

**Phylogenetics reveals the crustacean order Amphionidacea to be larval shrimps  
(Decapoda: Caridea)**

Sammy De Grave<sup>1</sup>, Tin-Yam Chan<sup>2,3</sup>, Ka Hou Chu<sup>4,5</sup>, Chien-Hui Yang<sup>2,\*</sup> & José M. Landeira<sup>6</sup>

<sup>1</sup> Oxford University Museum of Natural History, Oxford, United Kingdom

<sup>2</sup> Institute of Marine Biology, National Taiwan Ocean University, Keelung 20224, Taiwan

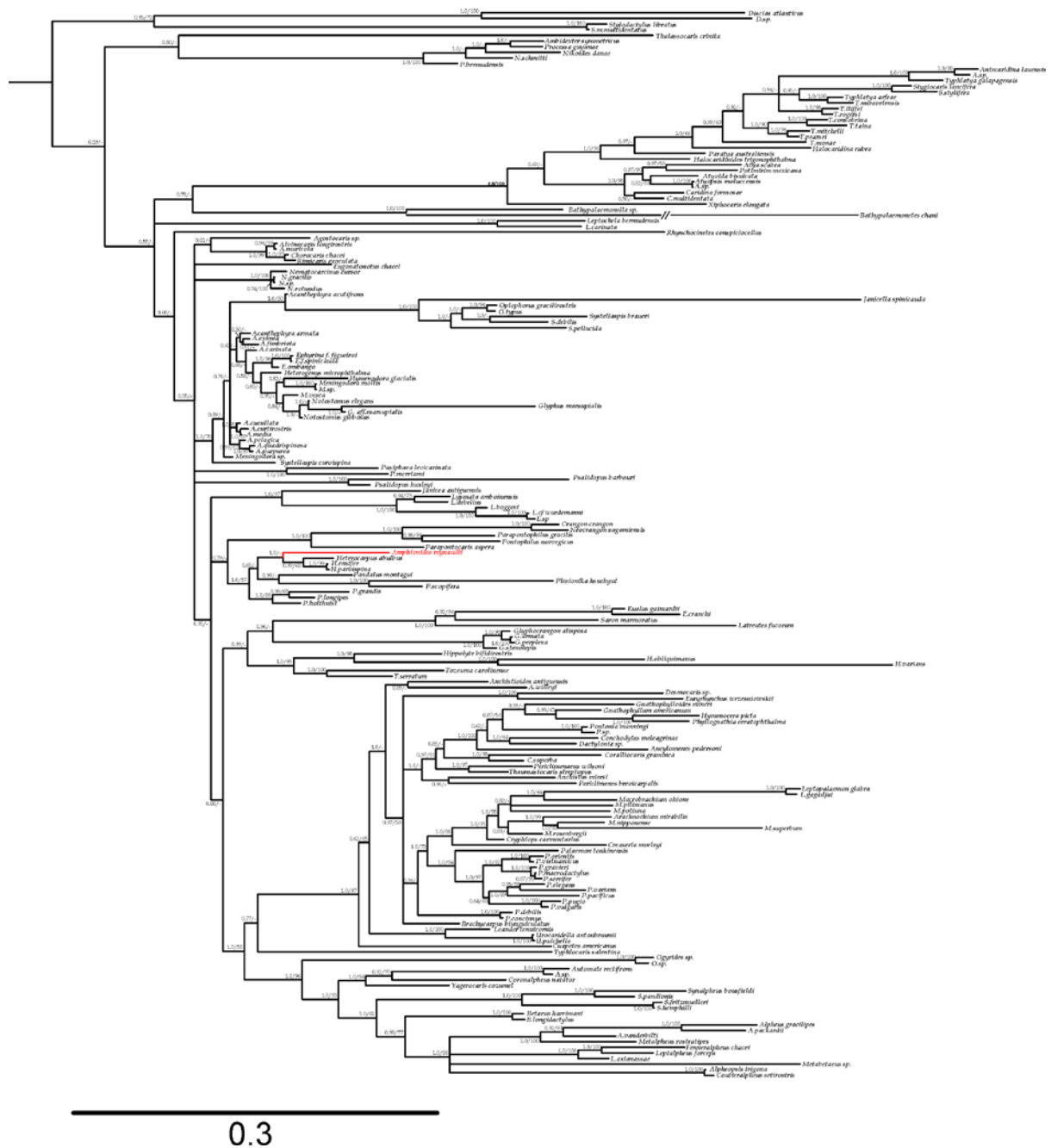
<sup>3</sup> Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung 20224, Taiwan

