

THE BOREAL-TETHYAN BIOGEOGRAPHICAL MOLLUSC ECOTONE IN EUROPE DURING THE JURASSIC-CRETACEOUS TRANSITION

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Abstract. Late Jurassic and earliest Cretaceous molluscs of the northern hemisphere were distinctly differentiated geographically into Boreal taxa, usually north of 50° N, and Tethyan taxa, usually south of 45° N. Between these latitudes certain areas were displaced from time to time, although the biogeographical ecotone was stable. The magnitude of the ecotone and the migration of molluscs inside the ecotone varied in time and space, in direction (unidirectional and bidirectional) and intensity (expansion and "isolate straying"). The frequency of the Boreal-Tethyan migrations of molluscs is explained by eustasy and by geographical barriers existing between the Northern Caucasus and Middle-Russian basins.

Riassunto. I molluschi marini del Giurassico superiore e del primo Cretaceo dell'emisfero settentrionale erano nettamente differenziati dal punto di vista geografico in taxa boreali, di solito a Nord dei 50° N, e taxa tetidei, di solito a Sud dei 45° N. Tra queste latitudini certe aree venivano di volta in volta spostate, sebbene l'ecotono biogeografico fosse stabile. L'ampiezza dell'ecotono e la migrazione dei molluschi al suo interno è variata nel tempo e nello spazio, in direzione (unidirezionale e bidirezionale) ed intensità (espansione e "dispersione isolata"). La frequenza delle migrazioni boreali-tetidee dei molluschi è spiegata dall'eustasia e dall'esistenza di una barriera geografica tra i bacini del Caucaso settentrionale e della Russia centrale.

Introduction

The Boreal-Tethyan biogeographical ecotone existed in Europe during the late Jurassic-earliest Cretaceous represented by a co-occurrence of Boreal and Tethyan forms. During the Mesozoic it was located in the Northern Hemisphere along the Tethys-Pantalassa / Panboreal Super-realms boundary. The ecotone was established by the molluscs in the Triassic, Jurassic and Early Creta-

ceous in the Boreal-Pacific Realm (Zakharov et al. 1996). The position of the Boreal-Tethyan ecotone in the Boreal-Atlantic Realm from Late Volgian to Early Neocomian is assumed on the basis of ammonites (Zakharov & Bogomolov 1998). It is very important to investigate the Boreal-Tethyan migrations inside the ecotone at the Jurassic/Cretaceous transition to make a precise correlation between the Tithonian-Volgian and the Berriasian-Boreal Berriasian.

Material and methods

Data on ammonite, belemnite and bivalve migrations across the south margin of the Boreal-Atlantic Realm from Late Jurassic (Kimmeridgian and Volgian) to Early Neocomian (Boreal Berriasian -Valanginian) were reviewed. The migrations were considered at substage intervals. The latitudes of 45° and 50° N were accepted as the northern margin of the Tethys-Pantalassa Super-realm, and as the southern margin of the Panboreal Super-realm, respectively. A taxon "advancing" from north to south and crossing 50° N was considered a boreal influence, and the limit of Tethyan influence was set at the crossing of 45° N for taxa "moving" from south to north.

New molluscan data collected over the last few decades, mainly from Upper Jurassic and Lower Neocomian sequences of Europe, have improved our knowledge of the Boreal-Tethyan ecotone, of the position of the southern margin of the Boreal-Atlantic Realm (Sachs et al. 1971; Fig. 1), and of the migration of Tethyan mollusc associations and taxa into and from the Boreal basins (Fig. 2). Migrations with different intensities and direction from the Kimmeridgian to the Valanginian, considered in this paper, were restricted to the Boreal-Atlantic Realm (West European and East European Provinces). The molluscs, such as ammonoids, belemnites and bivalves, were divided into 3 groups: Tethyan, Boreal and Sub-boreal (mostly with Tethyan affinities typical for the ecotones). It is impossible to attribute some ammonoids, such as Phylloceratida and Lytoceratida, to either the Tethyan or Boreal Realm. Their distribution was probably controlled by water depth.

