

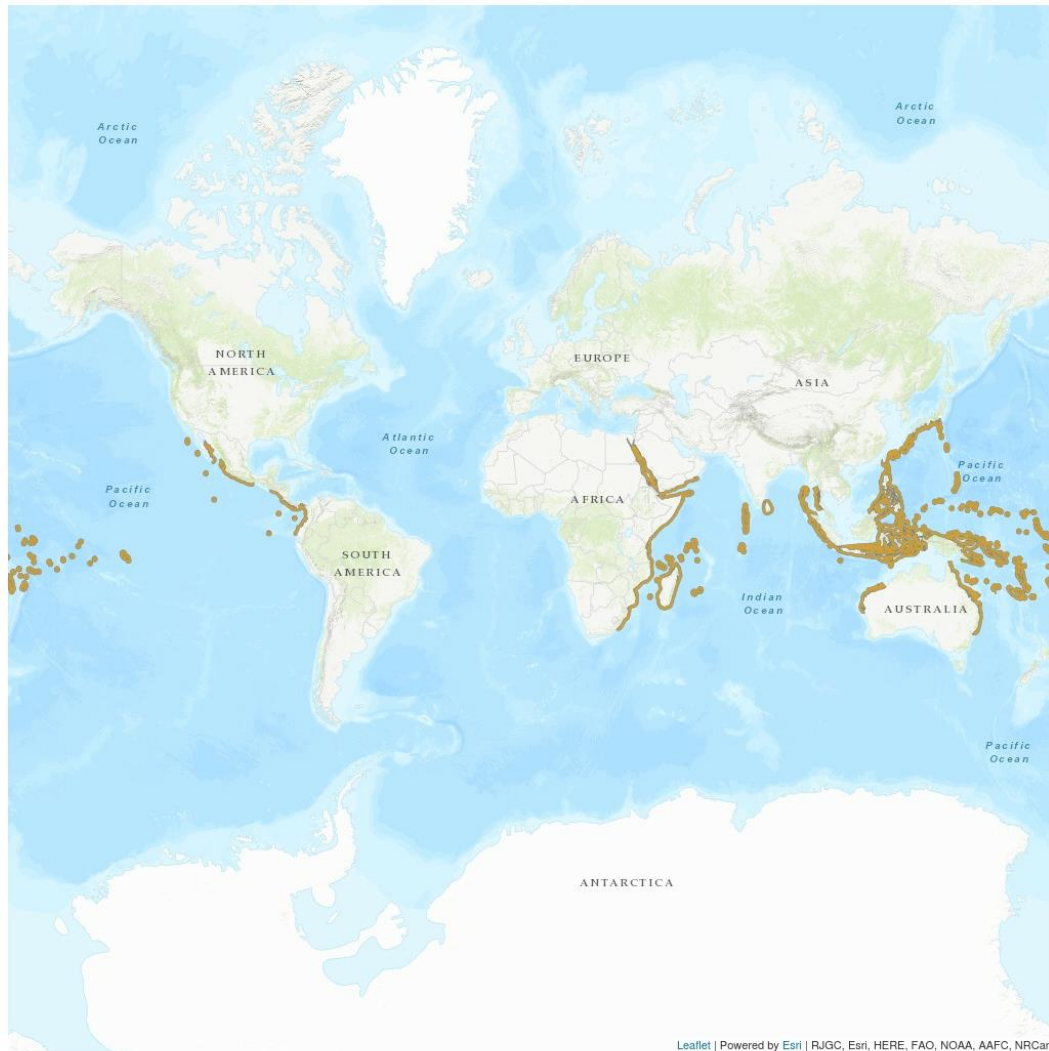
Geographic genetic variation in the Coral Hawkfish, *Cirrhitichthys oxycephalus* (Cirrhitidae), in relation to biogeographic barriers across the Tropical Indo-Pacific

ELECTRONIC SUPPLEMENTARY MATERIAL

Figure S1. IUCN Geographic range of *C. oxycephalus*. Image taken from Greenfield, D. & Williams, I. 2016. *Cirrhitichthys oxycephalus* (errata version published in 2017). The IUCN Red List of Threatened Species 2016: e.T67997668A115451295. <https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T67997668A68001661.en>

Distribution Map

Cirrhitichthys oxycephalus



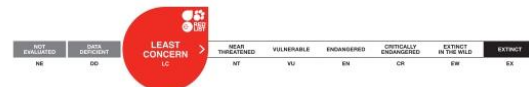
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The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Figure S2. The phylogenetic tree based on the *RAG1* gene and ML. Posterior probability supports are shown in the nodes. Colors represent the different haplogroups (Hg) found in the haplotype network (Fig. 3). TEP: Tropical Eastern Pacific region except for CL-TEP: Clipperton-TEP.

