

## **Molecular barcoding of the Persian Gulf mangrove associated brachyuran crabs**

### **Supplementary Material**

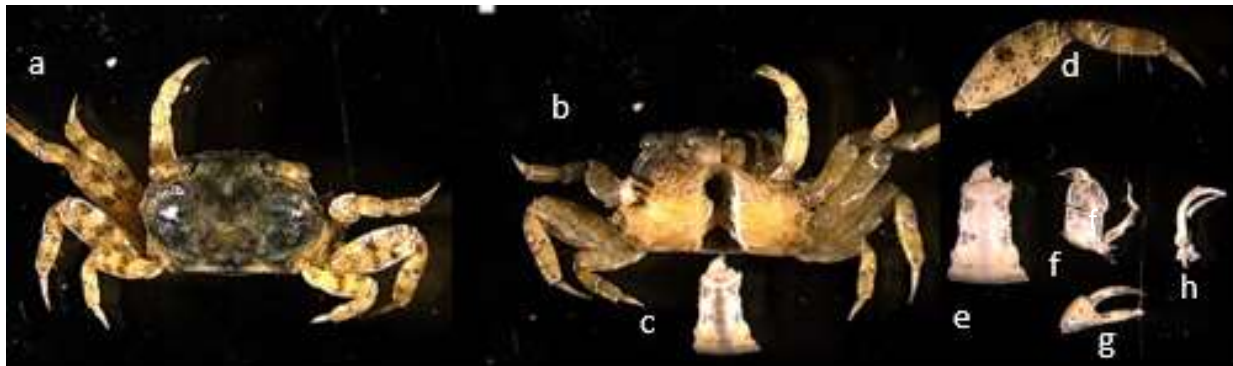
Supplementary Figures 1-8

Supplementary Tables 1-4

**Morphological features of dominant mangrove crabs of Persian Gulf and Sea of Oman**  
**Camptandriidae:**

For Camptandriidae, some key features included carapace subquadrate to subovate, eyestalks slender, long with long plumy setae, third maxillipeds with narrow gap between, merus as long as or longer than ischium, Chelipeds nearly equal, margin serrated with long setae, fingers long, usually twice of palm length, fingers sharply blade-shaped apically. Walking legs long, robust, setose, less setose in females, third one largest. G1 long, characteristically bent apically to mesial direction, with robust subapical spines (Supplementary Figure 1, 2).

**Sesarmidae:** For *P. persicum*, carapace quadrate to subquadrate, moderately thick, anterolateral margins of carapace entire, without dentation, third maxillipeds with broad rhomboidal gap between, mandibles visible when third maxillipeds closed, chelipeds robust, walking legs robust, distinctly flattened, usually armed with spines and bristles, G1 robust, nearly straight, usually with dense setae on apical part (Supplementary Figure 2).

