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GENERAL STRATIGRAPHIC SCALE AND BRACHIOPOD EVOLUTION IN THE LATE DEVONIAN AND CARBONIFEROUS SUBEQUATORIAL BELT

by

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ABSTRACT

Two main concepts - chronostratigraphic and biochronotypic - for working out the general Stratigraphic Scheme are compared. The biochronotypic concepts are based on the recognition of general elementary units (stages) of the Carboniferous in the Subequatorial Belt. Analysis of the available data on evolution and stratigraphic distribution of spiriferid and productid brachiopod genera made it possible to recognize 10 elementary units, to which the status of stages could be given.

KEY WORDS

Brachiopod, stratigraphy, Carboniferous.

1. INTRODUCTION

A General Scale for the Carboniferous was originally developed on a regional basis, similar to General Scales for other Paleozoic systems. This means that Carboniferous stages, as well as their scopes and boundaries, have regional prototypes. However, each region has its own geological history and sedimentary peculiarities, which are reflected in regional stratigraphic schemes. Hence, the result was a conventional, or artificial character of stages in a General Scale as applied to other, non-stratotypical regions. The situation is currently changing : a process of so-called General Scale repairs implies the search for substantiated boundaries of general stratigraphic units.

The principles of a General Scale construction were initially controversial from the methodological standpoint, as was evidenced in a two-volume monograph by Leonov (1973, 1974).

The first IGC sessions (1900) clearly identified three basic concepts :

1. all rank subdivisions of the General Scale should be natural and universal ;
2. they should be recognized as universal, being in fact conventional ;
3. the degree of their universality diminishes from major to minor subdivisions.

Fundamental differences of opinion were caused by the requirement of naturalness whose definition remained uncertain. Thus, the French Commission on stratigraphical nomenclature adhered to the first concept and outlined the paleontological criterion, on the one hand, and the interruptions criterion, on the other hand, as basic criteria for stratigraphic subdivisions of the General Scale. Incidentally, A. d'Orbigny resorted to the same criteria for identifying a stage. The difficulty of combining these criteria sometimes brought about a situation when the stage was determined not by the fossil assemblage but, on the contrary, the assemblage was subordinate to the section interval limited by the unconformities. A

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standard section, in d'Orbigny's opinion, controlled the coincidence of both requirements.

It should be emphasized that our compatriots, Nikitin and Tchernyshew who adhered to the second concept, indicated simultaneously the historic-geological naturalness of the regional subdivisions. This is constrained by the condition that whatever regional scale is taken for a general one, it will inevitably seems artificial with regard to other regions.

After the IGC Session (1900) methodological issues of developping a General Stratigraphic Scale were not discussed for half a century. After 1945, the second concept of the General Scale units became largely predominant. This refers to the chronostratigraphic concept outlined in Hedberg's papers (1948, 1951, 1965) and in the concluding document of the International Subcommission on Stratigraphic Classification of IUGS Commission on Stratigraphy, i.e. International Stratigraphic Guides (1976).

According to this concept, biostratigraphy and chronostratigraphy correspond to essentially different stratigraphic subdivisions. The chronostratigraphic subdivisions are based upon conventional stratigraphic markers fixed in stratotypes (geological time standard in section). The latter are necessary since any division (subdivision) of time is artificial ; a multiplex system of stratigraphic subdivision corresponds to different methods ; the artificial character of such subdivision requires international agreements (the Golden Spike method) ; evolutionary phenomena cannot be used as markers due to the instability of their assessment (therefore, stratotypes are not needed for biostratigraphic subdivisions).

The improvement of Phanerozoic General Stratigraphic Scales and Carboniferous scale in particular, has identified constraints and artificial character of the chronostratigraphic concept. It proved impossible to strictly comply with its requirements.

The Carboniferous General Scale suggested at the 8th ICC (Moscow, 1975) is evidently a construction of various regional schemes which were based on the stratotype concept. However, the discussion on boundaries, and in particular, the change of the Mid-Carboniferous boundary testifies that the majority of workers are not consistent with the principle of conventionality of stratigraphic subdivisions and their boundaries. It is natural that in a combined chronostratigraphic scale, gaps and overlaps are possible, which may be detected and corrected only by applying a biostratigraphic method. The search for better boundaries within the Carboniferous which is a priority today does not comply, strictly speaking, with the chronostratigraphic concept. Stratotype selection work with respect to the boundaries of Phanerozoic chronostratigraphic subdivisions has led to boundaries fixed according to zonal transitions of most important fossil groups, thus virtually legalizing the biostratigraphic method of defining boundaries of the General Scale subdivisions. The stratigraphical interval defined by such boundaries does not need a stratotype but a biochronotype (Ruzhentsev, 1975). In our opinion, a spontaneous process is currently progressing in the development of Phanerozoic General Scale. This process is characterized by a transition from the stratotype concept to the biochronotype concept, the very concept of stratotype (geological time standard) is imperceptible for many investigators who transformed this into a useful and acceptable concept of a basic section (i.e. a sequence where it is convenient to observe main indicators of the stratigraphic units and their changes).

