

Appendix S1. Detailed description of the 74 morphological characters and states analysed in the present study.

1 Palp surface [1]: smooth [= 0]; papillose [= 1]; ciliated [= 2]; rugose [= 3]. Surface of palps with papillae can be observed in few species of Polynoidae (Barnich & Fiege, 2009) without clear pattern (e.g. few members of Polynoinae subfamily). Palps are smooth in outgroup and most polynoids. Based on Gonzalez *et al.* (2018).

2 Inner palpal sheath [2]: absent [= 0]; present [= 1]. Medial continuation of anterior margin of segment 1 (Pettibone, 1970). Presence exclusive in outgroup and absent in polynoids. Based on Gonzalez *et al.* (2018).

3 Outer palpal sheath [3]: absent [= 0]; present [= 1]. Lateral continuation of anterior margin of segment 1 (Pettibone, 1970). Presence exclusive in outgroup and absent in polynoids. Based on Gonzalez *et al.* (2018).

4 Enlarged/elongated palpophores [4]: absent [=0]; present [=1]. Base of palps can be enlarged or elongated (Pettibone, 1976). Palpophores are enlarged or elongated in the genus *Bathyedithia* and *Hodor* **gen. nov.** (Fig. 13A) and most species of *Macellicephaloides* genus (Pettibone, 1976).

5 Palps ventrally directed [5]: absent [=0]; present [=1]. Palps can be ventrally directed (Pettibone, 1976). Palps are ventrally directed in *Abysarya* **gen. nov.** (Fig. 5H, I) and most species of *Macellicephaloides* (Fig. 16B, C).

6 Lower lip with wing-like structure [6]: absent [=0]; present [=1]. A unique wing-like structure on ventral side of lower lip and projecting posteriorly (Pettibone, 1979). Exclusively present in *Bruunilla* species (Fig. 11B, G).

7 Median antenna [7]: absent [= 0]; present [= 1]. A median antenna is present in most of polynoids and outgroup (Barnich & Fiege, 2003). Exclusively absent in Sinantennata clade (e.g., *Bathyedithia retierei* **sp. nov.** Fig. 6B). Based on Gonzalez *et al.* (2018).

8 Position of median antenna [8]: on the anterior half of prostomium anterior or anteriorly [= 0]; on the posterior half of prostomium or dorsally [= 1]. The insertion of median antenna (often with ceratophore) can be on the anterior half of prostomium being more anteriorly or in the posterior half being more dorsally (Pettibone, 1976; Barnich & Fiege, 2003; Neal *et al.*, 2012). Outgroup and most polynoids presented anterior insertion (e.g. *Bathyeliasona mariaae* **sp. nov.** Fig. 7A, C). Based on Gonzalez *et al.* (2018).

9 Ceratophore of median antenna [9]: no divisions or inconspicuous [= 0]; well-defined [= 1]. Basal joint projected from the prostomium connecting to median antenna (Barnich & Fiege, 2003). Exclusively absent in *Branchipolynoe* species. Based on Gonzalez *et al.* (2018).

10 Median antenna surface [10]: smooth [= 0]; papillate [= 1]. Surface of median antenna with papillae can be observed in few species of Polynoidae (Barnich & Fiege, 2009). Median antenna is smooth in outgroup and papillate in few polynoids (e.g., *Bathyfauvelia glacigena* **sp. nov.** Fig. 8L). Based on Gonzalez *et al.* (2018).

11 Lateral antennae [11]: absent [= 0]; present [= 1]. Two lateral antennae are present in most of polynoids and outgroup (Barnich & Fiege, 2003). Exclusively absent

in Macellicephalinae *sensu* Hartmann-Schröder (1971). Based on Gonzalez *et al.* (2018).

12 Insertion of lateral antennae [12]: on prostomium [= 0]; on segment 1 [= 1]. The lateral antennae can be inserted on the prostomium or on segment 1 (tentacular segment; Pettibone, 1970). Lateral antennae were inserted on segment 1 exclusively in outgroup. Based on Gonzalez *et al.* (2018).