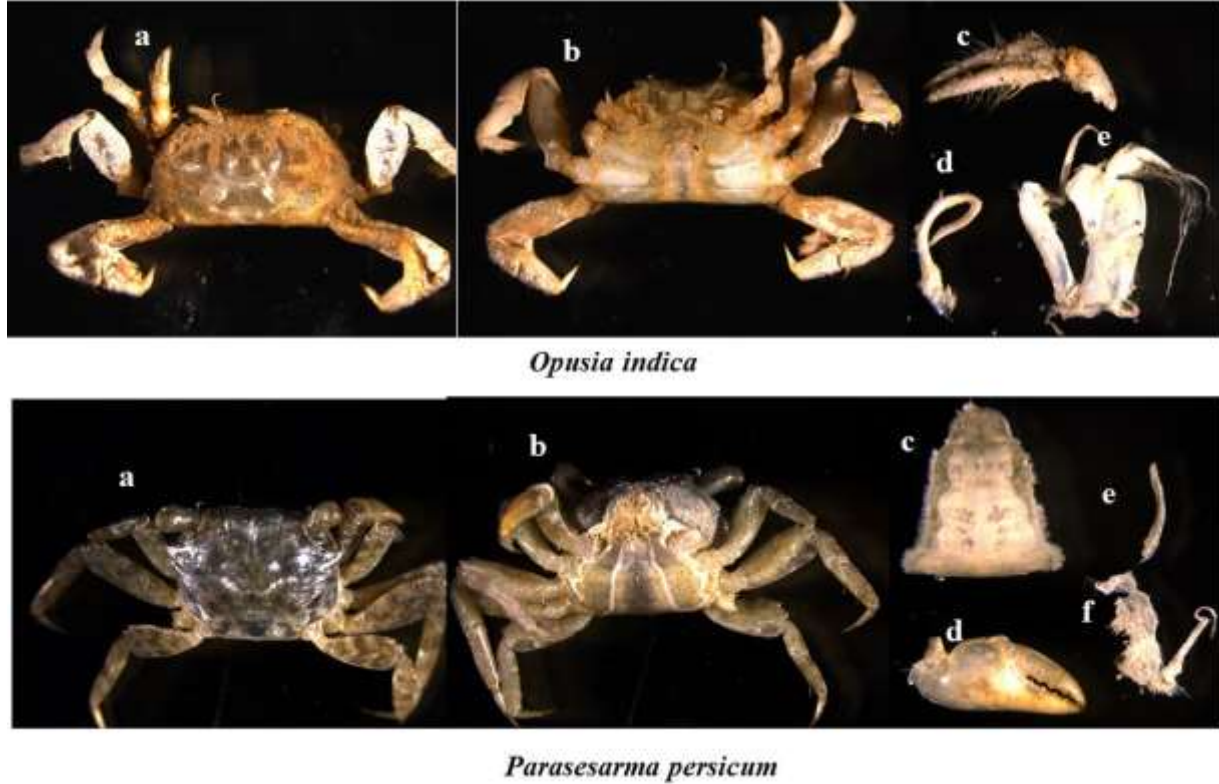


*Manningis arabicum*



*Nasima dotilliformes*

**Supplementary Figure 1.** *Manningis arabicum*. a) Posterior surface, b) ventral surface, c,e) abdomen, d) propodus of third, f) third maxilliped, g) cheliped, and h) gonopod 1. *Nasima dotilliformis*, a) ventral surface, b,d) abdomen, c) posterior surface, e) gonopod 1, f) third maxilliped, and g) propodus of third.



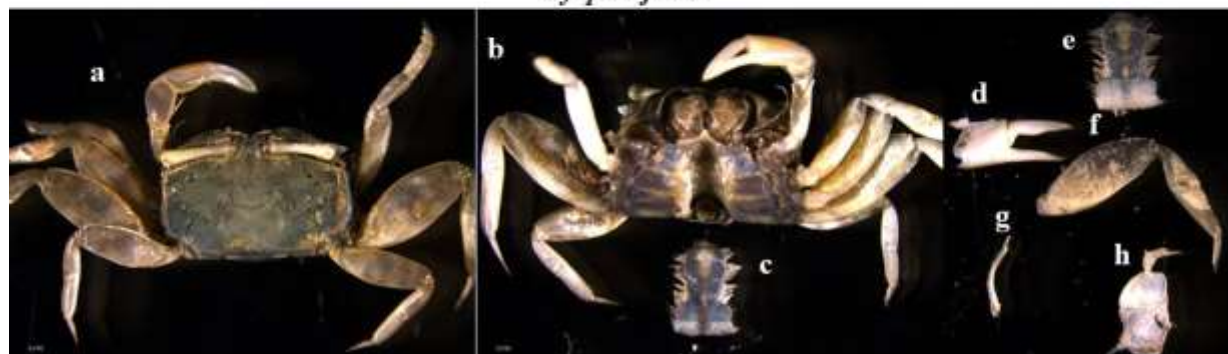
**Supplementary Figure 2.** *Opusia indica*. a) Posterior surface, b) ventral surface, c) cheliped, d) gonopod 1, and e) third maxilliped. *Parasesarma persicum*. a) Posterior surface, b) ventral surface, c) abdomen, d) cheliped, e) gonopod 1, and f) third maxilliped.

**Dotillidae:**

Dotillid crabs showed carapace subglobular, squarish or transversely rectangular, and relatively thick. Eyestalks elongate, exposed. Third maxillipeds swollen, with narrow gap between, merus as large as or larger than ischium. Chelipeds markedly robust, equal to slightly subequal, palm and carpus distinctly enlarged, fingers long, apically pointed. Walking legs relatively large, flat, setal tufts between first and second walking legs. G1 with apical long process, characteristically curved medially, apically serrated with long spines (Supplementary Figure 3, 4).



