

Appendix S1. Included taxa with museum information

Type of group	Species	Catalogue number	Family
In	<i>Belzebub chacei</i> Bowman & McCain, 1967	ZMUC CRU-4440	Luciferidae De Haan, 1849 (in De Haan, 1833–1850)
In	<i>Belzebub faxoni</i> Borradaile, 1915	ZMUC CRU-4448, ZMUC CRU-4450	
In	<i>Belzebub hanseni</i> Nobili, 1905	ZMUC CRU-4428	
In	<i>Belzebub intermedius</i> Hansen, 1919	ZMUC CRU-4422	
In	<i>Belzebub penicillifer</i> Hansen, 1919	ZMUC CRU-4431	
In	<i>Lucifer orientalis</i> Hansen, 1919	ZMUC CRU-4437	
In	<i>Lucifer typus</i> H. Milne Edwards, 1837	ZMUC CRU-4447	
Out	<i>Aristaeomorpha foliacea</i> (Risso, 1827)	ZMUC CRU-4451	Aristeidae Wood-Mason (in Wood-Mason & Alcock, 1891)
Out	<i>Gennadas parvus</i> Bate, 1881		Benthescymidae Wood-Mason (in Wood-Mason & Alcock, 1891)
Out	<i>Penaeus monodon</i> Fabricius, 1798		Penaeidae Rafinesque, 1815;
In	<i>Acetes indicus</i> H. Milne Edwards, 1830	ZMUC CRU-4441	Sergestidae Dana, 1852;
In	<i>Allosergestes sargassi</i> (Ortmann, 1893)	ZMUC CRU-4548	
In	<i>Challengerosergia challengerii</i> (Hansen, 1903)	NHM 1903.6.6.14	
In	<i>Cornutosergestes cornutus</i> (Krøyer, 1855)	ZMUC CRU-4533 (syntypes)	
In	<i>Deosergestes corniculum</i> (Krøyer, 1855)	ZMUC CRU-6077 (syntypes)	
In	<i>Eusergestes arcticus</i> (Krøyer, 1855)	ZMUC CRU-5590 (holotype, dissected), ZMUC CRU-4528	
In	<i>Gardinerosergia gardneri</i> (Kemp, 1913)	ZMUC CRU-3726	
In	<i>Lucensosergia lucens</i> (Hansen, 1922)	ZMUC CRU-4425	
In	<i>Neosergestes edwardsi</i> (Krøyer, 1855)	ZMUC CRU-4526	
In	<i>Parasergestes armatus</i> (Krøyer, 1855)	ZMUC CRU-5626 (postlarva), ZMUC CRU-4507	
In	<i>Peisos petrunkevitchi</i> Burkenroad, 1945	SMNH Type 2338 (holotype)	
In	<i>Petalidium foliaceum</i> Bate, 1881	NHM 1888.22, 1888.22, 1903.6.6.16 (syntypes, damaged), ZMUC CRU-20546	
In	<i>Petalidium obesum</i> (Krøyer, 1859)	ZMUC CRU-7582 (holotype)	
In	<i>Petalidium suspiriosum</i> Burkenroad, 1937	YPM IZ 039178, 068756	
In	<i>Phorcosergia phorca</i> (Faxon, 1893)	ZMUC CRU-4434	
In	<i>Prehensilosergia prehensilis</i> (Bate, 1881)	NHM 1888.2	
In	<i>Robustosergia robusta</i> (Smith, 1882)	USNM 7316	
In	<i>Scintillosergia scintillans</i> (Burkenroad, 1940)	ZMUC CRU-3613	
In	<i>Sergestes atlanticus</i> Milne-Edwards, 1830	MNHN, NA 331 (syntypes, bad condition), ZMUC CRU-4542	
In	<i>Sergia tenuiremis</i> (Krøyer, 1855)	ZMUC CRU-8362	
In	<i>Sicyonella maldivensis</i> Borradaile, 1910	ZMUC CRU-4443	

MNHN, Museum National d'Histoire Naturelle, Paris; NHM, British Museum (Natural History); SMNH, Naturhistoriska Riksmuseet, Sweden; USNM, United States National Museum; YPM, Yale Peabody Museum; ZMUC, Zoological Museum, University of Copenhagen.