13 Position of lateral antennae [13]: terminally [=0]; subterminally [=1]; terminoventrally [=2]; ventrally [=3]. When inserted on the prostomium, the lateral antennae can be positioned on several ways. For example, *Bathymoorea lucasi sp. nov.* presented lateral antennae positioned subterminally (Fig. 4H). Inapplicable to outgroup.

14 Antennal sheaths in lateral antennae [14]: absent [=0]; present [=1]. Paired processes attached between bases of ceratophores of median and lateral antennae (Pettibone, 1967). Exclusively present in Admetellinae members.

15 Prostomium [16]: without lobes [= 0]; bilobed [= 1]. A median groove can divide the prostomium in two lobes (Pettibone, 1985b, d). Outgroup and very few polynoids (e.g., *Branchiplicatus cupreus*) were coded without lobes. Based on Gonzalez *et al.* (2018).

16 Prostomial shape [15]: subrectangular [= 0]; oval [= 1]; conical/subtriangular [=2]. The shape of anterior margin of prostomium is highly variable within polynoids (Barnich & Fiege, 2009). Based on Gonzalez *et al.* (2018).

17 Frontal/facial tubercle [17]: absent [= 0]; present [= 1]. One, two or three lobes can be projected between the prostomium and the upper lip (Pettibone, 1976). Commonly present in *Macellicephalina* (e.g., *Macellicephalina parvafauces sp. nov.* Fig. 15B) and absent in outgroup. Based on Gonzalez *et al.* (2018).

18 Prostomial “cephalic” peak [18]: absent [= 0]; present [= 1]. Anterior distal projection of anterior lobes of prostomium (Barnich & Fiege, 2003). Absent in outgroup and present in few polynoids. Based on Gonzalez *et al.* (2018).

19 Frontal filaments [19]: absent [=0]; present [=1]. Paired frontal filaments are inserted on anterior lobes of prostomium (Pettibone, 1976). Incorrectly called frontal horns, cephalic peak or lateral antennae. Absent in outgroup and present in few species from deep-sea (e.g., *Macellicephalina clarionensis sp. nov.* Fig. 14A).

20 Prostomial auricle [20]: absent [= 0]; present [= 1]. Paired appendages “ear-shaped” inserted at the base of the ceratophore of median antenna (Pettibone, 1970). Exclusively present in outgroup. Based on Gonzalez *et al.* (2018).

21 Eyes [21]: absent [= 0]; present [= 1]. Paired or two-pairs of pigmented eyes are mostly present in polynoids. Absent in outgroup (*Neoleanira tetragona*) and deep-sea polynoids. Based on Gonzalez *et al.* (2018).

22 Position of anterior pair of eyes: dorso-laterally or on the widest part of prostomium [=0]; antero-ventrally [=1]. The anterior pair of eyes can be located dorso-laterally on the widest part of prostomium or antero-ventrally beneath the prostomium lobes (Barnich & Fiege, 2003). Most polynoids presented eyes dorso-laterally located. Inapplicable to outgroup.

23 Only one pair of big ocular areas [23]: absent [=0]; present [=1]. Paired ocular area larger than pigmented eyes (Pettibone, 1967). Absent in outgroup and present in few species (e.g., *Bathymoorea lucasi* sp. nov. Fig., 4A, H).

24 Segment 1 [24]: achaetous [= 0]; bearing chaetae [= 1]. Tentacular segment can lack chaetae or present a single (only inner acicula) to multiple chaetae (Barnich & Fiege, 2003). Present in outgroup and some polynoids (e.g., *Bathymoorea lucasi* sp. nov. Fig., 4A). Based on Gonzalez *et al.* (2018).

25 “Ctenidium-like” dorsal tentacular crests on segment 1 [25]: absent [= 0]; present [= 1]. Dorsal surface of tentacular parapodia can present ciliated ridges (Pettibone, 1970). Exclusively present in outgroup. Based on Gonzalez *et al.* (2018).