For a long time, the concept of naturalness of stratigraphic units was kept in the background. It is no coincidence that the concept of naturalness of stratigraphic units based on paleontological data (primarily, evolutionary ones) was developed by Schindewolf (1970) and Ruzhentsev (1977), who were specialists in ammonoids, i.e. the group whose systematics was primarily based on phylogenesis.

Event stratigraphy, causal stratigraphy or ecostratigraphy, which developed over the last decades, also favour recognition of naturalness of the General Scale units. The geosystematic nature of stratigraphic subdivisions and their boundaries are connected with the above guideline. These concepts were comprehensively outlined in Meyen's monograph (1989). The latter is based upon causal-consequential time conception which is inconsistent with the concept of chronostratigraphy as interpreted by Hedberg. The geosystematic nature of stratigraphic boundaries implies the requirement of "theoretical leveling of significance attached to various stratigraphic indications" (Meyen, 1989, p. 88). We believe that this requirement has a purely theoretical character, since stratigraphic indications are levelled only within the framework of an established geosystem. However, such a requirement cannot be taken for granted while developing a General Scale. Otherwise, a recourse to the conventionality and the stratotype is inevitable. Incidentally, according to Meyen, a stratotype is primarily a bearer of name, whereas the standartization, in his opinion, should be interpreted differently. He maintains that a stratotype is not a certain conventional standard of geological time, but a substrate, basis for "reference and comparison". Such concept is similar to that of a basic section.

2. BASIS OF THE MAIN STAGES

In our view, further prospects of improving Carboniferous General Scale and methods of its development are to be associated with the following guidelines :

1. Clear understanding of the necessity to reject the principle of conventionality of General Scale stratigraphic subdivisions, and of the stratotype as a conventional interval of geological time. A stratotype may have only a nomenclature function, i.e. to a be bearer of (geographic) name.

2. Search for substantiated boundaries of General Scale Phanerozoic stratigraphic units should be based primarily on evolutionary phenomena in greatest possible number of fossil groups. Ideally, this may form a basis for causal interpretations and definition of rank of the stratigraphic boundaries. This thesis in no way contradicts the geosystematic nature of boundaries. However, it proceeds from an obvious assumption that organisms are the most sensible indicators of the irreversible development of a geosystem.

3. Before the geosystem approach starts to work, lack of coincidence in boundaries as to various fossil groups will remain a problem. However, the boundaries of General Scale units, as the most reliably correlated levels, are usually confined to relatively narrow stratigraphic "intervals of condensation" of boundaries in various groups. Such "intervals of condensation" subdivide stratigraphic intervals, each being characterized by a certain fossil assemblage. The aggregation of elements of this unique assemblage makes a biochronotype (Ruzhentsev, 1977). In our opinion, this concept should be applied in a theoretical procedure of identifying coeval stratigraphic intervals in space.

4. The development of a General Scale implies a tedious work of revising the genera range in each region. Carter's (1991) and Legrand-Blain's (1991) recently published papers on North American Lower Carboniferous brachiopods and Western European Lower Carboniferous productids may serve as an example. After that, a comparative analysis is conducted, and biochronotypes for each unit are established alongside with the correlation regional chart. Such a scheme is represented in table 2. The drawbacks of this scheme, as well as of biochronotypes (steps) identified on the basis of that scheme, are related to insufficient studies of various regions and brachiopod groups.

5. Taxa of known phylogeny make the most significant element of the biochronotype, especially those whose ancestor was closer to the boundary of the stratigraphic unit corresponding to the biogeochrone. A greater number of taxa characterizing a biogeochronotype, enhances its possibilities for interregional correlations.

6. To substantiate biogeochronotypes, it is advisable to use not only the taxon language but also the meron language, i.e. the semiphyletic approach (Meyen, 1978). Further on, we try to apply elements of this language to substantiate the evolutionary cycles of Carboniferous brachiopods. This language is suitable to fix evolutionary phenomena arising independently and sometimes simultaneously with regard to various phyletic lineages. Earlier, we described such phenomena based upon the canalizing nature of evolution (Lazarev & Poletaev, 1982). They are suitable for substantiation of units of the General Scale and are possibly related to geosystematic reorganization.

