Blaicher seems to prefer conditions of higher calcareous content and lower sedimentary rate; flysch-type DWAF biot'acies.

19. Assemblage with *Chilostomella* div.sp. (Late Eocene) — index taxon belonging to calcareous benthic foraminifers is rela tively abundant but always occurs in a form of pyritized moulds; low taxonomical diversity; accompanying agglutinated taxa not characteristic and in small numbers; facies-related assemblages; slope DWAF biofacies.

20. Assemblage with *Pararotalia lithothamnica* and/or *Asterigerina rotula* (Late Eocene) — calcareous assemblages of medi um to very high diversity characteristic for the slump deposits; foraminifers representing different environmets from shelf to slope; primary sedimentation above FL.

21. Assemblage with *Globigerina ampliapertura* and *Globorotalia cocoaensis* (uppermost Priabonian) — mostly mixed assem blages with considerable amount of calcareous benthic and planktonic foraminifers; taxonomic diversity high; both agglutinated and calcareous benthic foraminifers of deep-water character.

22. Assemblage with *Tenuitella liverovskae* and *Tenuitella munda* (lower part of Oligocene) — mixed or calcareous assem blages of medium diversity; specimens not numerous; calcareous foraminifers relatively small in size; slope DWAF biofacies.

23. Assemblage with *Globorotalia praescitula* and *Globoquadrina dehiscens* (Early Miocene (N5)) — mixed assemblages with majority of reworked specimens; autochthonous planktonic foraminifers point to the pelagic sedimentation above FL.

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BOREAL-TETHYAN BIOGEOGRAPHICAL ECOTONE SETTING IN EUROPE DURING JURASSIC-CRETACEOUS TRANSITIONAL TIME ON THE BASE OF MOLLUSCA

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Abstract: Mollusca of northern hemisphere in Late Jurassic and most Early Cretaceous were rather distinctly geographically differentiated on boreal, which occurs in the seas, placed, as a rule, to the north of 50 parallels and Tethyan inhabited the seas placed usually to the south of 45 parallels. Between these latitudes long time on the certain aquatic areas, being from time to time displaced in space, biogeographical ecotone is settled.

Key words: mollusca, biogeographical ecotone, Jurassic/Cretaceous, Europe.

The new data received per last decade on mollusca mainly from Upper Jurassic and Lower Neocomian sequences of Europe, have allowed more precisely to establish the setting of Boreal-Tethyan ecotone in Late Jurassic and Early Neocomian and to determine a geographical position of southern border of the Boreal-Atlantic Realm (Saks et al. 1971; Fig.la,b). The new time intervals of moving of associations and separate taxons of Tethyan mollusca in Boreal basins and back are established (Fig. 2). The migrations (M) with the different intensity was occur during Kimmeridgian up to Valanginian and were restricted by the Boreal-Atlantic Realm in West-European [W-E] and East Europe [E-E] provinces. A mollusca: an ammonites, belemnites and bivalves were divided into 4 groups: Tethyan and boreal (most numerous groups), subboreal: mostly with the Tethyan affinities (they were most typical for eco-tones) and Arctic (assumed as extremely boreal). It is interesting, that during a rather long time (from Latest Volgian to the beginning of Valanginian), when ecotone zone established on ammonites in Europe was absent or quite restricted (for Late Boreal Ber-riasian), the subboreal ammonites are unknown or (like *Garnierlceras)* occupied a small area. Only in the beginning Valanginian appears *Platylenticeras,* which, though come from a boreal ancestors, but their geographical distribution are typically subboreal. In W-E province of the Boreal-Atlantic Realm a bivalves of a genus *Buchia* have penetrated on the south up to 48-th parallel, and in E-E of a province reached 42-40-th only in Berriasian and Valanginian (Zakharov 1981; Kelly 1990). Tethyan bivalves from family Trigoniidae in the Volgian penetrated up to 55° N.L. in E-E province (Gerassimov 1955). The most northern penetration of Tethyan ammonites is established for *Aspidoceras* (Late Kimmeridgian, E-E province, 65° N.L.; Bogomolov & Dzyuba 1998). By the degree of intensity M are subdivided into M-expansions (mass migrations) and M-influences (isolated "straying" after Rawson 1973). M-Expansions are characterized by the moving in space of mollusca associations (for example, Tethyan M of ammonite in E-E province in the Latest Kimmeridgian and Early Volgian). M-influences are recognize by the moving of separate taxa, usually submitted by insignificant number of a specimens (for example, immigration of T genus *Aspidoceras* northward to West Siberia). Expansions quite often lead to the origin of endemic phylolines *(Riasanites* in Central Russia, Late Valanginian Neocomitidae of Western Europe), but sometimes they are restricted by the short time-interval, and there is not arise of new taxa. The most indicative example of similar M is the penetration of numerous *Anaspidoceras neoburgensis* during the Early Volgian (Pseudoscythica Chron) into the E-E province (Rogov 2002). Bivalves of a genus *Buchia* also rather evidently illustrate

