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THE SUCCESSION OF BRACHIOPODS AS A TOOL FOR CORRELATION IN THE SILURIAN OF THE EAST BALTIC

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Fossil taxa can be grouped together in relation to their sequential occurence as observed in studied sections, for instance, into zonal schemes. They may also be arranged into various communities based on their spatial coexistence. When considered separately, these two arrangements represent either purely temporal or purely environmental aspects of stratigraphical study respectively.

It is difficult to define such as time and environment in a strict sense. But according to the main thesis of this paper it is necessary to estimate temporal and environmental factors separately. Moreover, it must be done in a certain order. Thus, if one observes differences in content of fossils from two exposures then it is difficult to say immediately whether the differences are temporal or environmental. But, as soon as dating of the exposures is possible, some paleogeographical conclusions can be achieved, and only then. Because of this the temporal aspect must be ranked first in all kinds of stratigraphical correlations, including ecostratigraphical ones.

Any stratigraphical events in the Baltic Silurian as well as in many other regions may be dated easily relative to existing stratigraphical scales, and the necessity of analysing the different aspects in a astrict order may therefore seem to be puzzling. However, if one wants to improve on the existing scales then it must be done not only through elucidation of temporally controlled successions of taxa as a first step, but also independently of the existing scales.

The Upper Silurian example discussed below shows that only a minor part of the brachiopods forms such a well defined temporal succession that can be used unambiguously in intraregional correlations.

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Material

The distribution of 74 brachiopods was studied in 16 borings located throughout the East Baltic region (see Table 1). Their succession in the borings was also checked by their occurrence in the outcrop area on the Island of Saaremaa. Range charts of the species in each section are stored at the Institute of Geology, Tallinn.

Table 1. Frequency of brachiopod occurrence and washed samples, and stratigraphy in the borings

A - percentage of intervals with brachiopods from the total interval studied.
B - percentage of washed samples from the total number of samples with brachiopods.
C - stratigraphy: D - Downton, L - Ludlow, W - Wenlock.
M - number of identified species or taxa.
Q - studied interval of the boring in meters.

No.	Boring	A	B	C	M	Q
1.	Paadla	80	0	L	4	0.0 - 10.0
2.	Kingissepp	62	7	L+D	11	0.0 - 26.0
3.	Kaugatuma	63	18	L+D	20	0.0 - 71.0
4.	Ohesaare-1	59	0	W+L+D	43	0.0 - 330.0
5.	Kolka-54	48	0	L+D	32	170.0 - 470.0
6.	Kolka-4	37	0	L+D	34	180.0 - 520.0
7.	Ventspils	23	11	L+D	32	270.0 - 640.0
8.	Piltene-1	18	0	W+L+D	28	418.0 - 827.5
9.	Pavilosta	44	5	L+D	34	487.5 - 800.0
10.	Ezere	33	17	L+D	27	925.0 - 1130.0
11.	Pašaltuonis-94	32	0	L	25	1100.0 - 1270.0
12.	Girdžai-50	11	40	L	27	950.0 - 1110.0
13.	Geluva-99	52	0	W+L+D	43	644.0 - 1020.0
14.	Virbalis	37	0	W+L+D	35	705.0 - 1155.0
15.	Kalvarija	57	100	W	25	695.0 - 850.0
16.	Dubovskoje	12	100	D	15	979.0 - 1312.0

Systematic notes

The following list of species or their groups gives the basis for the study. Each taxon has a code number, and those occurring in less than five sections have their code number in brackets. The references quoted give the authority on which the identification of the various species is based.

1 - *Shaleria* sp. sp.: = *Brachyprion ezerensis* - Рыбникова, 1966: 80, Pl.1:9,10; 1967: 193, Pl.21:1,2; = *B. costatula* - Рыбникова, 1966: 85, Pl.2:1-3; 1967: 194, Pl.20:1-3; = *Shaleria* aff. *ornatella* - Bassett & Cocks, 1974: 17; = *S. delicata* - Harper & Boucot, 1978: 161, Pl.34:11-25,29.

(3) - *Rhipidium tenuistriatum*: Bassett & Cocks, 1974: 23, Pl.6:1-4, Pl.7:1.

4 - *Aegiria grayi*: Bassett, 1974: 91, Pl.20:8-15; = *Plectodonta aknistensis* - Рыбникова, 1967: 188, Pl.19:1-2.

5 - *Glassia obovata*: = *G. rotunda* - Рыбникова, 1967: 201, Pl.23: 2; = *G. minuta* - ibid.: 203, Pl.23:3; = *G.* sp. - ibid.: 202, Pl. 23:4.

(7) - *Anastrophia deflexa*: Bassett & Cocks, 1974: 22.