7. The ranking of biostratigraphic boundaries as to the significance of evolutionary transformations will hardly correspond in full to the scale of geosystematic transformations. However, we believe that the elementary stratigraphic unit of the General Scale, as identified by various fauna types, may be correlated to the elementary biochronotype of the General Scale. It is generally recognized that some groups are more suitable for the most fractional (zonal) interregional correlation. The fewer rare interregional boundaries based on benthic groups are usually characterized by genera assemblages, rather than by species. Therefore, we suggest to consider a stage as the smallest interregional subdivision which may be fixed by the evolution of benthic groups. Such concept of the Stage is nearly consistent with the further identified 10 steps in the evolution of subequatorial belt brachiopods in the Carboniferous.

3. THE BRACHIOPOD BIOCHRONOTYPES OF THE MAIN CARBONIFEROUS STAGES

On the basis of currently available data on the stratigraphic distribution of brachiopod genera, primarily spiriferids and productids (Fig. 1), Poletaev developed a correlation scheme of brachiopod Zonal scales of North America, Western and Eastern Europe, Urals, Central Asia, South-Eastern China and Australia (Table 2). The taxonomic composition of 10 major steps in the evolution of subequatorial belt brachiopods corresponds to the sequence of 10 biochronotypes.

1. Strunian Stage approximately corresponds to Clymenia and Wocklumeria Zones. At its lower boundary, a complete change of productid genera composition took place, due to the teeth reduction. This time is characterized by the appearance of a thick network of thin spines on brachial valves of the *Productidina* and *Strophalosiidina* (Lazarev, 1989) and the appearance of spiriferids with bifurcate ribs and syringothyrids.

2. Hastarian Stage. Its lower boundary is characterized by :

a. independent appearance of dorsal spines in several phyletic lineages of productids (genera *Piloricilla, Scissicosta, Rugauris, Rhytiophora, Geniculifera,* etc.) ;

b. appearance of spiriferids with a porous shell (*Spiriferellinidae*) ;

c. abundance of *Eudoxina, Ectochoristites,* etc.

3. Ivorian Stage is characterized by the following events :

a. in the evolution of Productoideae the costae have reached the umbo ;

b. abundance of Tolmatchoffiinae ;

c. the appearance of *Acanthoplecta* and *Levitusia* ;

d. the apperance of *Palaeochoristites* and spiriferids with ovarian pits (scattered on all the internal surface of the brachial valve (*Spirifer* s.str.)

4. Early Visean (Moliniacian - Livian) Stage is inexpressive as to the productids and difficult to correlate. The time is indicated by :

a. the appearance of *Dictyoclostus, Retariinae* (genus *Keokukia*) ;

b. the first *Carringtonia, Linoprotonia, Latiproductus* (first forms with marginal formations on the visceral disc), *Marginirugus* and *Ozora* also.

5. Late Visean (Warnantian) Stage is characterized by maximum variety of productid genera. *Gigantoproductus (Latiproductus), Striatifera* and forms with a series of trails (*Productus, Pugilis, Eomarginifera*) have developed. Numerous new forms are characterized by the appearance of protective formations preventing undesirable particles from getting into the shell. Spiriferids with a limited area of development of genital markings and initial vascular system (*Angiospirifer*) appear. Neospiriferids appear in the boreal belt. By the end of the stage *Inflatia* appears.

6. Serpukhovian Stage is characterized by a decrease in the variety of productid genera. At that time *Linoprotonia* and *Semiplanus* disappear, but *Beleutella* and *Titanaria* appear, *Angiospirifer* and *Eobrachythyrina* are abundant. By the end of the stage *Gigantoproductus, Striatifera, Eobrachythyrina* disappear and neospiriferids penetrate into the subequatorial belt. The abundance of *Inflatia* is typical for boreal basins.

7. Early Bashkirian Stage is characterized by the appearance of muscular platform in several productid lineages : *Karavankina*, descendants of *Semicostella* (gen. nov.), *Companteris*. The typical genera are *Rugoclostus, Echinaria, Reticulatia, Desminnesia, Parajuresania*. Spiriferids with advanced type of genital markings (*Choristites* ex gr. *bisulcatiformis, Tiramnia, Brachythyrina*) appear ; reduction of dorsal vascula media in Orthidae up to two stocks. *Verchojania* s. str. appears in the boreal belt.

8. Late Bashkirian Stage is characterized by acme of *Densepustula*. Appearance of thin-ribbed *Choristites* (*Choristites* ex gr. *priscus*) as well as *Meristorygma, Purdonella* and ancestors of *Spiriferella* (gen. nov.).