*Ilyoplax frater*



*Ilyoplax stevensi*

**Supplementary Figure 3.** *Ilyoplax frater*. a) Posterior surface, b) ventral surface, c) cheliped, d) third maxilliped, f) abdomen, and e) gonopod 1. *Ilyoplax stevensi*. a) Posterior surface, b) ventral surface, c, e) abdomen, d) cheliped, f) propodus of third and h) third maxilliped.



*Dotilla blanfordi*



*Scopimera crabricauda*

**Supplementary Figure 4.** *Dotilla blanfordi*. a) Posterior surface, b) ventral surface, c) abdomen, d) cheliped and e) third maxilliped (*Scopimera crabricauda*). a) Posterior surface, b) ventral surface, c) propodus of third, d) cheliped, e) third maxilliped and f) gonopod 1.

**Macrophthalmidae:**

Some key features for *Ilyograpsus sp* from Macrophthalmidae was carapace with four teeth on anterolateral margins, second tooth blunt, longer than third one, no setal patch on inner surface of cheliped palm, front about 0.4 time as broad as carapace (Supplementary Figure 5).



*Ilyograpsus sp*

**Supplementary Figure 5.** *Ilyograpsus sp.* a) Posterior surface, b) ventral surface, c) abdomen, d) cheliped, e) gonopod 1 and f) third maxilliped.

### Ocypodidae:

Ocypodid crabs showed carapace quadrate, transversely rectangular, third maxillipeds completely covering buccal cavern, chelipeds characteristically unequal, larger cheliped always longer than carapace, sexually dimorphic, walking legs comparatively slender, long (Supplementary Figure 6).