(8) - *Kozlowskiellina deltidialis*: Bassett & Cocks, 1974: 38, Pl. 11:1.

9 - *Atrypa reticularis*: Алихова и др., 1954: 42, Pl.25:3; Bassett & Cocks, 1974: 28, Pl.9:2; = *A. reticularis dzwinogrodensis* - Рыбникова, 1967: 208, Pl.24:4-6; = *A. reticularis* aff. *tajnensis* - ibid.: 209, Pl. 24:7; = *A. dzwinogrodensis* - Рубель, 1970: 37, Pl. 19:1-12, Pl.20:1, 12-21, 23.

10 - *Resserella* sp. sp.: = *Parmorthis elegantula* - Алихова и др., 1954: 35, Pl.22:1,2; = *Resserella concavoconvexa* - Рубель, 1963: 134, Pl.5:1-7; = *R.* cf. *concavoconvexa* - Рыбникова, 1967: 172, Pl.14:5; = *R. canalis* - Walmsley & Boucot, 1971:

497, Pl.97:1,4-7, Pl.98:1,2, Pl.100:4; Bassett & Cocks, 1974: 10; = *R. elegantula* - Walmsley & Boucot, 1971: 499, Pl.91:5, Pl.96:1-4, Pl.17:2,3; Bassett & Cocks, 1974: 10; = *R. basalis* - Walmsley & Boucot, 1971: 501, Pl.91:7-10, Pl.98: 7, Pl. 99:2-6, Pl.100:3,5; Bassett & Cocks, 1974: 10.

11 - *Dicoelosia biloba*: Rubel, 1971: 55, Pl.9:26-31, Pl.10:1-17, non Pl.10:18-22; Bassett & Cocks, 1974: 11; non Рыбникова, 1967: Pl.15:1; = *D. oklahomensis* - ibid.: 175, Pl. 14:7,8; Rubel, 1971: 57, Pl.9:32, Pl.10:23-40.

12 - *Isorthis crassa*: Hurst & Watkins, 1978: 96, Pl.2:27; = *I. parvulus* - Рыбникова, 1967: 180, Pl.16:10, non Pl. 16:7-9; = *I. (Arcualla) crassa* - Walmsley & Boucot, 1975: 80, Pl.7:16-23; = *I. (Protocortezorthis) slitensis* - ibid.: 65, Pl. 3:9-11; = *Levenea muldensis* - ibid.; 92, Pl. 10:1-11.

13 - *Dalejina hybrida*: Bassett & Cocks, 1974; 11; = *Rhipidomelloides hybrida* - Рубель, 1963: 145, Pl.7:7-15; = *R. tripartita* - ibid.: 143, Pl.6:10-13, Pl.7:1-6, = *R.* cf. *hybrida* - Рыбникова, 1967: 176, Pl.15:5-7.

14 - *Cyrtia exporrecta*: Алихова и др., 1954: 38, Pl.23:2; Рыбникова, 1967: 212, Pl. 25:1; Рубель, 1970: 56, Pl. 35:1-11; Bassett & Cocks, 1974: 35; = *C. trapezoidalis* - Рубель, 1970: 57, Pl.36:1-15, Pl.38:1-5.

15 - *Skenidioides lewisii*: Рыбникова, 1967: 169, Pl. 4:1, non Pl.14:2-4; Bassett, 1972: 35, Pl.5:10, Pl. 6:1-12; non Рубель, 1963: 128, Pl. 3:1-10.

(16) - *Plectodonta* sp.

(17) - *Atrypina barrandii*: = *Plectatrypa barrandi* - Алихова и др., 1954: 37, Pl.22:8.

18 - *Clorinda* sp. sp.: = *C. rotunda* - Bassett & Cocks, 1974: 25, Pl.5:7; = *Atrypa ? dormitzeri* - Hede, 1917: 17, Pl. 1:15-19; Bergman, 1980: Fig.2:E.

19 - *Gypidula galeata*: Рубель, 1970: Pl.11:11-14; Bassett & Cocks, 1974: 24, Pl.5:8; = *G. magna* - Рыбникова, 1967: 183, Pl.17:4,5; Рубель, 1970: 21, Pl.11:1-10, Pl. 12:1-14.

20 - *Delthyris elevata*: Рыбникова, 1967: 214, Pl. 25:2,3; Рубель, 1970: 62, Pl.38:6-11; Bassett & Cocks, 1974: 37, Pl.10:6.