9. Moscowian Stage (without Vereisky Horizon) is characterized by the appearance of *Orthotetes* s. str., *Linoproductus* s. str., *Tubaria, Calliprotonia, Lopasnia* and other productids as well as of *Trautscholdia, Choristitella, Elinoria* and *Choristites* s. str. (*Ch.* ex gr. *sowerbyi*) etc. among spiriferids.

10. Kasimov - Gjelian Stage is characterized by :

a. the appearance of several new productid and spiriferid genera : *Juresania, Cubacula, Rugatia, Pulchratia, Muirwoodia, Spiriferella, Callispirina, Paeckelmanella*, etc. ;

b. the abundance of *Gypospirifer, Trautscholdia* and *Elinoria* etc. The beginning of the stage is associated with the total replacement of *Desmoinesia* by *Hystriculina*. The latter has a dorsal valve completely devoid of dorsal spines.

The succeeding Lower Permian Asselian Stage is characterized by new genera :*Nudau-ris,Paramarginifera, Horridonia, Squamaria, Spyridiophora, Tuberculata, Stepanoconchus* (which appears in Upper Carboniferous), *Waagenoconcha, Cancrinella* s. str., *Auriculispina, Monticulifera*, etc. *Jacutoproductus* s. str. (also forms without dorsal spines) appear in the boreal belt.

We would like to emphasize again that the level of knowledge on these data is very heterogeneous and in many cases needs refinement. Accordingly, the aforesaid stages may serve only as general guidelines for further work.