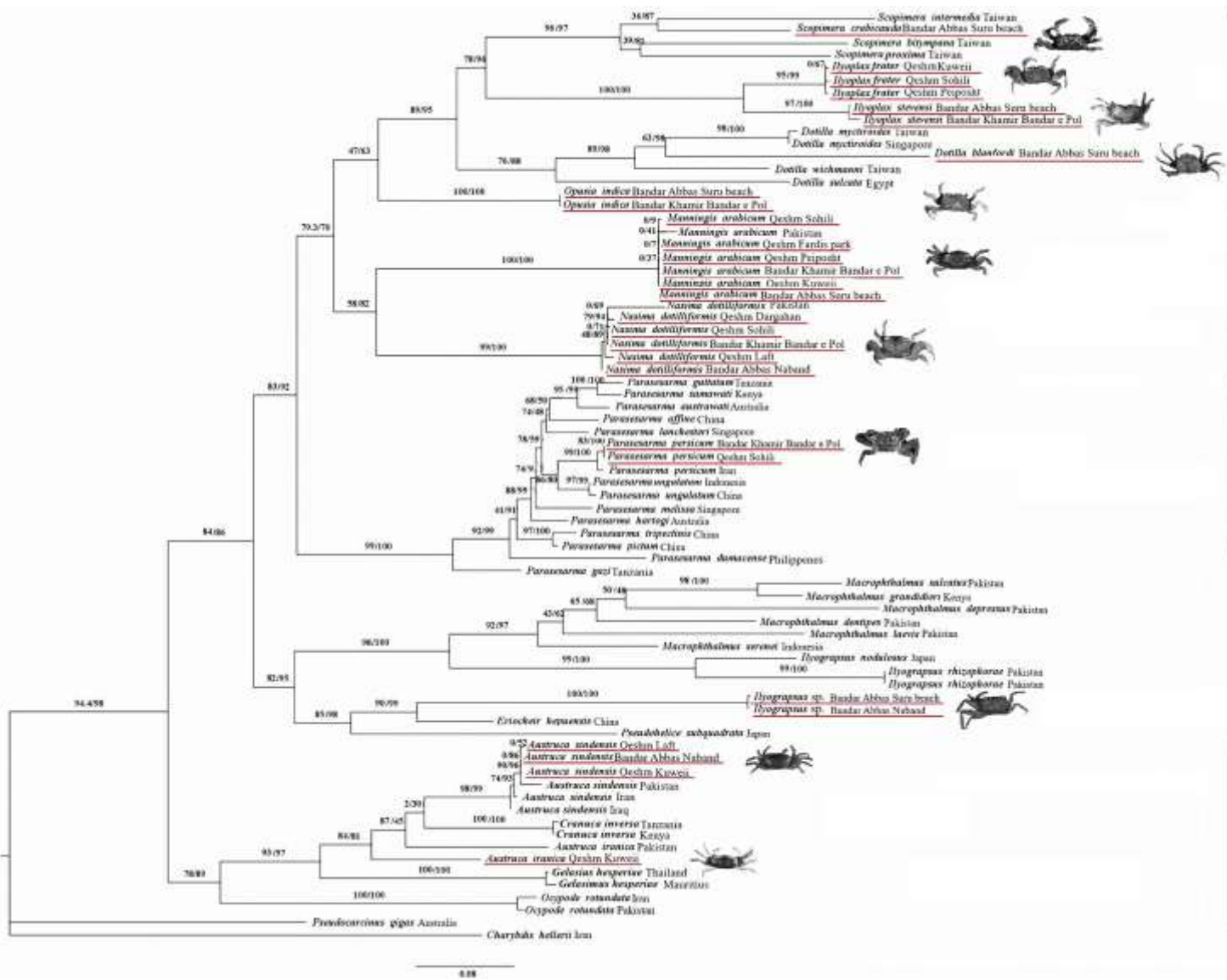


*Austruca iranica*

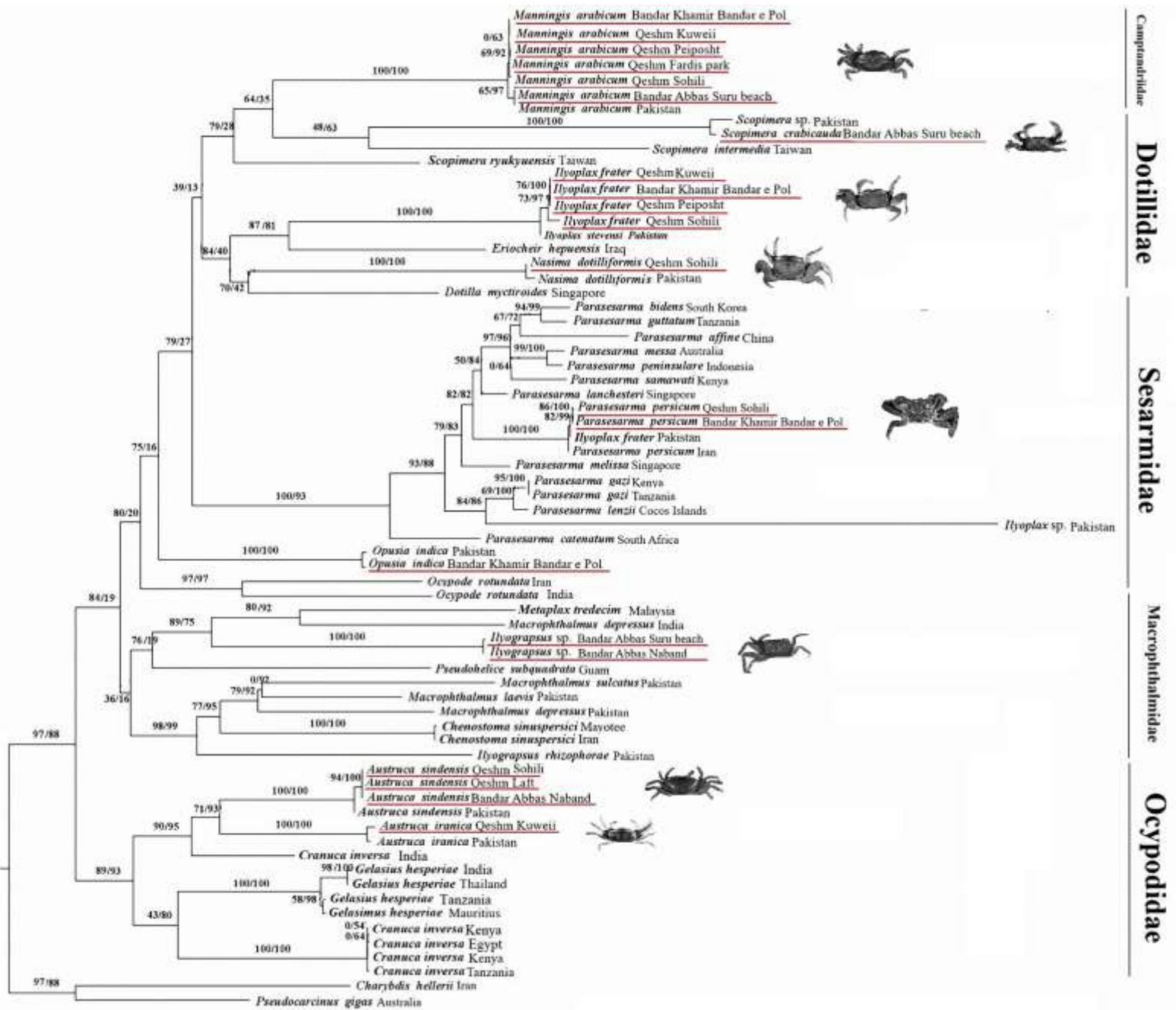


*Austruca sindensis*

**Supplementary Figure 6.** *Austruca iranica*. a) Posterior surface, b) ventral surface, c) cheliped, d) third maxilliped, and e) abdomen. *Austruca sindensis*. a) Posterior surface, b) ventral surface, c,d) abdomen, e) third maxilliped, f) cheliped and g) propodus of third.



**Supplementary Figure 7. 16S phylogeny of Grapsoidae and Ocypodoidae.** ML phylogeny based on 16S sequences. *Pseudocarcinus gigas* Australia and *Charybdis hellerii* Iran (Schubart et al., 2006) are outgroups. Support values are listed at nodes (SH-aLRT support (%)/ultrafast bootstrap support (%)). Scale bar show substitutions per site. Red lines show specimens sampled from the Persian Gulf for this study.



**Supplementary Figure 8. COI phylogeny of Grapsoidae and Ocypodidae.** ML phylogeny based on a concatenated alignment of COI sequences. *Pseudocarcinus gigas* Australia and *Charybdis hellerii* Iran (Schubart et al., 2006) are outgroups. Support values are listed at nodes (SH-aLRT support (%)/ultrafast bootstrap support (%)). Scale bar show substitutions per site. Red lines show specimens sampled from the Persian Gulf for this study.