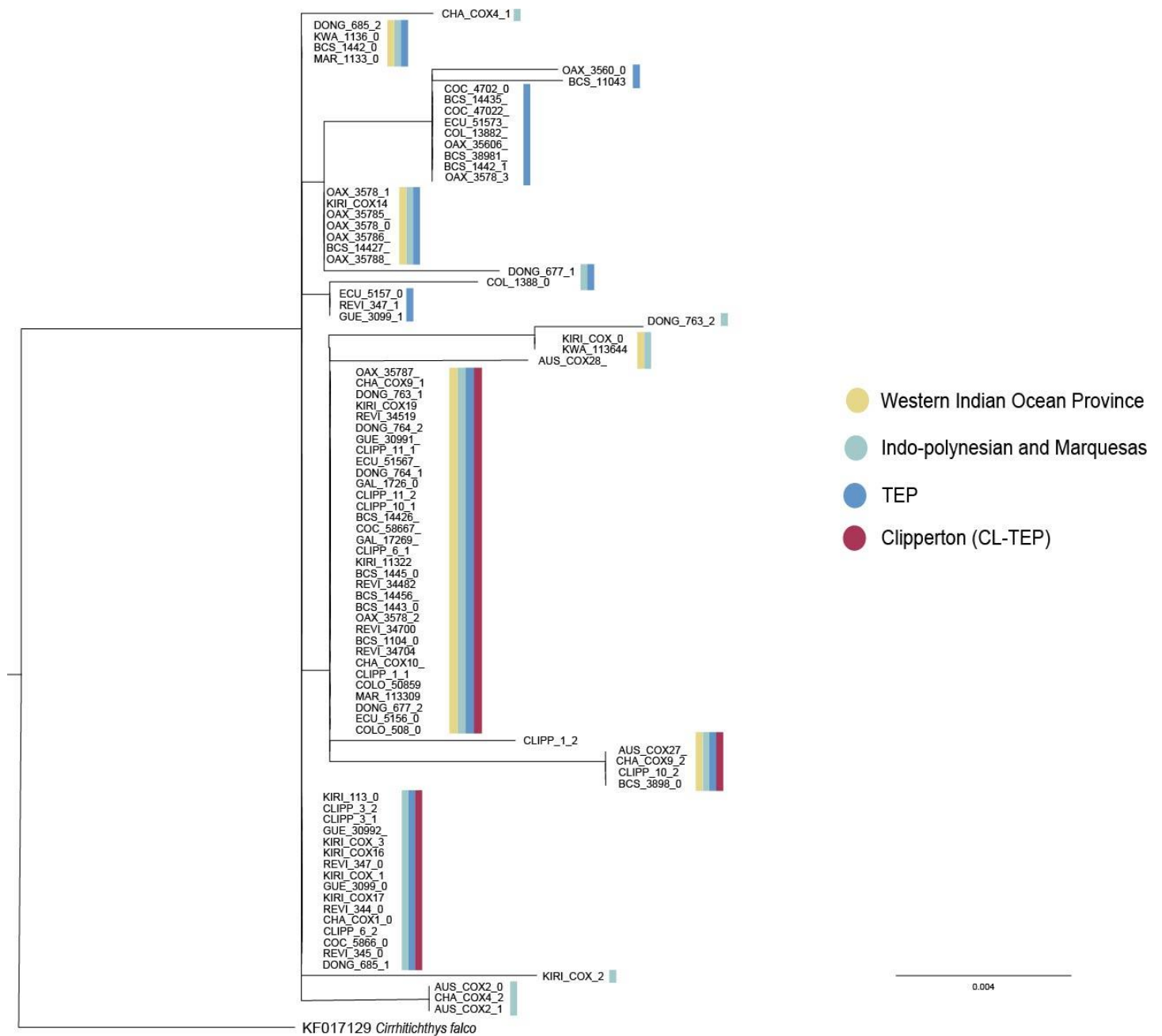


Table S1. Sample localities and associated information. CPUM: Fish collection of the Universidad Michoacana de San Nicolás de Hidalgo; UCF: University of Central Florida; KAUST: King Abdullah University of Science and Technology; Smithsonian: National Museum of Natural History of the Smithsonian Institute; UCSB: University of California Santa Barbara and HCMCUS: Ho Chi Minh City University of Science. N. *cytb*: number of specimens sequences for *cytb* gene; N. *RAG1*: number of specimens sequenced for *RAG1* gene.