26 Notopodial sensory projection [26]: absent [= 0]; present as dorsal cirri [= 1]. Cirriform projection can be present at the base of notopodia as dorsal cirri (Barnich & Fiege, 2003). Absent only in outgroup (*Sthenelais boa*). Based on Gonzalez *et al.* (2018).

27 Position/distribution of the dorsal cirri [27]: on segment 3 [= 0]; on most non-elytrigerous segments [= 1]. The dorsal cirri can be limited to one segment or be distributed on non-elytrigerous segment (Pettibone, 1970; Barnich & Fiege, 2003). Exclusively present only on segment 3 in *Neoleanira tetragona* and on non-elytrigerous segment in polynoids. Based on Gonzalez *et al.* (2018).

28 Dorsal tubercles on non-elytrigerous segments [28]: absent/inconspicuous [= 0]; distinct/prominent [= 1]. On cirriferous segment the dorsal part of notopodia can be prominent (Pettibone, 1976). Present in outgroup and some polynoids (e.g., *Macellicephala clarionensis* sp. nov. Fig. 14A). Based on Gonzalez *et al.* (2018).

29 Shape of dorsal tubercles [29]: nodular/bulbous [=0]; conical [=1]; lamelliform/short [=2]; cirriform/elongate [=3]; bifurcated [=4]. The dorsal tubercles can present varied shape from conical to elongated (Pettibone, 1976). Lamelliform in few polynoids (e.g., *Bathyfauvelia ignigena* sp. nov. Fig. 9C, L).

30 Notopodial development relative to neuropodia [30]: notopodia reduced to a very small pointed lobe [=0]; notopodia shorter than neuropodia [=1]; notopodia subequal to neuropodia [=2]; notopodia longer than neuropodia [=3]. The development of notopodia and neuropodia are often differentiated within polynoids. Outgroup was coded as subequal.

31 Noto- and neuroacicula penetrating epidermis [31]: absent [=0]; both penetrating [=1]; only notoacicula penetrating [=2]; only neuroacicula penetrating [=3]. The inner aciculae can sometime penetrate the epidermis of one or both lobes in parapodia. Inapplicable to outgroup. Most polynoids presented aciculae not penetrating epidermis.

32 Neurochaetae thickness relative to notochoetae [32]: neurochaetae more slender than notochoetae [=0]; about the same [=1]; neurochaetae stouter than notochoetae [=2]. The development of neurochaetae and notochoetae is often differentiated within polynoids. Outgroup presented notochoetae stouter than neurochaetae.

33 Notopodial stylodes [33]: absent [= 0]; present [= 1]. Some scattered finger-like structures can be present on surface of notopodia (Pettibone, 1970). Exclusively present in outgroup. Based on Gonzalez *et al.* (2018).

34 Notopodial flanges or bracts “lobes” [34]: absent [= 0]; present [= 1]. Prominent notopodial lobe enclosing acicular lobe and notochaetae varied in size and distribution along body (Pettibone, 1985a; 1997). Absent in outgroup (*Neoleanira tetragona*) and most polynoids. Based on Gonzalez *et al.* (2018).

35 Neuropodia with supra-acicular process [35]: absent [=0]; present [=1]. Elongate distal projection of neuropodial lobe. Absent in outgroup and most polynoids.

36 Neuropodial papilla [36]: absent [=0]; present [=1]. Cirriform projection, bulbous or elongate, inserted in upper part of neuropodial lobe (Loshamn, 1981). Exclusively present on *Diplaconotum* and *Bruunilla* species.

37 Neuropodial stylodes [37]: absent [= 0]; present [= 1]. Some scattered finger-like structures can be present on surface of neuropodia (Pettibone, 1970). Exclusively present in outgroup. Based on Gonzalez *et al.* (2018).