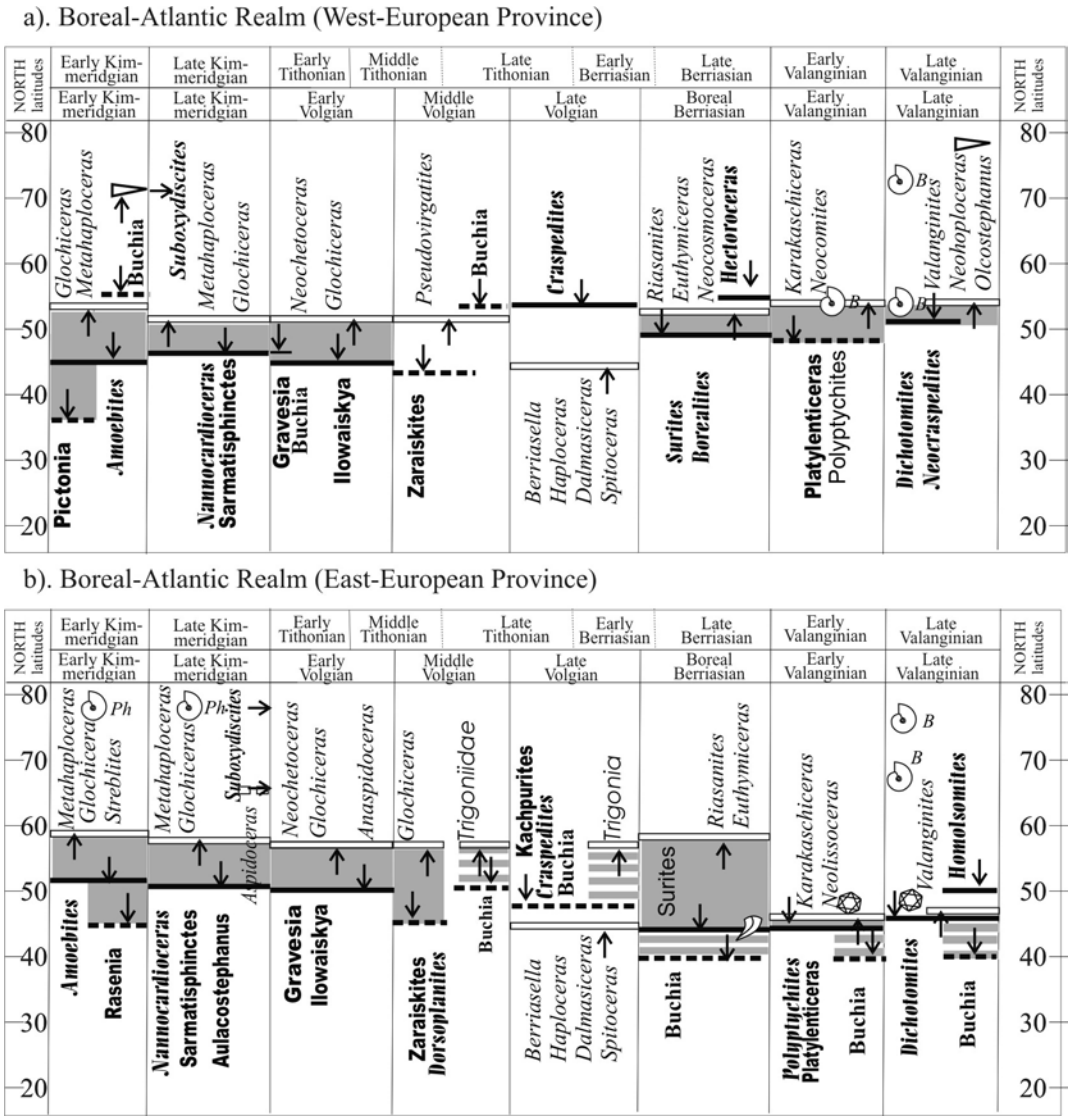

Fig. 1. Boreal–Tethyan mollusca migrations and biogeographical ecotone setting in the Boreal–Atlantic Realms from Kimmeridgian to Valanginian. Captions: Penetrations (a: of Boreal, and b: of Tethyan mollusca) 1. Expansions a: ▬▬ b: ▭▭ 2.Solitary penetrations a: ▬ ▬ b: ▭ ▭

Tethyan: belemnites (Hibolites): ▻ Rudistes Corals: Ecotone zones: with ammonites with bivalves

Ammonites: Tethyan: *Glochiceras*; endemic with the Tethyan affinity: ***Sachsia***; Boreal: Surites Subboreal: *Zaraiskites*; Bivalves: Tethyan: Trigoniidae; Boreal: **Buchia** Oceanic (Pelagic) ammonoids of temperate latitudes: B (B–*Bochianites*, Ph–Phylloceratida, L–Lytoceratida)

the intensity of M. The M-influences in the Boreal-Atlantic Realm took place during Late Jurassic and Early Neocomian in W-E province (Fig. la), and during Berriasian and Valanginian in E-E province (Fig. Ib). Two kinds of E on the direction of the penetrations are determined: mutually (for example, in the Volgian-Early Berriasian) and one-directional unilateral (for example, in the Latest Valanginian in W-E province). Mutually boreal-Tethyan M explained by reduction of a temperature gradient between paleozoochorems (influence of this factor is works, naturally, at absence of geographical barriers on ways of M). At this time, as a rule, there is an extension in width of ecotone. The one-directional M quite often are accompanied by displacement of the high rank paleozoochorems boundaries. They are characterized by sharp change of ammonite associations. In W-E and E-E provinces of the Boreal-Atlantic Realm, despite of