(21) - *Striispirifer plicatellus*: Boucot, 1963: 696, Pl.100: 8,14,15; Bassett & Cocks, 1974: 37; = *Hedeina plicatella* - Brunton & Cocks, 1967: 172, Pl.3:1-5; = *H. crispa* - ibid.: 171, Pl.2:28-33; = *Striispirifer* sp. - Рубель, 1970: 61, Pl.40:9, 10; = *Macropleura* sp. - ibid.:61, Pl.40:11; = *Striispirifer crispus* - Bassett & Cocks, 1974: 37; = *S. striolatus* - Bassett & Cocks, 1974: 37.

(22) - *Visbyella visbyensis*: Walmsley et al., 1968: 307, Pl.60: 1-9; Рубель, 1963: 137, Pl.5:8-16; Bassett & Cocks, 1974: 11.

23 - *Strophonella euglypha*: = *S. podolica* - Рыбникова, 1966: 87, Pl.2:9-11; = *S.* cf. *podolica* - Рыбникова, 1967: 194, Pl.21: 3-5; = *Strophoprion euglypha* - Harper & Boucot, 1978: 96, Pl.15:6,7, Pl. 16:1-4,6,7,11.

(25) - *Lanceomyonia* sp.

26 - *Isorthis canaliculata*: Walmsley & Boucot, 1975: 93, Pl. 10: 12-18; Hurst & Watkins, 1978: 95; Bassett & Cocks, 1974: 10; = *Platyorthis ovalis* - Пашкевичюс, 1962: 33, Pl.1,2; = *P.* cf. *ovalis* - Рубель, 1963: 149, Pl.1:1-4; = *Isorthis usari* - ibid.: 150, Pl.7:16-23; = *I. orbicularis ovalis* - Рыбникова, 1967: 178, Pl. 16:4-6; = *I. parvulus* - Рыбникова, 1967: 180, Pl.16:7-9, non.Pl.16: 10; = *Levenea canaliculata* - Walmsley & Boucot, 1975: 93, Pl.10:12-18.

27 - *Dayia navicula*: Рыбникова, 1967: 211, Pl. 24:10,11; Bassett & Cocks, 1974: 31; Рубель, 1977: 217, Pl. 1:8; = *D. bohemica* - ibid.: 215, Pl.3:1-3, Pl.4:1-11.

28 - *Protochonetes minimus*: Bassett & Cocks, 1974: 22; = *Chonetes gotlandicus* - Hede, 1917: 16, Pl.1:14.

(29) - *Strophochonetes cingulatus*: Muir-Wood, 1962: 40, Pl.2: 10;11; Bassett & Cocks, 1974: 21; Bergman, 1980: Fig. 2: F.

30 - *Protochonetes stonishkensis*: = *Strophochonetes stonishkensis* - Рыбникова, 1967: 198, Pl.22:1-3.

31 - "*Brachyprion*" *kurzemensis*: Рыбникова, 1966: 82, Pl. 1: 11-14; 1967: 194, Pl.22:9-12.

32 - *Microsphaeridiorhynchus nucula*: Bassett & Cocks, 1974: 27; = "*Camarotoechia*" *nucula* - Рыбникова, 1967: 199, Pl.22:8,9; = "*C*" *sp.* - Рыбникова, 1967:199.

34 - *Protochonetes piltenensis*: Рыбникова, 1967: 196, Pl.22:4; = *P.* aff. *ludloviensis* - ibid.: 195, Pl.22:5-7.

35 - *Homoeospira baylei*: Рубель, 1970: 43, Pl.24:12,14, Pl. 34: 1-20; Bassett & Cocks, 1974: 33; = *Rhynchospirina baylei* - Рыбникова, 1967: 217, Pl.25:13-15; = *Homoeospira* cf. *bouchardi* - Рубель, 1970: 45, Pl.23:7-10, Pl.34:21, Pl.24:13, 15-19.

36 - *Atrypoidea prunum*: Copper, 1977: 21, Pl. 3:5-9, Pl.5:6-10; = *Lissatrypa* sp. - Алихова и др., 1954: 42, Pl.26:1-2; = *L. prunum* - Рыбникова, 1967: 208, Pl.24:2, 3; = *Atrypella prunum* - Рубель, 1970: 40, Pl.22:1-15, Pl.23:1-6; = *Atrypoidea saaremaaensis* - Copper, 1977: 23, Pl.5:1-5.

37 - *Delthyris magna*: Рубель, 1970: 63, Pl.38:12-14; = *D. pyramidalis* - Рыбникова, 1967: 213, Pl.25:6-10.

38 - *Shaleria* "*dzwinogrodensis*": = *Brachyprion dzwinogrodensis* - Рыбникова, 1966; 83, Pl.2:4-8; 1967: 194, Pl.20: 4-8.

(39) - *Parastrophinella* sp.

