

SUPPLEMENTARY MATERIAL SM 1 TO:

Woźniak, P., Halamski, A. T. & Racki, G., 2022. Cyclic ecological replacement of brachiopod assemblages in the top-Eifelian Dobruchna Brachiopod Shale Member (Skały Formation) of the Holy Cross Mountains (Poland). *Annales Societatis Geologorum Poloniae*, 92: 445–464. <https://doi.org/10.14241/asgp.2022.13>

TAXONOMIC COMPOSITION OF BRACHIOPOD FAUNAS AND TAPHONOMIC AND DIVERSITY INDICES FOR PARTICULAR SAMPLES

Indices calculated for each sample:

$$= \sum_{\text{number of articulated shells for particular taxa}} + \sum_{\text{number of co-occurring ventral and dorsal valves for particular taxa}} + \sum_{\text{number of articulated shells and equivalent valve pairs (<5 mm) for particular taxa}}$$

$$\text{Disarticulation Index DI (\%)} = \frac{\text{Maximal number of potentially disarticulated individuals in the sample} (\sum_{\text{maximal number of one valve type for particular taxa}}) \times 100}{\text{Maximal number of individuals in the sample, excluding specimens <5 mm} (\sum_{\text{number of shells for particular taxa}} + \sum_{\text{maximal number of one valve type for particular taxa}})}$$

$$\text{Mortality Index MI (\%)} = \frac{\sum_{\text{number of assumed juvenile individuals for particular taxa}} \times 100}{\text{NI}}$$

It should be stressed that the quantity of individuals is conservatively calculated as an approximate minimum number by considering only the equivalent valve pairs, i.e., the ventral or dorsal valve excess is overall assumed as allochthonous element, as guided by evidence of hydrodynamic reworking in several layers. Similar approach concerns valves <5mm. As juveniles are granted shells < 5 mm for taxa larger than 15 mm (based on size data in Biernat, 1959, 1964, 1966, and Halamski, 2004b, 2009).

Juvenile specimens identifiable to the genus level only and arbitrarily referred to the co-occurring or strongly dominating (*Atrypa*) species are asterisked*. Indeterminable juveniles excluded from the diversity indices, calculated by the PAST software (Hammer, 2009).

Table 1

Taxonomic composition of brachiopod fauna in the sample XIV/1.

| No. | Taxon | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|-------------------------------------|-------------------------------|---------------|--------------------------|----------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Leptagonia analogaeformis</i> | 1 | | | | 1 | 0.3 |
| 2. | <i>Parastrophonella anaglypha</i> | 8 | | | | 8 | 2.7 |
| 3. | <i>Xystostrophia umbraculum</i> | 3 | | | | 3 | 1.0 |
| 4. | <i>Poloniproductus varians</i> | 22 | | | | 22 | 7.3 |
| 5. | <i>Dagnachonetes supragibbosus</i> | 2 | | | | 2 | 0.7 |
| 6. | <i>Devonaria zeuschneri</i> | 18 | | | | 18 | 6.0 |
| 7. | <i>Cyrtina</i> sp. | 9 | | | 2 | 11 | 3.7 |
| 8. | <i>Eleutherokomma diluvianoides</i> | 132 | 19 | 1 | 3 | 136 | 45.3 |
| 9. | Reticulariidae | | | | 61 | 61 | 20.3 |
| 10. | <i>Phragmophora schnuri</i> | 5 | | | | 5 | 1.7 |
| 11. | <i>Atrypa (Planatrypa) depressa</i> | 33 | | | | 33 | 11.0 |
| In total | | 233 | 19 | 1 | 66 | 300 | 100.0 |
| Calculated data | | 7.5% Disarticulation Index | | 22.0% Mortality Index | | 11 Number of taxa | |

| | | |
|---------------------------|------------|---------------------|
| Diversity indices: | Margalef M | 1.75 |
| Simpson SDI | 0.73 | Dominance D 0.27 |
| Shannon H | 1.67 | Equitability J 0.70 |