<sup>4</sup> Simon F.S. Li Marine Science Laboratory, School of Life Sciences, The Chinese University of Hong Kong, Hong Kong, China

<sup>5</sup> Shenzhen Research Institute, The Chinese University Hong Kong, Shenzhen, China

<sup>6</sup> Graduate School of Fisheries Sciences, Hokkaido University, 3-1 Minato, Hakodate, Hokkaido 041-8611, Japan

**Supplementary Figure S1 Full Bayesian phylogram for caridean shrimp taxa and *Amphionides reyaudii*.** Tree based on the concatenated dataset of 16S rRNA and 18S rRNA genes. Bayesian posterior probabilities (Pp) and maximum likelihood bootstrap values (MLb) are represented as percentages above or below the branches. Values <50% are not shown. Representatives of all other infra/suborders within Decapoda were used as outgroups (see Supplementary Table S2), but are not shown.



**Supplementary Table S2** Taxa and GenBank accession numbers used in the two-marker analysis. The latest overall classification scheme of Decapoda was followed<sup>35</sup>, with family level systematics within Caridea updated<sup>23,29,36,37</sup>.

Taxon	GenBank Nos.	
	16S	18S
<b>Amphionidacea</b>		
<i>Amphionides reynaudii</i>	KT699039	KT699040
<b>Euphausiacea</b>		
<i>Euphausia</i> sp.	EU868655	EU868746
<b>Decapod -Dendrobranchiata</b>		
<i>Penaeus semisulcatus</i>	DQ079731	DQ079766
<i>Sergia</i> sp.	EU868710	EU868807
<b>Decapoda-Achelata</b>		
<i>Palinurus argus</i>	AF337966	AY743955
<b>Decapoda-Anomura</b>		
<i>Pagurus longicarpus</i>	AF150756	AF436018
<b>Decapoda-Astacidea</b>		
<i>Enoplometopus occidentalis</i>	AY583892	AY583966
<i>Procambarus clarkii</i>	DQ666844	AF436001
<b>Decapoda-Axiidea</b>		
<i>Lepidophthalmus louisianensis</i>	DQ079717	DQ079751
<b>Decapoda-Brachyura</b>		
<i>Dromia dehaani</i>	AY583899	AY583972
<b>Decapoda-Gebiidea</b>		
<i>Upogebia affinis</i>	AF436047	AF436007
<b>Decapoda-Glypheidea</b>		
<i>Laurentaeglyphea neocaledonica</i>	HQ241517	HQ241528
<b>Decapoda-Polychelida</b>		
<i>Polycheles typhlops</i>	EU920932	EU920950
<b>Decapoda-Procarididea</b>		
<i>Procaris ascensionis</i>	GQ487494	GQ487502
<i>Procaris mexicana</i>	EU868715	EU868811
<b>Decapoda-Stenopodidea</b>		
<i>Stenopus hispidus</i>	AY583884	AY743957
<b>Decapoda-Caridea</b>		
ALPHEIDAE		
<i>Alpheopsis trigona</i>	EU868633	EU868723
<i>Alpheus gracilipes</i>	DQ642885	DQ642859
<i>Alpheus packardii</i>	EU868630	EU868720
<i>Alpheus vanderbilti</i>	EU868639	EU868730
<i>Automate rectifrons</i>	EU868631	EU868721
<i>Automate</i> sp.	EU868635	EU868725
<i>Betaeus harrimani</i>	FJ943434	FJ943440
<i>Betaeus longidactylus</i>	JX010752	JF346263
<i>Coronalpheus natator</i>	EU868636	EU868727
<i>Coutieralpheus</i> sp.	EU868637	EU868728
<i>Fenneralpheus chacei</i>	EU868638	EU868729
<i>Leptalpheus axianassae</i>	EU868671	EU868764
<i>Leptalpheus forceps</i>	EU868670	EU868763
<i>Metabetaeus</i> sp.	FJ943435	FJ943441
<i>Metalpheus rostratipes</i>	KF023115	JF346264
<i>Synalpheus bousfieldi</i>	EU868646	EU868737
<i>Synalpheus fritzmulleri</i>	EU868642	EU868733