**Supplementary Table 1.** Species and number of specimens used for DNA extraction.

<b>Family</b>	<b>Species</b>	<b>Region</b>	<b>Number specimens</b>
Camptandriidae	<i>Opusia indica</i>	(Bandar Khamir, Bandar e Pol) (Bandar Abbas, Sure beach)	2
	<i>Nasima dotilliformis</i>	(Bandar Khamir, Bandar e Pol) (Bandar Abbas, Nayband) (Qeshm, Dargahan) (Qeshm, Laft) (Qeshm, Sohili)	5
	<i>M. arabicum</i>	(Bandar Khamir, Bandar e Pol) (Bandar Abbas, Suru beach) (Qeshm, Sohili) (Qeshm, Kuweii) (Qeshm, Peipodht) (Qeshm, Fardis Park)	6
Dotillidae	<i>Ilyoplax frater</i>	(Bandar Khamir, Bandar e Pol) (Qeshm, Kuweii) (Qeshm, Peipodht) (Qeshm, Sohili)	4
	<i>Ilyoplax stevensi</i>	(Bandar Khamir, Bandar e Pol) (Bandar Abbas, Suru beach)	2
	<i>Scopimera crabricauda</i>	(Bandar Abbas, Suru beach)	1
Macrophthalmidae	<i>Dotilla blanfordi</i>	(Bandar Abbas, Suru beach)	1
	<i>Ilyograpsus sp</i>	(Bandar Abbas, Suru beach) (Bandar Abbas, Nayband)	2
Ocypodidae	<i>Austruca iranica</i>	(Qeshm, Kuweii)	1
	<i>Austruca sindensis</i>	(Bandar Abbas, Nayband) (Qeshm, Sohili) (Qeshm, Laft)	3
Sesarmidae	<i>Parasesarma persicum</i>	(Bandar Khamir, Bandar e Pol) (Qeshm, Sohili)	2