Table 2

Taxonomic composition of brachiopod fauna in the sample XIV/2.

| No. | Species | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | 'All 'individuals' | |
|-----------------|-------------------------------------|-----------------------------|---------------|--------|----------------------------|---------------------|---------|
| | | | ventral | dorsal | | number | ventral |
| 1. | <i>Parastrophonella anaglypha</i> | 6 | | | | 6 | 5.9 |
| 2. | <i>Poloniproductus varians</i> | 49 | | | | 49 | 48.5 |
| 3. | <i>Devonaria zeuschneri</i> | 6 | | | | 6 | 5.9 |
| 4. | <i>Eleutherokomma diluvianoides</i> | 24 | 1 | | 2 | 26 | 25.7 |
| 5. | <i>Crurispina "inflata"</i> | 2 | | | | 2 | 2.0 |
| 6. | <i>Atrypa (Planatrypa) depressa</i> | 12 | | | | 12 | 11.9 |
| In total | | 99 | 1 | 0 | 2 | 101 | 100.0 |
| Calculated data | | 1% Disarticulation Index | | | 2.0% Mortality Index | 6 Number of taxa | |

Diversity indices: Shannon_H 1.37 Dominance D 0.32
 Simpson SDI 0.68 Margalef M 1.08 Equitability J 0.76

Table 3

Taxonomic composition of brachiopod fauna in the sample XIV/3.

| No. | Species | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|---------------------------------------|-------------------------------|---------------|--------|----------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Parastrophonella anaglypha</i> | 9 | | | | 9 | 3.0 |
| 2. | <i>Xystostrophia umbraculum</i> | 3 | | 1 | | 3 | 1.0 |
| 3. | <i>Poloniproductus varians</i> | 227 | | 2 | | 227 | 74.7 |
| 4. | <i>Dagnachonetes supragibbosus</i> | 5 | | | | 5 | 1.6 |
| 5. | <i>Devonaria zeuschneri</i> | 11 | | | 2 | 12 | 3.9 |
| 6. | <i>Gibbodouwillina interstitialis</i> | 4 | | | | 4 | 1.3 |
| 7. | <i>Cyrtina</i> sp. | 3 | | | | 3 | 1.0 |
| 8. | <i>Eleutherokomma diluvianoides</i> | 28 | 5 | | | 28 | 9.2 |
| 9. | <i>Crurispina "inflata"</i> | 1 | | | | 1 | 0.3 |
| 10. | <i>Phragmophora schnuri</i> | 4 | | | 1 | 1 | 0.3 |
| 11. | <i>Atrypa (Planatrypa) depressa</i> | 4 | 3 | 9 | | 7 | 2.3 |
| 12. | <i>Desquamatia subzonata</i> | 3 | 1 | 1 | | 4 | 1.3 |
| In total | | 298 | 8 | 13 | 3 | 304 | 100.0 |
| Calculated data | | 5.7% Disarticulation Index | | | 1.0% Mortality Index | 12 Number of taxa | |

Diversity indices: Shannon_H 1.01 Dominance_D 0.57
 Simpson SDI 0.43 Margalef M 1.92 Equitability_J 0.43

Table 4

Taxonomic composition of brachiopod fauna in the sample XIV/4.