40 - *Morinorhynchus orbignyi*: = *Schellwienella* sp. - Рыбникова, 1966: 88, Pl.1:7,8; 1967: 195, Pl.21:6,7; = *Morinorhynchus crispus* - Bassett & Cocks, 1974: 20, Pl. 4: 1-8; *M. adnatus* - Bassett & Cocks, 1974: 21, Pl.4:9-12.

(41) - *Craniidae*

(42) - *Shagamella minor*: = *S. ludloviensis* - Boucot & Harper, 1968: 168, Pl.29:4-12; = *S.* cf. *ludloviensis* - Bassett 1977: 164, Pl.43:26-29.

(43) - *Eomartiniops ludloviensis*: Рыбникова, 1967: 215, Pl.25:11,12.

44 - *Leptaena* sp. sp.: = *L. depressa* - Bassett & Cocks, 1974: 14; = *Rugoleptaena venzavensis* - Рыбникова, 1966: 76, Pl.1:1-3; = *Leptaena altera* - Рыбникова, 1966: 78, Pl.1:4-6; = *Leptagonia venzavensis* - Рыбникова, 1967: 192, Pl.18:1-3; *L. altera* - ibid.: 193, Pl.18:4-6; = *Leptaena rhomboidalis* - Bassett & Cocks, 1974: 14, Pl.2:7-8.

45 - *Eospirifer radiatus*: Алихова и др., 1954: 38, Pl.23:1; Рыбникова, 1967: 213, Pl.25:4,5; Рубель, 1970: 59, Pl.35:12-18; Bassett & Cocks, 1974: 35.

46 - *Lingulidae*

48 - *Howelella* sp. sp.: = *H. elegans* - Рубель, 1970: 64, Pl.39:18-24, Pl.40:12; Bassett & Cocks, 1974: 38, Pl.10:5; = *H. nucula* - Рубель, 1970: 65, Pl.39:13-17; = *H. cuneata* - ibid.: 66, Pl.39:1-12; = *H. angulata* - ibid.: 68, Pl.40: 1-5; = *H.* cf. *subinsignis* - Bassett & Cocks, 1974: 38.

(49) - *Sphaerirhynchia wilsoni*: Schmidt, 1954: Abb.6.

(50) - *Stegerhynchus diodontus*: Рубель, Розман, 1977: 227, Pl. 7: 7-10, Pl.8,9, Pl.10:1; = *Ferganella diodonta* - Bassett & Cocks, 1974: 26, Pl.8:2.

51 - Pentameridae gen. et sp. indet.

52 - *Orbiculoidea* sp.

(54) - *Whitfieldella* sp.: Bassett & Cocks, 1974: 34; = *W. upsilon* - Rubel, 1970: 50, Pl.30:18-27, Pl.31, Pl.32:18,19.

55 - *Craniops* sp. sp.

(56) - *Coelospira pusilla*: Bassett & Cocks, 1974: 32, Pl.9:4; = *C. baltica* - Рыбникова, 1967: 209, Pl.24:8-9.

58 - *Didymothyris didyma*: Рубель, Модзалевская, 1967: 239, Pl.1:1-13, Pl.3:1-20; Рубель, 1970: 52, Pl.27, Pl.28: 11-15, Pl.30:1-17; = *D. biohermica* - Рубель,

Модзалевская, 1967: 242, Pl.2:11-20; Рубель, 1970: 54, Pl.28: 1-10; = *D. katriensis* - Рубель, Модзалевская, 1967: 243, Pl.1:14-17, Pl.2: 1-10; Рубель, 1970: 54, Pl.29: 1-17.

(61) - *Stegerhynchus pseudobidentatus*: Рубель, Розман, 1977: 230, Pl.10:2-7; = *Camarotoechia* (?) *pseudobidentatus* - Рыбникова, 1967: 200, Pl.23:1.

(62) - *Protochonetes striatellus*: Muir-Wood, 1962: 50, Pl.3: 6,7, Pl.8:1,2; Böger, 1968: Figs 1-6, 9-11; Bassett & Cocks, 1974: 22.

63 - *Salopina conservatrix*: Walmsley et al., 1969: 505, Pl. 77:15-22, Pl.78:1-11; Bassett & Cocks, 1974: 9.

(64) - *Boucotinskia sulcata*: Brunton & Cocks, 1967: 180; Bassett & Cocks, 1974: 38, Pl.11:2; = *Hedeina crispa* - Boucot, 1957: 324, Pl.2:9,10.

66 - *Septatrypa subaequalis*: Bassett, 1979: 202, Figs 63-64; = *S. secreta* - Рыбникова, 1967: 205, Pl.23:7,8.

