

SUPPLEMENTARY INFORMATION

to accompany

Multiple host switching events shape the evolution of symbiotic palaemonid shrimps (Crustacea: Decapoda)

Ivona Horká, Sammy De Grave, Charles H.J.M. Fransen, Adam Petrušek, Zdeněk Ďuriš

Supplementary Table S1: Details of the analysed specimens and freshly obtained DNA sequences used in the phylogenetic analyses. Used abbreviations and symbols: EA, East Atlantic; WA, West Atlantic; IWP, Indo-West Pacific; MNHN, National Museum of Natural History, France; MTQ, Museum of Tropical Queensland, Australia; NTOU, National Taiwan Ocean University; PNG, Papua New Guinea; RMNH, Naturalis Biodiversity Center, Leiden, the Netherlands; UO, University of Ostrava, Czech Republic; ULLZ, University of Louisiana at Lafayette Zoological Collection, U.S.A; and USVI, U.S. Virgin Island; * - specific host not identified.

Supplementary Table S2: Additional sequences obtained from GenBank and used in the present analyses.

Supplementary Table S3: Alignment length (saturation test for protein-coding genes and GBlock for rRNA genes was applied), character variation, parsimony-informative sites, sample size and evolutionary models used for the genes in this study. Models for protein-coding genes (H3 and COI) are shown for the 1st, 2nd or 3rd codon positions. Used abbreviations: VS – variable sites, PI – parsimony-informative sites, N – number of sequences obtained within this study (with number of sequences used from GenBank in parentheses).

Supplementary Figure S1: Phylogenetic tree of symbiotic Palaemonidae shrimp taxa (including sequences of taxa retrieved from GenBank) resolved by RAxML analysis based on the combined dataset for three genes (COI, 16S, H3). Bootstrap supports >50 are displayed.

Supplementary Table S1: Details of the analysed specimens and freshly obtained DNA sequences used in the phylogenetic analyses.

