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COMMENTS ON A TENTATIVE CORRELATION CHART FOR THE MOST IMPORTANT MARINE PROVINCES AT THE JURASSIC/CRETACEOUS BOUNDARY

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The author, who has been studying the correlation of zonal schemes of different areas since 1965, elaborated a new correlation chart for the uppermost Jurassic and lowermost Cretaceous Stages in 1977, which was published with explanations in 1979 in Russian language; a revised and somewhat reduced version appeared in 1983 in German language. Therefore this paper is a short outline of the possible correlations and some additional comments prompted by new data in the literature which have become known to the author since 1983.

Keywords: Jurassic/Cretaceous boundary, worldwide correlation of marine provinces, Ammonites, Buchia

As there are no important new results on the correlation of Lower and Middle Tithonian beds with their boreal equivalents, and this problem was discussed by the author in 1979, we will begin with our explanations at the boundary Middle/Upper Tithonian (or Lower/Middle Volgian = base of the Pavlovia/Zaraiskites zone). In Poland, below the beds with *Zaraiskites scythicus*, there exists a layer containing an assemblage of late *Isterites* and early *Pseudovirgatites* which mark the uppermost Middle Tithonian (Zeiss, 1977). In southern Central-Europe above this bed there are layers with assemblages of late *Pseudovirgatites (scruposus* group) and an hitherto unknown pre-*Paraulacosphinctes* ammonite fauna (at present under study by the author). Within this interval no calpionellids have been discovered, and thus it corresponds well to the basal Micracanthoceras zone (Simplisphinctes subzone) of southern Spain (Oloriz–Tavera, 1979), which is also situated below the true Transitorius (sub)zone with *Crassicollaria*. There are no big problems in the correlation of the higher part of the Upper Tithonian of the middle and eastern Mediterranean (Transitorius zone) with the western part (Micracanthum and Durangites zones). Also a thorough analysis of the faunas of the latter zones and those of the Micracanthoceras/Kossmatia/Durangites/Corongoceras zones of Mexico and South America makes a correlation possible between the Mediterranean and eastern Pacific realm. Via the western United States one can find ways of cor-

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relation to western Canada by the common occurrence of *Kossmatia*, *Bupiochhi* and *Bu. elderensis*; the Buchias and (and in the author's opinion probably) the giant *Titanites occidentalis*, the generic determination of which is still open, are significant for the middle Volgian (Surlyk)—(Sakharov, 1982). The parallelization within the boreal realm was discussed by the author in detail earlier (1983).

Above the Upper Tithonian (Durangites/Corongoceras zones) and the middle Volgian (Epilaugeites zone) a worldwide correlation by ammonites, in the Lower Berriasian and its equivalents is not possible; therefore the author used index species of buchias and calpionellids instead. The term Berriasian is used here as defined by Le Hégarat (1973), but including the Jacobi zone at the base.

In Mexico, above the Durangites faunal complex follows the Substeueroceras zone, which contains, according to Cantú (1968), calpionellid faunas of zone B and C of Remane (C. alpina and C. elliptica zone). As shown in Fig. 1 there may be some overlapping at the boundary, as Trejo (1975, 1980) indicated that questionable *Substeueroceras* and *Parodontoceras* already occur together with *Crassicollaria massutiniana* of the uppermost Durangites/Crassicollaria zone (see also Cantú, 1982).

On the other hand, as, following Imlay–Jones (1970), the highest parts of the elderensis zone yielded *true Parodontoceras*, these parts should belong already to the basal *Substeueroceras* beds as indicated in Fig. 1 (see also below).

The Substeueroceras beds of South America and their equivalents in Mexico (Cantú, 1968) correspond well to the *Substeueroceras/Parodontoceras* assemblage of North-America, the lower part of which was correlated by Imlay–Jones (1970, p. 8–9) with the Bu. fischeriana zone, the upper with the Bu. aff. okensis zone. As *Bu. fischeriana* has its main frequency in the two lower zones of the Upper Volgian of the Russian Platform and occurs also elsewhere in the boreal realm this time the correlation seems to be rather well established; besides, a correlation within the boreal realm is possible by craspeditid ammonites. In the Bu. aff. okensis zone also *Bu. terebratuloides* is represented and gives a strong evidence for equating this zone with the upper Craspedites and Chetaites/Praetollia zones of the boreal realm where this species has been found, too, as well as *Bu. unschensis*.

The approximate equivalence of the Substeueroceras/Paradontoceras zones of the south-eastern Pacific realm to the Euxinus/Occitanica zones seem to be rather well established by the same calpionellid associations (fauna B and C) in both complexes. Within the Mediterranean area the faunal differences are not very accentuated.