Appendix S2. List of characters used. New or revised characters are marked with asterisks (*)

Character no.	Character state	State no.	Reference to figure and source
Carapace			
0	Integument firm	0	
	Integument membranous	1	
1	Labrum not much separated from antennae and eyes	0	
	Labrum widely separated from antennae and eyes	1	
2	Rostrum bears 2 or more dorsal teeth behind the orbital margin	0	
	Rostrum bears 0–1 dorsal teeth behind the orbital margin	1	
3	Frontal margin of rostrum oblique	0	fig. 2B, D in Vereshchaka <i>et al.</i> (2014)
	Frontal margin of rostrum vertical	1	fig. 2A in Vereshchaka <i>et al.</i> (2014)
4	Supraorbital tooth absent	0	fig. 2A–C in Vereshchaka <i>et al.</i> (2014)
	Supraorbital tooth present	1	fig. 2D in Vereshchaka <i>et al.</i> (2014)
5	Pterygostomial tooth absent	0	
	Pterygostomial tooth present	1	
6	Hepatic protrusion prominent	0	
	Hepatic protrusion inconspicuous	1	
7	Hepatic protrusion forming a barb	0	fig. 2A–C in Vereshchaka <i>et al.</i> (2014)
	Hepatic protrusion forming a spine	1	fig. 2D in Vereshchaka <i>et al.</i> (2014)
Branchia			
8	Somite VIII, arthrobranch developed	0	
	Somite VIII, arthrobranch rudimentary or absent	1	
9	Somite VIII, arthrobranch absent	0	
	Somite VIII, arthrobranch present	1	
10	Somite IX, anterior arthrobranch present	0	
	Somite IX, anterior arthrobranch absent	1	
11	Somite IX, posterior arthrobranch present	0	
	Somite IX, posterior arthrobranch absent	1	
12	Somite IX, posterior arthrobranch developed	0	
	Somite IX, posterior arthrobranch reduced	1	
13	Somite IX, posterior arthrobranch dendritic	0	
	Somite IX, posterior arthrobranch lamellar	1	
14	Somite X, anterior arthrobranch present	0	
	Somite X, anterior arthrobranch absent	1	
15	Somite X, posterior arthrobranch present	0	
	Somite X, posterior arthrobranch absent	1	
16	Somite X, posterior arthrobranch developed	0	
	Somite X, posterior arthrobranch reduced	1	
17	Somite X, posterior arthrobranch dendritic	0	
	Somite X, posterior arthrobranch lamellar	1	
18	Somite XI, anterior arthrobranch present	0	
	Somite XI, anterior arthrobranch absent	1	
19	Somite XI, posterior arthrobranch present	0	
	Somite XI, posterior arthrobranch absent	1	
20	Somite XI, posterior arthrobranch developed	0	
	Somite XI, posterior arthrobranch reduced	1	
21	Somite XI, posterior arthrobranch dendritic	0	
	Somite XI, posterior arthrobranch lamellar	1	
22	Somite XII, anterior arthrobranch present	0	
	Somite XII, anterior arthrobranch absent	1	
23	Somite XII, posterior arthrobranch developed	0	
	Somite XII, posterior arthrobranch reduced	1	

Appendix S2. Continued

Character no.	Character state	State no.	Reference to figure and source
24	Somite XII, posterior arthrobranch present	0	
	Somite XII, posterior arthrobranch absent	1	
25	Somite XII, posterior arthrobranch developed	0	
	Somite XII, posterior arthrobranch reduced	1	
26	Somite XII, posterior arthrobranch dendritic	0	
	Somite XII, posterior arthrobranch lamellar	1	
27	Somite XIII, anterior arthrobranch present	0	
	Somite XIII, anterior arthrobranch absent	1	
28	Somite XIII, posterior arthrobranch present	0	
	Somite XIII, posterior arthrobranch absent	1	
29	Somite XIII, posterior arthrobranch developed	0	
	Somite XIII, posterior arthrobranch reduced	1	
30	Somite XIII, posterior arthrobranch dendritic	0	
	Somite XIII, posterior arthrobranch lamellar	1	
Abdomen and telson			
31	Abdominal somite VI in male without ventral processes	0	
	Abdominal somite VI in male with two ventral processes	1	
32	Abdominal somite VI in male, posterior ventral process not tapering, obtuse at the end	0	
	Abdominal somite VI in male, posterior ventral process tapering, nearly acute at the end	1	
33	Abdominal somite VI in male, posterior ventral process curved	0	
	Abdominal somite VI in male, posterior ventral process straight	1	
34	Telson, movable lateral spines present	0	
	Telson, movable lateral spines absent	1	
35	Telson, four movable lateral spines	0	
	Telson, two movable lateral spines	1	
36	Telson in male without distoventral protuberance	0	
	Telson in male with conspicuous distoventral protuberance	1	
Eye			
37	Eyes not sexually dimorphic	0	
	Eyes sexually dimorphic	1	
38	Eyestalks not elongated, nearly reaching end of scaphocerite	0	
	Eyestalks elongated, not reaching end of scaphocerite	1	
Antennule			
39	Antennule, first segment much longer (by half or more) than third segment	0	fig. 2E in Vereshchaka <i>et al.</i> (2014)
	Antennule, first segment subequal or slightly longer (by less than half) than third segment	1	
	Antennule, first segment shorter than third segment	2	fig. 2F in Vereshchaka <i>et al.</i> (2014)
40	Third segment without distoventral processus in male	0	
	Third segment with distoventral processus in male	1	fig. 2G in Vereshchaka <i>et al.</i> (2014)
41	Third segment, distoventral processus in male short	0	
	Third segment, distoventral processus in male long	1	
42	Antennules in male with ventral flagellum	0	
	Antennules in male without ventral flagellum	1	

