

Table S1 Number of unique UCE loci recovered from *in-silico* samples for 65/65 % coverage/identity percentage thresholds when matching UCE probes to contigs and number of UCE loci retained in a 50% taxon coverage matrix after trimming and filtering. Species in bold were used for probe set design

Higher taxonomy	Species	GenBank accession No.	# UCEs (raw)	# UCEs (final)
Brachyura: Portunidae	<i>Callinectes sapidus</i>	GCA 020233015.1	1,026	784
Brachyura: Portunidae	<i>Portunus trituberculatus</i>	GCA 017591435.1	1,112	850
Brachyura: Oregoniidae	<i>Chionoecetes opilio</i>	GCA 016584305.1	1,155	837
Brachyura: Varunidae	<i>Eriocheir sinensis</i>	GCA 013436485.1	1,167	863
Anomura: Coenobitidae	<i>Birgus latro</i>	GCA 018397915.1	1,196	840
Anomura: Lithodidae	<i>Paralithodes camtschaticus</i>	GCA 018397895.1	949	682
Astacidea: Cambaridae	<i>Procambarus clarkii</i>	GCA 020424385.2	1,156	828
Astacidea: Nephropidae	<i>Homarus americanus</i>	GCA 018991925.1	1,190	852
Astacidea: Parastacidae	<i>Cherax destructor</i>	GCA 009830355.1	1,023	744
Achelata: Palinuridae	<i>Panulirus ornatus</i>	GCA 018397875.1	1,175	836
Caridea: Atyidae	<i>Caridina multidentata</i>	GCA 002091895.1	919	680
Caridea: Palaemonidae	<i>Macrobrachium nipponense</i>	GCA 015104395.1	994	682
Dendrobranchiata: Penaeidae	<i>Penaeus japonicus</i>	GCA 017312705.2	1,098	845
Isopoda: Armadillidiidae	<i>Armadillidium vulgare</i>	GCA 004104545.1	840	569
Isopoda: Cirolanidae	<i>Bathynomus jamesi</i>	GCA 023014485.1	805	567
Isopoda: Idoteidae	<i>Idotea balthica</i>	GCA 023373965.1	704	509
Amphipoda: Hyalidae	<i>Parhyale hawaiiensis</i>	GCA 001587735.2	851	556
Amphipoda: Hyalellidae	<i>Hyalella azteca</i>	GCA 000764305.4	1,015	665
Amphipoda: Gammaridae	<i>Gammarus roeseli</i>	GCA 016164225.1	946	619
Branchiopoda: Artemiidae	<i>Artemia franciscana</i>	GCA 019857095.1	381	143
Copepoda: Temoridae	<i>Eurytemora affinis</i>	GCA 000591075.2	452	115

Table S2 Assembly and UCE extraction summary statistics for the *Eumunida* dataset, including the number of assembled contigs, the number of raw UCE loci recovered from contigs, the length of the raw UCE loci, and the final number of UCE loci in a 50% taxon coverage matrix after trimming and filtering. Small letters appended to voucher numbers (*a* or *b*) denote different individuals from multi-specimen lots. Samples marked with an asterisk are included in the subset of Western Indian Ocean species, used to assess species-level variation via a “smiogram” (see Figure 2 in the main manuscript).