Area/Country	Locality	Coordinates	Collection	N. <i>cytb</i>	ID Tissue	GenBank accession numbers	N. <i>RAG1</i>	ID Tissue
Saudi Arabia	Farasan Banks	18° 5' 52.31" N 41° 18' 38.35" E	UCF	1	ARA_COX11	PP328592	0	--
	Thuwal	22° 14' 15.73" N 39° 0' 27.67" E	KAUST	1	ARA_COX6789	PP328593	0	--
	Al Lith	19° 50.527' N 39° 55.941' E	KAUST	2	ARA_COX7741 ARA_COX7752	PP328594 PP328595	0 0	-- --
South Africa	Durban, KwaZulu-Natal	29° 51' 36" S 31° 3' 35.9" E	Smithsonian	2	KWA_113041	PP328596	0	--
					KWA_113044	PP328597	0	--
	Sodwana, KwaZulu-Natal	27° 33' 0" S 32° 41' 23.9" E	Smithsonian	2	KWA_113644 KWA_113645	PP328598 PP328599	0 1	KWA_113644 --
France	Reunion Island	21° 7' 58.8" S 55° 32' 16.80" E	Smithsonian	3	REU_113201	PP328600	0	--
					REU_113202	PP328601	0	--
					REU_113203	PP328602	0	--
Chagos Archipelago, United Kingdom	Egmont Atoll	6° 41' 26.18" S 71° 50' 12.67" E	UCF	2	CHA_COX4	PP328603	1	CHA_COX4
					CHA_COX5	PP328604	0	0
					CHA_COX2	PP328605	0	0
	Salomon Atoll	5° 13' 57.16" S 72° 22' 25.71" E	UCF	5	CHA_COX3	PP328606	0	0
					CHA_COX6	PP328607	0	0
					CHA_COX7	PP328608	0	0
					CHA_COX8	PP328609	0	0
	Great Chagos Bank	6° 41' 26.18" S 71° 50' 12.67" E	UCF	3	CHA_COX1	PP328610	0	0
					CHA_COX9	PP328611	2	CHA_COX9
					CHA_COX10	PP328612	0	CHA_COX10
Australia	Christmas Island	10° 26' 22.96" S 105° 38' 9.41" E	UCF	3	AUS_COX27	PP328613	2	AUS_COX27
					AUS_COX28	PP328614	0	AUS_COX28
					AUS_COX29	PP328615	0	0
	Great Barrier Reef	16° 51' 0" S 145° 46' 12" E	Smithsonian	1	AUS_113045	PP328616	0	0

Vietnam	No date	No date	HCMCUS	3	VIET_3	PP328617	0	0
					VIET_4	PP328618	0	0
					VIET_5	PP328619	0	0
Taiwan	Dongsha Atoll	20° 42' 9.72" N 116° 48' 28" E	UCF	19	DONG_468	PP328620	0	0
					DONG_671	PP328621	0	0
					DONG_672	PP328622	0	0
					DONG_673	PP328623	0	0
					DONG_674	PP328624	0	0
					DONG_675	PP328625	0	0
					DONG_676	PP328626	0	0
					DONG_677	PP328627	4	DONG_677
					DONG_678	PP328628	0	0
					DONG_679	PP328629	0	0
					DONG_680	PP328630	0	0
					DONG_684	PP328631	0	0
					DONG_685	PP328632	0	DONG_685
					DONG_763	PP328633	0	DONG_763
					DONG_764	PP328634	0	DONG_764
					DONG_778	PP328635	0	0
					DONG_782	PP328636	0	0
					DONG_783	PP328637	0	0
					DONG_784	PP328638	0	0
Kiribati	Kiritimati	1° 52' 12" N 157° 18' 36" W	Smithsonian	1	0	--	5	KIRI_113223
					KIRI_113225	PP328639	0	0
					0	--	0	0
		1° 57' 0.238" N 157° 31' 19.07" W	UCF	9	KIRI_COX13	PP328640	0	0
					KIRI_COX14	PP328641	0	KIRI_COX14
					KIRI_COX15	PP328642	0	0
					KIRI_COX16	PP328643	0	KIRI_COX16
					0	--	0	KIRI_COX17
					KIRI_COX18	PP328644	0	0
					KIRI_COX19	PP328645	0	KIRI_COX19
					KIRI_COX22	PP328646	0	0
					KIRI_COX24	PP328647	0	0