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
43	Stylocerite absent	0	
	Stylocerite present	1	
44	Stylocerite mobile	0	
	Stylocerite fixed	1	
Antenna			
45	Distal tooth of scaphocerite not reaching distal end of blade	0	
	Distal tooth of scaphocerite reaching distal end of blade	1	fig. 7G in Vereshchaka <i>et al.</i> (2014)
	Distal tooth of scaphocerite overreaching distal end of blade	2	fig. 7E in Vereshchaka <i>et al.</i> (2014)
Mandible			
46	Mandibular palp present	0	
	Mandibular palp absent	1	
Maxillule			
47	Maxillula in adults with 4 endites	0	
	Maxillula in adults with 3 endites	1	
	Maxillula in adults with 2 endites	2	
	Maxillula in adults with a single endite	3	
First maxilliped			
48	Epipod present	0	
	Epipod absent	1	
49	Exopod present	0	
	Exopod absent	1	
50	Endopod with 3–4 segments	0	
	Endopod with 2 segments	1	
	Endopod rudimentary or absent	2	
Second maxilliped			
51	Epipod present	0	
	Epipod absent	1	
Third maxilliped			
52	Moderately developed, < 2.0 times as long as first pereopod	0	fig. 2E in Vereshchaka <i>et al.</i> (2014)
	Enlarged, > 2.0 times as long as first pereopod	1	fig. 2F in Vereshchaka <i>et al.</i> (2014)
53	Not sexually dimorphic, dactyl not modified	0	fig. 3D in Vereshchaka <i>et al.</i> (2014)
	Sexually dimorphic, dactyl modified in males	1	fig. 3E in Vereshchaka <i>et al.</i> (2014)
54	Dactyl entire	0	
	Dactyl subdivided	1	
55	Dactyl subdivided into ordinary subsegments	0	fig. 2E in Vereshchaka <i>et al.</i> (2014)
	Dactyl subdivided into specialized subsegments	1	fig. 2F in Vereshchaka <i>et al.</i> (2014)
56	Dactyl consists of 4 specialized subsegments	0	fig. 6 in Vereshchaka (2009)
	Dactyl consists of 5 specialized subsegments	1	fig. 6 in Vereshchaka (2009)
	Dactyl consists of 6 specialized subsegments	2	fig. 6 in Vereshchaka (2009)
	Dactyl consists of 7 specialized subsegments	3	fig. 6 in Vereshchaka (2009)
First pereopod			
57	Ischium without strong movable spines	0	
	Ischium with strong movable spines	1	fig. 3F in Vereshchaka <i>et al.</i> (2014)
58*	Chela absent	0	
	Chela present	1	
59*	Chela developed, palm nearly as long as fingers	0	
	Chela much reduced, palm > 10 times as long as fingers	1	

Appendix S2. Continued

Character no.	Character state	State no.	Reference to figure and source
Second pereopod			
60	Ischium without strong distally curved tooth	0	
	Ischium with strong distally curved tooth	1	fig. 3G in Vereshchaka <i>et al.</i> (2014)
61	Merus without distal protrusion	0	
	Merus with distal protrusion	1	fig. 3G in Vereshchaka <i>et al.</i> (2014)
62*	Chela present	0	
	Chela absent	1	
63*	Chela developed, palm nearly as long as fingers	0	
	Chela reduced, palm nearly twice as long as fingers	1	
	Chela much reduced, palm > 10 times as long as fingers	2	
64	Fixed finger in chela rudimentary, shorter than dactyl	0	fig. 3H in Vereshchaka <i>et al.</i> (2014)
	Fixed finger developed, as long as dactyl	1	fig. 3I in Vereshchaka <i>et al.</i> (2014)
65	Chela without very long setae overreaching setae in tufts	0	
	Chela with very long setae overreaching setae in tufts	1	fig. 3I in Vereshchaka <i>et al.</i> (2014)
Third pereopod			
66	Coxa, mesial tooth absent	0	
	Coxa, mesial tooth present	1	
67	Basis in female rounded	0	
	Basis in female with small projection	1	
	Basis in female with tooth	2	
68	Propodus without specialized strong curved spines proximal to tufts of setae	0	
	Propodus with specialized strong curved spines proximal to tufts of setae	1	fig. 3J in Vereshchaka <i>et al.</i> (2014)
69	True chela	0	
	Subchela	1	fig. 3I in Vereshchaka <i>et al.</i> (2014)
70	True chela developed, palm nearly as long as fingers	0	
	True chela reduced, palm nearly twice as long as fingers	1	
	True chela much reduced, palm > 10 times as long as fingers	2	
71	Fixed finger in chela rudimentary, shorter than dactyl	0	fig. 3J in Vereshchaka <i>et al.</i> (2014)
	Fixed finger developed, as long as dactyl	1	fig. 3K in Vereshchaka <i>et al.</i> (2014)
72	Chela without very long setae overreaching setae in tufts	0	
	Chela with very long setae overreaching setae in tufts	1	fig. 3J in Vereshchaka <i>et al.</i> (2014)
Fourth pereopod			
73	Present in female	0	
	Absent in female	1	
74	Fourth pereopod consists of 7 segments in female	0	
	Fourth pereopod consists of 6 segments in female	1	
	Fourth pereopod consists of 5 segments in female	2	
75	Present in male	0	
	Absent in male	1	
76	Fourth pereopod consists of 7 segments in male	0	
	Fourth pereopod consists of 6 segments in male	1	
	Fourth pereopod consists of 3 segments in male	2	