| No. | Species | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|--|-------------------------------|---------------|--------|----------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Parastrophonella anaglypha</i> | 40 | | | | 40 | 7.5 |
| 2. | <i>Xystostrophia umbraculum</i> | 4 | 1 | 1 | | 5 | 0.9 |
| 3. | <i>Poloniproductus varians</i> | 374 | | 28 | | 374 | 70.2 |
| 4. | <i>Dagnachonetes supragibbosus</i> | 9 | | | | 9 | 1.7 |
| 5. | <i>Devonaria zeuschneri</i> | 41 | | | 1 | 42 | 7.9 |
| 6. | <i>Gibboudouvillina interstitialis</i> | 1 | | | | 1 | 0.2 |
| 7. | <i>Cyrtina</i> sp. | 8 | | | | 8 | 1.5 |
| 8. | <i>Eleutherokomma diluvianoides</i> | 22 | 4 | | 2 | 24 | 4.5 |
| 9. | <i>Crurispina "inflata"</i> | 5 | | | | 5 | 0.9 |
| 10. | <i>Aulacella prisca</i> | 1 | | | | 1 | 0.2 |
| 11. | <i>Phragmophora schnuri</i> | 2 | | | | 2 | 0.4 |
| 12. | <i>Kyrtatrypa</i> sp. A | | 1 | | ?1* | 1 | 0.2 |
| 13. | <i>Desquamatia subzonata</i> | 16 | 2 | 1 | ?4* | 21 | 3.9 |
| In total | | 523 | 8 | 30 | 8 | 533 | 100.0 |
| Calculated data | | 6.4% Disarticulation Index | | | 1.5% Mortality Index | 13 Number of taxa | |

Diversity indices:

| | |
|----------------|------|
| Simpson SDI | 0.49 |
| Shannon H | 1.12 |
| Margalef M | 1.91 |
| Dominance D | 0.51 |
| Equitability J | 0.46 |

Table 6

Taxonomic composition of brachiopod fauna in the sample XIV/6.

| No. | Taxon | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | 'Individuals' >5 mm | |
|-----------------|---|--------------------------------|---------------|--------------------------|-------------------------|----------------------|---------|
| | | | ventral | dorsal | | number | ventral |
| 1. | <i>Parastrophonella anaglypha</i> | 2 | | | | 2 | 1.0 |
| 2. | <i>Xystostrophia umbraculum</i> | 2 | | | | 2 | 1.0 |
| 3. | <i>Poloniproductus varians</i> | 43 | | 4 | | 43 | 21.9 |
| 4. | <i>Devonaria zeuschneri</i> | 14 | | | 6 | 20 | 10.2 |
| 5. | <i>Primipilaria</i> spp. | 1 | 2 | | | 1 | 0.5 |
| 6. | <i>Peratos minor</i> | 2 | | | | 2 | 1.0 |
| 7. | <i>Cyrtina</i> sp. | 3 | | | | 3 | 1.5 |
| 8. | <i>Nucleospira lens</i> | 3 | | | 2 | 5 | 2.6 |
| 9. | <i>Bifida lepida</i> | 2 | | | 13 | 15 | 7.7 |
| 10. | <i>Eleutherokomma diluvianoides</i> | 1 | | | 2* | 3 | 1.5 |
| 11. | <i>Crurispina "inflata"</i> | 4 | | | | 4 | 2.1 |
| 12. | Reticulariidae | 2 | 1 | | 2 | 4 | 2.1 |
| 13. | <i>Athyris concentrica</i> s.l. | 1 | | 1 | | 1 | 0.5 |
| 14. | <i>Aulacella prisca</i> | 20 | 13 | 43 | | 33 | 16.8 |
| 15. | <i>Costisorthis canalicula</i> | 13 | 4 | | 9 | 22 | 11.2 |
| 16. | <i>Schizophoria schnuri</i> | 2 | 2 | | | 2 | 1.0 |
| 17. | <i>Atrypa (Planatrypa) depressa</i> | 14 | 2 | | ?9* | 23 | 11.7 |
| 18. | <i>Kyrtatrypa</i> sp. A | 1 | | | ?1* | 2 | 1.0 |
| 19. | <i>Desquamatia subzonata</i> | 4 | | | | 4 | 2.1 |
| 20. | <i>Spinatrypa</i> sp. | | | | 4 | 4 | 2.1 |
| | Indet. smooth taxa (? <i>Nucleospira</i>) | | | | | 2 | 1.0 |
| In total | | 134 | 24 | 48 | 33 | 197 | 100.5 |
| Calculated data | | 30.6% Disarticulation Index | | 16.8% Mortality Index | | 20 Number of taxa | |