In the sections studied by Cantú (1968) in Mexico presumed equivalents of the Argentiniceras and Spiticeras zones have delivered a calpionellid assemblage, approximately of zone D of Remane, clearly indicating an Upper,

not a Lower Berriasian age. Therefore correlation of the Subthurmannia mazetepensis zone of Mexico and its equivalents in South America with the Fauriella boissieri/Calpionellopsis zone of the Mediterranean area can be demonstrated well.

From the Mediterranean area a correlation can be traced to the eastern submediterranean province (Caucasus, Crimea) by ammonites and calpionellids and from here to the Rjasan beds of the Subboreal province by common occurrences of *Rjasanites*, *Euthymiceras*, *Surites* and *Bu. okensis* (Fig. 1). There are of course a lot of minor problems, but the correlation in general has a solid foundation.

The correlation from the subboreal to the boreal sections can be arranged by *Buchia* species, especially *Bu. okensis*, *Bu. jasikovi*, *Bu. uncitoides* and *Bu. tolmatschowi*. These buchias also occur in the northeastern Pacific province and are important correlation tools between these two provinces.

The correlation of the base of the Argentiniceras zone of Argentina are unsolved question. According to Cantú (1968) the base of this zone would be coeval with that of the S. mazatepensis zone, but due to the correlation with the *Buchia*bearing *Substeueroceras* and *Argentiniceras* beds of North America, it would lay somewhat higher. The interval in question is documented in Argentina by non-fossiliferous beds (Spath, 1952), while Bíró (1981) mentions from Chile *Parodontoceras* in the Argentiniceras zone.

Another problem is the upper boundary of the *Bu. terebratuloides*. *Bu-unschensis*- *Bu. fischeriana* zonal complex. The latest occurrences of these assemblages or parts of it have been observed in the two lowermost Rjasanian beds, the Maynci/Sibiricus and lower Kochi zones as well as in the *Parodontoceras* beds of Canada. Having in mind that Bíró (1981) reported *Parodontoceras* together with *Argentiniceras* in Chile one may assume that all these intervals correspond approximately (space with question mark in last column of Fig. 1). But Surlyk–Zakharov (1982) record from Eastern Greenland the above-mentioned *Buchia* assemblage from the still younger true Bu. okensis zone.

While the general framework of the correlation shown here has a solid base, I am fully aware that a lot of problems are to be cleared up, and many correlation lines can only be drawn tentatively at present. Our knowledge about the exact vertical ranges and quantitative distribution of many index fossils are restricted. Therefore, it is necessary to undertake comparative studies and more detailed work on all fossil groups by joint research groups.