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
77	Fourth pereopod subcylindrical	0	
	Fourth pereopod flattened	1	
78	Carpus and propodus setose along both margins	0	
	Carpus and propodus setose along one margin only	1	
Fifth pereopod			
79	Present in female	0	
	Absent in female	1	
80	Fourth pereopod consists of 7 segments in female	0	
	Fourth pereopod consists of 6 segments in female	1	
	Fourth pereopod consists of 3 segments in female	2	
81	Present in male	0	
	Absent in male	1	
82	Fourth pereopod consists of 7 segments in male	0	
	Fourth pereopod consists of 6 segments in male	1	
	Fourth pereopod consists of a single segments (coxa) in male	2	
83	Fourth pereopod subcylindrical	0	
	Fourth pereopod flattened	1	
84	Carpus and propodus setose along both margins	0	
	Carpus and propodus setose along one margin only	1	
Uropodal exopod			
85	Outer spine absent	0	fig. 10 in Vereshchaka (2009)
	Outer spine present	1	fig. 10 in Vereshchaka (2009)
86	Outer spine by far not reaching distal end of exopod	0	
	Outer spine nearly reaching distal end of exopod	1	
87	Outer margin of proximal segment not setose	0	fig. 10 in Vereshchaka (2009)
	Outer margin of proximal segment setose	1	fig. 10 in Vereshchaka (2009)
88	Outer margin of proximal segment not setose partly	0	fig. 10 in Vereshchaka (2009)
	Outer margin of proximal segment not setose entirely	1	fig. 10 in Vereshchaka (2009)
Male clasping organ			
89	Absent	0	
	Present	1	fig. 4B–E in Vereshchaka <i>et al.</i> (2014)
90	Clasping organ rudimentary	0	fig. 4B in Vereshchaka <i>et al.</i> (2014)
	Clasping organ developed	1	fig. 4C–E in Vereshchaka <i>et al.</i> (2014)
91	Clasping tubercle absent or rudimentary	0	
	Clasping tubercle present	1	
92	A single clasping tubercle present	0	
	Two clasping tubercles present	1	
93	Serrated bristles at the base of the fourth segment absent	0	
	Serrated bristles at the base of the fourth segment present	1	
94	Specialized structures on the fourth segment opposite the tubercle absent	0	
	A set of specialized structures on the fourth segment opposite the tubercle present	1	
95*	A set of specialized claw-like setae on the fourth segment opposite the tubercle	0	
	A row of serrated bristles on the fourth segment opposite the tubercle	1	

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
96	Claw-like setae on the fourth segment opposite the tubercle positioned in scattered pairs	0	
	Claw-like setae on the fourth segment opposite the tubercle positioned in two contiguous rows with a gap between them	1	
97*	Scales opposite the tubercle absent	0	
	Scales opposite the tubercle present	1	
98	A row of morchella-like setae adjacent to the tubercle absent	0	
	A row of morchella-like setae adjacent to the tubercle present	1	
99	Strong distal tooth on the fourth segment absent	0	
	Strong distal tooth on the fourth segment present	1	
Petasma			
100	Pars astrigens present	0	
	Pars astrigens absent	1	
101*	Pars externa absent	0	
	Pars astrigens present	1	
102*	Pars externa vestigial	0	
	Pars externa developed	1	
103*	Pars externa not transformed into a wide, unsupported sheath	0	
	Pars externa transformed into a wide, unsupported sheath	1	
104*	Pars externa not transformed into a narrow sheath supported by chitinous rib	0	
	Pars externa transformed into a narrow sheath supported by chitinous rib	1	
105	Processus uncifer without hook	0	figs 5C, 6D in Vereshchaka <i>et al.</i> (2014)
	Processus uncifer with a hook	1	fig. 5A, B, D in Vereshchaka <i>et al.</i> (2014)
106*	Processus uncifer without terminal setae	0	
	Processus uncifer with terminal setae	1	
107*	Processus uncifer unarmed at the tip	0	
	Processus uncifer with fine friction structures at the tip	1	
108*	Processus uncifer not armed with transverse ribs along entire margin	0	
	Processus uncifer armed with transverse ribs along entire margin	1	
109*	Processus uncifer without plate-like structures in addition to friction structures	0	
	Processus uncifer with plate-like structures in addition to friction structures	1	
110*	Capitulum of pars media absent	0	
	Capitulum of pars media present	1	
111*	Capitulum of pars media developed	0	
	Capitulum of pars media vestigial	1	
112	Capitulum of pars media armed with pincers	0	
	Capitulum of pars media armed with strong claws	1	
113	Capitulum with strong claws entire	0	
	Capitulum with strong claws divided	1	