					KIRI_COX25	PP328648	0	0
French Polynesia	Ua-huka, Marquesas Island	8° 54′0" S 139° 33′0" W	Smithsonian	2	0	--	1	MAR_113309
					MAR_113310	PP328649	0	0
					MAR_113311	PP328650	0	0
Revillagigedo Archipelago, Mexico	North beach bay, Socorro Island	18° 51′36.66″N 110° 59′4.82" W	CPUM	21	REVI_34482	PP328651	4	REVI_34482
					REVI_34483	PP328652	0	0
					REVI_34484	PP328653	0	0
					REVI_34518	PP328654	0	0
					REVI_34519	PP328655	0	REVI_34519
					REVI_34665	PP328656	0	0
					REVI_34694	PP328657	0	0
					REVI_34696	PP328658	0	0
					REVI_34697	PP328659	0	0
					REVI_34700	PP328660	0	REVI_34700
					REVI_34704	PP328661	0	REVI_34704
					REVI_34720	PP328662	0	0
					REVI_34721	PP328663	0	0
					REVI_34722	PP328664	0	0
					REVI_34792	PP328665	0	0
					REVI_34796	PP328666	0	0
					REVI_34798	PP328667	0	0
					REVI_34803	PP328668	0	0
					REVI_34804	PP328669	0	0
					REVI_41125	PP328670	0	0
REVI_41126	PP328671	0	0					
Mainland Mexico	Concepción Bay, BCS	26° 53′ 39.2" N 111° 49′ 25.6" W	CPUM	1	BCS_14456	PP328672	1	BCS_14456
	De los Sueños Bay BCS	23° 59′37.1" N 109° 49′32.5" W	CPUM	2	BCS_15232	PP328673	0	0
					BCS_38981	PP328674	1	BCS_38981
	Tortuga Island, BCS	27° 25′50.3" N 111° 51′58.3" W	CPUM	2	BCS_11043	PP328675	1	BCS_11043
					BCS_14600	PP328676	0	0
	Espíritu Santo Island, BCS	24° 29′9.78" N 110° 24′2.03" W	CPUM	2	BCS_15585	PP328677	0	0
					BCS_15586	PP328678	0	0
	Punta Pulpito, BCS	26° 30′52.3" N 111° 26′ 35.2" W	CPUM	4	BCS_14423	PP328679	0	0
BCS_14426					PP328680	3	BCS_14426	

					BCS_14427	PP328681	0	BCS_14427
					BCS_14435	PP328682	0	BCS_14435
	Punta Carrizales, Colima	19° 5' 47.8" N 104° 26' 20.56" W	CPUM	3	COL_13881	PP328683	1	0
					COL_13882	PP328684	0	COL_13882
					COL_13934	PP328685	0	0
	Morros del Potosí, Guerrero	17° 32' 2.8" N 101° 29' 50.4" W	CPUM	1	GUE_19074	PP328686	0	0
	Zacatoso, Guerrero	17° 39' 14.33" N 101° 37' 20.53" W	CPUM	1	GUE_19131	PP328687	0	0
	La Pedregosa, Guerrero	17° 37' 20.4" N 101° 31' 19.89" W	CPUM	2	GUE_30991	PP328688	2	GUE_30991
					GUE_30992	PP328689	0	GUE_30992
	Punta Chahue, Oaxaca	15° 45' 9.97" N 96° 7' 27.39" W	CPUM	7	OAX_35605	PP328690	1	0
					OAX_35606	PP328691	0	OAX_35606
					OAX_35607	PP328692	0	0
					OAX_35785	PP328693	4	OAX_35785
					OAX_35786	PP328694	0	OAX_35786
					OAX_35787	PP328695	0	OAX_35787
					OAX_35788	PP328696	0	OAX_35788
El Salvador	Los Cobanos, Sonsonate	13° 31' 51.2" N 89° 50' 48.1" W	CPUM	5	SALV_24377	PP328697	0	0
					SALV_24378	PP328698	0	0
					SALV_24409	PP328699	0	0
					SALV_24529	PP328700	0	0
					SALV_24538	PP328701	0	0
Mainland Costa Rica	Cabo Blanco, Puntarenas	9° 32' 26.21" N 85° 6' 40.35" W	CPUM	1	CR_39990	PP328702	0	0
Coco Island, Costa Rica	Punta María, Coco island	5° 32' 7.3" N 87° 5' 12.5" W	CPUM	3	COC_47020	PP328703	2	0
					COC_47021	PP328704	0	0
					COC_47022	PP328705	0	COC_47022
	Wafer bay, Coco island	5° 30' 36" N 87° 3' 36" W	Smithsonian	2	COC_110215	PP328706	0	0
			CPUM		COC_58667	PP328707	0	COC_58667
	Manuelita, Coco island	5° 33' 37.67" N 87° 2' 48.73" W	CPUM	4	COC_58707	PP328708	0	0
					COC_58708	PP328709	0	0
					COC_58709	PP328710	0	0
					COC_58737	PP328711	0	0
Panamá	Los Frailes, Darien	10° 17' 24" N 80° 2' 59.99" W	Smithsonian	3	PAN_113794	PP328712	0	0
					PAN_113795	PP328713	0	0

