



## Early Jurassic (Pliensbachian) brachiopod biogeography in the western Tethys: The Euro-Boreal and Mediterranean faunal provinces revised



Attila Vörös

Department of Palaeontology and Geology, Hungarian Natural History Museum and MTA-MTM-ELTE Research Group for Paleontology, P.O.B. 137, H-1431 Budapest, Hungary

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### ABSTRACT

The Pliensbachian brachiopod biogeography of the western Tethyan region and the Euro-Boreal vs. Mediterranean faunal provinciality is evaluated. The data base was developed from improved and mostly revised taxonomical data of 25 Pliensbachian brachiopod localities selected from Europe and North Africa. The revised list and presence-absence data of 405 Pliensbachian brachiopod species formed the taxonomic units of the numerical analysis based on similarity coefficients. Cluster analysis (hCA) carried out from the Jaccard and Raup–Crick coefficient data showed clear dichotomy between the Euro-Boreal and Mediterranean brachiopod biochores. Principal coordinates (PCO) technique and non-metric multi-dimensional scaling (NMDS), complemented with the minimal spanning trees, resulted in similar grouping of the Pliensbachian brachiopod faunas. In de-trended correspondence analysis (DCA), besides the clearly separated Euro-Boreal and Intra-Mediterranean units, the Peri-Mediterranean assemblage formed a discrete scatter between the two major biochores. The three Algerian faunas (Ouar, Trar, Ksou) appear in a somewhat marginal position within the Euro-Boreal province. The above Pliensbachian brachiopod biochores reveal very high degree of endemism, probably related to the limited dispersal potential of brachiopods. From the complete data set distinctive Euro-Boreal and Mediterranean species, ten from both provinces, were selected. Ribbed spiriferinid morphotypes are frequent among the distinctive Euro-Boreal species, whereas, besides smooth spiriferinids, some rhynchonellid and terebratulid morphotypes with expanded anterior margins are common among the distinctive Mediterranean species. In the Early Jurassic Tethyan palaeogeography, the marked dichotomy between the Euro-Boreal and Mediterranean provinces is interpreted in terms of deep-sea/oceanic barriers, which isolated the intra-Tethyan microcontinent from the European and African shelf regions. Geographical position and local environmental factors caused the differentiation of the Peri-Mediterranean subprovince along the north-western margin of the microcontinent. This palaeobiogeographical unit formed an interface between the Intra-Mediterranean and the Euro-Boreal biochores.

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### 1. Introduction

The principles of the Jurassic palaeobiogeography of the Tethyan region have been set over a century ago when the two major units have been defined by Neumayr (1883: “Boreal” versus “Equatorial” Zones) and by Uhlig (1911: “Boreal Reich” versus “Mediterranean Reich”). The subject, as part of a complex attempt at biochore classification, was recently summarized and evaluated by Westermann (2000a, 2000b). The definition of Jurassic palaeobiogeographical units were based chiefly on the distribution of ammonoid faunas and were exhaustively documented and discussed in the last decades (Donovan 1967; Géczy 1973, 1984; Dommergues 1983; Cariou et al. 1985). Recently, comprehensive, numerical studies on the Euro-Boreal and Mediterranean ammonoid palaeobiogeography were also presented (Dommergues et al. 2009; Dera et al. 2011). The middle Early Jurassic

(Pliensbachian) appeared as suitable to demonstrate the provinciality of the Tethyan marine fossil groups because then, for the first time in the Mesozoic, the “Boreal” vs. “Tethyan” differentiation reached the realm level (Westermann 2000b).

The remarkable patterns of brachiopod distribution in the western part of the Early Jurassic Tethys and their implications for palaeogeography were recognized long ago by Ager (1967, 1971, 1973, 1986); and the subject was analyzed and discussed in detail by the present author in a series of papers (Vörös 1977, 1980, 1984, 1987, 1988, 1993). These works used mostly the simple occurrence data of characteristic brachiopod taxa; numerical methods were only partially applied. In their conclusions, the above authors separated the Mediterranean Province from the contemporaneous Euro-Boreal Province (called NW-European in those publications) and outlined their area of distribution in Europe and partly in North Africa. As for the Jurassic palaeogeography, Ager (1980, 1986) placed the Mediterranean fauna to and around the “Adriatic microplate”, and, as a somewhat similar solution, Vörös (1980, 1987, 1993) introduced the concept of the

E-mail address: [voros@nhmus.hu](mailto:voros@nhmus.hu).

