

Appendix S2. Morphological data matrix listing all 128 taxa and the 74 characters included in the analysis. Characters doubtful or unknown were coded as '?'. Inapplicable characters were coded as '-'.

MATRIX

```
[
      10      20      30      40      50      60      70  ]
[
      .      .      .      .      .      .      .  ]
```

```
Sigalionidae (outgroup)
Neoleanira tetragona      011000101011-00100010-01110172??11001100110033-10?100000010--10011-100-000
Sthenelais boa           010000101011-00100011-0110-172??10001100110033-101100100110001110001110000
```

Polynoidae

```
Acholoe squamosa      000000101010201000001000011141120000010000?33?111100110000001000000010020
Admetella longipedata 000000111?10011010001-100110010200000100000033010010010001000100000????20
Alentia gelatinosa    000000101010101000001000011?01020000010000002201011001100100010000211101-0
Antarctinoe ferox     1000001010103011010010010111021?0010010000?2201101001000100010000011121-0
Abyssarya acus        00001010100---1100100-000110-10200000100000000100100111000001000000010010
Austropolaria magnicirrata 000000111?0---10?0000-000110-1000000010000?10?10001010001100000000????11
Bathyadmetella commando 000000101?10011010001-100110010-000001?00?3200- ---10001000100000????20
Bathybahamas charlenae 00000011100---1111000-00011132000000010000?00010001010001100000000????20
Bathycanadia diaphana 0000000---0---00?0000-000110-1020000010000?1011001001000010000000-????10
Bathycatalina filamentosa 000000101?0---12?0100-01011132000000010001?11?10010010001100000000????10
Bathyedithia berkeleyi 0001000---0---1200000-000110-1020000010000?10?10000110001100000000????10
Bathyedithia retierei 0001000---0---1000000-000110-002000001000000111100100100011000000000010?10
Bathyedithia tuberculata 0001000---0---12?0000-00011101020000010000?11010010010001100000000????20
Bathyeliasona abyssicola 000000101?0---1200100-010110-1020000010000?00?10010010001110000000????10
Bathyeliasona kirkegaardii 0000001?110---1100100-010110-1020000010000?00?10010010001110000000????10
Bathyeliasona mariaae 000000101?0---1200100-010110-10000000100000000?10010010001110000000????10
Bathyeliasona nigra 000000101?0---1200100-010110-1020000010000?00010010010001110000000????10
Bathyfauvelia affinis 00000010110---1210100-010111310?0000010000?10010010010001100000000????10
Bathyfauvelia glacigena 00000010110---1201000-0101112100000001000000002100100100011000000001110010
Bathyfauvelia grandelytris 0000001?1?0---12???00-010111310?0000010?00?10?100???10001100000000110-010
Bathyfauvelia ignigena 000000101?0---1201000-0101112100000001000000102100100100011000000001110010
Bathykermadeca hadalis 00000010100---1200100-000110-2000000010000?10210001010001100000000????10
Bathykermadeca turnerae 00000010100---1210100-00011102000000010000?10210001010001100000000000-010
Bathykurila guaymasensis 00000010100---12?0100-00011101000000010000?002100010100011000000000012010
Bathykurila zenkevitchi 00000010100---12?0100-00011102000000010000?00110001010001100000000????10
Bathylevensteina bicornis 000000111?0---1-10?00-000110-1020000010000?00?10000010001000100000????10
Bathymacella uschakovi 000000101?0---1200100-0001110102000000-00?00010010010001000100000000-010
Bathymariana zebra 000?000---0---12?0000-00011?20?0000010000?1111?0????????????0000????10
Bathymiranda microcephala 000?000???0---11???00-01011?10?0000010000?1011001001000010000000-????10
Bathymoorea lucasi 000000101?10101010001-110111210000000100000022010010010001000100000????20
Bathymoorea renotubulata 000000111?10001010001-100110010?00001?00?22010010010001000100000????20
Bathypolaria carinata 000000111?0---10?0?00-000110-10?0000010000?00010001010001100000000????11
Bathyvitiazia pallida 000000111?0---1000000-000110-1020000010000?00?10000110001100000000????10
Bathyvitiazia pettibonae 0000001?1?0---11?0?00-000110010?0000010000?00?10010010000100100000????10
Branchinotogluma burkensis 000000101?0---11?0100-00011101000100010010?11210001010001100000000000-010
```