					PAN_113925	PP328714	0	0
					PAN_22317	PP328715	0	0
					PAN_22318	PP328716	0	0
					PAN_22319	PP328717	0	0
Colombia	Piedra Wacha, Choco	7° 20' 51.6" N 80° 8' 11.5" W	CPUM	3	COLO_50859	PP328718	1	COLO_50859
					COLO_50860	PP328719	0	0
Mainland Ecuador	Ureles, Manabí	1° 15' 32.62" N 81° 4' 20.62" W	CPUM	7	ECU_51191	PP328720	2	0
					ECU_51192	PP328721	0	0
					ECU_51563	PP328722	0	0
					ECU_51565	PP328723	0	0
					ECU_51567	PP328724	0	ECU_51567
					ECU_51569	PP328725	0	0
					ECU_51573	PP328726	0	ECU_51573
France	Clipperton Atoll	10° 18' 14.4" N 109° 13' 4.8" W	UCSB	4	CLIPP_1	PP328727	5	CLIPP_1
					CLIPP_4	PP328728	0	0
					CLIPP_5	PP328729	0	CLIPP_3
					CLIPP_9	PP328730	0	0
					0		0	CLIPP_6
					0		0	CLIPP_10
					0		0	CLIPP_11
			Smithsonian	15	CLIP_110373	PP328731	0	0
					CLIP_110459	PP328732	0	0
					CLIP_110460	PP328733	0	0
					CLIP_110461	PP328734	0	0
					CLIP_110462	PP328735	0	0
					CLIP_110463	PP328736	0	0
					CLIP_110464	PP328737	0	0
					CLIP_110465	PP328738	0	0
					CLIP_110466	PP328739	0	0
					CLIP_110467	PP328740	0	0
					CLIP_110468	PP328741	0	0
					CLIP_110469	PP328742	0	0
					CLIP_110470	PP328743	0	0
					CLIP_110471	PP328744	0	0

Galapagos Archipelago, Ecuador	Rocas Daphne,	0° 25' 27.71" N 90° 21' 30.4" W	CPUM	3	CLIP_113383	PP328745	0	0
					GAL_18395	PP328746	1	0
					GAL_18408	PP328747	0	0
					GAL_18438	PP328748	0	0
	Barco Hundido Karagua	0° 53' 40.2" N 89° 37' 2.19" W	CPUM	2	GAL_17269	PP328749	0	GAL_17269
					GAL_25476	PP328750	0	0
	Islote Mosquera,	0° 24' 17.1" N 90° 16' 32.4" W	CPUM	3	GAL_17483	PP328751	0	0
					GAL_17484	PP328752	0	0
					GAL_17485	PP328753	0	0
	León Dormido	0° 46' 42.76" N 89° 31' 18.3" W	CPUM	3	GAL_17575	PP328754	0	0
					GAL_17576	PP328755	0	0
					GAL_25460	PP328756	0	0
	Roca Ballena	0° 56' 48.01" N 89° 34' 52.1" W	CPUM	1	GAL_17404	PP328757	0	0
	Total						45	

Table S2. Above diagonal pairwise population comparison (Φ ST) and below diagonal mean genetic distances (D_p) According with location/regions for *cytb* and *RAG1* gene.