38 Proboscis/muscular pharynx [38]: without chitinized structures [= 0]; with chitinized structures [= 1]. The proboscis usually presents a pair of distal and opposed chitinized structures (Barnich & Fiege, 2003). Chitinized structures absent only in *Bathymacella uschakovi*. Based on Gonzalez *et al.* (2018).

39 Shape of chitinized structures [39]: hook-shaped [= 0]; jaw-plate [= 1]; numerous keratinized teeth [=2]. The usual shape of the chitinized structures on proboscis is hook-shaped but it can be rarely presented differently. *Macelloides antarctica* presented paired jaw-plates with series of prominent denticles along each side (Uschakov, 1957; Pettibone, 1976); and *Vampiropolynoe embleyi* presented numerous keratinized teeth in the junction of mouth opening and pharynx. Based on Gonzalez *et al.* (2018).

40 Dorsal and ventral jaws different [40]: absent [=0]; present [=1]. The dorsal and ventral pairs of jaws are different if the dorsal pair is fused (Pettibone, 1976). Dorsal fused jaws were exclusively present in *Macellicephaloides* (e.g., *Macellicephaloides moustachu* sp. nov. Fig. 16E, F).

41 Branchiae [41]: absent [= 0]; present [= 1]. In sigalionids the branchiae is a common character being digitiform while in polynoids it is a rare character being arborescent or folded (Miura, 1994; Pettibone, 1970). Present in outgroup and few polynoids. Based on Gonzalez *et al.* (2018).

42 Parapodial ctenidia [42]: absent [= 0]; present [= 1]. Cushion-like ciliated ctenidia present between the notopodia and neuropodia. Gonzalez *et al.* (2018) considered this structure similar to the accessory filamentous sensory organs attached to cirrophores in *Gesiella* and *Bathycatalina* (Pettibone, 1994). Present in outgroup and *G. jameensis* and *B. filamentosa*. Based on Gonzalez *et al.* (2018).

43 Dorsal body surface [43]: smooth [= 0]; papillate [= 1]. Scattered papillae or tubercles can be present in dorsum of sigalionids and polynoids. *Hermenia verruculosa* and few species of *Macellicephalo* genus presented papillated dorsal body surface. Based on Gonzalez *et al.* (2018).

44 Ventral body surface [44]: smooth [= 0]; papillate [= 1]. Scattered papillae or tubercles can be present in ventrum of sigalionids and polynoids. *Hermenia verruculosa* and *Macellicephalo longipalpata* presented papillated ventral body surface. Based on Gonzalez *et al.* (2018).

45 Number of segments [45]: ≤ 18 [=0]; ≥ 19 or ≤ 26 [=1]; ≥ 27 or ≤ 50 [=2]; ≥ 51 [=3]. Very variable character with most sigalionids having long body while polynoids have shorter. Most polynoids from deep-sea showed shorter body.

46 Number of pairs of elytra [46]: ≤ 9 [=0]; ≥ 10 or ≤ 12 [=1]; 13 ≥ or ≤ 23 [=2]; ≥ 24 [=3]. Variable character with most sigalionids having high number of pairs of elytra while polynoids have fewer. Most polynoids from deep-sea showed up to 12 pairs of elytra.

47 First segment with nephridial papillae [47]: before or from segment 7 [=0]; between segment 8 and 10 [=1]; from segment 11 or 12 [=2]. Very variable character, the nephridial papillae can be present ventrally to neuropodia as a globular, elongate or digitiform structure. Not applicable when absent; present in most polynoids (e.g., *Bathymoorea lucasi* sp. nov. Fig. 4L).

48 Notochaetae [49]: absent [= 0]; present [= 1]. The notopodia usually bears chaetae although with some exceptions. Absent in few polynoids (e.g., *Nu aakhu* gen. nov., sp. nov. Fig. 17D). Based on Gonzalez *et al.* (2018).