**Supplementary Table 2.** Accession number and catalog number for each nucleotide sequence used in the study.

Species-region	Accession number (16S)	Accession number (COI)	Catalog number	Species-region	Accession number (16S)	Accession number (COI)	Catalog number
<i>N. dotilliformes</i> (Qeshm, Dargahan)	MT820436	-	SMF-56126	<i>P. persicum</i> (Qeshm, Sohili)	MT844060	MT969009	SMF-56159
<i>N. dotilliformes</i> (Qeshm, Sohili)	MT835122	MT966020	SMF-56127	<i>P. persicum</i> (Bandar Khamir, Bandar e Pol)	MT835165	MT969019	SMF-56160
<i>N. dotilliformes</i> (Bandar Khamir, Bandar e Pol)	MT835123	-	SMF-56129	<i>M. arabicum</i> (Qeshm, Sohili)	MT835167	MT973504	SMF-56132
<i>N. dotilliformes</i> (Qeshm, Laft)	MT835144	-	SMF-56128	<i>M. arabicum</i> (Bandar Abbas, Suru)	MT835224	MT977048	SMF-56136
<i>N. dotilliformes</i> (Bandar Abbas, Nayband)	MT835145	-	SMF-56130	<i>M. arabicum</i> (Qeshm, Kuweii)	MT835225	MT973503	SMF-56133
<i>D. blanfordi</i> (Bandar Abbas, Suru)	MT835146	-	SMF-56125	<i>M. arabicum</i> (Bandar Khamir, Bandar e Pol)	MT844062	MT973501	SMF-56135
<i>I. stevensi</i> (Bandar Abbas, Suru)	MT835147	-	SMF-56123	<i>M. arabicum</i> (Qeshm, Fardis Park)	MT844058	MT973502	SMF-56134
<i>I. stevensi</i> (Bandar Khamir, Bandar e Pol)	MT844057	-	SMF-56122	<i>M. arabicum</i> (Qeshm, Peipodht)	MT835226	MT973505	SMF-56131
<i>I. frater</i> (Qeshm, Sohili)	MT835162	MT969016	SMF-56121	<i>A. sindensis</i> (Qeshm, Laft)	MT835231	MT969017	SMF-56154
<i>I. frater</i> (Qeshm, Kuweii)	MT835157	MT969013	SMF-56120	<i>A. sindensis</i> (Qeshm, Sohili)	MT835232	MT969014	SMF-56152
<i>I. frater</i> (Bandar Khamir, Bandar e Pol)	-	MT969018	SMF-56118	<i>A. sindensis</i> (Bandar Abbas, Nayband)	MT844063	MT969011	SMF-56158
<i>I. frater</i> (Qeshm, Peipodht)	MT835163	MT969015	SMF-56119	<i>A. iranica</i> (Qeshm, Kuweii)	MT835235	MT966717	SMF-56144
<i>O. indica</i> (Bandar Abbas, Suru)	MT835164	-	SMF-56138	<i>Ilyograpsus sp</i> (Bandar Abbas, Suru)	MT852028	MT984210	SMF-56139
<i>O. indica</i> (Bandar Khamir, Bandar e Pol)	MT844059	MT969012	SMF-56137	<i>Ilyograpsus sp</i> (Bandar Abbas, Nayband)	MT852027	MT984211	SMF-56140