Gene	Arabia	South Africa	Christmas	Vietnam	Dongsha	Australia	Kiribati	Chagos	Marquesas	Revilla	Cortez	Mexican	Panamic	Cocos	Clipperton	Galapagos
<i>cytb</i>	Arabia	-0.029	-0.157	-0.018	0.118	-0.569	0.073	0.018	-0.054	0.583*	0.671*	0.497*	0.715*	0.63*	0.747*	0.719*
	S.Africa	1.783	-0.036	0.022	0.077	-0.268	0.126*	0.032	0.065	0.543*	0.609*	0.468*	0.657*	0.566*	0.696*	0.643*
	Christmas	1.562	1.672	-0.043	0.163	-0.684	0.081	0.069	-0.02	0.604*	0.715*	0.512*	0.746*	0.678*	0.773*	0.769*
	Vietnam	1.404	1.440	1.207	0.032	-0.6	-0.011	0.003	0.117	0.621*	0.76*	0.532*	0.769*	0.724*	0.801*	0.818*
	Dongsha	1.515	1.448	1.448	0.975	-0.125	0.059	0.027	0.173	0.599*	0.658*	0.558*	0.681*	0.638*	0.716*	0.68*
	Australia	1.22	1.395	0.997	0.525	0.887	-0.411	-0.23	-0.2	0.597*	0.782	0.465	0.785*	0.731	0.82*	0.859
	Kiribati	1.409	1.448	1.276	0.861	1.007	0.630	0.005	-0.007	0.623*	0.71*	0.568*	0.732*	0.688*	0.762*	0.746*
	Chagos	1.457	1.458	1.396	0.997	1.068	0.882	0.992	-0.005	0.589*	0.67*	0.533*	0.7*	0.645*	0.728*	0.703*
	Marquesas	1.496	1.642	1.365	0.997	1.194	0.787	0.898	1.039	0.634*	0.781*	0.538*	0.79*	0.747*	0.805*	0.841*
	Revilla	2.972	2.783	2.910	2.612	2.524	2.542	2.587	2.553	2.775	0.03	-0.011	0.039	0.026	0.426*	0.066*
	Cortez	2.795	2.638	2.715	2.424	2.355	2.348	2.388	2.385	2.591	0.805	0.002	0.001	0.077	0.646*	0.072*
	Mexican	3.228	3.021	3.161	2.868	2.773	2.801	2.846	2.818	3.048	1.241	1.016	0.017	-0.019	0.425*	0.028
	Panamic	2.814	2.624	2.745	2.435	2.342	2.392	2.418	2.396	2.640	0.800	0.512	1.009	0.082*	0.64*	0.01
	Cocos	2.865	2.655	2.817	2.496	2.397	2.380	2.471	2.457	2.712	0.869	0.620	1.064	0.621	0.626*	0.212*
	Clipperton	3.081	2.909	2.956	2.688	2.612	2.677	2.657	2.598	2.702	1.324	1.392	1.650	1.385	1.441	0.675*
	Galapagos	2.690	2.510	2.612	2.340	2.259	2.323	2.310	2.281	2.507	0.743	0.450	0.948	0.428	0.602	1.287
<i>RAG1</i>	Arabian	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	SouthAfrica	--	0.111	--	-0.227	--	-0.147	-0.304	-0.500	-0.039	0.043	0.179	-0.058	0.055	0.016	0
	Christmas	--	1.515	--	0.205*	--	0.254**	0.021	0.040	0.259	0.214	0.317	0.172	0.222	0.295*	0.245
	Vietnam	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dongsha	--	1.042	1.515	--	--	0.001	-0.074	-0.350	-0.047	0.083	0.214*	-0.038	0.144	-0.037	-0.192
	Australia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Kiribati	--	0.985	1.439	--	1.061	--	-0.041	-0.308	-0.023	0.119	0.156*	0.073	0.122	0.096	0.141
	Chagos	--	1.010	1.263	--	1.105	--	1.035	-0.384	-0.105	0.046	0.174*	-0.080	0.070	-0.037	-0.09
	Marquesas	--	0.758	1.136	--	0.758	--	0.682	0.758	-0.416	-0.092	0.073	-0.263	-0.029	-0.301	0
	Revilla	--	0.852	1.184	--	0.852	--	0.777	0.821	0.473	0.078	0.209*	-0.055	0.177	-0.055	0.053
	Cortez	--	1.452	1.673	--	1.373	--	1.313	1.347	1.073	1.089	0.007	-0.066	-0.136	0.130	0.074
	Mexican	--	1.563	1.799	--	1.515	--	1.297	1.468	1.184	1.207	1.286	0.123	-0.158	0.298***	0.319
	Panamic	--	1.136	1.389	--	1.073	--	1.086	1.052	0.758	0.789	1.136	1.310	-0.008	-0.047	-0.135
	Cocos	--	1.515	1.705	--	1.468	--	1.288	1.389	1.136	1.136	1.199	1.113	1.199	0.278	0.284