Branchinotogluma hessleri 00000010170---1270100-00011121000100010010??11210001010001100000000000-010
Branchinotogluma marianus ?0000010170---1270100-00011121000000010010??11210010010001100000000000-010
Branchinotogluma sandersi ?0000010170---1170100-00011001000100010010??112100001000110000000000-010
Branchinotogluma segonzaci 00000010170---1070100-000117?1000100010010001121000101000110000000000-010
Branchinotogluma trifurcus 00000010170---1170000-00011101710700010010??11210001010001100000000000-010
Branchinotogluma tunnicliffeae 00000010170---1270100-00011121000100010010??11210001010001100000000000-010
Branchiplicatus cupreus ?0000011170---0000000-00011101000100010010??21?100010100011000000000110110
Branchipolynoe longiensis 0000001070---1170000-000110-1070000010010??11210000011000100100000000-110
Branchipolynoe pettiboneae 00000010000---1170000-000110-1020000010010??11210000?11001000100000000-010
Branchipolynoe seepensis 00000010070---1170000-000110-1000000010010??11210000010000100000000000-110
Branchipolynoe symmytilida ?0000010070---1200100-000110-1070000010010??11210000011000000100000000-110
Bruunilla natalensis ?0000111170---1110000-000110-1070001010700?00?10????1????????0000?????10
Bruunilla nealae 00000111100---1170100-000110-1020001010000000?1000011000110000000000-?10
Bylgides elegans 000000101110301001001001011101100010010000?22011010010001000100000110-0-0
Bylgides sarsi 000000101110301001001001011101100010010000?22011010010001000100000110-0-0
Capitulatinoe cf. cupisetis 0000001010101000000010000110-10-00000?07000033?0----10000001100001000-110
Diplaconotum paucidendum ?000000--0---1000000-000117?1020001010000?21110010010001100000000????10
Eulagisca gigantea 200000101?10001010001001011101010000010000?22010010010001000100000010020
Eunoe nodosa 1000001011103010010010010111?11000100?0?00002201101001100000010000011120-0
Gastrolepidia clavigera 000000101010201100001000011?1?1?0000010000?22?11010011001000100002000-?10
Gattyana ciliata 1000001011103010000011010111???00?0010?00?2201011001000000010000011120-0
Gattyana cirrhosa 1000001011103011010011010111?1?200?0010?000022?1101001100100010000011120-0
Gesielia jameensis ?0000010170---1200100-000110-1000000010001?10?10010010001100000000????10
Halosydna brevisetosa 1000001010100010100010010110-1?700?0010000?22?11?1001100?00010000011120-0
Halosydnella australis 0000001011103001000010010111?200?001000?0023?1111001100000010000111100-0
Harmothoe glabra 1000001011103010010010010111?1100010010000?22?1101001100100010000211100-0
Harmothoe imbricata 1000001011103010010010010111?1100010010000?22?1101001100000010000211120-0
Harmothoe impar 1000001011103010010010010111?1100010010000?22?1101001100000010000211120-0
Harmothoe ocularum 1000001011103010010010010111?1100010010000?22?1101001100000010000211100-0
Harmothoe varispina 100000101110301001001000011?21000100?00000022?1101001100100010000011121-0
Hermedia verruculosa 0000001010103010000010010110-0020000010000111101011001000100010000011121-0
Hodor anduril 0001000---0---1200000-000110-10200000100000010210010010001100000000????10
Hodor hodor 0001000---0---1200000-000110-10200000100000010210010010001100000000????10
Hyperhalosydna striata 0000001?101000?100001000011?7?00-0000010000?2211?01001?0000001000011110?-0
Lepidasthenia elegans 000000101010001100001000011?700-0000010000?33?0----11000000100002000-120
Lepidonotopodium atalantae 00000010100---1200100-00011101000100010000?112100010100011000000000111010
Lepidonotopodium fimbriatum 00000010170---1200100-00011101310100010000?212100010100011000000000011010
Lepidonotopodium jouinae 00000010100---1200100-00011101000100010000?11210001010001100000000010-010
Lepidonotopodium minutum ?0000010170---1200100-000111?1000100010000?11?10001010001100000000010-010
Lepidonotopodium okinawae 00000010170---1270100-00011101700100010000?11?10001010001100000000010-010
Lepidonotopodium piscesae 00000010170---120010?0-00011101300100010000?112100010100011000000000110010
Lepidonotopodium riftense ?0000010170---1270100-00011101300100010000?112100010100011000000000111010
Lepidonotopodium williamsae 00000010170---127010?0-00011101300100010000?11210000010001100000000010010
Lepidonotus clava 1000001010100011000010010111?11?000001000000111110100110000001000001121-0
Lepidonotus squamatus 0000001010100011000010010111?11?00?001000000111111001100000010000011120-0
Lepidonotus sublevis 10000010101030?100001001011??1?00?00?0000?111111001100000010000011101-0
Levensteiniella intermedia ?0000010170---1270100-00011101300000010000??1210001010001100000000110-?10
Levensteiniella iris 00000010100---1211100-00011101000000010000?112100010100010000000000011010