<i>Synalpheus hemphilli</i>	EU868643	EU868734
<i>Synalpheus pandionis</i>	EU868647	EU868738
<i>Yagerocaris cozumel</i>	EU868645	EU868736
BARBOURIIDAE		
<i>Janicea antiquensis</i>	KF023112	JF346262
HIPPOLYTIDAE		
<i>Hippolyte bifidirostris</i>	EU920927	EU920939
<i>Hippolyte obliquimanus</i>	EU868661	EU868752
<i>Hippolyte varians</i>	EU868662	EU868753
<i>Latreutes fucorum</i>	EU868664	EU868755
<i>Saron marmoratus</i>	KF023102	JF346244
<i>Tozeuma carolinense</i>	EU868669	EU868760
<i>Tozeuma serratum</i>	EU868668	EU868759
THORIDAE		
<i>Eualus gaimardii</i>	EU920923	EU920940
<i>Eualus cranchii</i>	EU868667	EU868758
LYSMATIDAE		
<i>Lysmata boggei</i>	DQ079719	DQ079753
<i>Lysmata debelius</i>	DQ079718	DQ079752
<i>Lysmata cf. wurdemanni</i>	EU868666	EU868757
<i>Lysmata sp.</i>	EU868665	EU868756
OGYRIDIDAE		
<i>Ogyrides sp.1</i>	EU868679	EU868772
<i>Ogyrides sp.2</i>	EU868680	EU868773
ATYIDAE		
<i>Antecaridina lauensis</i>	EU123851	HE801016
<i>Antecaridina sp.</i>	EF173754	EF173850
<i>Atya scabra</i>	EU868632	EU868722
<i>Atyoida bisulcata</i>	DQ079704	DQ079738
<i>Atyopsis moluccensis</i>	DQ681281	JF346252
<i>Atyopsis sp.</i>	EU868634	EU868724
<i>Caridina formosae</i>	DQ478496	GQ131924
<i>Caridina multidentata</i>	DQ478505	JF346236
<i>Halocaridina rubra</i>	EF173749	EF173848
<i>Halocaridinides trigonophthalma</i>	EF173752	EF173849
<i>Paratya australiensis</i>	EU868640	EU868731
<i>Potimirim mexicana</i>	EU868641	EU868732
<i>Stygiocaris lancifera</i>	EU123831	HE801019
<i>Stygiocaris stylifera</i>	EU123839	HE801020
<i>Typhlatya arfeae</i>	HE801000	HE801025
<i>Typhlatya consobrina</i>	HE801011	HE801028
<i>Typhlatya iliffei</i>	HE800998	HE801023
<i>Typhlatya galapagensis</i>	HE800991	HE801017
<i>Typhlatya miravetensis</i>	HE800999	HE801024
<i>Typhlatya mitchelli</i>	EU868644	EU868735
<i>Typhlatya monae</i>	HE801001	HE801026
<i>Typhlatya pearsei</i>	DQ079735	DQ079770
<i>Typhlatya rogersi</i>	HE801002	HE801027
<i>Typhlatya taina</i>	HE801005	HE801029
AGOSTOCARIDIDAE		
<i>Agostocaris sp.</i>	EU868626	EU868716
ALVINOCARIDIDAE		
<i>Alvinocaris longirostris</i>	JQ035659	JF346247
<i>Alvinocaris muricola</i>	EU868628	EU868718
<i>Chorocaris chacei</i>	AM087922	AM087653
<i>Rimicaris exoculata</i>	AM076958	AM087652
DISCIADIDAE		
<i>Discias atlanticus</i>	EU868652	EU868743