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
114*	Capitulum without enlarged claws in addition to ordinary claws	0	
	Capitulum with enlarged claws in addition to ordinary claws	1	
115*	Capitulum with pincers not divided into lobi or processi	0	
	Capitulum with pincers with at least one lobus or processus	1	
116	Capitulum with pincers with all lobi and processi present, not divided/significantly modified	0	
	Capitulum with pincers with at least one lobus or processus absent or divided/significantly modified	1	
117*	Lobus armatus absent	0	
	Lobus armatus present	1	
118	Lobus armatus rudimentary	0	fig. 5E in Vereshchaka <i>et al.</i> (2014)
	Lobus armatus developed	1	fig. 5A–D in Vereshchaka <i>et al.</i> (2014)
119	Lobus connectens and lobus terminalis not twisted	0	fig. 5A–E in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens and lobus terminalis twisted	1	fig. 6D in Vereshchaka <i>et al.</i> (2014)
120	Lobus connectens absent	0	fig. 5B in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens present	1	fig. 4A, C–E in Vereshchaka <i>et al.</i> (2014)
121	Lobus connectens rudimentary	0	fig. 5C in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens developed	1	fig. 5A, D, E in Vereshchaka <i>et al.</i> (2014)
122	Lobus connectens entire	0	fig. 5A, C, D in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens divided	1	fig. 5E in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens with additional lobe at base directed upward	2	fig. 6C in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens with additional lobe at base directed downward	3	
123	Lobus connectens not swan-shaped	0	fig. 6B, C in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens swan-shaped	1	fig. 6E in Vereshchaka <i>et al.</i> (2014)
124	Lobus connectens without pillow at base	0	fig. 6C, D in Vereshchaka <i>et al.</i> (2014)
	Lobus connectens with pillow at base	1	fig. 6E in Vereshchaka <i>et al.</i> (2014)
125	Apex of lobus connectens unarmed or with a few ordinary suckers	0	fig. 5D, E in Vereshchaka <i>et al.</i> (2014)
	Apex of lobus connectens bearing a single, much enlarged sucker with a hook inside	1	fig. 6E in Vereshchaka <i>et al.</i> (2014)
126	Lobus inermis straight	0	fig. 5A, B, E in Vereshchaka <i>et al.</i> (2014)
	Lobus inermis curved	1	fig. 6A in Vereshchaka <i>et al.</i> (2014)
127	Lobus inermis narrow	0	fig. 5B in Vereshchaka <i>et al.</i> (2014)
	Lobus inermis inflated	1	fig. 6A in Vereshchaka <i>et al.</i> (2014)
128	Lobus terminalis absent or rudimentary	0	
	Lobus terminalis developed	1	fig. 5A–D in Vereshchaka <i>et al.</i> (2014)
129	Lobus terminalis entire	0	fig. 5A–D in Vereshchaka <i>et al.</i> (2014)
	Lobus terminalis apically divided	1	fig. 6A in Vereshchaka <i>et al.</i> (2014)
	Lobus terminalis with additional lobe at base	2	figs 1C, 3C in Vereshchaka <i>et al.</i> (2014)
130	Processus ventralis absent	0	fig. 5C in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis present	1	fig. 5A, B, D in Vereshchaka <i>et al.</i> (2014)
131	Processus ventralis rudimentary	0	fig. 5E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis developed	1	fig. 5A, B, D in Vereshchaka <i>et al.</i> (2014)
132*	Processus ventralis without lateral friction structures	0	
	Processus ventralis with lateral friction structures	1	