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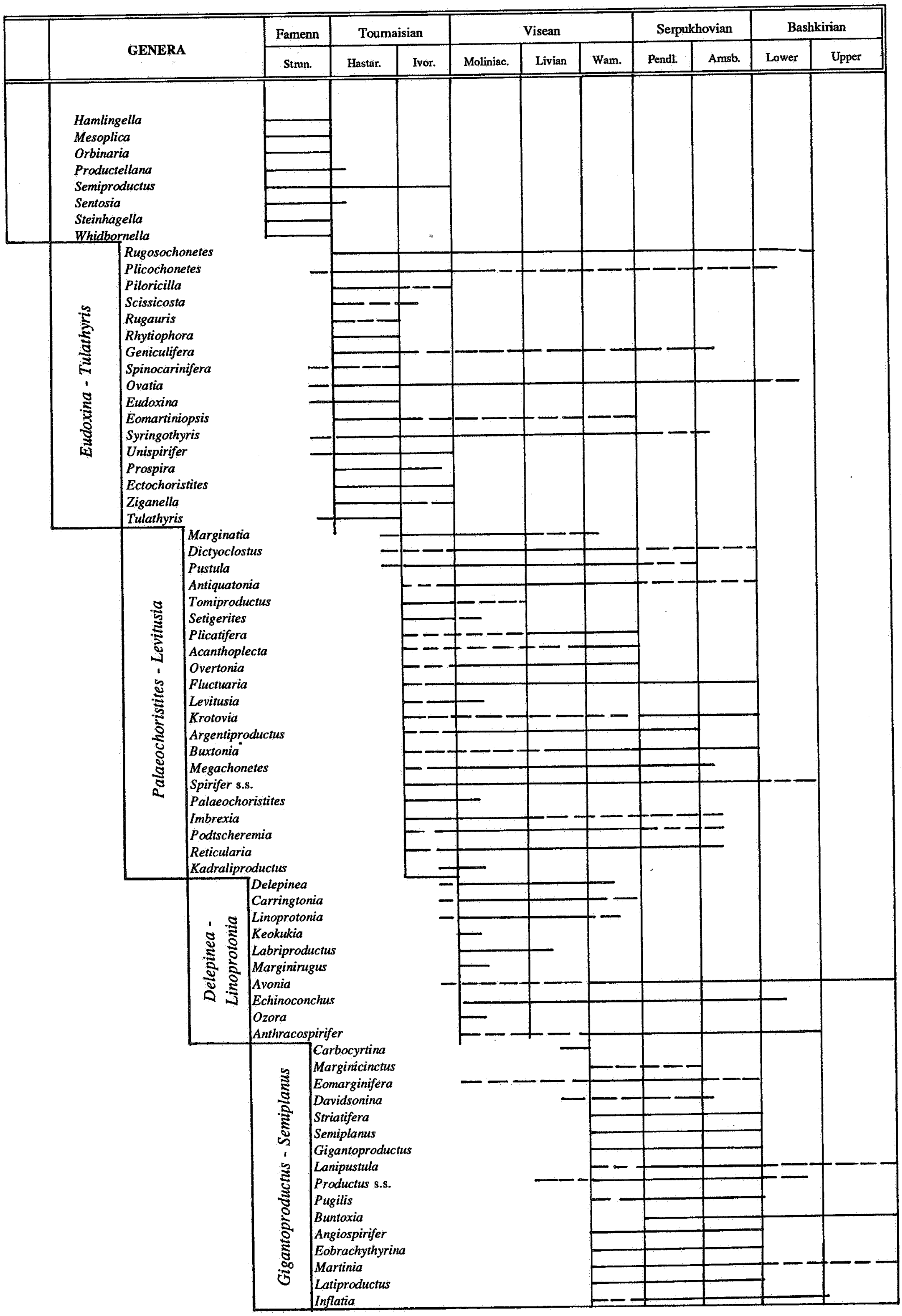
GENERA
Famenn
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Warn.
Pendl.
Arnsb.
Lower
Upper
Hamlingella
Mesoplica
Orbinaria
Productellana
Semiproductus
Sentosia
Steinhagella
Whidbornella
Eudoxina - Tulathyris
Rugosochonetes
Plicochonetes
Piloricilla
Scissicosta
Rugauris
Rhytiophora
Geniculifera
Spinocarinifera
Ovatia
Eudoxina
Eomartiniopsis
Syringothyris
Unispirifer
Prospira
Ectochoristites
Ziganella
Tulathyris
Palaeochoristites - Levitusia
Marginatia
Dictyoclostus
Pustula
Antiquatonia
Tomiproductus
Setigerites
Plicatifera
Acanthoplecta
Overtonia
Fluctuaria
Levitusia
Krotovia
Argentiproductus
Buxtonia
Megachonetes
Spirifer s.s.
Palaeochoristites
Imbrexia
Podtscheremia
Reticularia
Kadraliproductus
Delepinea - Linoprotonia
Delepinea
Carringtonia
Linoprotonia
Keokukia
Labriproductus
Marginirugus
Avonia
Echinoconchus
Ozora
Anthracospirifer
Gigantoproductus - Semiplanus
Carbocyrtina
Marginicinctus
Eomarginifera
Davidsonina
Striatifera
Semiplanus
Gigantoproductus
Lanipustula
Productus s.s.
Pugilis
Buntoxia
Angiospirifer
Eobrachythyrina
Martinia
Latiproductus
Inflatia

