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Miocene marine-continental correlations in the Lisbon area and some discussion related to personnal experience

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Abstract

Key-words: Lower Tagus basin; Miocene marine-continental correlations; difficulties and discussion; results.

Sandpit exploitation near Lisbon allowed collecting of many miocene, non marine fossils. These sands are part of the mostly marine Miocene series in the Lower Tagus basin. The particularly favourable situation led several researchers to deal with marine-continental correlations. Difficulties often concern methodologic aspects. Some poorly based interpretations exerced a lasting influence. A critical approach is presented.

Analysis requires data. Methods based upon models often lead to the temptation of fitting data in order to confirm a priori conclusions, or of mixing up data as if of equal statistic value while they have not at all the same weight. Erroneous interpretations' uncritical repetition for many years "upgraded" them into absolute truth.

Another point is endemism vs. europeism. Miocene mammals from Lisbon compared well with corresponding French, contemporaneous taxa, while this was apparently not true for Spanish ones. Too much accent had been put on the endemic character of Spanish, or even regional, mammalian faunas. Nationalist bias and sensationalism also weigh, albeit negatively. Meanwhile nearly all the more evident examples as the rhinoceros *Hispanotherium* are discredited as Iberian endemisms. Taxa may appear as endemic just because they have not yet been found elsewhere. At least for the medium to large-sized mammals, with their huge geographic distribution, faunal differences depend much more on ecology, climate and environmental conditions.

Emphasis on differences may also result from researchers that are often in a precarious situation and need very much to achieve short-term, preferably sensational results. Overvalued differences may mask real similarities. Unethic and not scientific behaviour are further enhanced by "nomina nuda" tricks that may simply be a way to circunvent or cheat the Priority Rule. On the other hand, access to communication networks may present as sensational novelties items that are not new at all, misleading the audience. A new class of "science people" arose, created by the media and not by the value of their real achievements.

Discussion is presented on sedimentation processes and discontinuities that are often regarded as absolute precision dating tools, as well as on some geochemical and paleomagnetic interpretations.

A very good chronologic frame has been obtained for the basin under study on the basis of an impressive set of data, providing a rather detailed and accurate frame for Miocene marine-continental correlations.

Resumo

Palavras-chave: Bacia do Baixo Tejo; Miocénico correlações entre meios marinhos e continentais; dificuldades e discussão; resultados.

A exploração de areeiros perto de Lisboa permitiu a colheita de muitos fósseis miocénicos não-marinhos. As areias fazem parte da série, predominantemente marinha, da bacia do baixo Tejo. A situação particularmente favorável levou investigadores a tratarem de correlações entre depósitos marinhos e continentais. Contudo, há dificuldades que envolvem aspectos metodológicos. Interpretações mal fundamentadas exerceram influência que tem perdurado. Apresenta-se uma aproximação crítica.

A análise carece de dados. Métodos baseados em modelos conduzem, com frequência, à tentação de ajeitar dados para confirmar conclusões apriorísticas, ou em misturar dados de peso desigual como se fossem estatisticamente equivalentes. A repetição acrítica, durante muito tempo, de interpretações erróneas "promoveram-nas" a verdade absoluta.

Outro ponto diz respeito a endemismo vs. europeismo. Os mamíferos miocénicos de Lisboa são perfeitamente comparáveis aos seus correspondentes contemporâneos representados em França, o que aparentemente não sucedia com as faunas mamalógicas de Espanha. Havia sido posto ênfase demasiado no carácter endémico espanhol, senão mesmo regional, de tais faunas. Preconceitos nacionalistas e sensacionalismo também pesam, embora negativamente. Entretanto, quase todos os exemplos mais evidentes, tal como o rinoceronte *Hispanotherium*, estão desacreditados como endemismos ibéricos. Táxones podem parecer endémicos apenas porque ainda não foram encontrados noutras áreas. Pelo menos no que diz respeito a mamíferos de porte médio a grande, com a sua muito vasta distribuição geográfica, diferenças faunísticas dependem muito mais da ecologia, do clima e de condições ambientais.