(68) - *Resserella sawddensis*: = *R.* cf. *sabrinae* - Bassett, 1972: Pl.11:11, 13, 14; = *R. sabrinae sawddensis* - Hurst, 1975: 323, Pl.2:12-16.

(69) - *Protozeuga bicarinata*: Bassett & Cocks, 1974: 32, Pl.9:3; Рубель, 1977: 213, Pl.2:1-6; = *P. carinata* - ibid. :214, Pl.2:7-9.

(71) - *Pholidostrophia* (*Mesopholidostrophia*) *laevigata*: Bassett, 1977: 155, Pl.42-12.

(76) - *Nucleospira pisum*: Bassett & Cocks, 1974: 35.

(80) - *Eoplectodonta* sp. sp.: = *Sowerbyella transversalis* var. *lata* - Алихова и др., 1954: 36, Pl.22:6,7; = *Eoplectodonta transversalis* - Bassett & Cocks, 1974: 13; = *E. duvalii* - ibid.: 13.

(87) - *Coolinia* sp.

(88) - *Conchidium biloculare*: Bassett & Cocks, 1974: 24.

(89) - *Brachyprion* (*Protomegastrophia*) *semiglobosa*: = *B.* (*P.*) cf. *semiglobosa* - Harper & Boucot, 1978: Pl.38:3-8; = *B.* (*P.*) sp. - ibid.: Pl.37:1-11, Pl.38:9.

(94) - *Leptostrophia filosa*: Bassett & Cocks, 1974: 15.

(95) - *Plagiorhyncha depressa*: = *Septatrypa* (?) *subanaloga* - Рыбникова, 1967: 206, Pl. 23:9; = *Plagiorhyncha cordata* - Bassett & Cocks, 1974: 28; Bergman, 1980: Fig. 2:A.

(97) - *Leangella* sp. sp.: = *L. scissa* - Рыбникова, 1967: 186, Pl. 18:7-10; = *L. segmentum* - Bassett & Cocks, 1974: 13.

(99) - *Cyrtia laevis*: Рубель, 1970: 58, Pl.37:1-10.

(100) - *Ptychopleurella* sp.

(101) - *Rhynchotreta cuneata*: Bassett & Cocks, 1974: 25; Рубель, Розман, 1977: 214, Pl. 1:1-3; = *R. gracilis* - ibid.: 216, Pl.2:1-4, Pl.3:1-6.

(102) - *Estonirhynchia estonica*: = *Sphaerirhynchia* (*Estonirhynchia*) *estonica* - Schmidt, 1954: 236, Fig. 1-5,7,9-12.

(104) - *Stegerhynchus borealis*: Рубель, Розман, 1977: 222, Pl.6:4,5; = *Ferganella borealis* - Bassett & Cocks, 1974: 26; = *Stegerhynchus estonicus* - Рубель, Розман, 1977: 220, Pl. 4:7-10, Pl.5; Pl.6:1-3, Pl.7:1-6.

(105) - *Antirhynchonella linguifera*: = *A.* cf. *linguifera* - Рубель, 1970: 25, Pl.12:15-18.

(106) - *Janius barrandi*: Bassett & Cocks, 1974: 36, Pl.10:3-4; = *J. schmidti* - Boucot, 1963: 699, Pl.101:1-6; = *Howelella cuniculi* - Рубель, 1970: 67, Pl.40:6-8.

(107) - *Meristina obtusa*: = *Meristella* (?) *podolica* - Алихова и др., 1954: 39, Pl.23:3; = *Meristina tumida* - Рубель, 1970: 47, Pl.26:1-5,11, non Pl.26:6-10: Bassett & Cocks, 1974: 34, Pl.9:10.

(108) - *Ancillotoechia bidentata*: Bassett & Cocks, 1974: 27; Рубель, Розман, 1977: 234, Pl.11:4-8.

(109) - *Collarothyris canaliculata*: Рубель, Модзалевская, 1967: 245, Pl.4:1-18; = *Didy-*

mothyris ? collaris - Рубель, 1970: 55, Pl.29:18-22, Pl.33:14-17.
(110) - *Quadrithyris sinuata*: Рубель, 1970: 69, Pl.23:11-14.

Temporal aspect

The correlative value of fossils is determined by their rate of evolution and environmental limitations of distribution. In order to estimate the correlative value of species or any taxa it is necessary to know their total range and occurrence in the sections studied (McCammon, 1970).

There are two main approaches to estimate the total range of taxa: (1) relative to existing stratigraphical scales, and (2) with respect to their mutual vertical position (Blank, 1979). The latter method is used here because such a succession of biostratigraphical events can be plotted before any kind of correlations are made, and therefore the succession can be used for the correlation of sections.