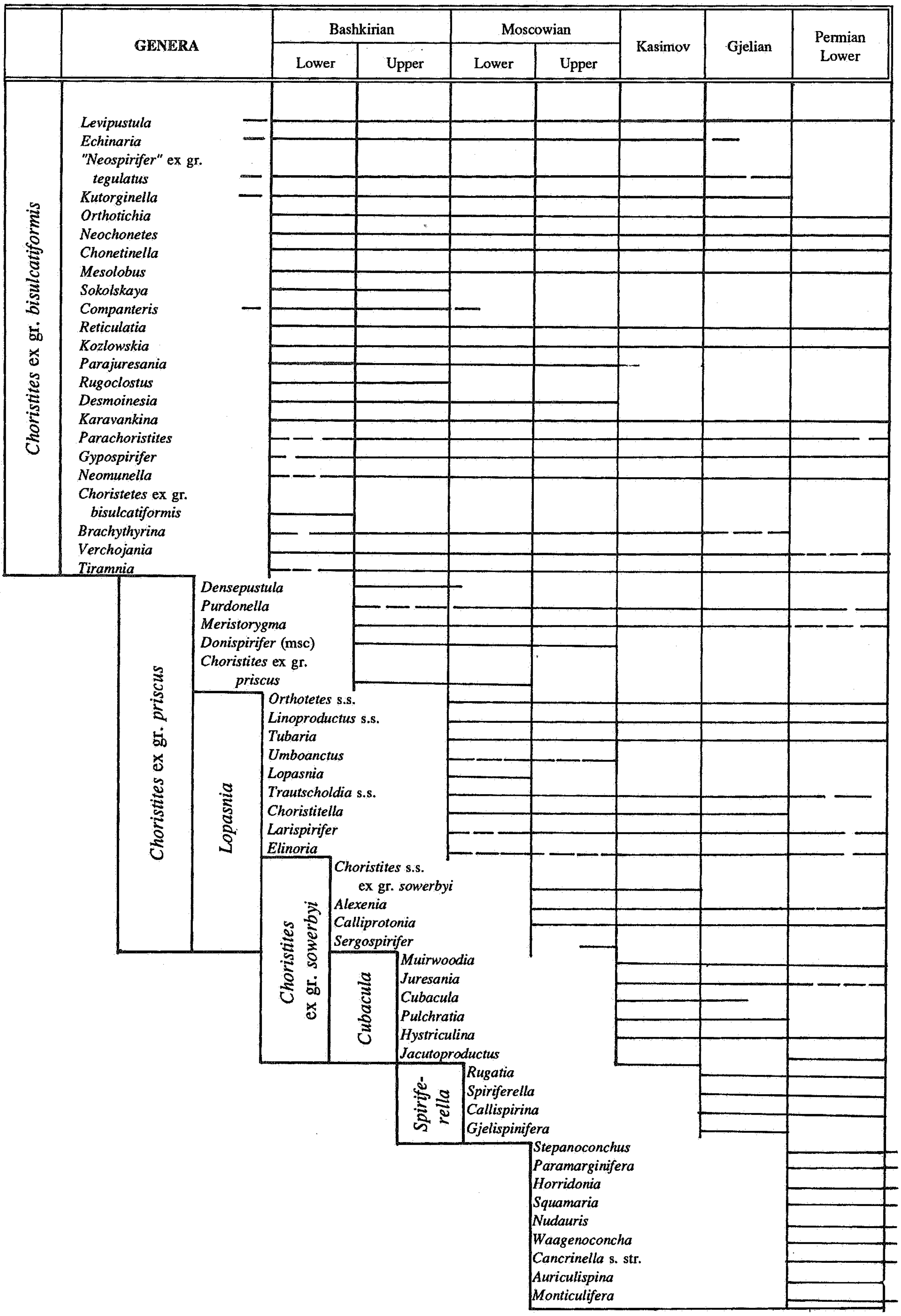

Table 1. Stratigraphic ranges of Late Devonian, Carboniferous and Early Permian selected brachiopod genera in Subequatorial belt (by the data of J. Carter, 1991 ; S. Lazarev, 1990 ; M. Legrand-Blain, 1991).

SER.	Ammonoids (1, 2, 3)	Foraminifera *et al.* (4, 5)	Conodonts (6)	U.S.A. (7) Mississippi Region: Stages	U.S.A. (7) Mississippi Region: Formations	U.S.A. (7): Zones	Western Europe (8): Stages	Western Europe (8): Stages	Western Europe (8): Index	Western Europe (8): Zones	Eastern Europe: Horizons	Eastern Europe: Gen. Z.
GJELIAN	*Schumardites* *Uddenites* *Paraschumardites* *Prouddenites*	*Schw. vulgaris* *Schw. fusiformis* *Daix. sokensis* *Jig. jigulensis* *Tr. rossicus* *Tr. stuckenbergi*		Virgilian			Autunian				Sokoljegorsky Noginsky Paul.-Posadsky Amerevsky Rechitsky	*Spiriferella*
							Stephanian C.		St. C			
KASIMOVIAN		*Tr. acutus* *Tr. quasiarcticus* *Mont. montiparus* *Protr. pseudomont.* *Obsol. obsoletes*		Missourian			Stephanian B		St. B		Yauzsky Dorogomilovsky Khamovnich. Krevyakinsky	*Choristites* ex gr. *sowerbyi*
							Barruelian		St. A			
							Cantabrian					
MOSCOWIAN		*Fus-lla bockii* *Pulchr. eopulchra* *Fus. cylindrica*		Desmoines.			Westphal. D		WD			
	Wellerites	*Fus. colaniae* *Fus. vozhgalensis* *Beedeina kamensis*					Bolsovian		WC		Podolsky	
	Eowellerites	*Fus. subpulchra* *Hemifus. kashirica*		Atokan			Duckmantian		WB		Kashirsky	*Choristites* ex gr. *priscus*
		Aljut. priscoidea *Al. enensis* *Hemitus. volgensis*									Tsninsky	
	Winslowoceras	*Al. aljutovica* *Schubert. pauciscept.*					Langsettian		WA		Vereisky	
BASHKIRIAN	*Axinolobus*	*Verella spicata* *Aljut. tikhorovichi*		Morrowan							Melekesky	
	Branneroceras	*Oz. pararhomboidalis* *Profus. primitiva*									Cheremshan.	*Choristites* ex gr. *bisulcatiformis*
		Ps. praegorskyi *Ps. staffellaeformis*					Yeadonian		G1		Prikamsky	
	Megapronorit.	*Ps. antiqua*					Marsdenian		R2		Severokeltmensky	