Ênfase em diferenças pode também resultar de investigadores que, frequentemente, se encontram em situação precária e muito necessitam de resultados a curto prazo, de preferência sensacionais. Diferenças sobrevalorizadas podem mascarar reais semelhanças. Comportamentos contrários à ética e à ciência são ainda mais realçados por truques dos "nomina nuda" que podem, simplesmente, ser uma maneira de ladear, ou um embuste para ultrapassar a Lei de Prioridade. Por outro lado, o acesso a redes de comunicação social pode apresentar como novidades sensacionais items que não o são de nenhum modo, enganando o público. Surgiu uma nova classe de "cientistas" criados pelos media e não pelo real valor das suas realizações.

Apresenta-se uma discussão acerca de processos de sedimentação e descontinuidades que, muita vez, têm sido encaradas como ferramentas de precisão para datação, bem como acerca de interpretações geoquímicas e paleomagnéticas.

Foi obtido um excelente enquadramento para a bacia considerada com base num conjunto impressionante de dados, que proporcionam uma visão bastante pormenorizada e precisa para correlações entre meios marinhos e continentais.

Introduction

When I started working in the Neogene of Lisbon area, in 1957, there were many sandpits where lower and early middle Miocene, non marine vertebrate fossils were common. Artisanal exploitation allowed many specimens to be collected. It therefore became possible to obtain a wealth of paleontologic data concerning some continental intercalations in an otherwise mainly marine series. This series is part of the infillings of the Lisbon and Setúbal Peninsula area of the lower Tagus basin and yielded a most rich set of stratigraphic, paleontologic, age, geochemical and other data.

This situation being particularly favourable to direct correlation led several researchers to deal with marine-continental correlation as completely as possible. Nevertheless, difficulties and confusions arose, related in part to pre-Miocene, underlying stratigraphic units. Difficulties often concern methodologic aspects. Poorly based viewpoints exerced a rather long lasting influence. Sometimes routine seemed to outweigh the truth. Hence one may think a critical, historical approach seen through my own experience may perhaps be useful.

The lower Tagus basin pre-Miocene units

Geology is very closely linked to an Historic methodology. Dating is of paramount importance to correlations: when not accurate enough, interpretation errors may occur. This is even more prone to happen if we take into account that the geologic record is generally incomplete. Similar situations may not correspond to correlative phenomena. Analysis needs data as support for conclusions. On the contrary, methods based upon models often lead to the temptation of arranging (or fitting) data in order to see in them the confirmation of a priori conclusions; and of mixing together as statistically equals data that indeed have not the same weight. Results may be true by pure chance or nearly so, not necessarily valid. In general, knowledge implies a multidisciplinary approach and not a single-sided one, although valuable it may be.

The Cenozoic evolution of the area where is Portugal only can be understood under an historic viewpoint (Antunes, 1979).

After contributions by Daniel Sharpe, the Baron Wilhelm von Eschwege, Carlos Ribeiro and other ones, a systematic account has been presented by J. C. Berkeley Cotter (1904, pp.1-3). Cotter refers the Nappe basaltique as the basal unit of the Tagus basin (right bank) Tertiary, now considered as "Formação vulcânica de Lisboa--Mafra". He also refers the next unit, the "Grupo de Benfica", and states (p. 2) "Pour le moment on doit se borner à indiquer que les marnes basaltiques du voisinage de Lisbonne se trouvent au dessous du conglomérat oligocénique de Benfica, sans préciser leur synchronisme exact". However, Cotter does not justify the allegedly oligocene age of the latter, regarded as so owing to its stratigraphic position just under the marine lowermost Miocene unit. Furthermore he does not give an age for the Volcanic, Lisbon-Mafra Fm; nevertheless, according to the status of knowledge at those times and especially to its position over upper Cretaceous beds then ascribed to the Turonian, this was equivalent to admit an Eocene (s.l., prior to the seggregation of the Paleocene) age. As a consequence, the uncritical repetition for many decades (see Choffat, 1950), upgraded these problematical datings to absolute, accepted truth. This eventually became harmful to the progress of the knowledge.