“Mediterranean microcontinent” as the homeland of the brachiopods of Mediterranean faunal character. In both interpretations the NW European brachiopod province was confined to the European shelf and epicontinental areas, plus some regions in the Balkans and/or in North Africa in the Early Jurassic.

Although many of the above conclusions are still regarded as valid, the more than two decades progress in science gives reason to re-evaluate the subject of Early Jurassic brachiopod biogeography in the western Tethys. A revision of this kind seems to be justified particularly by the following reasons. (1) New attempts at classification in palaeobiogeography, with special attention to the formal nomenclature of Mesozoic marine faunal realms/biochores were published (Westermann 2000a, 2000b; Manceñido 2002; Cecca and Westermann 2003). (2) Comprehensive palaeontological statistics software of (PAST) became widespread, facilitating the use of numerical methods in comparative palaeobiogeography (Hammer et al. 2001). (3) Recently, several new, well illustrated publications and monographic descriptions appeared, greatly improving knowledge of the Early Jurassic brachiopod faunas both in the Euro-Boreal (France: Alméras et al. 2010; Alméras and Fauré 2000, 2013; Germany: Höflinger 2012; Northern Spain: Comas-Rengifo et al. 2006; Serbia: Ruban et al. 2015), and in the Mediterranean provinces (Subbetic zone: Baeza-Carratalá 2008, 2013; Northern Calcareous Alps: Siblík 2003, 2008; Bakony Mts.: Vörös 2009).

It is worth mentioning also that, after more than two decades pause, the subject of the palaeobiogeography of Tethyan Jurassic brachiopods emerged again, although in a somewhat specified approach or in limited framework, e.g. in context of the similarity of the NW-Caucasian fauna (Ruban and Vörös 2015) and of the palaeobiogeographical changes in the Serbian terranes (Radulović et al. 2016) and around the Iberian region (Andrade et al. 2016; Baeza-Carratalá et al., in press). These studies

evaluate mainly the faunas of transitional zones between the Euro-Boreal and Mediterranean provinces. For comparative studies of this kind (which are anticipated in the near future) it is crucial to have a firm knowledge on the faunal (taxonomical) content of the two major west-Tethyan palaeogeographical units and to formulate their updated definition. Therefore, a re-evaluation of the Early Jurassic Euro-Boreal and Mediterranean brachiopod provinces and the numerical assessment of their similarity versus difference seem to be reasonable and well-timed.

## 2. Data and methods

For the purpose of the numerical comparison, 25 occurrences of Pliensbachian brachiopod faunas were selected from the area of Europe and North Africa (Algeria) (Fig. 1). The major criteria of the selection were: (1) an approximately complete coverage of the investigated areas with Pliensbachian sedimentary outcrops; (2) nearly equal representation of the occurrences with Euro-Boreal versus Mediterranean faunal character; (3) large faunal size (>20 species each), for the sake of statistical confidence; and (4) proper documentation of the respective faunas with current taxonomical revision. The two latter criteria need some further explication.

Large sized faunas were preferred because the numerical methods of faunal similarity use presence-absence data; therefore a comparison of small faunas to much larger ones may produce rather misleading results. The palaeontological literature on Pliensbachian brachiopods comprises hundreds of articles with a wide spectrum of species numbers from one to nearly one hundred. In the data base of the present study the lower limit was drawn at faunas containing at least 20 species.



**Fig. 1.** Locality map of the 25 Pliensbachian brachiopod occurrences considered in the present work. Acronyms: **Engl**: England, **SGer**: Southern Germany, **Jura**: Jura Mts., **MArm**: Massif Armoricain, **SFra**: Southern France, **Pyre**: Pyrenees, **NSpa**: Northern Spain, **Subb**: Subbetic Zone, **WSic**: Western Sicily, **CApp**: Central Appennines, **Tosc**: Toscana, **Gozz**: Gozzano, **Arzo**: Arzo, **Tren**: Trento Zone, **Salz**: Salzkammergut, **Kost**: Kostelec, **WCar**: Inner West Carpathians, **Bako**: Bakony Mts., **MeVi**: Mecsek and Villány Mts., **Apus**: Apuseni Mts., **Serb**: Eastern Serbia, **WGre**: Western Greece, **Ouar**: Ouarensis, **Trar**: Traras Mts., **Ksou**: Ksour Mts. Further explanation in the text.

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