Analysed taxa	Region	Sampling location	Host	Voucher ID	H3	GenBank accession numbers			
						COI	16S	18S	
PALAEONIDAE Rafinesque, 1815									
Altopontonia Bruce, 1990									
<i>A. disparostris</i> Bruce, 1990	IWP	Norfolk Ridge	no data	RMNH.CRUS.D.51028	KU065026	KM921671	KU064797	N/A	
Ancylomenes Okuno & Bruce, 2010									
<i>A. adularans</i> (Bruce, 2003)	IWP	Madang Bay, PNG	Cnidaria: Actiniaria*	MNH IU-2013-11101	KU065027	KU064944	KU064798	KU064869	
<i>A. aqabai</i> (Bruce, 2008)	IWP	Aqaba, Jordan	Cnidaria: Scyphozoa: <i>Cassiopea andromeda</i>	UO Aq09-26	KU065028	KU064945	KU064799	KU064870	
<i>A. holthuisi</i> Bruce, 1969	IWP	Nhatrang Bay, Vietnam	Cnidaria: Actiniaria: <i>Stichodactyla haddoni</i>	UO V08-21B	KU065029	KU064946	KU064800	KU064871	
<i>A. kobayashii</i> (Okuno & Nomura, 2002)	IWP	Okinawa, Japan	Cnidaria: Actiniaria*	NTOU M01865	KU065030	KU064947	KU064801	KU064872	
<i>A. kuboi</i> Bruce, 2010	IWP	Nhatrang Bay, Vietnam	Cnidaria: Actiniaria: <i>Actinodendron</i> sp.	UO V08-120A	KU065031	KU064948	KU064802	KU064873	
<i>A. luteomaculatus</i> Okuno & Bruce, 2010	IWP	Okinawa, Japan	Cnidaria: Actiniaria*	NTOU M01866	KU065033	KU064950	KU170693	KU170699	
<i>A. magnificus</i> (Bruce, 1979)	IWP	Nhatrang Bay, Vietnam	Cnidaria: Ceriantharia*	UO V08-109	KU065034	KU064951	KU064804	KU064875	
<i>A. pedersoni</i> (Chace, 1958)	WA	St. Thomas, USVI	Cnidaria: Actiniaria: <i>Bartholomea annulata</i>	UO USVI-5	KU065035	KU065003	KU064805	KU064876	
<i>A. speciosus</i> (Okuno, 2004)	IWP	Lizard Island, Australia	Cnidaria: Actiniaria: <i>Heteractis</i> sp.	MTQ W-33108	KU065036	KU064952	KU170694	KU170698	
<i>A. venustus</i> (Bruce, 1989)	IWP	Nhatrang Bay, Vietnam	Cnidaria: Actiniaria: <i>Megalactis</i> sp.	UO V08-79A	KU065037	KU064953	KU064806	KU064877	
Anchiopontonia Bruce, 1992									
<i>A. hurii</i> (Holthuis, 1981)	IWP	Okinawa, Japan	Mollusca: Bivalvia*	NTOU M01830	KU065038	KU064955	N/A	N/A	
Anchistus Borradaile, 1898									
<i>A. custoides</i> Bruce, 1977	IWP	Okinawa, Japan	Mollusca: Bivalvia*	NTOU M01867	KU065039	KU064954	KU064807	KU064878	
Araiopontonia Fujino & Miyake, 1970									
<i>A. odontorhyncha</i> Fujino & Miyake, 1970	IWP	Okinawa, Japan	Echinodermata: Crinoidea*	NTOU M01868	KU065040	KU064956	N/A	N/A	
Ascidonia Fransen, 2002									
<i>A. quasipusilla</i> (Chace, 1972)	WA	Curaçao, West Indies	Tunicata: Ascidiacea: <i>Pyura torpida</i>	RMNH.CRUS.D.57050	KU065041	KU064957	KU064808	N/A	
Brucecaris Marin & Chan, 2007									
<i>B. tenuis</i> (Bruce, 1969)	IWP	Lizard Island, Australia	Echinodermata: Crinoidea*	MTQ W-33309	KU065042	KU064958	KU064809	KU064879	
Conchodytes Peters, 1852									