Appendix S2. Continued

Character no.	Character state	State no.	Reference to figure and source
133*	Processus ventralis without minute apical setae	0	
	Processus ventralis with minute apical setae	1	
134	Processus ventralis entire	0	fig. 5A, B, D in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis divided	1	Figs 2C, 4C in present paper
135	Processus ventralis divided once	0	
	Processus ventralis divided more than once	1	
136	Processus ventralis elongate	0	fig. 5A, B, D in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis triangular	1	fig. 5E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis needle-like	2	
137	Processus ventralis without hooks and suckers	0	fig. 5A–E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis with hooks and suckers	1	fig. 6B in Vereshchaka <i>et al.</i> (2014)
138	Processus ventralis without simple spines	0	fig. 5A, C, E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis with simple spines	1	fig. 5B, D in Vereshchaka <i>et al.</i> (2014)
139	Processus ventralis without stellate spines	0	fig. 5A, D, E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis with stellate spines	1	fig. 5B in Vereshchaka <i>et al.</i> (2014)
140*	Processus ventralis, a single simple spine	0	
	Processus ventralis, 5 or more simple spines	1	
	Processus ventralis, 2–4 simple spines	2	
141	Processus ventralis without apical lashes	0	fig. 5B–E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis with apical lashes	1	fig. 5A in Vereshchaka <i>et al.</i> (2014)
142	Processus ventralis with 2 apical lashes positioned as a pincer	0	fig. 5B–E in Vereshchaka <i>et al.</i> (2014)
	Processus ventralis with 5–25 apical lashes in row	1	fig. 5A in Vereshchaka <i>et al.</i> (2014)
Photophores			
143	The organ of Pesta absent	0	fig. 2F in Vereshchaka <i>et al.</i> (2014)
	The organ of Pesta present	1	fig. 2E in Vereshchaka <i>et al.</i> (2014)
144	The organ of Pesta: anterolateral organs lobed and posterolateral organs fringed	0	fig. 12, upper row, in Vereshchaka (2009)
	The organ of Pesta: both anterolateral and posterolateral organs spheroid	1	fig. 12, middle and lower rows, in Vereshchaka (2009)
145	The organ of Pesta: 3 distinct organs (2 lateral midgastric and 1 continuous posterior fringe)	0	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 6–anteromedian, 2 lateral midgastric, 3–5 posterolateral fringes)	1	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 1 distinct posteromedian organ	2	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 2–3 distinct organs (2 posterolateral and, in some species, 1 posteromedian)	3	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 3 distinct organs (1 anteromedian and 2 posterolateral)	4	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 4 distinct organs (1 anteromedian, 2 posterolateral, and 1 posteromedian)	5	fig. 12 in Vereshchaka (2009)
	The organ of Pesta: 5 distinct organs (1 anteromedian, 2 lateral midgastric, and 2 posterolateral)	6	fig. 12 in Vereshchaka (2009)
146	Dermal photophores absent	0	
	Dermal photophores present	1	
147	Dermal photophores without lens	0	fig. 7C–F in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores with lens	1	fig. 7A, B in Vereshchaka <i>et al.</i> (2014)

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
148	A total of 130–170 dermal photophores	0	
	A total of 190–210 dermal photophores	1	
	A total of 225 or more dermal photophores	2	
149	Dermal photophores arranged in a single lateral row on carapace	0	fig. 7B in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores arranged in 2 lateral rows on carapace	1	fig. 7A in Vereshchaka <i>et al.</i> (2014)
150	Number of dermal photophores in the upper row on carapace fixed	0	
	Number of dermal photophores in the upper row on carapace not fixed	1	
151	Three or fewer dermal photophores in the upper row on carapace	0	
	Four or more dermal photophores in the upper row on carapace	1	fig. 7A, B in Vereshchaka <i>et al.</i> (2014)
152	Number of dermal photophores on scaphocerite not fixed	0	
	Number of dermal photophores on scaphocerite fixed	1	
153	A total of 8 or more dermal photophores on scaphocerite	0	fig. 7C, E in Vereshchaka <i>et al.</i> (2014)
	A total of 7 dermal photophores on scaphocerite	1	
	A total of 4–6 dermal photophores on scaphocerite	2	fig. 7G in Vereshchaka <i>et al.</i> (2014)
	A total of 2–3 dermal photophores on scaphocerite	3	
154	Dermal photophores on scaphocerite large	0	fig. 7C in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on scaphocerite small	1	fig. 7E in Vereshchaka <i>et al.</i> (2014)
155	Dermal photophores on scaphocerite partly fused	0	fig. 7C in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on scaphocerite separated from each other	1	fig. 7E in Vereshchaka <i>et al.</i> (2014)
156	Dermal photophores arranged on scaphocerite in a single longitudinal row	0	fig. 7E, G in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores arranged on scaphocerite in 2 rows, longitudinal and oblique	1	fig. 7C in Vereshchaka <i>et al.</i> (2014)
157	Dermal lens-less photophores on uropodal exopod positioned with gaps, at least between distal and basal segments	0	fig. 7D, H in Vereshchaka <i>et al.</i> (2014)
	Dermal lens-less photophores on uropodal exopod positioned in contiguous row, equally spaced from each other	1	fig. 7F in Vereshchaka <i>et al.</i> (2014)
158	Dermal photophores on uropodal exopod large	0	fig. 7D in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on uropodal exopod small	1	fig. 7F, H in Vereshchaka <i>et al.</i> (2014)
159	Dermal photophores on uropodal exopod separated from each other	0	fig. 7F in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on uropodal exopod partly fused	1	fig. 7D in Vereshchaka <i>et al.</i> (2014)
160	Dermal photophores on basal segment of uropodal exopod positioned closer to central axis	0	fig. 7D, H in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on basal segment of uropodal exopod positioned closer to margin	1	fig. 7F in Vereshchaka <i>et al.</i> (2014)
161	Number of dermal photophores on basal segment of uropodal exopod not fixed	0	
	Number of dermal photophores on basal segment of uropodal exopod fixed	1	