**Supplementary Table 3.** Sequences used for 16S phylogeny.

<b>Family</b>	<b>Species</b>	
<b>Camptandriidae</b>	<i>Nasima dotilliformes</i> MH933974	
	<i>Nasima dotilliformis</i> Qeshm Dargahan	
	<i>Nasima dotilliformis</i> Qeshm Soheili	
	<i>Nasima dotilliformis</i> Bandar Khamir Bandar e Pol	
	<i>Nasima dotilliformis</i> Qeshm Laft	
	<i>Nasima dotilliformis</i> Bandar Abbas Naband	
	<i>Manningis arabicum</i> Qeshm Soheili	
	<i>Manningis arabicum</i> Bandar Abbas Suru Beach	
	<i>Manningis arabicum</i> MH933975	
	<i>Manningis arabicum</i> Qeshm Kuweii	
	<i>Manningis arabicum</i> Qeshm Peiposht	
	<i>Manningis arabicum</i> Qeshm fardis Park	
	<i>Manningis arabicum</i> Bandar Khamir Bandar e Pol	
	<i>Opusia indica</i> Bandar Abbas Suru Beach	
	<i>Opusia indica</i> Bandar Khamir Bandar e Pol	
	<b>Dotillidae</b>	<i>Ilyoplax stevensi</i> Bandar Abbas Suru Beach
		<i>Ilyoplax stevensi</i> Bandar Khamir Bandar e Pol
<i>Ilyoplax frater</i> Qeshm Kuweii		
<i>Ilyoplax stevensi</i> Qeshm Sohili		
<i>Ilyoplax frater</i> Qeshm Peiposht		
<i>Scopimera bitympana</i> KJ132630		
<i>Scopimera proxima</i> KJ132632		
<i>Scopimera crabicauda</i> Bandar Abbas Suru Beach		
<i>Scopimera intermedia</i> KJ132634		
<i>Dotilla blanfordi</i> Bandar Abbas Suru Beach		
<i>Dotilla sulcata</i> AM180688		
<i>Dotilla wichmanni</i> KJ132538		
<i>Dotilla myctiroides</i> KJ132534		
<i>Dotilla myctiroides</i> DOm1 LC150395		
<b>Macrophthalmidae</b>		<i>Macrophthalmus laevis</i> MH842285
		<i>Macrophthalmus dentipes</i> MH842284
		<i>Macrophthalmus depressus</i> MH842288
	<i>Macrophthalmus serenei</i> MHs44 LC097109	
	<i>Macrophthalmus grandidieri</i> AM180686	
	<i>Macrophthalmus sulcatus</i> MH842286	
	<i>Ilyograpsus nodulosus</i> LC057209	
	<i>Ilyograpsus rhizophorae</i> IR01 MK025793	
	<i>Ilyograpsus rhizophorae</i> MK568548	
	<i>Ilyograpsus</i> sp. Bandar Abbas Suru Beach	
<i>Ilyograpsus</i> sp. Bandar Abbas Naband		
<b>Ocypodidae</b>	<i>Gelasimus hesperiae</i> AB535398	
	<i>Gelasimus hesperiae</i> LC150342	
	<i>Austruca iranica</i> Qeshm Kuweii	
	<i>Cranuca inversa</i> AB471904	
	<i>Cranuca inversa</i> AB813658	
<i>Austruca iranica</i> MG024475		

	<i>Austruca sindensis</i> Qeshm Laft
	<i>Austruca sindensis</i> MF509809
	<i>Austruca sindensis</i> Qeshm Kuweii
	<i>Austruca sindensis</i> Bandar Abbas Naband
	<i>Austruca sindensis</i> LC015059
	<i>Austruca sindensis</i> LC015058
	<i>Ocypode rotundata</i> LC150369
	<i>Ocypode rotundata</i> MF509793
<b>sesarmidae</b>	<i>Parasesarma gazi</i> MF564029
	<i>Parasesarma dumacense</i> KX423837
	<i>Parasesarma tripectinis</i> KU052885
	<i>Parasesarma pictum</i> KU052884
	<i>Parasesarma affine</i> KU052883
	<i>Parasesarma melissa</i> MF564031
	<i>Parasesarma hartogi</i> KX423836
	<i>Parasesarma guttatum</i> MF564032
	<i>Parasesarma austrawati</i> MH552896
	<i>Parasesarma samawati</i> MF564033
	<i>Parasesarma lanchesteri</i> KX761174
	<i>Parasesarma unguatum</i> FN659067
	<i>Parasesarma unguatum</i> KU052887
	<i>Parasesarma persicum</i> Bandar Khamir Bandar e Pol
	<i>Parasesarma persicum</i> Qeshm Soheili
	<i>Parasesarma persicum</i> FN659066
<b>Varunidae</b>	<i>Pseudohelice subquadrata</i> AB334542
	<i>Eriocheir hepuensis</i> AF516706
<b>Outgroup</b>	<i>Pseudocarcinus gigas</i> HM637969
	<i>Charybdis_hellerii_XDNA_KX060527</i>