In theory, species intervals that are successive (i.e. not overlapping) in the same order in all sections studied, and successions of which can be arranged mutually without contradictions, form the standard (Rubel, 1978) or the most likely sequence (cf. Hay, 1972). The standard for the Upper Silurian brachiopods, based on the 16 Baltic sections, appears as follows:

					$\underline{E}$	27	36	9	13	$\underline{E}$	20	32	40	35	34	26	$\underline{31}$	$\underline{37}$	$\underline{38}$
				$\underline{D}$	45	27	36	9	13	19	20	32	40	35	34	$\underline{26}$		E	
			$\underline{C}$	12	45	27	36	9	13	19	20	32	40	35	$\underline{34}$	D			
		$\underline{B}$	15	12	45	27	36	9	13	19	20	32	40	$\underline{35}$	C				
	$\underline{A}$	14	15	12	45	27	36	9	13	$\underline{19}$	$\underline{20}$	$\underline{32}$	$\underline{40}$	B					
	66	14	15	12	45	27	36	9	13			A							
N_i:	6	8	9	12	8	11	12	14	12	9	12	14	10	13	13	14	6	13	11

Each row of the standard represents a unique association of the species, that is a time interval of their potential or actual coexistence. The relative total range of each species is determined by the number of rows in which each is written. Thus, the species 27, 36, 9, 13 occupy the whole time interval considered. At the same time the first and last occurrences of other species according to the standard form contacts between their immediately succeeding total ranges. Such datum planes are denoted here by the letters A to E. The notation N_i denotes the number of sections in which a given species was found. The species included in the standard have the best correlative value for the correlation of the Upper Silurian sections studied in that they allow correlations to be unambiguous. They may be taken as a pure time scale for the same sections in the sense of Leibniz (Rubel, in press).

Taxa 1, 44, 46, 48, 51, 52, 55 are not included in the standard because they are as yet not studied in detail and because of this their ranges are equal to the considered time interval, or even longer. The species occurring in five or less sections were not taken into consideration because of their poorly known distribution with respect to the studied sections.

The remaining species constitute the so-called contradictory species and their relationships to the species in the standard include some information relating to the environmental factors (see below).

Correlation

The use of the standard for stratigraphical correlation lies in the plotting of the datum planes A to E in every section studied according to the first and last occurrences of the standard species (text-Fig. 1 and Table 2).