Levensteiniella kincaidi 00000010100---1210100-00011101000000010000??11210010010001100000000110-010
Levensteiniella plicata 00000010100---12?1100-00011??1100000010000??21210010010001100000000000-110
Levensteiniella raisae ?00000101?0---1210100-00011101000000010000??212100010100011000000001112010
Macellicephala aciculata ?000001????0---1?0010?-00011001000000010?001000110001010001100000000?????10
Macellicephala atlantica ?000001?1?0---1000?00-000110-1000000010000000?10001010001100000000?????10
Macellicephala australis ?00000111?0---11?0100-000110-1000000010?00?700110010010000100000000?????10
Macellicephala clarionensis 000000111?0---1010100-000111110000000100000000110010010001100000001?????10
Macellicephala galapagensis 000000111?0---1110000-00011101010000010000?700?10010010001100000000000-110
Macellicephala laubieri 000000111?0---1000000-000110-10100000100000000110010010001100000000?????10
Macellicephala longipalpa 00000011100---1000000-000110-10100000100001100110010010001100000000?????10
Macellicephala mirabilis 00000011100---1110100-000110-100000001000010001100000010001100000000?????10
Macellicephala parvafauces 000000111?0---1010100-000111110100000100000000110010010001100000001100-?10
Macellicephala remigata 000000111?0---1110100-00011101000000010?000000110010010001100000000?????10
Macellicephala violacea 00000011100---1110100-00011111000000010?000000110010010001000100000000-010
Macellicephaloides alvini ?00000111?0---11?0?00-000110-12-00000101000000?0-----10001100000000?????10
Macellicephaloides grandicirra ?00100111?0---11?0100-000110-32-0000010100?700?0-----10001100000000?????10
Macellicephaloides moustachu 00001010100---1010100-000110-00-0000010100000000-----10001100000000?????10
Macellicephaloides uschakovi ?00110111?0---11?0000-000110-32-0000010100?710?0-----10001100000000?????0
Macellicephaloides verrucosa ?00110111?0---11?0000-000110032-0000010100?700?0-----10001100000000?????10
Macellicephaloides vitiazi ?00110111?0---11?0000-000110-32-0000010100?700?0-----10001100000000?????10
Malleoides antarctica 000000111?0---1100000-000110-00-0000011000?72210-----10001000100000000-?10
Malmgreniella mcintoshii 0000001011102010000010010111011?000001000000220100100110000001000021110?-0
Melaenis loveni 000000101010?01000001001011?1?7?00?00?0?00?72201?01001?001000100002000-1-0
Natopolynoe kensmithi 00000010100---11?0000-000110-10?0000010000?700?1000101000010000000000-?10
Neopolynoe paradoxa 000000101110301001001001011?71000000010?00?7320110100110000001000001010?-0
Nu aakhu 00000000---0---1000000-000110-00-000001?7000000?0-----10000100000000?????10
Paradyte crinoidicola 000000101010301000001000011001200000010000?722111001011100001100002010-?-0
Paralepidonotus ampulliferus 100000101110201010001000011101100000010000?72201101001101000010000211120-0
Peinaleopolynoe santacatalina ?00000101?0---12?0100-00011??2300000010010??11210001010001100000000?????10
Peinaleopolynoe sillardi ?00000101?0---12?0100-00011??2100000010010??10210000010001100000000000-?10
Pelagomacellicephala iliffei 00000011100---1010000-000110010?0000010000?710?1000101000110000000000-010
Polaruschakov lamellae 00000000---0---1000000-000111210200000100000011?10010010001100000000?????10
Polaruschakov limaee 00000000---0---1200000-000110-0020000010?000000110010010001100000000?????10
Polaruschakov omnesae 00000000---0---1200000-000110-10200000100000010?10010010001100000000?????10
Polaruschakov polaris 00000000---0---1000000-00011111020000010000?71011001001000010000000-?????10
Polaruschakov reysii 00000000---0---1000000-000110-1320000010000?710?10110010001100000000?????10
Polyeunoa laevis 000000101010301001001000011001110000010000?732?10010010001000100000000-?-0
Polynoe scolopendrina 1000001011103011010011010111?70?0000010000003201111001100000010000211101-0
Thermopolynoe branchiata 00000010100---11?0100-0001111100010001001000212100010100011001000010010010
Thormora jukesii 100000101010001100001001011??1?7?0000010000??111100100100000010000011121-0
Uncopolynoe corallicola ?00000101?100010000010000110-??-000000--00??21?0-----10100000100002000-??0
Vampiropolynoe embleyi ?00000101?0---1200100-00011121000000012-00??2101000001000110000000000-?-0
Yodanoe desbruyeresii 000000101?0---1200000-0001113101000001?7000000?10010010001000100000?????10