<i>Discias</i> sp.	EU920921	EU920941
BATHYPALAEONELLIDAE		
<i>Bathypalaemonella</i> sp.	EU868648	EU868739
<i>Bathypalaemonetes chani</i>	GQ131910	GQ131933
CRANGONIDAE		
<i>Crangon crangon</i>	EU868649	EU868740
<i>Neocrangon sagamiensis</i>	KF023106	GQ131936
<i>Parapontocaris aspera</i>	KF023107	JF346235
<i>Parapontophilus gracilis</i>	EU868650	EU868741
<i>Pontophilus norvegicus</i>	GQ487496	GQ487504
GLYPHOCRANGONIDAE		
<i>Glyphocrangon alispina</i>	EU868656	EU868747
<i>Glyphocrangon armata</i>	HQ241513	HQ241525
<i>Glyphocrangon perplexa</i>	KF023104	JF346255
<i>Glyphocrangon stenolepis</i>	KF023103	JF346241
EUGONATONOTIDAE		
<i>Eugonatonotus chacei</i>	EU868653	EU868744
NEMATOCARCINIDAE		
<i>Nematocarcinus cursor</i>	EU868673	EU868766
<i>Nematocarcinus gracilis</i>	KP075927	KP075825
<i>Nematocarcinus rotundus</i>	EU868672	EU868765
<i>Nematocarcinus</i> sp.	GQ131895	GQ131919
RHYNCHOCINETIDAE		
<i>Rhynchocinetes conspicioellus</i>	GQ131914	JF346243
XIPHOCARIDIDAE		
<i>Xiphocaris elongata</i>	EU868714	EU868809
OPOPHORIDAE		
<i>AcanthePHYRA acutifrons</i>	KP075878	KP075829
<i>AcanthePHYRA armata</i>	KP075894	KP075786
<i>AcanthePHYRA carinata</i>	KP075896	KP075798
<i>AcanthePHYRA cucullata</i>	KP075893	KP075809
<i>AcanthePHYRA curtirostris</i>	EU868676	EU868769
<i>AcanthePHYRA eximia</i>	KP075897	KP075823
<i>AcanthePHYRA fimbriata</i>	KP075895	KP075788
<i>AcanthePHYRA media</i>	KP075892	KP075805
<i>AcanthePHYRA pelagica</i>	KP075881	KP075808
<i>AcanthePHYRA purpurea</i>	EU868677	EU868770
<i>AcanthePHYRA quadrispinosa</i>	KP075886	KP075821
<i>Ephyrina figueirai</i>	AM076960	AM087654
<i>Ephyrina figueirai spinicauda</i>	KP075911	KP075800
<i>Ephyrina ombango</i>	KP075915	KP075810
<i>Heterogenys microphthalmia</i>	KP075898	KP075787
<i>Hymenodora glacialis</i>	KP075908	KP075828
<i>Janicella spinicauda</i>	KP075933	KP075858
<i>Meningodora mollis</i>	KP075910	KP075783
<i>Meningodora vesca</i>	KP075907	KP075791
<i>Meningodora</i> sp.1	EU868678	EU868771
<i>Meningodora</i> sp.2	GQ131890	GQ131931
<i>Notostomus elegans</i>	KP075901	KP075797
<i>Notostomus gibbosus</i>	KP075905	GQ131917
<i>Oplophorus gracilirostris</i>	KP075922	KP075848
<i>Oplophorus typus</i>	KP075923	KP075835
<i>Systellaspis braueri</i>	KP075926	KP075853
<i>Systellaspis curvispina</i>	KP075916	KP075784
<i>Systellaspis debilis</i>	EU868682	EU868775
<i>Systellaspis pellucida</i>	KP075925	KP075857
ANCHISTIOIDIDAE		
<i>Anchistioides antiguensis</i>	EU868629	EU868719