<i>C. meleagrinae</i> Peters, 1852	IWP	Nhatrang Bay, Vietnam	Mollusca: Bivalvia: <i>Pinctada</i> sp.	UO V08-100	KU065043	KU064959	KU064810	KU064880	
Coralliocaris Stimpson, 1860									
<i>C. superba</i> (Dana, 1852)	IWP	Aqaba, Jordan	Cnidaria: Scleractinia: <i>Acropora</i> sp.	UO Aq09-40	KU065044	KU064960	KU064811	KU064881	
Cuapetes Bruce, 2004									
<i>C. americanus</i> (Kingsley, 1878)	WA	Curaçao, West Indies	Porifera: <i>Desmapsamma anchorata</i>	RMNH.CRUS.D.57051	KU065045	KU064961	N/A	N/A	
<i>C. amyone</i> (De Man, 1902)	IWP	Lizard Island, Australia	Cnidaria: Scleractinia: <i>Acropora</i> sp.	MTQ W-33116	KU065046	KU064962	KU064812	KU064882	
<i>C. grandis</i> (Stimpson, 1860)	IWP	Aqaba, Jordan	free-living	UO Aq09-58A	KU065047	KU064963	KU064813	KU064883	
<i>C. kororensis</i> (Bruce, 1977)	IWP	Lizard Island, Australia	Cnidaria: Scleractinia: <i>Heliofungia actiniformis</i>	MTQ W-33107	KU065048	KU064964	N/A	KU064884	
<i>C. tenuipes</i> (Borradaile, 1898)	IWP	Nhatrang Bay, Vietnam	Cnidaria: Actiniaria: <i>Actinodendron</i> sp.	UO V08-48	KU065049	KU064965	KU064814	KU064885	
Dactyлонia Fransen, 2002									
<i>D. ascidicola</i> (Borradaile, 1898)	IWP	Bali, Indonesia	Tunicata: Ascidiacea: <i>Ascidia</i> sp.	RMNH.CRUS.D.48678	N/A	N/A	KU170688	N/A	
Dasella Lebour, 1945									
<i>D. herdmaniae</i> (Lebour, 1938)	IWP	Sabah, Malaysia	Tunicata: Ascidiacea: <i>Herdmania momus</i>	RMNH.CRUS.D.53924	N/A	KU064966	N/A	N/A	
<i>D. herdmaniae</i> (Lebour, 1938)	IWP	Bali, Indonesia	Tunicata: Ascidiacea: <i>Herdmania momus</i>	RMNH.CRUS.D.49846	N/A	N/A	KU170689	N/A	
Diapontonia Bruce, 1986									
<i>D. maranus</i> Bruce, 1986	WA	Curaçao, West Indies	Echinodermata: Echinoidea: <i>Paleopneustes tholiformis</i>	RMNH.CRUS.D.57052	KU065050	KU064967	KU064815	N/A	
Exoclimenella Bruce, 1995									
<i>E. maldivensis</i> Đuriš & Bruce, 1995	IWP	Lizard Island, Australia	coral rubble	MTQ W-33394	KU065051	KU064968	KU064816	KU064886	
<i>E. sibogae</i> (Holthuis, 1952)	IWP	Lizard Island, Australia	coral rubble	MTQ W-33263	KU065052	KU064969	N/A	KU064887	
<i>E. sudanensis</i> Đuriš & Bruce, 1995	IWP	Aqaba, Jordan	free-living	UO Aq09-6A	KU065053	KU064970	N/A	KU064888	
Hamodactylus Holthuis, 1952									
<i>H. aqabai</i> Bruce & Svoboda, 1983	IWP	Aqaba, Jordan	Cnidaria: Alcyonacea: <i>Dendronephthya</i> sp.	UO Aq09-55	KU065054	KR088750	KU064817	KU064889	
<i>H. noumeae</i> Bruce, 1970	IWP	Lizard Island, Australia	Cnidaria: Alcyonacea: <i>Isis</i> sp.	MTQ W-33246	KU065055	KU064971	N/A	KU064890	
Hamopontonia Bruce, 1970									
<i>H. corallicola</i> Bruce, 1970	IWP	Lizard Island, Australia	Cnidaria: Scleractinia: <i>Goniopora</i> sp.	MTQ W-33307	KU065056	KU064972	KU064818	KU064891	