Species	Voucher/ Sample ID	Year	contigs	UCEs (raw)	Locus length (bp)			UCEs (final)
					mean	min	max	
<i>Eumunida</i> aff. <i>annulosa</i>	MNHN-IU-2011-8607	2011	108,038	1,026	439.9	220	6,328	416
<i>Eumunida annulosa</i>	MNHN-IU-2012-469	2001	208,899	962	409.8	71	2,840	383
<i>Eumunida balssi</i>	USNM 150463	1920	10,556	272	282.0	229	734	144
<i>Eumunida bella</i>	MNHN-IU-2021-311	1963	1,878	31	285.5	80	1,043	8
<i>Eumunida bispinata</i> [†]	MNHN-IU-2011-5547	1973	3,014	28	256.8	231	508	18
<i>Eumunida bispinata</i> [†]	MNHN-IU-2016-7024	2017	143,437	1,103	540.6	230	4,642	424
<i>Eumunida capillata</i>	CAS:IZ:190358a	1979	474,225	1,013	939.0	231	7,641	434
<i>Eumunida capillata</i>	CAS:IZ:190358b	1979	417,814	1,047	930.1	232	5,465	428
<i>Eumunida capillata</i>	USNM 277774	1989	223	14	235.3	80	281	5
<i>Eumunida capillata</i>	USNM 243943a	1986	95	8	229.6	80	344	1
<i>Eumunica capillata</i>	USNM 243943b	1986	117	10	210.1	79	268	2
<i>Eumunida capillata</i>	USNM 1457346	2017	334,765	1,048	1,249.3	231	6,422	451
<i>Eumunida depressa</i>	MNHN-IU-2014-10256	1979	16,507	71	267.7	80	452	20
<i>Eumunida dofleini</i>	USNM 1188905	1906	264	8	190.4	80	298	1
<i>Eumunida funambululus</i>	MNHN-IU-2011-5558	1976	22,850	81	255.8	89	334	36
<i>Eumunida keiji</i>	MNHN-IU-2011-5528	1985	5,025	15	242.1	83	332	6
<i>Eumunida keiji</i>	MNHN-IU-20212-750b	2020	25,113	1,078	895.8	231	5,011	443
<i>Eumunida keiji</i>	MNHN-IU-20212-750a	2020	152,772	853	1,278.2	233	7,116	401
<i>Eumunida</i> aff. <i>keiji</i>	USNM 1188639	1972	199,092	1,082	783.4	229	5,385	434
<i>Eumunida leavimana</i>	MNHN-IU-2011-5524	2001	53,206	905	357.7	83	5,023	396
<i>Eumunida laevimana</i>	MNHN-IU-2012-310	1991	7,631	110	287.0	229	509	29
<i>Eumunida macphersoni</i>	MNHN-IU-2014-10805	1979	2,087	20	299.8	80	538	2
<i>Eumunida marginata</i>	MNHN-IU-2011-5446	2001	3,771	59	259.0	83	372	29
<i>Eumunida minor</i> [†]	CAS:IZ:190357	2010	745,615	1,044	1,166.4	322	7,807	440
<i>Eumunida minor</i> [†]	MNHN-IU-2014-19256	2010	116,423	1,009	378.8	219	5,756	396
<i>Eumunida multilineata</i>	MNHN-IU-2011-5549	1984	1,967	25	262.7	83	461	7
<i>Eumunida multispina</i> [†]	H036 [‡]	2019	356,376	1,149	684.0	256	4,243	455
<i>Eumunida multispina</i> [†]	H037 [‡]	2019	143,500	796	1,038.8	234	4,374	372

Species	Voucher/ Sample ID	Year	contigs	UCEs (raw)	Locus length (bp)		UCEs (final)	
					mean	min		
<i>Eumunida pacifica</i>	MNHN-IU-2014-23737	1991	110,384	973	398.2	171	3,215	381
<i>Eumunida cf. pacifica</i>	MCZ:IZ:153356	2019	510,382	1,043	1,292.4	81	12,599	452
<i>Eumunida cf. pacifica</i>	MCZ:IZ:153353	2019	331,230	142	1,338.7	256	3,853	75
<i>Eumunida picta</i>	MNHN-IU-2013-19053	2015	38,721	1,012	397.6	83	3,963	440
<i>Eumunida aff. picta</i>	USNM 1604206	2017	123,341	1,108	1,038.4	240	4,878	467
<i>Eumunida proprior</i>	USNM 150335	1909	16,902	623	287.4	219	502	286
<i>Eumunida similior</i> [†]	MNHN-IU-2011-5516	1972	6,375	57	315.9	78	3,409	27
<i>Eumunida smithii</i>	MNHN-IU-2014-5678	1991	2,366	10	258.0	83	430	2
<i>Eumunida smithii</i>	MNHN-IU-2021-2751	2020	300,040	743	1,332.0	231	6,363	348
<i>Eumunida spinosa</i>	MNHN-IU-2014-5682	2003	124,762	1,147	1,016.5	249	5,034	423
<i>Eumunida spiridonovi</i> [†]	MNHN-IU-2016-8714	1983	214,685	77	1,096.9	242	8,866	44
<i>Eumunida squamifera</i>	H001 [‡]	2022	167,849	1,141	782.7	238	6,430	455
<i>Eumunida squamifera</i>	MNHN-IU-2012-283	1984	17,724	451	288.2	229	1,762	220
<i>Eumunida sternomaculata</i>	MNHN-IU-2013-14824	1987	130,497	996	481.8	229	3,808	382
<i>Eumunida treguieri</i>	MNHN-IU-2011-5445	1991	18,337	308	302.4	80	1,956	161
<i>Eumunida turbulenta</i>	MNHN-IU-2014-21174	2003	14,817	267	296.0	83	5,426	144
<i>Eumunida sp.</i>	CAS:IZ:1151811	1998	5,411	38	293.2	80	1,646	12
<i>Eumunida sp.</i>	USNM 1424077	2016	193,075	1,123	448.8	230	3,651	466
<i>Eumunida sp.</i>	USNM 1490646	2018	6,503	1,094	278.4	80	1,061	458
<i>Pseudomunida fragilis</i>	MCZ:IZ:151084	2018	84,402	957	1,284.1	229	6,068	421