	Reticuloceras	*Eost. pseudostruvei* *Eost. postmosquensis*					Kinderscoutian		R1		Krasnopolyan.	
	Homoceras- *Dombarocanites*		*Declinognathus noduliferus*		Caseyville	17	Alportian		H2		Voznesensky	
							Chokierian		H1			
SERPUKHOVIAN	*Eumorphoceras* *Cravenoceras*	*Eosigmoilina* *Brenckleina*	*Upp. R. muricat.* *Low. R. muricat.* *Adetognathus unicornis*	Chesterian	Elvira	16		Amsbergian	E_2	8	Zapaltyubinsky	*Gigantoproductus* - *Semiplanus*
											Protvinsky	
		Eumorphoceras -	*Cavusgnathus naviculus*					Pendleian	E_1	7	Steshevsky	
											Tarussky	
VISEAN	*Goniatites*	*Neoglyphioceras* -	*Paragnathod. nodosus*		Homberg	15	Warnantian	Brig.	V3c		Venevsky	
		Asteroarchaediscidae	Fu 10		New design Gr.	14			V3b	6	Mikhailovsky	
	Beirichoceras		-*G. bilineatus* Fu 9	Meram.	Ste Geneviève	13		Asb.			Alexinsky	
	Bollandites - *Bollandoceras*	Planoarchaediscinae	Fu 8		St. Louis	12	Livian	Holk.	V3a	5	Tulsky	
					Salem	11			V2b		Bobrikovsky	*Delepinea* - *Linoprotonia*
			- *Gnath. texanus*		Warsow	10	Moliniacian	Arund.	V2a V1b	4		
	Fascipericyclus *Merocanites*	*Eoparastaffella* *Eoendothyranopsis*	*Scaliognath. anchoralis*	Osagean	Keokuk	9		Chad.	V1a		Radayevsky	
TOURNAISIAN	*Dezapracoceras* *Ammogellipst.*	*Tuberendothyra tuberculata* - *Polygnatus communis carina*	*D. latus*		Upper Burlington	8			Tn3c	3	Kosvinsky	*Paleo-choristites* - *Levitusia*
	Munsteroceras *Pericyclus*		*Upper G. typicus*		Fern Glen	7	Ivorian	Courceyan	Tn3b Tn3a		Kizelovsky	
			Lower G. typicus		Meppen							
	Goniocyclus *Protocanites*	*Pericyclus* - *Siph. crenulata*	*Siphonodella*: *isostich.* / *Upper crenul*	Kinderhookian		6	Hastarian		Tn2c	2	Cherepet.	
			Lower crenul		Wassonville	5			Tn2b Tn2a		Karakubsky	
	Pseudarietites *Paprothites* *Gattendorfia*	*Gattendorfia* - *Siph. sulcata*	*sandbergi* *duplicata* *sulcata*		Chouteau / Hannibal	4			Tn1b	1	Upinsky	*Eudoxina* - *Tulathyris*
					Bush.-Hannibal						Malevsky	
					Glen Park	3					Humerovsky	