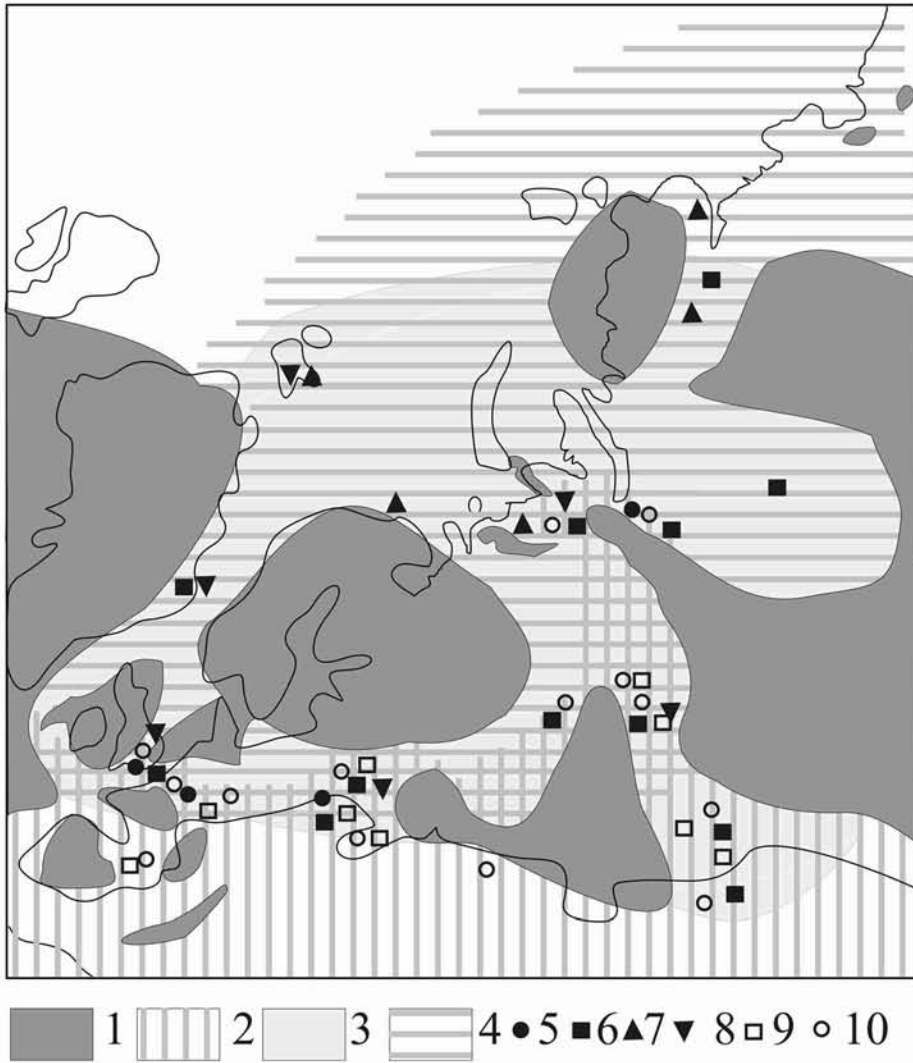


Fig. 1 - Boreal-Tethyan ecotone in the Upper Kimmeridgian (Autissiodorensis Chron) of Europe. 1 - land; 2 - Tethyan ammonites, 3 - Sub-boreal ammonites, 4 - Boreal ammonites; 5-10. Finds of the selected ammonite genera: Sub-boreal: 5 - *Gravesia*, 6 - *Aulacostephanus*; Boreal: 7 - *Suboxydites*, 8 - *Amoeboceras*; Tethyan: 9 - *Metahaploceras/Neohetoceras*, 10 - *Aspidoceras*.

Results

It is interesting to note that in Europe an ammonite ecotone was either absent for a rather long time (from the Latest Volgian to the beginning of the Valanginian) or quite restricted (during the Late Boreal Berriasian). Sub-boreal ammonites are either unknown or they occupied a small area (e.g. *Garniericeras*). At the beginning of the Valanginian, *Platylenticeras* appeared, presumably from Boreal ancestors, but its geographical distribution was typically Sub-boreal. During the Berriasian and Valanginian, the bivalve *Buchia* extended to the South, up to 48° N in the West-European Province of the Boreal-Atlantic Realm, and reached 42 - 40° N in the East-European Province (Zakharov 1981; Kelly 1990). Tethyan trigoniid bivalves penetrated up to 55° N into the East-European Province during the Volgian (Gerasimov 1955). The most northern penetration of Tethyan ammonoids known was made by *Aspidoceras* (Late Kimmeridgian, East-European Province, 65° N; Bogomolov & Dzyuba 1998; Fig.1).

Based on intensity, migrations are subdivided into expansions (mass migrations) and influences (isolated «straying», after Rawson 1973). Expansions are characterized by the moving of mollusc associations (e.g., mi-

grations of the Mediterranean ammonoids into the East-European Province during the Latest Kimmeridgian and Early Volgian), while influences refer to the moving of separate taxa, usually with an insignificant number of specimens (e.g., penetration of *Aspidoceras* northward into West Siberia). Expansions quite often lead to the starting of endemic clades (e.g. *Riasanites* in Central Russia, Late Valanginian Neocomitidae of Western Europe), but they may be restricted to short intervals without new taxa. The most indicative example of such migrations was the penetration of numerous *Anaspidoceras neoburgense* into the East-European Province during the Early Volgian (Pseudoscythica Chron, *neoburgense* hemera) (Rogov 2002). *Buchia* bivalves also illustrate the intensity of migrations. The migration-influences in the Boreal-Atlantic Realm took place during the Late Jurassic - Early Neocomian in the West-European Province (Fig. 2a), and during the Berriasian - Valanginian in the East-European Province (Fig. 2b).

Two kinds of migrations were determined based on the direction of penetration: bidirectional (e.g., Volgian- Early Berriasian) and unidirectional (e.g., latest Valanginian of West-European Province). Bidirectional Boreal-Tethyan migrations are explained by a reduction of