[†] Sample included in the subset of Western Indian Ocean species, used to assess species-level variation via a “smilogram” (see Figure 2 in the main manuscript)

[‡] Uncatalogued specimens, internal specimen ID provided

Table S3 Assembly and UCE extraction summary statistics for the *Aratus pisonii* dataset, including sampling locality, the number of assembled contigs, the number of raw UCE loci recovered from contigs, the length of the raw UCE loci, and the final number of UCE loci in a 50% taxon coverage matrix after trimming and filtering. Lowercase letters appended to voucher numbers (a to e) denote different individuals from multi-specimen lots.

Locality	Voucher	Year	contigs	UCEs (raw)	Locus length (bp)			UCEs (final)
					mean	min	max	
Hollywood, FL	MCZ:IZ:161741a	2021	1,359,477	947	1,435.6	249	8,369	776
Hollywood, FL	MCZ:IZ:161741b	2021	1,190,925	1,007	1,181.5	308	6,790	757
Hollywood, FL	MCZ:IZ:161741c	2021	1,671,386	1,017	1,643.4	462	7,762	793
Hollywood, FL	MCZ:IZ:161742b	2021	1,205,609	971	1,241.6	334	8,747	758
Hollywood, FL	MCZ:IZ:161742c	2021	1,450,070	865	1,676.4	240	9,294	727
Hollywood, FL	MCZ:IZ:161742d	2021	1,241,967	942	1,318.4	337	5,837	757
Hollywood, FL	UF 11375a	2005	4,922	15	328.1	80	1,605	5
Hollywood, FL	UF 11375b	2005	26,001	94	276.6	80	497	50
Hollywood, FL	UF 11375c	2005	31,463	111	283.5	229	1,254	81
Hollywood, FL	UF 32623a	2005	94,498	296	319.3	229	3,812	180
Miami, Virginia Key, FL	MCZ:IZ:161740a	2021	1,252,535	917	1,370.4	311	12,252	766
Miami, Virginia Key, FL	MCZ:IZ:161740b	2021	1,427,479	897	1,591.4	392	6,538	748
Miami, Virginia Key, FL	MCZ:IZ:161740c	2021	1,329,040	960	1,384.4	347	6,977	766
Miami, Virginia Key, FL	MCZ:IZ:161740d	2021	1,318,555	918	1,436.3	392	7,089	760
Miami, Virginia Key, FL	MCZ:IZ:161740e	2021	1,180,088	994	1,187.2	310	10,072	765
Miami, Virginia Key, FL	USNM 25559a	1901	1,674	8	209.3	80	278	2
Miami, Virginia Key, FL	USNM 25559b	1901	17,990	65	276.8	80	801	35
Miami, Virginia Key, FL	USNM 25559c	1901	18,661	68	274.4	83	1,014	35
Miami, Key Biscayne, FL	MCZ:IZ:161739b	2021	1,517,363	934	1,624.6	403	7,093	765
Miami, Key Biscayne, FL	MCZ:IZ:161739c	2021	1,244,634	973	1,279.2	230	5,745	764
Miami, Key Biscayne, FL	MCZ:IZ:161739d	2021	1,123,724	954	1,177.9	269	6,594	749
Miami, Key Biscayne, FL	MCZ:IZ:6194a	1859	6,295	26	242.1	80	342	14
Miami, Key Biscayne, FL	MCZ:IZ:6194b	1859	5,493	21	261.6	80	340	9

Figure S1 Phylogenetic hypothesis (maximum-likelihood) for Malacostraca, based on a partitioned analysis of a 50% taxon-coverage matrix of 897 UCEs. Collection years are given for historical samples, "(NCBI)" denotes *in-silico* samples. Bootstrap values are given for nodes with support < 100%