**Supplementary Table 4.** Sequences used for ML phylogeny using COI sequences.

<b>Family</b>	<b>species</b>	
<b>Camptandriidae</b>	<i>Nasima dotilliformis</i> Qeshm Soheili	
	<i>Nasima dotilliformis</i> ND02 MH926044	
	<i>Manningis arabicum</i> Bandar Abbas Suru Beach	
	<i>Manningis arabicum</i> MA01 MH926045	
	<i>Manningis arabicum</i> Bandar Khamir Bandar e Pol	
	<i>Manningis arabicum</i> Qeshm fardis Park	
	<i>Manningis arabicum</i> Qeshm Kuweii	
	<i>Manningis arabicum</i> Qeshm Peiposht	
	<i>Manningis arabicum</i> Qeshm Soheili	
	<i>Opusia indica</i> MH926041	
	<i>Opusia indica</i> Bandar Khamir Bandar e Pol	
	<b>Dotillidae</b>	<i>Ilyoplax stevensi</i> Qeshm Sohili
		<i>Ilyoplax frater</i> Qeshm Kuweii
<i>Ilyoplax frater</i> Qeshm Peiposht		
<i>Ilyoplax frater</i> Bandar Khamir Bandar e Pol		
<i>Ilyoplax stevensi</i> 180813 033 C09 20 N1 MN421848		
<i>Ilyoplax sp.</i> MK503851		

*Ilyoplax frater* 170626 031 O15 N64 M MK431533  
*Scopimera* sp. Ssp01 MK033425  
*Scopimera crabicauda* Bandar Abbas Suru Beach  
*Scopimera intermedia* SOP1 AB515326  
*Scopimera ryukyuensis* D K4 AB515327  
*Dotilla myctiroides* D0m1 LC150452  
**Macrophthalmidae**  
*Chaenostoma sinuspersici* Mho31 LC155129  
*Chaenostoma sinuspersici* MHo40 LC155128  
*Macrophthalmus depressus* Md03 MG836999  
*Macrophthalmus sulcatus* Mds04 MG836996  
*Macrophthalmus laevis* MML02 MH115583  
*Macrophthalmus depressus* KY427938  
*Ilyograpsus* sp. Bandar Abbas Naband  
*Ilyograpsus* sp. Bandar Abbas Suru Beach  
*Ilyograpsus rhizophorae* isolate IR MK097277  
*Metaplax tredecim* MXp7 LC498191  
**Ocypodidae**  
*Austruca sindensis* Qeshm Soheili  
*Austruca sindensis* Bandar Abbas Naband  
*Austruca sindensis* Qeshm Laft  
*Austruca sindensis* Usin 2 MF614781  
*Cranuca inversa* Usp152 LC465146  
*Austruca iranica* Qeshm Kuweii  
*Austruca iranica* Uir 3 MF614779  
*Cranuca inversa* H26 KX396543  
*Cranuca inversa* Uiv3 AB471917  
*Cranuca inversa* AB813674  
*Cranuca inversa* Uiv5 LC087973  
*Gelasimus hesperiae* Uvv21 AB535423  
*Gelasimus hesperiae* H28 KX396517  
*Gelasimus hesperiae* Uhp4 LC150403  
*Ocypode rotundata* LC150424  
*Ocypode rotundata* MH577534  
**Sesarmidae**  
*Parasesarma catenatum* MZUF 2509 MF564013  
*Parasesarma affine* MK611589  
*Parasesarma lenzii* MK584923  
*Parasesarma gazi* MZUF 3670 MF564005  
*Parasesarma gazi* MZUF 3677 MF564006  
*Parasesarma persicum* Qeshm Soheili  
*Parasesarma persicum* Bandar Khamir Bandar e Pol  
*Parasesarma persicum* Sp482 MT020721  
*Parasesarma lanchesteri* T341 16 KX761168  
*Parasesarma melissa* MZUF 2597 MF564015  
*Parasesarma bidens* MABIK GR00002606 MT117073  
*Parasesarma guttatum* MZUF 3848 MF564016  
*Parasesarma samawati* MF564017  
*Parasesarma messa* S386 MK033185  
*Parasesarma peninsulare* S133 MK033184  
**Varunidae**  
*Pseudohelice subquadrata* Hx2 LC511081  
*Gelasimus hesperiae* KLUh04 MN428529  
*Eriocheir hepuensis* JF810991

**Outgroups**

*Pseudocarcinus gigas* HM638058

*Charybdis hellerii*\_XDNA\_KX060332

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