Appendix S2. *Continued*

Character no.	Character state	State no.	Reference to figure and source
162	A total of 3 or more dermal photophores on basal segment of uropodal exopod	0	fig. 7F in Vereshchaka <i>et al.</i> (2014)
	Two dermal photophores on basal segment of uropodal exopod	1	
	A single dermal photophore on basal segment of uropodal exopod	2	fig. 7H in Vereshchaka <i>et al.</i> (2014)
163	Dermal photophores on distal segment of uropodal exopod positioned closer to central axis	0	fig. 7D, H in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on distal segment of uropodal exopod positioned closer to margin	1	fig. 7F in Vereshchaka <i>et al.</i> (2014)
164	Dermal photophores on distal segment of uropodal exopod arranged in a single row	0	fig. 7F, H in Vereshchaka <i>et al.</i> (2014)
	Dermal photophores on distal segment of uropodal exopod arranged in 2 rows/triangle	1	fig. 7D in Vereshchaka <i>et al.</i> (2014)
165	Number of dermal photophores on distal segment of uropodal exopod not fixed	0	
	Number of dermal photophores on distal segment of uropodal exopod fixed	1	
166	No dermal photophores on distal segment of uropodal exopod	0	
	A single dermal photophore on distal segment of uropodal exopod	1	fig. 7H in Vereshchaka <i>et al.</i> (2014)
	A total of 3 or more dermal photophores on distal segment of uropodal exopod	2	fig. 7F in Vereshchaka <i>et al.</i> (2014)
Larva			
167	Metamorphosis of usual dendrobranchiate type	0	
	Metamorphosis elaborated, including elaphocaris and acanthosoma stages	1	
168	Elaphocaris stage of <i>dohrni</i> type	0	fig. 2 in Vereshchaka (2009)
	Elaphocaris stage of <i>hispida</i> type	1	fig. 2 in Vereshchaka (2009)
	Elaphocaris stage of <i>ortmanni</i> type	2	fig. 2 in Vereshchaka (2009)

Appendix S3. Continued

Acetes indicus	-01000300200010-00100021011002101-1-1-1-0
Peisos petrunkevitchi	-01000300200010-001000210000021002021-020
Sicyonella maldivensis	-0100020000201100000001100000110000011000
Petalidium obesum	-010001000000-----02--00-02--010111010
Sergia tenuiremis	-01100000000010-01-0002101000210010110010
Gardinerosergia gardneri	-01120000000010-01-0002101000210010110010
Phorcosergia phorca	-01100000000010-01-0002101000210010110010
Robustosergia robusta	-01100000000010-01-0002101000210010110010
Prehensilosergia prehensilis	-01110000000010-01-0002101000210010110010
Scintillosergia scintillans	-01110000000010-01-0002101000210010110010
Challengerosergia challengerii	001110000000010-01-0002101000210010110010
Lucenosergia lucens	-01110000000010-01-0002101000210010110010
Deosergestes corniculum	-01110000000011201-0002111010201010110010
Eusergestes arcticus	-01110000000011201-0002101000210010111010
Sergestes atlanticus	-01020000000011401-0002100000210010111010
Cornutosergestes cornutus	-01020000100011401-0002100000210010111010
Allosergestes sargassi	-00-10000001011101-0002001010201010110010
Parasergestes armatus	-00-20000001011011-1002101000210010111010
Neosergestes edwardsi	-01120000001011201-1102100000210010111010