Diversity indices:

| | |
|----------------|------|
| Simpson SDI | 0.88 |
| Shannon H | 2.39 |
| Margalef M | 3.60 |
| Dominance D | 0.12 |
| Equitability J | 0.80 |
| Evenness E | 0.55 |

Table 7

Taxonomic composition of brachiopod fauna in the sample XIV/7/1.

| No. | Taxon | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|---------------------------------------|--------------------------------|---------------|--------|-----------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Parastraphonella anaglypha</i> | 7 | | | | 7 | 1.9 |
| 2. | <i>Xystostrophia umbraculum</i> | 33 | | 2 | | 33 | 9.0 |
| 3. | <i>Gibbodouwillina interstitialis</i> | 1 | | | | 1 | 0.3 |
| 4. | <i>Poloniproductus varians</i> | 79 | | 1 | | 79 | 21.6 |
| 5. | <i>Devonaria zeuschneri</i> | 29 | 1 | | 14 | 43 | 11.8 |
| 6. | <i>Primipilaria</i> spp. | 3 | 2 | | | 3 | 0.8 |
| 7. | <i>Peratos minor</i> | 2 | | | | 2 | 0.5 |
| 8. | <i>Cyrtina</i> sp. | 1 | | | | 1 | 0.3 |
| 9. | <i>Eleutherokomma diluvianoides</i> | 64 | 31 | 1 | 4 | 69 | 18.9 |
| 10. | Reticulariidae | 11 | | | 52 | 63 | 17.3 |
| 11. | <i>Aulacella prisca</i> | 4 | 1 | 3 | | 5 | 1.4 |
| 12. | <i>Biernatium "fallax"</i> | 1 | | | | 1 | 0.3 |
| 13. | <i>Phragmophora schnuri</i> | 1 | | | | 1 | 0.3 |
| 14. | <i>Schizophoria schnuri</i> | 8 | 1 | 1 | | 9 | 2.5 |
| 15. | <i>Costisorthis canalicula</i> | | 4 | | 1* | 1 | 0.3 |
| 16. | <i>Atrypa (Planatrypa) depressa</i> | 35 | 2 | | | 35 | 9.6 |
| 17. | <i>Spinatrypa</i> sp. | | | | 3 | 3 | 0.8 |
| 18. | <i>Desquamatia subzonata</i> | 3 | | 1 | | 3 | 0.8 |
| 19. | ? <i>Athyris concentrica</i> s.l. | | | | 6* | 6* | 1.6 |
| In total | | 282 | 42 | 9 | 80 | 365 | 100.0 |
| Calculated data | | 14.5% Disarticulation Index | | | 21.9% Mortality Index | 19 Number of taxa | |

Diversity indices:

| | |
|----------------|------|
| Simpson SDI | 0.85 |
| Shannon H | 2.17 |
| Margalef M | 3.05 |
| Dominance D | 0.15 |
| Equitability_J | 0.74 |
| Evenness E | 0.46 |

Table 8

Taxonomic composition of brachiopod fauna in the sample XIV/7/2.