their territorial affinity, M of mollusca not always were mutually correlated, that it is possible to explain by influence of currents and presence of geographical barriers. So, in the Latest Valanginian, in W-E province there was a significant northward displacement of Tethyan-Panthalassa-Panboreal Superrealms boundary. Nevertheless, in E-E of a province in this time occurs only boreal ammonites. The boreal-Tethyan ecotone in Europe was not always precisely expressed. The increasing of the boreal influence can be caught out in Northern Hemisphere to the beginning of Cretaceous: the Superrealms boundary, in particular, in the Early Valanginian is displaced to the south (Fig. *2).* It obviously testifies the development of the boreal transgression. The Tethyan influence in Kimmeridgian and Earliest Volgian is well appreciable only within the limits of Boreal-Atlantic Realm, where are observed «migration waves» (Fig. *2).* What factors influenced on a Boreal-Tethyan M of mollusca and the dispose of the biogeographical ecotone? A primary factor, as it is seems to the majority of the researchers, was temperature of waters, more cool in north. However only separate boreal and Tethyan mollusca were involved in M. Some typical Tethyan mollusca reached 60-th and even 65-th of degrees of N.L., i.e. move away from border Tethyan-Panthalassa (45° N.L.) to north on *2-2.5* thousand km. Among «boreal wanderers» cephalopods, which penetrate southward further than 38° NL, are not known so far, i.e. these mollusca move away from the border of Panboreal Superrealm more than on 700 km. Probably, separate Tethyan mollusca