49 Notochaetal spines [49]: absent [= 0]; present [= 1]. A stout, spike-like chaetae can be present in notopodia (Barnich *et al.*, 2006). Absent in outgroup and present in few polynoids from shallow-water. Based on Gonzalez *et al.* (2018).

50 Distally finely tapering simple notochaetae [50]: absent [= 0]; present [= 1]. Notochaetae can have very thin tapering tips. Present in outgroup (*Sthenelais boa*) and few polynoids. Based on Gonzalez *et al.* (2018).

51 Notochaetae with serrulations/spinous rows [51]: absent [= 0]; present [= 1]. Rows of tooth-like protuberances more or less distinct can be observed transversally along the chaetae (Barnich & Fiege, 2003). Present in outgroup and most polynoids (e.g., *Bathymoorea lucasi* sp. nov. Fig. 4M, N). Based on Gonzalez *et al.* (2018).

52 Notochaetae with spines along only one side [52]: absent [= 0]; present [= 1]. Small cusps or spines can be present along one side of notochaetae sometimes present as two rows of spines along the same side (Pettibone, 1986; Neal *et al.*, 2012). Absent in outgroup and present in few polynoids (e.g., *Bathypolaria* sp. 173 Fig. 10E).

53 Spinous pockets or spines on notochaetae along both sides [53]: absent [= 0]; present [= 1]. Both margins of notochaetae can present spines or pocket like cavity surrounded by enlarged serrations (Gonzalez *et al.*, 2018). This character is difficult to be separated in spines or pocket like cavity without SEM thus we coded as one character. Absent in outgroup and present in few polynoids (e.g., *Bruunilla nealae* sp. nov. Fig. 11D).

54 Simple neurochaetae [54]: absent [= 0]; present [= 1]. Entire neurochaetae are present in polynoids and absent in some sigalionids (Barnich & Fiege, 2003). Exclusively absent in outgroup (*Neoleanira tetragona*). Based on Gonzalez *et al.* (2018).

55 Neurochaetal spines [55]: absent [= 0]; present [= 1]. A stout, spike-like chaetae can be present in neuropodia. Absent in outgroup and present in some polynoids (e.g. *Abysarya acus* sp. nov. Fig. 5P). Based on Gonzalez *et al.* (2018).

56 Neurochaetae distally recurved [56]: absent [= 0]; present [= 1]. The distal part of neurochaetae can be bent backward. Absent in outgroup and present in *Abysarya acus* sp. nov. (Fig. 5Q) and *Paradyte crinoidicola*. Based on Gonzalez *et al.* (2018).

57 Pinnate neurochaetae [57]: absent [= 0]; present [= 1]. Some lateral branches can be observed in the shaft of neurochaeta. Present only in *Sthenelais boa* and *Paralepidonotus ampulliferus*. Based on Gonzalez *et al.* (2018).

58 Distally tapered neurochaetae [58]: absent [= 0]; present [= 1]. Neurochaetae with tapered tips. Present in outgroup and some polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8I). Based on Gonzalez *et al.* (2018).

59 Crenulate/serrated neurochaetae [59]: absent [= 0]; present [= 1]. Both margins of neurochaetae can present spines or pocket like cavity surrounded by enlarged serrations (Gonzalez *et al.*, 2018). This character is difficult to be separated in spines or pocket like cavity without SEM thus we coded as one character. Absent in outgroup and present in most deep-sea polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8I). Based on Gonzalez *et al.* (2018).

60 Very wide neurochaetae [60]: absent [=0]; present [=1]. Neurochaetae greatly expanded and flattened distally (Pettibone, 1976). Exclusively present in *Bathyeliasona* species (e.g., *Bathyeliasona mariaae* sp. nov. Fig. 7I).

61 Semilunar pocket on neurochaetae [61]: absent [=0]; present [=1]. An enlarged pocket serrated in the base of blade of chaetae. Present only in *Capitulatinoe* cf. *cupisetis* and *Paradyte crinoidicola*.