As for the Volcanic Lisbon-Mafra Fm scant Sr dating points out to late Cretaceous age. That is perfectly clear on the basis of a gastropod fauna much richer than is known and currently under study by P. Callapez.

Direct age evidence on the heterogenous "Grupo de Benfica" remains nearly nul. Many continental deposits elsewhere in Portugal had been "labeled" as Oligocene, just through correlation with the "Benfica Group" – even if such correlations where not based on sound dating. Definite dating evidence was obtained in several localities out of lower Tagus basin; comparisons with mammal faunas and correlations with stratigraphic units in Spain were most useful (Antunes *et al.*, 1997). As a consequence, the deeply-rooted "Oligocene" age belief was contradicted (sometimes with reactions of annoyance or anger by some people) just by the truth: a clearly Eocene age.

On the other hand, the upper time limit of the "Benfica Group" is older than the earliest Miocene well-dated deposits at 24.0 ± 1.0 Ma. As a consequence, the still inaccurate dating of the "Benfica Group" is partly Eocene and Oligocene as far as the upper levels are concerned.

The lower Tagus (Lisbon area) Miocene units and comparison problems – Endemism *vs.* Europeism

The study of Miocene mammals had progressed since Eschwege. Following an old tradition, the Geological Survey, that previously had obtained the collaboration of Professor Frédéric Roman, from Lyon, asked Roman's successor, Jean Viret, to continue this task. By these times, unfortunately, Viret (who I still had a chance to meet in 1958 at the IV Cursillo held at Sabadell) was in poor health. He tried to determinate some specimens, but he was no longer able to accomplish a good job. Further work was badly needed, i.e. comparisons with more or less contemporary collections from other european regions.

The study of the material collected by myself was therefore one of the main goals of my first stay in Paris. I departed in April 1961 in a small car full of parcels with fossil bones that were searched in detail by suspicious agents of the Guardia Civil at Fuentes de Oñoro frontier, a search that ended in laughter at "los huesos del Galvón" after the name of a portuguese revolutionary of these times. The trip went along until the end of the scheduled step at the city of the Tormes, Salamanca, that was shining beautifully under the afternoon sun. The Roman Bridge led me, unaware that car traffic was forbidden through it and after a good fine, to a quarter of monuments built with this golden-yellow stones. "Amarillo", the colours of Tertiary in geologic maps. The same "amarillo" that was somewhat despised a few years later during a Meeting on the Geology of the Northwestern Iberia - just at Salamanca, where the old and venerable University was expanding into the area of Geology and where an excellent team of "Amarillo"-worshipers settled down.

In Paris, I worked at the Laboratoire de Paléontologie du Muséum national d'Histoire naturelle. There I had the honour to meet and to be helped by remarkable paleontologists. Among the French, I recall specially Camille Arambourg, Jean Piveteau, Jean-Pierre Lehman, Robert Hoffstetter, René Lavocat and overall my good friend Léonard Ginsburg. Miocene mammals from Lisbon compared well with their French counterparts, with but rare exceptions. How to conciliate it with the heavy differences in lists concerning some more or less contemporaneous Spanish localities if, as for Lisbon, an even greater distance to the rest of Europe and all other physiographic and other barriers were between? How to explain this lack of endemisms, a feature so stressed by some remarkable paleontologists so far as to regard Spain as the craddle and grave of phylla? As we met in Paris in 1964, when participating in a CNRS-promoted Meeting on Vertebrate Paleontology and Evolution, Professor Miquel Crusafont did not fail to remark it and to stress again his endemism viewpoints, even at the regional level in Spain. Indeed this did not look convincing against the observed facts of identical (except for minor differences that could well be ascribed to population variancy) size and morphology of skeletal parts from several mammals from Lisbon when checked against their approximatively synchronous counterparts at the Paris Museum collections as well as from the Sabadell Museum, during my visit there in July 1961. This has been corroborated later when I had the opportunity to observe at the Utrecht University material from Aragon, Spain collected by my late friend Hans de Bruijn.

