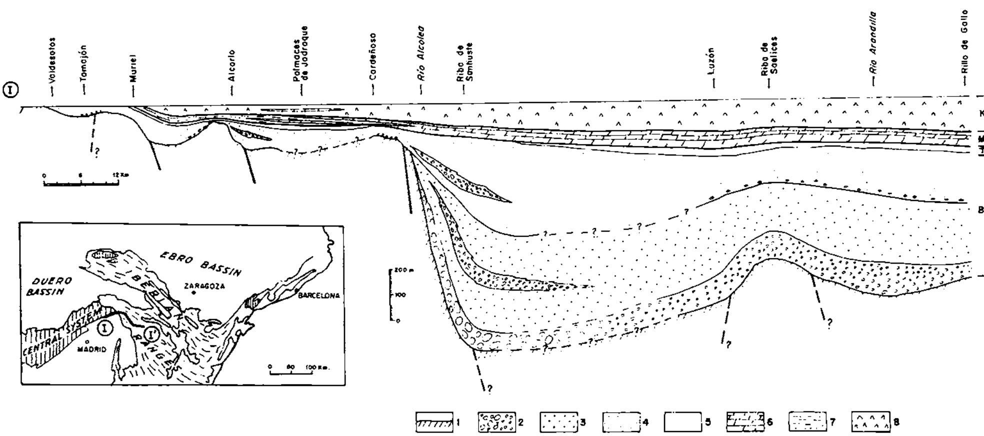

Fig. 2
Essay of a reconstruction of the Triassic transgression over the plateau edge

B Buntsandstein
T Transitional sequence
M Muschelkalk
K Keuper
1 Paleozoic basement
2 Conglomerates
3 Sandstones with some red mudstones levels
4 Red Sandstones and Mudstones
5 Red and green mudstones with some sandstone and sandy dolostone levels.
6 Dolostones and dolomitic marls
7 Green mudstones with some sandstone and sandy dolostone levels
8 Green and red mudstones with gypsum.
(after Sopeña et al. 1980)

References

Boulouard, Ch. & Viallard, P. (1981): "Identification du Ladinien et du Carnien dans les marnes triasiques de la Serrania de Cuenca (Chaine Ibérique sud occidentale, Espagne)". *Bull. Centre Rech. Explor. Prod. Elf-Aquitaine*, n° 5. pp. 31—41.

Castillo-Herrador, F. (1974): "Le Trias évaporitique des bassins de la vallée de l'Ebre et de Cuenca". *Bull. Soc. Géol. France.* (7), 16 (6): 666—676.

Courel, L.; Durant, M.; Gall, J.C. & Juriar, G. (1973): "Quelques aspects de la transgression triasique dans le nord-est de la France. Influence d'un éperon bourginou". *Rev. Géographie Physique et Géol. Dynamique*, Vol. XV, fasc. 5. pp. 247—554.

Durand, M. (1978): "Paléocourants et reconstitution paléogéographique. — L'exemple du Buntsandstein des Vosges meridionales". *Science de la Terre*, T. XXII, n° 4. pp. 301—390. Nancy.

Geiger, M. E. & Hopping, C. A. (1968): "Triassic stratigraphy the southern North Sea Basin". *Phil. Trans. Roy. Soc. London*, 254, pp. 1—36.

Goy, A.; Gomez, J. J. & Yebenes, A. (1976): "El Jurásico de la Rama Castellana de la Cordillera Ibérica (Mitad Norte). I. Unidades litoestratigráficas". *Estudios Geológicos*, Vol. 32, pp. 391—423.

Hernando, S.; Doubinger, J. & Adloff, M. C. (1977): "Datos cronoestratigráficos del Triásico superior de la región de Ayllón-Atienza (Provincias de Segovia, Soria y Guadalajara)". *Cuad. Geol. Ibérica*, 4, pp. 399—410.

Hernando, S. (1977): "Pérmico y Triásico de la región Ayllón-Atienza (Provincias de Segovia, Soria y Guadalajara)". Tesis Doc. Universidad Complutense de Madrid (1975). *Seminarios de Estratigrafía, Serie monografías*, n° 2. pp. 1—408.

Kozur, H. (1980): "Beiträge zur Stratigraphie des Perms. Teil III (2) Zur Korrelation der überwiegend kontinentalen Ablagerungen des obersten Karbon und Perms von Mittel- und Westeuropa". *Freiberger Forsch.* Leipzig C. 348, pp. 69—172.

Marin, Ph. (1974): "Stratigraphie et évolution paléogéographique post-hercynienne de la Chaine Celtibérique orientale aux confins de l'Aragon et du Haut-Maestrazgo (Provinces de Teruel et Castellon de La Plana, Espagne). I. Le socle paleozoique et sa couverture Permo ?-Triasique". *Thesis Doct.* Univ. Claude-Bernard. Lyon, pp. 1—231.

Marzo, M. (1980): "El Buntsandstein de los Catalánides. Estratigrafía y procesos de sedimentación". Tesis Doctoral (Ined.). Universidad de Barcelona, 317 págs.

Ramos, A. & Doubinger, J. (1979): "Découverte d'une microflore thuringiense dans le Buntsandstein de la Cordillere Ibérique (Espagne)". *C. R. Acad. Sc. de Paris*, t. 289, pp. 525—528.

Ramos, A. (1979): "Estratigrafia y paleogeografía del Pérmico y Triásico al Oeste de Molina de Aragón (Provincia de Guadalajara)". *Seminarios de Estratigrafía, Serie Monografia*, n° 6, pp. 1—313.

Sopeña, A. (1979): "Estratigrafía del Pérmico y Triásico del noroeste de la provincia de Guadalajara". *Seminarios de Estratigrafía, Serie Monograías*, n° 5. pp. 1—329.

Sopeña, A.; Virgili, C.; Arche, A.; Hernando, S. y Ramos, A. (1980): "Triásico". Libro Homenaje a D. José María Rios (in litt.). *I. G. M. E.* Madrid.

Virgili, C. (1958): "El Triásico de las Catalánides". *Bol. Inst. Geol. y — Min. de España*, T. 69, pp. 1—856.

Virgili, C. (1977): "Le Trias du nord de l'Espagne". *Bull. B.R.G.M.* Sect. IV, n° 3. pp. 205—213.

Virgili, C.; Sopeña, A.; Ramos, A. & Hernando, S. (1977): "Problemas de la cronoestratigrafía del Trías de España". *Cuadernos de Geología Ibérica*, Vol. 4. pp. 57—88.

Virgili, C.; Sopeña, A.; Ramos, A.; Broutin, J.; Doubinger, J. (1979): "The Autunian of Central Spain". Compte Rendu IX Congres International del Carbonifero. General Stratigraphy (en publicación).

Virgili, C.; Hernando, S.; Arche, A.; Sopeña, A. & Ramos, A. (1980): "El relleno posthercínico y el comienzo de la sedimentación mesozoica". Libro Homenaje a D. José Mª Rios (in litt.). *I.G.M.E.* Madrid.

Visscher, H. (1971): "The Permian and Triassic of the Kingscour outlier, Ireland". *Geol. Surv. of Ireland.* Sp. Paper, 1, 114 págs.