62 Neurochaetae with serrulations/spinous rows [62]: absent [= 0]; present [= 1]. Rows of tooth-like protuberances more or less distinct can be observed transversally along the chaetae (Barnich & Fiege, 2003). Present in outgroup and most polynoids (e.g., *Bathymoorea lucasi* sp. nov. Fig. 4O, P).

63 Compound falcigerous neurochaetae [63]: absent [= 0]; present [= 1]. A jointed chaeta composed by chaeta and a distal article with falcate tip. Present only in outgroup (*Sthenelais boa*). Based on Gonzalez *et al.* (2018).

64 Compound falcigerous neurochaetae with articulate blades [64]: absent [= 0]; present [= 1]. A jointed chaeta composed by chaeta and a distal article divided in smaller articles with falcate tip. Present only in outgroup (*Sthenelais boa*). Based on Gonzalez *et al.* (2018).

65 Compound spinigerous neurochaetae [65]: absent [= 0]; present [= 1]. A jointed chaeta composed by chaeta and a distal article with tapered tip (Pettibone, 1970). Present only in outgroup (*Neoleanira tetragona*). Based on Gonzalez *et al.* (2018).

66 Compound spinigerous neurochaetae with canaliculate blades [66]: absent [= 0]; present [= 1]. A jointed chaeta composed by chaeta and a distal article internally camerated with tapered tip (Pettibone, 1970). Present only in outgroup (*Neoleanira tetragona*). Based on Gonzalez *et al.* (2018).

67 Terminal ends of simple neurochaetae [67]: unidentate [= 0]; bidentate [= 1]; combination [= 2]. The tip of neurochaetae can be entire (unidentate), having a secondary tooth (bidentate) or having both types in same bundle. Few polynoids present bidentate neurochaetae. Based on Gonzalez *et al.* (2018).

68 Margins of the elytra [68]: smooth [= 0]; with papillae [= 1]. Some papillae can be observed along or in part of elytra margin. Present in outgroup and some polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8C, D). Based on Gonzalez *et al.* (2018).

69 Surface of the elytra [69]: smooth [= 0]; with papillae [= 1]. Some papillae can be observed in all or in part of elytra surface. Present in outgroup (*Sthenelais boa*) and some polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8C, D). Based on Gonzalez *et al.* (2018).

70 Elytral surface with tubercles [70] absent [= 0]; present [= 1]. Some structures of different shape and size can be observed in all or in part of elytra surface. Present in outgroup (*Sthenelais boa*) and some polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8C, D). Based on Gonzalez *et al.* (2018).

71 Type of elytral tubercles [71]: microtubercles [= 0]; macrotubercles [= 1]; both micro and macro [= 2]. Some structures on elytra surface can be large or small. Present in outgroup (*Sthenelais boa*) and some polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8C, D). Based on Gonzalez *et al.* (2018).

72 Dorsum covered by elytra [72]: completely [= 0]; partially, mid-dorsum exposed [= 1]. Elytra can cover completely the dorsum of some species or allow the mid-dorsum exposed. Dorsum was completely covered in outgroup and most polynoids (e.g., *Bathyfauvelia glacigena* sp. nov. Fig. 8A). Based on Gonzalez *et al.* (2018).

73 Posterior elytral arrangement [73]: elytra present on every segment [= 0]; elytra present on every second segment [= 1]; elytra present on every third segment [= 2]. Posterior elytral arrangement can be different: elytra present on every segment, on every second or on every third segment. Elytra was present in posterior body on every segment in outgroup and on every second segment (e.g., *Bathyliasona mariaae* sp. nov. Fig. 7A) or every third segment (e.g., *Bathymoorea lucasi* sp. nov. Fig. 4A) among polynoids. Based on Gonzalez *et al.* (2018).

74 Ventral pygidial keel [74]: absent [=0]; present [=1]. A median ridge can be present ventrally in last segments (Neal *et al.*, 2012). Present exclusively in *Bathypolaria* and *Austropolaria* species.