As the years elapsed, the main arguments for faunal differences fell. This was especially the case of the rhinocerotid *Hispanotherium*. Collected for the first time in the Madrid area, it was subsequently found from China, the Siwaliks, and Turkey, to France and Portugal. At least as far as medium to large-sized mammals, with their usually very broad geographic distributions, differences have much more to do with ecology, environmental conditions and climate. Nevertheless, things may be partly different as far as small mammals are concerned.

Certain species may prevail to other ones whose presence in a certain area is but marginal. However, such situations may shift in space and time, even seasonally. Other apparent differences could be ascribed to lack of knowledge of same age faunas from elsewhere.

Some differences too are of different nature. The Research system itself may in part be responsible. Young post-graduates, precariously maintained with some temporary research grant, need to achieve positive, if possible sensational results. If not, chances for a career are dim. That, plus juvenile enthusiasm, often results in overvaluing differences, which may mask real similarities and are negative to sound comparison basis. This is prone to confusion. Faunal lists tend to be much more different than the real associations are; hence comparisons became difficult and problematic. Without a thorough and critical revision, subsequent correlation work may become an uncertain task. The real truth is needed.

A further difficulty is a consequence of nationalist bias, associated to a sensationalist side too. All must be new and different, even if there are but minor differences that could better be explained through variation. This unethic and not scientific behaviour is further enhanced by the "nomina nuda" tricks that consist in despising taxa (albeit recognizable enough and described according to the Rules) on the pretext of the corresponding material being

insufficient, and then renaming them – that is, a way to circunvent or cheat the Priority Rule. In a more sophisticated way, somebody who by chance had access to broad diffusion communication networks may present in the most sensational way results that indeed are not new at all, but omitting earlier (and with priority) contributions on the same theme. Hence the public will unconsciously link these results to a "discoverer" that is not so, but just an individual that steals somebody's legitimate show. In our times, a new class of "science people" arose, created by the media and not by their achievements.

Anyway, mammals provide the best frame for continental biochronology. Mammal-units were defined, and are useful. Events as first appearances, immigrations and (maybe less) extinctions may be good time references.

On the other hand, continental "stages" were considered, often reflecting (perhaps too much) regional viewpoints and interests, much less the general value that should be expected. Or, in Stratigraphy, marine units were preferred because sedimentary record may be less uncomplete. Record completeness is of utmost importance in any historic process. Even so, more and more discontinuities, lacunes and hiatuses have been demonstrated. Lags in the sedimentary record are even more important as far as continental sedimentation is concerned. More often than not, events of no sedimentation and erosion occur. Diachronism, even in the same formation, may be important.

Sedimentation processes, cycle analysis and discontinuities may afford interesting data. However, overconfidence and self-regarding only may result in errors. In several cases, an apparently high precision dating has been achieved, yet vainly because it is not supported by true chronologic data.

Continental, mammal-based biochronology is generally successful, but how is it possible to correlate it with marine scales, i.e. based on plankton foraminifera and calcareous nannoplankton? And how to arrive at conclusions if account is taken that planktic foraminifera and calcareous nannoplankton (even if they provide excellent scales) are so dependent on water temperature that different yet synchronous associations may develop? How to date these associations with a satisfactory accuracy?

Of course, biochronology remains essential because of the irreversible, one-way nature of evolution. A relative chronology may be established and perfectionned, but it cannot be converted in time directly, except if in direct correlation with otherwise, isotopic age-dated rocks, as intercalated volcanics.

Indeed there are alternatives, albeit none entirely sactisfactory. The quest for accurate datation is of paramount importance.