<i>P. latirostris</i> Holthuis, 1952	IWP	Aqaba, Jordan	Cnidaria: Scleractinia: <i>Galaxea</i> sp.	UO Aq09-45C	KU065099	KU065014	KU064854	KU064928
Pliopontonia Bruce, 1973								
<i>P. furtiva</i> Bruce, 1973	IWP	Nhatrang Bay, Vietnam	Cnidaria: Corallimorpharia: <i>Discosoma</i> sp.	UO V08-20	KU065100	KU065015	KU064855	KU064929
Pontonia Latreille, 1829								
<i>P. pinnophylax</i> (Otto, 1821)	EA	Cape Verde Islands	Mollusca: Bivalvia: <i>Pinna</i> sp.	RMNH.CRUS.D.42607	N/A	N/A	KU170692	N/A
Pontoniopsis Borradaile, 1915								
<i>P. comanthi</i> Borradaile, 1915	IWP	Taiwan	Echinodermata: Crinoidea*	UO Tw12-1	KU065101	KU065016	KU064856	KU064930
Rapipontonia Marin, 2007								
<i>R. galene</i> (Holthuis, 1952)	IWP	Lizard Island, Australia	Cnidaria: Hydrozoa: <i>Macrorhynchia philippina</i>	MTQ W-33104	KU065102	N/A	KU064857	KU064931
Stegopontonia Nobili, 1906								
<i>S. commensalis</i> Nobili, 1906	IWP	Nhatrang Bay, Vietnam	Echinodermata: Echinoidea*	UO V10-47	KU065103	KU065017	KU064858	KU064932
Thaumastocaris Kemp, 1922								
<i>T. streptopus</i> Kemp, 1922	IWP	Aqaba, Jordan	Porifera: Demospongiae: <i>Callyspongia</i> sp.	UO Aq09-15A	KU065105	KU065018	KU064860	KU064934
Tuleariocaris Hipeau-Jacquotte, 1965								
<i>Tuleariocaris</i> sp.	IWP	Aqaba, Jordan	Echinodermata: Echinoidea: <i>Echinothrix diadema</i>	UO Aq09-14	KU065106	N/A	KU064861	KU064935
Typton Costa, 1844								
<i>T. wasini</i> Bruce, 1977	IWP	Lizard Island, Australia	Porifera: Demospongiae: <i>Callyspongia</i> sp.	MTQ W-33302	KU065107	KU065019	KU064862	KU064936
Unguicaris Marin & Chan, 2006								
<i>Unguicaris</i> sp.	IWP	Taiwan	Echinodermata: Crinoidea*	NTOU 6687-09	KU065108	KU065020	KU064863	KU064937
Vir Holthuis, 1952								
<i>V. euphyllius</i> Marin & Anker, 2005	IWP	Nhatrang Bay, Vietnam	Cnidaria: Scleractinia: <i>Euphyllia</i> sp.	UO V10-46	KU065109	KU065021	KU064864	KU064938
<i>V. orientalis</i> (Dana, 1852)	IWP	Lizard Island, Australia	Cnidaria: Scleractinia: <i>Pocillopora</i> sp.	MTQ W-33130	KU065110	KU065022	KU064865	KU064939
<i>V. philippinensis</i> Bruce & Svoboda, 1984	IWP	Nhatrang Bay, Vietnam	Cnidaria: Scleractinia: <i>Plerogyra</i> sp.	UO V10-48	KU065111	KU065023	KU064866	KU064940
Zenopontonia Bruce, 1975								
<i>Z. rex</i> (Bruce, 1967)	IWP	Nhatrang Bay, Vietnam	Echinodermata: Holothuroidea: <i>Holothuria</i> sp.	UO V08-105	KU065112	KU065024	KU064867	KU064941
<i>Z. soror</i> Nobili, 1904	IWP	Nhatrang Bay, Vietnam	Echinodermata: Asteroidea: <i>Culcita</i> sp.	UO V08-111	KU065113	KU065025	KU064868	KU064942
PANDALIDAE Haworth, 1825 (outgroup)								
<i>Miropandalus hardingi</i> Bruce, 1983	IWP	Taiwan	Cnidaria: Antipatharia*	UO Tw11-20A	KU065065	KJ690259	KU064827	KU064901
<i>Chlorotocella gracilis</i> Bals, 1914	IWP	Nhatrang Bay, Vietnam	Porifera: Demospongiae: <i>Callyspongia</i> sp.	UO V10-42	KU065061	KU064977	KU064823	KU064896
STENOPODIDAE Claus, 1872 (outgroup)								
<i>Stenopus hispidus</i> (Olivier, 1811)	IWP	Nhatrang Bay, Vietnam	free-living	UO V10-17	KU065104	KJ690260	KU064859	KU064933