| No. | Taxon | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|---------------------------------------|-------------------------------|---------------|--------|----------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Leptagonia analogaeformis</i> | 1 | | | | 1 | 00.1 |
| 2. | <i>Xystostrophia umbraculum</i> | 14 | | | | 14 | 1.9 |
| 3. | <i>Parastrophonella anaglypha</i> | 86 | | | | 86 | 12.0 |
| 4. | <i>Gibbodouvillina interstitialis</i> | 1 | | | | 1 | 0.1 |
| 5. | <i>Poloniproductus varians</i> | 388 | | 19 | | 388 | 54.0 |
| 6. | <i>Dagnachonetes supragibbosus</i> | 32 | | | | 32 | 4.5 |
| 7. | <i>Devonaria zeuschneri</i> | 60 | | | 10 | 70 | 9.7 |
| 8. | <i>Primipilaria</i> spp. | 4 | | | | 4 | 0.6 |
| 9. | <i>Cyrtina</i> sp. | 1 | | | | 1 | 0.1 |
| 10. | <i>Eleutherokomma diluvianoides</i> | 24 | 5 | | 1 | 25 | 3.5 |
| 11. | Reticulariidae | 6 | 1 | | 4 | 10 | 1.4 |
| 12. | <i>Aulacella prisca</i> | 10 | 4 | 7 | | 14 | 1.9 |
| 13. | <i>Phragmophora schnuri</i> | 4 | | | | 4 | 0.6 |
| 14. | <i>Schizophoria schnuri</i> | 8 | | | | 8 | 1.1 |
| 15. | <i>Costisorthis canalicula</i> | 2 | | 1 | | 2 | 0.3 |
| 16. | <i>Atrypa (Planatrypa) depressa</i> | 37 | | 2 | 2* | 39 | 5.7 |
| 18. | <i>Desquamatia subzonata</i> | 17 | 1 | 4 | | 18 | 2.5 |
| In total | | 695 | 11 | 33 | 17 | 717 | 100.0 |
| Calculated data | | 5.3% Disarticulation Index | | | 2.3% Mortality Index | 17 Number of taxa | |

Diversity indices:

| | |
|----------------|------|
| Simpson SDI | 0.68 |
| Shannon_H | 1.69 |
| Margalef M | 2.43 |
| Dominance_D | 0.32 |
| Equitability_J | 0.60 |
| Evenness E | 0.32 |

Table 9

Taxonomic composition of brachiopod fauna in the sample XIV/9/1.

| No. | Taxon | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|--|-------------------------------|---------------|--------|-----------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Leptagonia analogaeformis</i> | 1 | | | | 1 | 0.2 |
| 2. | <i>Parastrophonella anaglypha</i> | 5 | | | | 5 | 1.2 |
| 3. | <i>Xystostrophia umbraculum</i> | 18 | 1 | | 1 | 19 | 4.6 |
| 4. | <i>Gibboudouvillina interstitialis</i> | 1 | | | | 1 | 0.2 |
| 5. | <i>Poloniproductus varians</i> | 185 | | 1 | | 185 | 44.6 |
| 6. | <i>Dagnachonetes supragibbosus</i> | 1 | | | | 1 | 0.2 |
| 7. | <i>Devonaria zeuschneri</i> | 49 | | | 4 | 53 | 12.8 |
| 8. | <i>Primipilaria</i> spp. | 2 | | | | 2 | 0.5 |
| 9. | <i>Peratos minor</i> | 2 | | | | 2 | 0.5 |
| 10. | <i>Cyrtina</i> sp. | 1 | | | | 1 | 0.2 |
| 11. | <i>Eleutherokomma diluvianoides</i> | 23 | 10 | 1 | 8 | 32 | 7.7 |
| 12. | <i>Crurispina "inflata"</i> | 1 | | | | 1 | 0.2 |
| 13. | Reticulariidae | 7 | 2 | | 39 | 46 | 11.1 |
| 14. | <i>Skenidioides polonicus</i> | 1 | | | | 1 | 0.2 |
| 15. | <i>Aulacella prisca</i> | 8 | 5 | 4 | | 12 | 2.9 |
| 16. | <i>Phragmophora schnuri</i> | 6 | | | | 6 | 1.4 |
| 17. | <i>Schizophoria schnuri</i> | 1 | | | | 1 | 0.2 |
| 18. | <i>Atrypa (Planatrypa) depressa</i> | 33 | 6 | 10 | 4* | 43 | 10.4 |
| 19. | ? <i>Spinatrypa</i> sp. | 1 | | | | 1 | 0.2 |
| 20. | ? <i>Desquamatia subzonata</i> | 2 | | | | 2 | 0.5 |
| In total | | 348 | 24 | 16 | 66 | 415 | 100.0 |
| Calculated data | | 7.7% Disarticulation Index | | | 15.9% Mortality Index | 20 Number of taxa | |