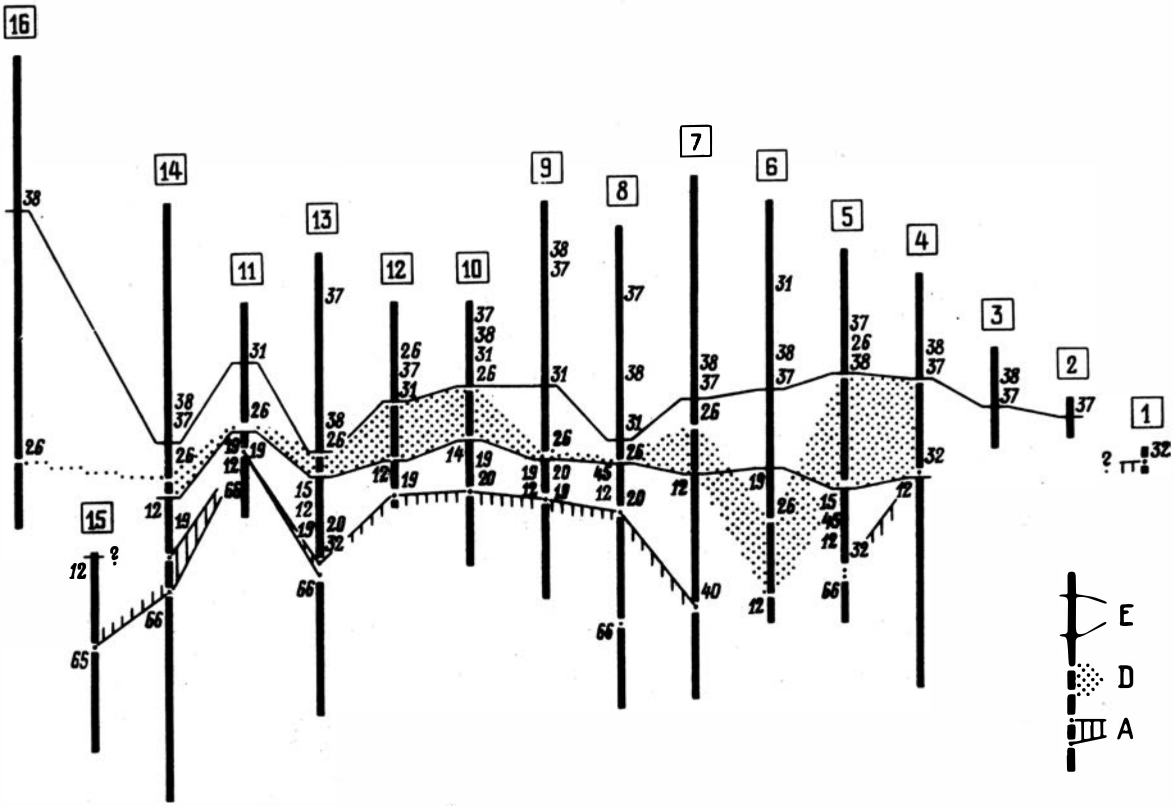

Fig. 1. Correlation of sections (1) to (16) by the datum planes A, D and E. The code numbers of species on the right side of the columns denote their appearance, and those on the left sides indicate their disappearance.

From these datum planes only three that can be traced most easily are drawn in text-Fig. 2. The intervals for the datum planes B and C, both dated by only two species (respectively, 35/14 and 34/15) and often overlapped by the intervals of the preceeding or succeeding datum planes, have little independent correlative value.

Of the three traceable datum planes A, D and E, D has the most restricted interval in the sections. Because of this only plane D was chosen for further analysis. It is dated by occurrences of two species: 12 = *Isorthis crassa* and 26 = *I. canaliculata*, both occurring also in sections on the Island of Gotland (see: Hurst and Watkins, 1978: Fig. 5). These successive species were considered by Hurst and Watkins (1978) as biological species with a complicated intraspecific structure. The use of the concept of biological species for the classification of fossil brachiopods often leads to many complications. However, it is accepted here and used for groups of brachiopods that can be differentiated clearly on the basis of morphology. Such an approach has at least one obvious advantage: it leads to an increase in the number of common species in sections and, therefore, to an increase of unconditional prerequisites for any kind of stratigraphical correlation.

Table 2. Species used for extraction of the datum planes A to E in the sections (1) to (16), and the traceability of the datum planes (lower part of table)

	A	B	C	D	E
(1)	32/-	-	-	-	-
(2)	-	-	-	-	37/-
(3)	-	-	-	-	37/-
(4)	32/-	-/14	-	-/12	37/-
(5)	32/66	-/14	34/15	-/12	38/45
(6)	-	-	-/15	26/12	37/19
(7)	40/-	-/14	34/15	26/12	37/-
(8)	20/66	-	34/-	26/12	31/45
(9)	19/-	-/14	-/15	26/12	31/19
(10)	20/-	30/14	-	26/-	38,31/-
(11)	19/66	-	-	26/12	31/-
(12)	19/-	-	-	-/12	31/-
(13)	32/66	35/14	-/15	26/12	38/-
(14)	19/66	-	-/15	26/12	37/-
(15)	-/66	-	-	-/12	-
(16)	-	30/-	-	26/-	38/-
x/-:	6	2	1	2	10
-/x:	1	4	4	4	0
x/x:	5	2	2	7	4
Σ:	12	3	7	13	14

On the other hand, the larger the species grouping the longer its total range. But if any one species has a preceeding and/or succeeding species and if their respective appearances (and disappearances) do not coincide in time (cf. Shaw, 1964; Hay, 1972) then the possibilities of plotting the succession by means of them does not depend on their duration.

The requirement of having a preceeding and succeeding species restricted the use of the standard here, so that only its medial part works sufficiently well. Further refinement of the standard for Baltic Silurian brachiopods can be extended only into older beds, but there are no obstacles for its extension in both directions by means of corresponding data from other regions.

Environmental aspect

The position of species in the standard expresses their purely temporal relationships according to their known total ranges in the area studied. But it is usually impossible to discover such a position unambiguously for all species because all relationships needed are not yet examined in the sections, or sometimes the actual distribution of species makes it impossible (see Rubel, 1978). The latter case is related to the environmental limitations of species distribution and is illustrated below.

Such a distribution is assumed for two contradictory species: 58 = *Didymothyris didyma* and 27 = *Dayia navicula*. According to the known relationships, species 58 must preceed species 27 and coexist at least with species 19, 20, 32, 40 and 35. It is impossible to carry out these requirements in the standard. There are two ways to eliminate the contradictions: to exclude species 27 from the standard or to exclude the use of species 58. As species 27 occurs in many more sections than 58,then the latter was excluded from further study. Similar exclusions were made with species 10, 11, 18, 4, 5, 23, 28, 30 and 63 too.