Russian Platform — Donets Basin (this paper)

	Spiriferella gjeliensis
	Choristites supramosquensis / *Trautscholdia jigulensis*
	Choristites sowerbyi
	Choristites priscus
	Choristites inferus
	Choristites priorus
	Choristites notabilis / *Choristites vetus*
	Choristites medovensis
	Choristites pseudobisulcat.
	Choristites vulgaris
	Interval-Zone from *Gigantoproductus* distinction up to *Choristites s.l.* appearance
edelburgensis	*Echinaria kutorginella*
edelburgensis	*Striatifera magna*
expansus	*Semiplanus latissimus*
giganteus	*S. semiplanus*
giganteus	*S. mikhailov.*
giganteus	*Serbarinia kalugensis*
	Gig. maximus
Linoprotonia	*L. mira*
Linoprotonia	*L. proba*
	Palaeoch. grabovi / *Delepin. lebedevi*
Palaeochoristites cinctus	*P. c. kosvensis* / *L. humerosa*
Palaeochoristites cinctus	*Levitusia hyperborea*
Palaeochoristites cinctus	*Marginatia antiquissima*
	E. laevis - implexina
	Eud. media / *Eomart. waschkur.*
	Eud. praemedia / *Eomartiniopsis elongata*

Urals (9)

W.	E. slope
	"*Trautscholdia fritschi*" / *Neospirifer condoriformis*
	Trautscholdia gigulensis / *Tomiopsis petrenkoi*
	Choristites laticostataef. / *Choristites sowerbyi*
	Choristites laticostataef. / *Choristites uralicus*
	Choristites priscus / *Choristites radiculosus*
	Choristites inferus
	Choristites notabilis
	Choristites planus
	Reticulatia sp. / *Choristites bisulcatiformis*
	Choristites bisulcatiformis / *Eom. schartimien.*
	Choristites pseudobisulc. / *Ovat. postovata.*
Latiproductus	*Latiproduc. edelburgensis*
Latiproductus	*Goniophoria monstrosa*
Latiproductus	*Latiproduct. latissimus*
Gigantoproductus	*G. striatosule*
Gigantoproductus	*G. giganteus*
Gigantoproductus	*Gig. maxim.* / *Moder. praem.*
	Globosoproductus
	magnificus / *mirus*
Delepinea	*D. lebedevi*
Delepinea	*Ovatia markovskyi*
Levitusia	*L. humerosa* / *P. "desinuatus"*
Levitusia	*L. hyperbor.* / *Palaeochoristites cinctus*
Eudoxina	*Eudoxina media* / *Eomartiniopsis waschkuricus*

(10) Central Asia (11)

Suit	Mid Tian-Shan
Arpanynskaya	"*Spirifer*" *pseudobisulcatus*
Koman	*Spirifer bisulcatus*
Zanginsk.	*Inflatia inflata*; *Gigantoproduct. edelburgensis*
Teshikskaya	*Gig. sonculensis*: *Dictyoclostus ischimicus*; *Gigantoprod. sonkulensis*
Helg.	*Gig. sarsimbaii*; *Gig. maximus*
Karaki-ins-kaya	*Dict. deruptus*: *Verchotomia plena*; *Dictyoclos. deruptus*
Dzh.	Interval Zone
Kadrian	*Spirifer grimesi* / *Lev. humerosa*
Akche-tash.	*Levitusia praehumerosa*
	Pal. chatkalicus / *Pal. cinctus desin.*
Katun-aryksk.	*Eomartiniopsis waschkuricus*
Sonkul.	*Semiproductus irregular.*

Suit.	Chatkal Talass
Yakhak	*Ch. bisulcatiform.*
Seslavinsk.	*Spirifer bisulcatus*
Koikeb.	*Beleutella magna*
Keltema-shat-skaya	*Beleutella kirgisica*
Mash.	*Latiproductus rectestrius*
Aksu.	*Pugilis dikarevae*
Itelgui.	*Moderatoprod. sarsimbaii*
Kibrai-skaya	*Dictyoclostus deruptus*
Ksh.	
Irisu.	
Sarg.	*Spirifer subgrandis*
Taldy-bulak	*Palaeochoristites cinctus*
Koksu	*Pal. chatkalicus*
	?
Temip.bast.	*Rhytiophora temir.*

South China

Suit.	Fm.	Zones (12)
Map.	Huanglong Formation	*Choristites*
Xiao-dusha-nian		
Dalan		
?		
Huashibanian		
Luosuanian		
Datangian (Tatangian)	Zimengiao Formation	*Gigantoprod. edelburgensis*; *Kansuella kansuensis*
	Ceshui Fm.	*Echinoconch. elegans* - *Marginifera viseeniana*
	Shidengzi Formation	*Pug. hunanensis* / *Vitiliproductus gröberi*; *Megachonetes zimmermanni*
Yanguanian (Aikuanian)	Liujiatang Formation	*Eochoristit. neipentaiensis* / *Martiniella elongata*
	Menggongao Formation	*Paulonia-Cleiothyrid. serra*

Zones (13)
Alexenia gratiodentalis / *Nantanella mapingensis* / *Choristites latum*
Marginifera tenuistriata / *Goniophoria carinata*
Gigantoproductus cf. moderatus

Australia — Zones (14)

Zones
Auriculaspina levis
?
Levipustula levis
Marginirugus barringtonensis
Rhipidom. fortimuscula
Delepinea aspinosa; *Gigant. tenuirugos.*
inflatia elegans
Orthotetes australis
Schellwienella cf. burlingtonensis; *Pustula gracilis*
Spirifer sol
Tulcumbella tenuistriata

Table 2. Correlation and age of brachiopod units in different regions of Subequatorial belt (by the data : 1. Kullman, J. *et al.*, 1991 ; 2. Riley, N., 1993 ; 3. Wagner, R. and Winkler Prins, C.F., 1987 ; 4. Winkler Prins, C.F., 1991 ; 5. Higgins, A.C. *et al.*, 1987 ; 6. Ziegler, W. & Lane, R., 1987 ; 7. Carter, J.L., 1991 ; 8. Legrand-Blain, M., 1991 ; 9. Kalashnikov, N.V. *et al.*, 1989 ; 10. Galitskaya, A. Ya., 1977 ; 11. Sergunkova, O.I., 1989 ; 12. Xu Shouyoung and Yang Deli, 1988 ; 1988 ; 13. Li Shoujun, 1987 ; 14. Jones, P.J. & Roberts, J., 1976).