Diversity indices:

| | |
|----------------|------|
| Simpson SDI | 0.75 |
| Shannon H | 1.85 |
| Margalef M | 3.15 |
| Dominance D | 0.25 |
| Equitability J | 0.62 |
| Evenness E | 0.32 |

Table 10

Taxonomic composition of brachiopod fauna in the sample XIV/9/2.

| No. | Taxon | Shells >5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|--|-----------------------------|---------------|--------|-------------------------|----------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Leptagonia analogaeformis</i> | 2 | | | | 2 | 0.7 |
| 2. | <i>Xystostrophia umbraculum</i> | 12 | | | 1 | 13 | 4.8 |
| 3. | <i>Poloniproductus varians</i> | 191 | | 2 | | 191 | 70 |
| 4. | <i>Devonaria zeuschneri</i> | 31 | | | 3 | 34 | 12.5 |
| 5. | <i>Gibboudouvillina interstitialis</i> | 1 | | | | 1 | 0.4 |
| 6. | <i>Eleutherokomma diluvianoides</i> | 5 | 4 | | 1 | 6 | 2.2 |
| 7. | Reticulariidae | 4 | | | | 4 | 15 |
| 8. | <i>Aulacella prisca</i> | 1 | | | | 1 | 0.4 |
| 9. | <i>Phragmophora schnuri</i> | 2 | 1 | | | 2 | 0.7 |
| 10. | <i>Atrypa (Planatrypa) depressa</i> | 12 | 3 | 4 | 4* | 19 | 7.0 |
| In total | | 261 | 8 | 6 | 9 | 273 | 100.0 |
| Calculated data | | 4% Disarticulation Index | | | 4.5% Mortality Index | 10 Number of taxa | |

Diversity indices:

| | | | |
|------------|------|----------------|------|
| Simpson S | 0.49 | Dominance D | 0.51 |
| Shannon H | 1.10 | Equitability J | 0.48 |
| Margalef M | 1.60 | Evenness | 0.30 |

Table 11

Taxonomic composition of brachiopod fauna in the sample XV/3.

| No. | Species | Shells > 5 mm | Valves > 5 mm | | 'Individuals' < 5 mm | All 'individuals' | |
|-----------------|--|-------------------------------|---------------|--------|-------------------------|---------------------|-------|
| | | | ventral | dorsal | | number | % |
| 1. | <i>Parastrophonella anaglypha</i> | 3 | | | | 3 | 2.3 |
| 2. | <i>Xystostrophia umbraculum</i> | 51 | 1 | | 4* | 55 | 38.6 |
| 3. | <i>Poloniproductus varians</i> | 28 | | 5 | | 28 | 21.2 |
| 4. | <i>Devonaria zeuschneri</i> | 5 | | | | 5 | 3.8 |
| 5. | <i>Gibboudouvillina interstitialis</i> | 3 | | | | 3 | 2.3 |
| 6. | <i>Eleutherokomma diluvianoides</i> | 26 | 3 | 1 | 2 | 29 | 20.5 |
| 7. | <i>Atrypa (Planatrypa) depressa</i> | 9 | 1 | | | 9 | 6.8 |
| In total | | 125 | 5 | 6 | 6 | 132 | 100.0 |
| Calculated data | | 7.2% Disarticulation Index | | | 4.5% Mortality Index | 7 Number of taxa | |

Diversity indices:

| | | | |
|-------------|------|----------------|------|
| Simpson SDI | 0.81 | Dominance D | 0.19 |
| Shannon H | 1.84 | Equitability J | 0.84 |
| Margalef M | 1.58 | Evenness E | 0.70 |