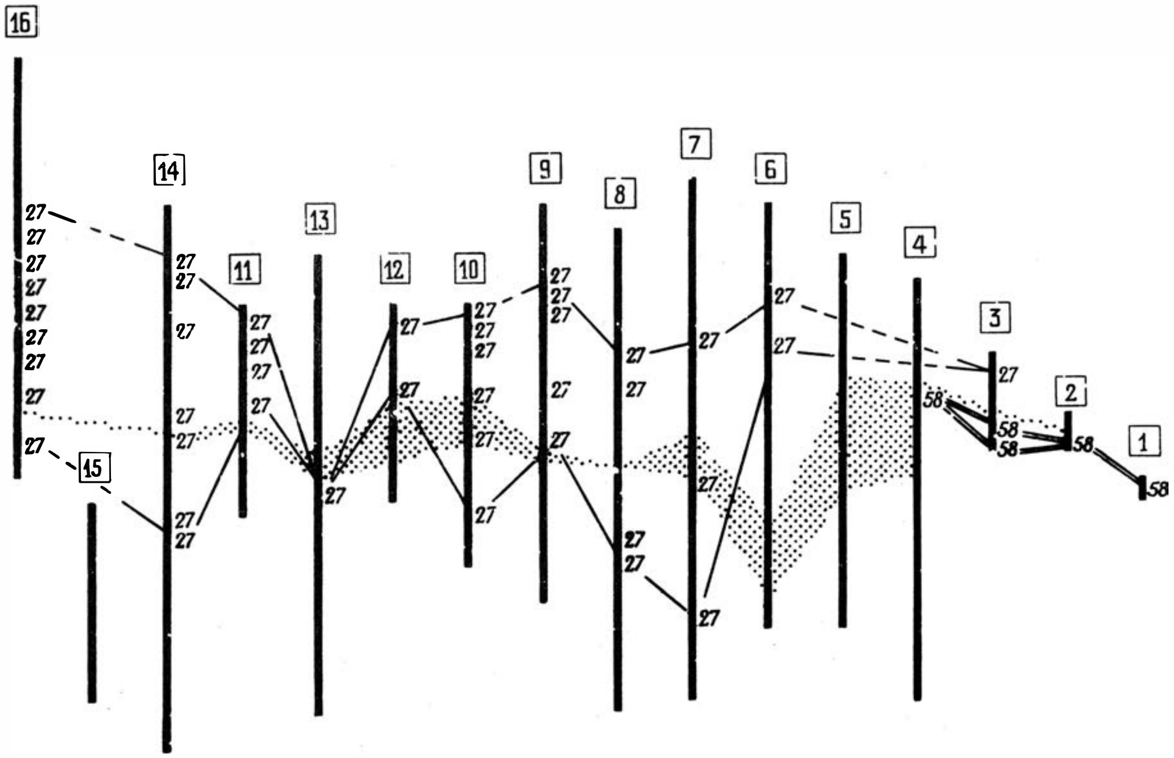

Fig. 2. Occurrence of the species 27 and 58.

Text-Fig. 2 explains the possible reason for the contradiction between species 58 and 27: due to their quite different ecological positions that probably reflect only short transgressive conditions in sections (6) and (3), neither temporal nor environmental coexistence of these species can be deduced in any sections (cf. Rubel, 1978, Text-Fig. 2).

Therefore, the contradictions that arose during the composing of the standard may already indicate relationships that can be interpreted in terms of environmental factors (ecology, biogeography, migrational rates, etc.). But, as there are many reasons for the contradictions then it is not easy to say for every case which of them is operating.

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ПОСЛЕДОВАТЕЛЬНОСТЬ БРАХИОПОД КАК ИНСТРУМЕНТ КОРРЕЛЯЦИИ СИЛУРА ПРИБАЛТИКИ

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В целях оценки значения брахиопод при корреляции удаленных и разнофациальных разрезов было изучено распределение 77 видов верхнесилурийских брахиопод в разрезах 14 скважин Прибалтики. Их корреляционная значимость выводилась, с одной стороны, оценкой относительной длительности полных интервалов существования установленных таксонов и, с другой, встречаемостью таксонов по изученным разрезам. Если в первом случае мы получим чисто временные соотношения между таксонами, то во втором определенную роль играло наличие подходящей среды для тех или других брахиопод.

Полные интервалы существования оценивались на основе взаимоположений таксонов в частных разрезах. Оказалось, что из всех рассмотренных только полные интервалы 19 широкораспространенных видов могут быть упорядочены так, чтобы их последовательность не дала при корреляции изученных разрезов противоречивых результатов.

На основе таких корреляций можно показать, что многие, в том числе и широкораспространенные брахиоподы, имеют в удаленных разрезах сдвинутые во времени неполные интервалы существования. В то же время именно по неприменённым при корреляции видам легче всего установить характерные для тех или других фаций сообщества брахиопод.