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		Mediterranean			Submediterranean		Subboreal		Boreal		NE Pacific			E and SE Pacific		
		Southern France, Southern Spain			Southern Mid-Europe, Crimea, Caucasus		Russian Platform		Greenland, Northern Siberia		Canada		Western United States	Middle and South America		
LOWER VALANGINIAN		*Thurmanniceras campylotoxum*		*Calpionellites T. carpathica*	*Kilianella roubaudiana*		*Polyptychites michalskii*		*Polyptychites michalskii*		*Polyptychites* sp. *div.*		*Neocraspedites giganteus.* *Buchia keyserlingi*	*Neocomites wichmanni* *Acantholissonia gerthi.* *Thurmannic. pertransiens*		
		Th. pertransiens. *Th. otopeta*			*Thurmanniceras thurmanni*		*Temnoptychites hoplitoides*		*Temnoptychites syzranicus*		*Thorsteinssonoceras*					
							Ps. undulatoplicatilis		*Neotollia klimovskiensis*		*Temnoptychites.* *Tollia* *Buchia pacifica*		*Kilianella.* *Tollia.* *Thurmanniceras.* *Bu. pacifica*			
UPPER BERRIASIAN	RJASANIAN	*Fauriella boissieri*	*Berriasella callisto,* *Tirnovella alpillensis*	*Calpionellopsis* — *Lorenz. hungarica*	*Rjasanites rjasanensis*	?	*Buchia uncitoides*	*Peregrinoceras* aff. *albidum*	*Surites mezeshnikovi,* *Surites payeri,* *Buchia tolmatschowi*		*Surites* aff. *simplex,* *Buchia tolmatschowi,* *Buchia uncitoides*		*Spiticeras (Negreliceras) stoneyense.* *Neocosmoceras* sp. *Buchia uncitoides.* *Bu. okensis.* *Buchia jasikovi*	*Cuyaniceras transgrediens,* *Spiticeras damesi*	*Subthurmannia mazatepensis*	*Remaniella cadischiana, R. dadayi*
						Fauriella boissieri		*Surites tzikwinianus*								
						Surites, Euthym. transfig., Rjasanites rjasanensis		*Surites spasskensis,* *Euthym. transfigurabilis*	*Surites analogus,* *Buchia jasikovi*							
			Picteticeras picteti	*oblonga*	*Rjasanites rjasanensis*	*Rjasanites rjasanensis* *Tauricoceras crassicostatum* *Bu. okensis*	*Buchia okensis*	*Rjasanites rjasanensis.* *Hectoroceras* sp.	*Pseudocrasp. anglicus,* *Hectoroceras kochi.* *Bu. okensis*		*Pseudocraspedites* aff. *anglicus,* *Argentiniceras cf. noduliferum,* *Bu. okensis*			*Argentiniceras noduliferum.* *Neocosm. egregium*		
			Malbosiceras paramimounum (Euthymiceras)	*simplex*	*E. euthymi*	*Euthymiceras euthymi.* *Rjasanites* sp.		*Hectoroceras cf. kochi*	*Chetaites sibiricus.* *Praetollia maynci,* *Hectoroceras*	*Buchia unschensis*	*Praetollia antiqua.* *Parodontoceras callistoides*	*B. terebratuloides*	*Substeueroceras.* *Proniceras.* *Blanfordiceras.* *Buchia* aff. *okensis* *Buchia terebratuloides*	?		
						Tirnovella berriasensis		*Rjasanites,* *Euthymiceras,* *Garnierieras*								
LOWER BERRIASIAN	UPPER VOLGIAN	*Ti. occitanica*	*Dalmasiceras dalmasi*	*Calpionella elliptica*	*Ti. occitanica*	*Dalmasiceras dalmasi*	*Craspedites nodiger*	*Craspedites kaschpuricus*	*Chetaites chetae.* *Crasp. singulare*		*Craspedites canadensis.* *Buchia terebratuloides,* *Buchia unschensis.*			*Substeueroceras koeneni (Proniceras,* *Himalayites.* *Spiticeras.* *Berriasella.* *Parodontoceras.* *Aulacosphinctes)*		*Calpionella alpina, C. elliptica*
			Berriasella privasensis			*Tirnovella occitanica.* *Spiticeras spitiense*		*Craspedites mosquensis*	*Craspedites taimyrensis*							
			Tirnovella subalpina													
		Ps. euxinus	*Pseudosubplanites grandis*	*Calpionella alpina*	*Ps. euxinus*	*Berriasella latecostata, Pseudusubpl. euxinus*	*Craspedites subditus*		*Craspedites originalis*		*Buchia fischeriana*		*Parodontoceras.* *Buchia fischeriana.* *Buchia piochii*			
									Craspedites okensis							
			Berriasella jacobi		*Ps. euxinus*	*Chapericeras chaperi*	*Kaschpurites fulgens*		*Praechetaites exoticus*							
UPPER TITHONIAN	MIDDLE VOLGIAN	*Durangites*	*P. senex*	*Crassicollaria intermedia*	*Paraulacosphinctes transitorius.* *Micracanthoceras micracanthum*		*Lomonossovella blakei*		*Epilaugeites vogulicus*	?	*Titanites occidentalis.* *Buchia piochii*		*Kossmatia.* *Buchia piochii.* *Buchia elderensis*	?		
									Laugeites groenlandicus							
							Epivirgatites nikitini		*Crendonites anguinus*	*Epivirgatites variabilis*				*Corongoceras alternans*		
		Micracanthoceras micracanthum	*P. transitorius*				*Virgatites rosanovi*		*Epipallasiceras pseudapertum*	*Taimyrosph excentricus*	*Buchia cf. blanfordiana.* *Buchia* n. sp. aff. *piochii*			*(Durangites, Kossmatia. Anavirgatites.* *Micracanthoceras-* *Virgatosphinctes.* *Hildoglochiceras)*		
							Virgatites virgatus		*Dorsopl. maximus.* *Dorsoplanites gracilis*							
			Simplisphinctes	*Chitinoidella*	*Pseudivirgatites scruposus*		*Zaraiskites scythicus.* *Pavlovia pavlovi*		*D. ilovaiskyi, D. liostraca* *Strajevskya strajevskyi* *D. communis, D. rugosa*					*Windhauseniceras internispinosum*		
									Pavlovia iatrensis							
MIDDLE TITHONIAN	up. LOWER VOLGIAN	*Djurjuriceras ponti.* *Burckhardticeras*			*Pseudovirgatises puschi.* *Isterites*		*Ilowaiskya tenuicostata*		*Dorsoplanites primus*		*Buchia mosquensis.* *Buchia rugosa*			*Aulacosphinctes proximus*		
		Simoceras admirandum			*Pseudolissoceras bavaricum*	*Isterites*	*Ilowaiskya pseudoscythica*							*Pseudolissoceras zitteli*		
		Semiformiceras fallauxi. *Richterella richteri*				*Lemencia*			*Paravirgatites* sp. *B*							
		Semiformiceras semiforme. *Haploceras verruciferum*				*Sublithacoceras, Virgatosimoceras*										