Used abbreviations and symbols: EA, East Atlantic; WA, West Atlantic; IWP, Indo-West Pacific; MNHN, National Museum of Natural History, France; MTQ, Museum of Tropical Queensland, Australia; NTOU, National Taiwan Ocean University; PNG, Papua New Guinea; RMNH, Naturalis Biodiversity Center, Leiden, the Netherlands; UO, University of Ostrava, Czech Republic; and USVI, U.S. Virgin Island; N/A - sequence not available; * - specific host not identified.

Supplementary Table S2: Additional sequences obtained from GenBank and used in the present analyses.

Analysed taxa	GenBank accession numbers			Source
	H3	16S	18S	
Anchiopontonia Bruce, 1992				
<i>A. hurii</i> (Holthuis, 1981)	N/A	KF738358	N/A	2
Araiopontonia Fujino & Miyake, 1970				
<i>A. odontorhyncha</i> Fujino & Miyake, 1970	N/A	KJ019633	N/A	3
Bathymenes Kou, Li & Bruce, 2015				
<i>B. ngi</i> (Li, Mitsuhashi & Chan, 2008)	N/A	JX025182	N/A	4
Cuapetes Bruce, 2004				
<i>C. americanus</i> (Kingsley, 1878)	N/A	EU868701	EU868795	1
<i>C. elegans</i> (Paulson, 1875)	KJ584135	JX025213	N/A	4, 6
Dactyлонia Fransen, 2002				
<i>D. ascidicola</i> (Borradaile, 1898)	KJ584137	N/A	N/A	6
Echinopericlimenes Marin & Chan, 2014				
<i>E. dentidactylus</i> Bruce, 1984	N/A	JX025189	N/A	4
<i>E. hertwigi</i> (Balss, 1913)	KJ019730	JX025186	N/A	4, 5
Gnathophyllum Latreille, 1819				
<i>G. americanum</i> Guérin-Méneville, 1855	KC515075	EU868660	EU868751	1, 5
Harpiliopsis Borradaile, 1917				
<i>H. spinigera</i> (Ortmann, 1890)	KF738319	JX025206	N/A	2, 4
<i>H. beaupresii</i> (Audouin, 1926)	KJ019704	JX025207	N/A	3, 4
Hymenocera Latreille, 1819				
<i>H. picta</i>	JF346328	EU868663	EU868754	1, 7
Laomenes Clark, 1919				
<i>L. ceratophthalmus</i> (Borradaile, 1915b)	KJ019709	JX025203	N/A	3, 4
Palaemonella Dana, 1852				
<i>P. pottsi</i> (Borradaile, 1915)	KF738324	JX025198	N/A	2, 4
Periclimenes G.O. Costa, 1844				
<i>P. affinis</i> (Zehntner, 1894)	KJ019725	JX025193	N/A	3, 4
<i>P. boucheti</i> Li, Mitsuhashi & Chan, 2008	KJ019727	JX025192	N/A	3, 4
<i>P. laccadivensis</i> (Alcock & Anderson, 1894)	KJ019732	JX025184	N/A	3, 4
<i>P. leptunguis</i> Li, Mitsuhashi & Chan, 2008	N/A	JX025183	N/A	4
<i>P. sandybrucei</i> Mitsuhashi & Chan, 2009	N/A	JX025179	N/A	4
Philarius Holthuis, 1952				
<i>P. gerlachei</i> (Nobili, 1905)	KJ019737	JX025177	N/A	3, 4
<i>P. imperialis</i> (Kubo, 1940)	KF738334	JX025176	N/A	3, 4
<i>P. minor</i> Marin & Anker, 2011	N/A	JX025175	N/A	4
Phycomenes Bruce, 2008				
<i>P. cobourgi</i> (Bruce & Coombes, 1995)	KJ019738	JX025174	N/A	3, 4

Sources:

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5. Kou, Q., Li, X. Z., Chan, T.-Y., Chu, K. H. & Gan, Z. B., Molecular phylogeny of the superfamily Palaemonoidea (Crustacea: Decapoda: Caridea) based on mitochondrial and nuclear DNA reveals discrepancies with the current classification. *Invertebr. Syst.* 27, 502-514 (2013).
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Supplementary Table S3: Alignment length (saturation test for protein-coding genes and GBlock for rRNA genes was applied), character variation, parsimony-informative sites, sample size and evolutionary models used for the genes in this study. Models for protein-coding genes (H3 and COI) are shown for the 1st, 2nd or 3rd codon positions. Used abbreviations: VS – variable sites, PI – parsimony-informative sites, N – number of sequences obtained within this study (with number of sequences used from GenBank in parentheses).

Four-gene analysis (90 taxa)

Gene	Length (bp)	VS	PI	N	Models selected by PartitionFinder
H3	293	105	94	89 (2)	GTR+I+ Γ , JC+I, GTR+I+ Γ
COI	436	121	89	85	SYM+I+ Γ , GTR+I+ Γ
16S	467	289	252	80 (5)	GTR+I+ Γ
18S	663	166	96	79 (3)	SYM+I+ Γ
Total	1859	681	531	333 (8)	

Three-gene analysis (112 taxa)

Gene	Length (bp)	VS	PI	N	Models selected by PartitionFinder
H3	293	105	93	102 (15)	GTR+ Γ , JC+I, GTR+I+ Γ
COI	436	121	89	85	SYM+I+ Γ , GTR+I+ Γ
16S	478	307	260	105 (22)	GTR+I+ Γ
Total	1207	533	442	292 (37)	

Supplementary Figure S1.

Phylogenetic tree of symbiotic Palaemonidae shrimp taxa (including sequences of taxa retrieved from GenBank) resolved by RAxML analysis based on the combined dataset for three genes (COI, 16S, H3). Bootstrap supports >50 are displayed.