Characters 82 - 122

	82	87	92	97	102	107	112	117	122
Aristaeomorpha foliacea	00-100-0-----00-----0-----								
Gennadas parvus	00-100-0-----011000000010-----								
Penaeus monodon	00-100-0-----00-----0-----								
Lucifer typus	---110-0-----111101001011---11-----								
Lucifer orientalis	---110-0-----111100001011---11-----								
Lucifer intermedius	---110-0-----111010110111---11-----								
Lucifer penicillifer	---110-0-----111010110111---11-----								
Lucifer faxoni	---110-0-----111010110111---11-----								
Lucifer chacei	---110-0-----111010110111---11-----								
Lucifer hanseni	---100-0-----111010110111---11-----								
Acetes indicus	21-100-1110110000000---000011100-----								
Peisos petrunkevitchi	21-100-110-111-001011001000011110-----								
Sicyonella maldivensis	011100-110-01010000110000000110--11110110								
Petalidium obesum	111100-110-011-0100110010000110--11110100								
Sergia tenuiremis	110100-111000--0000110010000110--10110110								
Gardinerosergia gardneri	110100-111010-00000110010000110--11110112								
Phorcosergia phorca	110100-111010--0000110010000110--11110113								
Robustosergia robusta	110100-111010--0000110010000110--11111110								
Prehensilosergia prehensilis	110100-111010--0000110010000110--11110111								
Scintillosergia scintillans	110100-111010--0000110010000110--11110110								
Challengerosergia challengerii	110100-1110011-0000110010000110--11100110								
Lucenosergia lucens	110100-111010-00000110010000110--11100100								
Deosergestes corniculum	1100-10111000--0000110010000110--11110110								
Eusergestes arcticus	111100-111000--0000110010000110--11110110								

Appendix S3. Continued

<i>Sergestes atlanticus</i>	111100-111000--0000110000000110--11100111
<i>Cornutosergestes cornutus</i>	111100-111000--0000110000000110--11110100
<i>Allosergestes sargassi</i>	1100-10111000--0000110010000110--111100--
<i>Parasergestes armatus</i>	1110-10111000--0000110000000110--11110100
<i>Neosergestes edwardsi</i>	1110-11111000--0000110000000110--11110111

Characters 123 - 168

	123	128	133	138	143	148	153	158	163
<i>Aristaeomorpha foliacea</i>	-----	0	-	0	-----	0	-----	0	-----
<i>Gennadas parvus</i>	-----	0	-	0	-----	0	-----	0	-----
<i>Penaeus monodon</i>	-----	0	-	0	-----	0	-----	0	-----
<i>Lucifer typus</i>	-----	11000	-	0000	-	100	-	0	-----
<i>Lucifer orientalis</i>	-----	11000	-	0000	-	100	-	0	-----
<i>Lucifer intermedius</i>	-----	11	-	00	-	2000	-	0	-----
<i>Lucifer penicillifer</i>	-----	11110	-	2000	-	0	-	0	-----
<i>Lucifer faxoni</i>	-----	11100	-	2000	-	0	-	0	-----
<i>Lucifer chacei</i>	-----	11100	-	2000	-	0	-	0	-----
<i>Lucifer hanseni</i>	-----	11100	-	2000	-	0	-	0	-----
<i>Acetes indicus</i>	-----	11000	-	2000	-	0	-	0	-----
<i>Peisos petrunkevitchi</i>	-----	0	-----	0	-	0	-----	0	-----
<i>Sicyonella maldivensis</i>	000	-	121100110100	-	0	-	0	-----	0
<i>Petalidium obesum</i>	000	-	121100100100	-	0	-	0	-----	0
<i>Sergia tenuiremis</i>	000001011000	-	0000	-	0	-	0	-----	11
<i>Gardinerosergia gardneri</i>	000	-	1011000	-	0000	-	0	-	10211100110110100100211
<i>Phorcosergia phorca</i>	110001011000	-	0000	-	0	-	0	-	10211100001001000010211
<i>Robustosergia robusta</i>	111001011000	-	0000	-	0	-	0	-	10211100110010000000211
<i>Prehensilosergia prehensilis</i>	000001011000	-	0000	-	0	-	0	-	11211100110010000000211
<i>Scintillosergia scintillans</i>	000010	-	0	-	00	-	0	-	11210111110010011001111
<i>Challengerosergia challengerii</i>	000111111000	-	0000	-	0	-	0	-	11100112110010012001111
<i>Lucenosergia lucens</i>	000	-	1011000	-	0100	-	0	-	11000013110010012001111
<i>Deosergestes corniculum</i>	000001011000	-	0000	-	111010	-----	-----	-----	12
<i>Eusergestes arcticus</i>	000	-	1011000	-	0010	-	0	-	1000
<i>Sergestes atlanticus</i>	000001010000	-	1000	-	0	-	1150	-----	10
<i>Cornutosergestes cornutus</i>	000	-	100	-	00	-	0	-	1120
<i>Allosergestes sargassi</i>	--	001011000	-	001110	-	1130	-----	-----	10
<i>Parasergestes armatus</i>	000011010000	-	0000	-	0	-	1140	-----	10
<i>Neosergestes edwardsi</i>	000011210000	-	0000	-	0	-	1160	-----	10