The sedimentary approach has some virtues, but record gaps and diachrony are obvious limits that impair its global value. Diastems may sometimes be followed for thousands of kilometres, but diachronism counts heavily.

Much hope was placed in several geochemical and physical approaches. As about geochemistry, isotopes are no magic panacea. Geochemical reservoirs are different, hence results may differ. On the other hand, identical or nearly so isotope compositions do not necessarily mean synchronism. Results may be of great interest, particularly for paleoclimate reconstitution, but not so much as age is concerned.

Otherwise, faith in Paleomagnetism has limits. Paleomagnetism seemed well suited for non marine deposits without isotopic age possibilities. But the method cannot result without the support of other age data, and that often looks as a vicious circle. Furthermore, many sedimentary rocks are not suitable for paleomagnetic study, others weakly so. As Aubry & Berggren (at the Biochrom Conference, Montpellier, April 1997) have shown, (a) correlations are very variable according to the authors; (b) chrons are very brief for the Neogene and especially for the Middle and Upper Miocene; (c) hence correlations are very weakly based and lack resolution power, even more if account is taken of record hiatuses that may completely confuse the sequence of polarity events; (d) among many North Atlantic sites, only three yielded satisfying data allowing correlation between planktic foraminifera N15-N16 Blow zones with basal chron 5. These problems are much worse for continental series. Non depositional events are much more frequent. It is obvious therefore that paleomagnetic evidence is not at all a sound basis for correlation. Too much faith in paleomagnetism may led to error, as it may perhaps be the case for some continental mammal sites supposed to be distinctly earlier than others with similar mammal faunas.

Without isotopic dating from intercalated volcanics, only glauconites yielded fairly good results (^{40}K-^{40}Ar; ^{40}Ar-^{39}Ar). However, glauconites only occur in some marine deposits. Finding suitable glauconite samples, well preserved enough and without contaminations is not always a success. Hence only a minority of a minority of sedimentary marine sediments may give reliable dating, even so with error margins that may be quite broad. Nevertheless, many interesting data were obtained.

The need for an accurate datation was met later owing to ^{87}Sr-^{86}Sr dating on marine fossils.

Taking advantage of the good biostratigraphic calibration and of some K-Ar dating for the Lower Tagus basin Miocene series, we launched a program for Sr dates on mollusk shells in collaboration with H. Elderfield, University of Cambridge. Sr dating revealed to be an excellent tool. It is only somewhat less so for the parts of the curve where slope is weaker (hence with wider margins of error), as for upper Miocene. A lot of fine results was obtained. Sr dating is perhaps less reliable if applied to brackish environments. The corresponding values seem too modern.

As a whole, we obtained a very good chronologic frame for the basin under study since from the lowermost (Aquitanian) units to the lower part of the Upper Miocene. Furthermore, stratigraphy allows direct correlation with five main mammal faunas yielded by intercalated continental beds; as a consequence, a reliable approximation to their ages may be presented at our extant

status of knowledge (Antunes *et al.*, 2000). Some mammal-units along with a few immigration and extinction events as shown can therefore be dated too (Antunes, 2000, Table 2). If comparable results are obtained for marine to brackish facies at the inner part of the Lower Tagus basin, there is a distinct possibility to extend radiometric dating results at least to late Middle and lower Upper Miocene faunas.

That is the point of the status of knowledge at this moment. Further developments are being achieved. A complete borehole across the whole Lower Tagus basin Neogene series is yielding a bounty of new data (stratigraphy, sedimentology, micropaleontological and diagraphic evidence, etc.) that will take a certain time to study.

Better than in most other situations, in the case of the Lower Tagus basin in Lisbon and the Setúbal peninsula there is a detailed knowledge, based on an impressive set of data, of several lower and middle Miocene continental intercalations and their mammalian and other vertebrate faunas. All have been accurately dated owing to marine beds' evidence and by itselves on continental scale. Hence their knowledge as a whole provides an excellent basis for correlation with purely continental beds elsewhere.

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