<i>Anchistoides willeyi</i>	DQ642883	DQ642857
DESMOCARIDIDAE		
<i>Desmocarid sp.</i>	EU868651	EU868742
EURYRHYNCHIDAE		
<i>Euryrhynchus wrzesniowski</i>	EU868654	EU868745
PALAEONIDAE		
<i>Anchistus miersi</i>	DQ642877	DQ642851
<i>Ancylomenes pedersoni</i>	KM071741	AY743954
<i>Arachnochium mirabilis</i>	KC515033	KC515052
<i>Brachycarpus biunguiculatus</i>	EU868686	EU868778
<i>Conchodytes meleagrinae</i>	KC515051	EF540837
<i>Coralliocaris graminea</i>	KF738361	AM083319
<i>Coralliocaris superba</i>	DQ642880	DQ642854
<i>Creaseria morleyi</i>	DQ079710	DQ079746
<i>Cuapetes americanus</i>	EU868701	EU868795
<i>Cryphiops caementarius</i>	DQ079711	DQ079747
<i>Dactylonia sp.</i>	DQ642876	DQ642850
<i>Gnathophylloides mineri</i>	EU868659	EU868750
<i>Gnathophyllum americanum</i>	EU868660	EU868751
<i>Hymenocera picta</i>	EU868663	EU868754
<i>Leander tenuicornis</i>	EU868690	EU868783
<i>Leptopalaemon gagadju</i>	EU868693	EU868787
<i>Leptopalaemon glabra</i>	EF588318	EU249463
<i>Macrobrachium nipponense</i>	HQ830201	DQ531769
<i>Macrobrachium ohione</i>	EU868694	EU868788
<i>Macrobrachium pilimanus</i>	GQ487497	GQ487505
<i>Macrobrachium potiuna</i>	DQ079721	DQ079756
<i>Macrobrachium rosenbergii</i>	GQ131903	GQ131934
<i>Macrobrachium superbum</i>	KC515041	KC515055
<i>Palaemon concinnus</i>	KC515043	KC515056
<i>Palaemon debilis</i>	KC515044	KC515057
<i>Palaemon elegans</i>	EU868696	EU868790
<i>Palaemon gravieri</i>	KC515045	KC515058
<i>Palaemon macrodactylus</i>	DQ642875	DQ642849
<i>Palaemon pacificus</i>	KC515046	KC515059
<i>Palaemon serrifer</i>	KC515048	KC515060
<i>Palaemon orientis</i>	KC515036	KC515053
<i>Palaemon pugio</i>	EU868697	EU868791
<i>Palaemon tonkinensis</i>	EU920920	EU920937
<i>Palaemon varians</i>	JQ042301	KC763180
<i>Palaemon vietnamicus</i>	KC515037	KC515054
<i>Palaemon vulgaris</i>	JQ042300	AY743941
<i>Periclimenaeus wilsoni</i>	EU868702	EU868797
<i>Periclimenes brevicarpalis</i>	DQ642879	DQ642853
<i>Phyllognathia ceratophthalma</i>	DQ642873	DQ642847
<i>Pontonia manningi</i>	EU868705	EU868800
<i>Pontonia sp.</i>	EU868706	EU868801
<i>Thaumastocaris streptopus</i>	DQ642878	DQ642852
<i>Urocaridella antonbruunii</i>	KC515049	KC515061
<i>Urocaridella pulchella</i>	KC515050	KC515062
TYPHLOCARIDIDAE		
<i>Typhlocaris salentina</i>	EU868713	EU868808
PANDALIDAE		
<i>Heterocarpus abulbus</i>	KF023186	JF346257
<i>Heterocarpus ensifer</i>	KP075930	KP075776
<i>Heterocarpus parvispina</i>	HQ241514	HQ241526
<i>Pandalus montagui</i>	GQ487498	GQ487506
<i>Plesionika grandis</i>	KF023113	JF346258

<i>Plesionika holthuisi</i>	EU868703	EU868798
<i>Plesionika hsuehyui</i>	AM076968	AM083322
<i>Plesionika longipes</i>	EU868704	EU868799
<i>Plesionika scopifera</i>	HQ241519	HQ241530
THALASSOCARIDIDAE		
<i>Thalassocaris crinita</i>	EU868712	EU868810
PASIPHAEIDAE		
<i>Glyphus marsupialis</i>	KP075861	KP075775
<i>Glyphus</i> aff. <i>marsupialis</i>	KP075902	KP075772
<i>Leptochela bermudensis</i>	EU868691	EU868785
<i>Leptochela carinata</i>	EU868692	EU868786
<i>Pasiphaea levicarinata</i>	GQ131899	GQ131921
<i>Pasiphaea merriami</i>	EU868700	EU868796
PROCESSIDAE		
<i>Ambidexter symmetricus</i>	EU868683	EU868776
<i>Nikoides danae</i>	FJ943436	FJ943442
<i>Nikoides schmitti</i>	EU868695	EU868789
<i>Processa bermudensis</i>	GQ487499	GQ487507
<i>Processa guyanae</i>	EU868708	EU868803
PSALIDOPODIDAE		
<i>Psalidopus barbouri</i>	EU868709	EU868804
<i>Psalidopus huxleyi</i>	GQ131898	GQ131923
STYLODACTYLIDAE		
<i>Stylodactylus libratus</i>	AM076943	AM083323
<i>Stylodactylus multidentatus multidentatus</i>	EU868711	EU868806