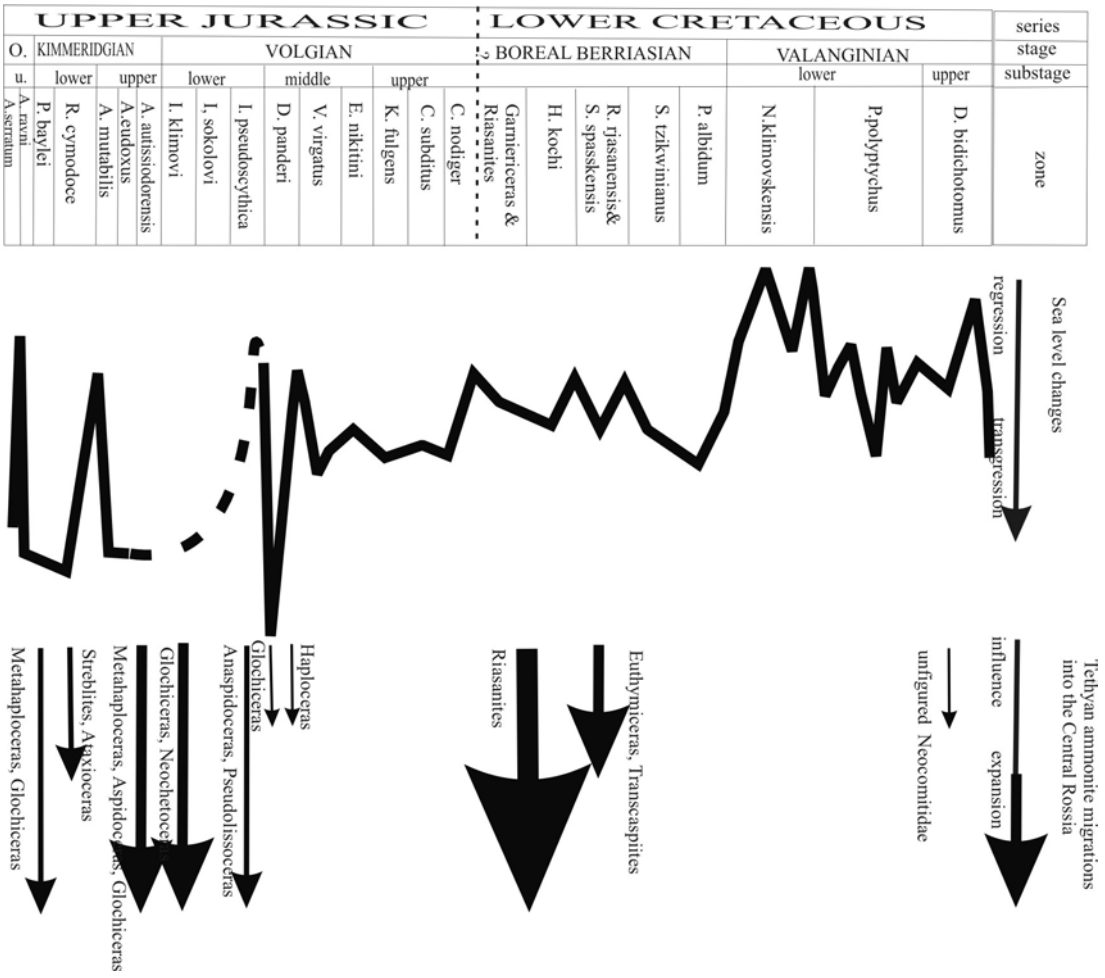

Fig. 2. Transgressive-regressive curve (from Sahagian et al. 1996) and ammonite migrations via Middle Russian sea during Kimmeridgian-Valanginian.

had wider temperature tolerance, than boreal. Possibly, it is necessary to involve this fact for the confirmation of a mainly southern origin of the majority Boreal taxa. Frequency of the Boreal-Tethyan M are explained by eustasy: during rise of a sea level the M ways opened, and during sea level fall the M ways were closed (Kemper et al. 1981, and others). Besides it is supposed, that rises of a sea level are eliminated temperature barriers between water mass. For check of these hypotheses most suitable are given on the central part of the E-E province of the Boreal-Atlantic Realm (Middle-Russian sea). The coincidence of peaks of transgressions with episodes of M of ammonites is observed only for the Kimmeridgian-Middle Volgian interval. In Berriasian the correlation is absent. The M-expansion of berriasellids in Boreal Berriasian obviously is not connected with eustatic rise. This fact it is possible to explain by destruction of a geographical barrier existing between the Northern Caucasus and Middle-Russian water masses. Apparently, the influence of Tethyan water mass prevailed above Boreal ones, as connections of the Middle-Russian sea with the Arctic basin were restricted at the north.

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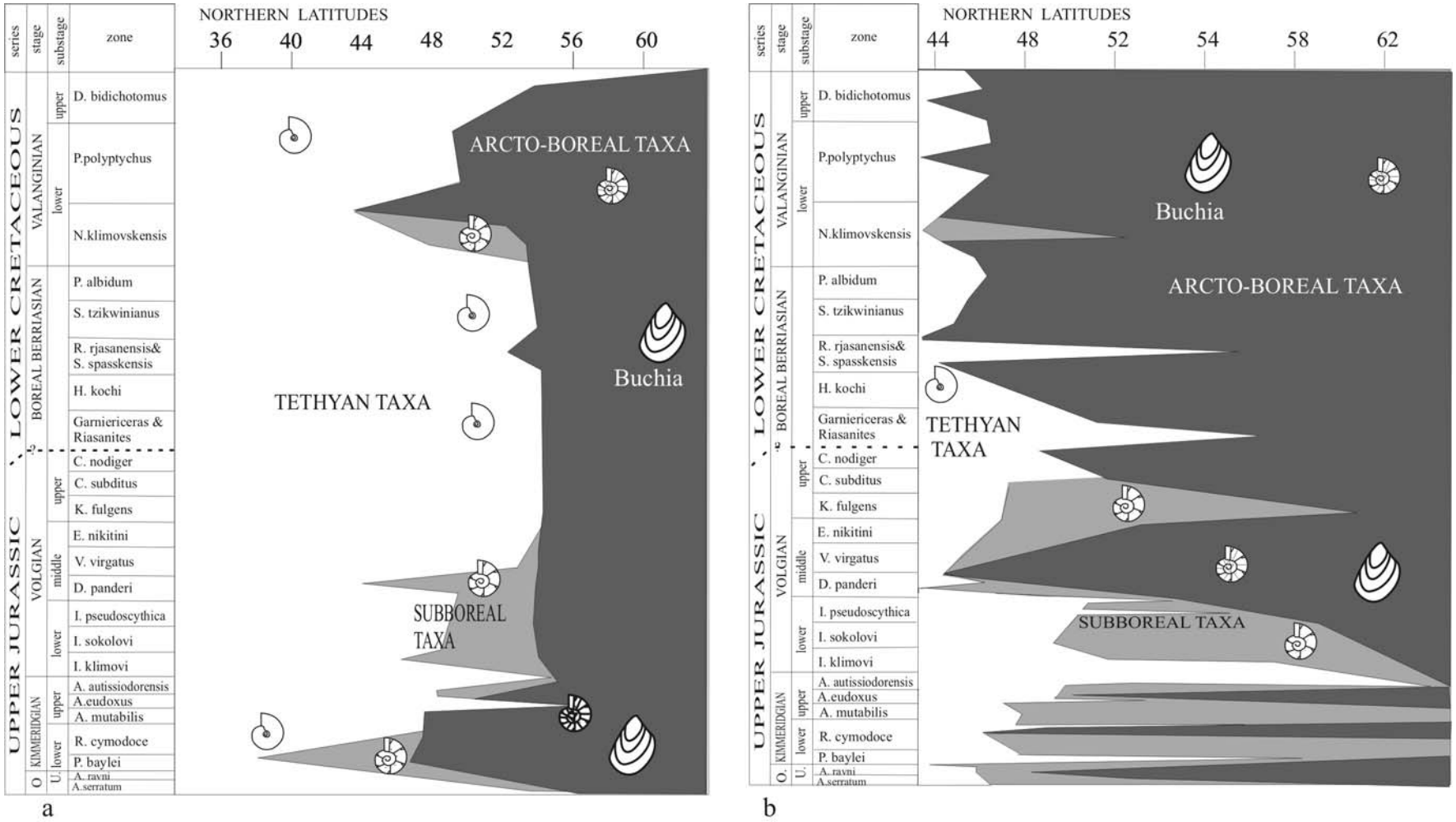

Fig.3. (*Zakharov & Rogov*) Mollusca migrations restricted by ecotone in the Boreal-Atlantic Realm from Kimmeridgian to Valanginian. a) West-European prov., B) East-European prov.