Clipperton	--	0.909	1.250	--	0.871	--	0.894	0.884	0.530	0.606	1.162	1.373	0.808	1.288		-0.189
Galapagos	--	0.758	1.136	--	0.663	--	0.833	0.758	0.379	0.473	1.073	1.420	0.631	1.326	0.379	

Note. One asterisk = $p < 0.05$, two asterisks = $p < 0.01$ and three asterisks = $p < 0.001$. Revilla = Revillagigedo. Highest values highlighted in bold text.

Table S3. Above diagonal pairwise comparison (Φ_{ST}) and below diagonal mean genetic distances (D_p) in percentage for *cytb* and *RAG1* gene. According with the regionalization presented by Briggs & Bowen (2012).

Gene	Region	RSP	WIOP	IPHMEIP	TEP
<i>cytb</i>	Red Sea Province (RSP)		-0.029	0.074	0.617***
	Western Indian Ocean Province (WIOP)	1.783		0.092*	0.586***
	Indo-Polynesian and Marquesas Provinces (IP-M)	1.47	1.479		0.606***
	Tropical Eastern Pacific	2.935	2.749	2.537	
<i>RAG1</i>	Red Sea Province		--	--	--
	Western Indian Ocean Province	--		-0.158	0.024
	Indo-Polynesian and Marquesas Provinces	--	1.061		0.061**
	Tropical Eastern Pacific	--	1.254	1.192	

Note. One asterisk = $p < 0.05$, two asterisks = $p < 0.01$ and three asterisks = $p < 0.001$.

Table S4. Diversity indices of mitochondrial *cytb* and nuclear *RAG1* genes. According with location/regions.

<i>cytb</i>	<i>N</i>	<i>hn</i>	<i>SS</i>	<i>h</i>	π
Arabian	4	4	24	1 +/- 0.177	0.019 +/- 0.004
South Africa	7	7	36	1 +/- 0.076	0.018 +/- 0.002
Christmas	3	3	17	1 +/- 0.272	0.017 +/- 0.005
Vietnam	3	2	9	0.667 +/- 0.314	0.009 +/- 0.004
Dongsha	19	16	32	0.977 +/- 0.027	0.010 +/- 0.001
Australia	1	0	0	0	0
Kiribati	10	9	22	0.978 +/- 0.054	0.009 +/- 0.001
Chagos	10	10	31	1 +/- 0.045	0.011 +/- 0.001
Marquesas	2	2	6	1 +/- 0.500	0.009 +/- 0.007
Revillagigedo	21	17	33	0.976 +/- 0.023	0.010 +/- 0.001
Cortez	11	9	12	0.964 +/- 0.051	0.005 +/- 0.001
Mexican	14	13	53	0.989 +/- 0.031	0.015 +/- 0.005
Panamic	21	16	24	0.929 +/- 0.051	0.005 +/- 0.001
Cocos	9	6	10	0.880 +/- 0.091	0.006 +/- 0.001
Clipperton	19	7	25	0.754 +/- 0.071	0.005 +/- 0.002
Galapagos	12	9	13	0.909 +/- 0.079	0.004 +/- 0.001
<i>RAG1</i>					
Arabian	0	0	0	0	0
South Africa	2	2	2	1 +/- 0.500	0.015 +/- 0.008
Christmas	4	3	3	0.049 +/- 0.222	0.013 +/- 0.005
Vietnam	0	0	0	0	0
Dongsha	8	4	5	0.75 +/- 0.139	0.012 +/- 0.004
Australia	0	0	0	0	0
Kiribati	10	5	5	0.756 +/- 0.130	0.0096 +/- 0.003
Chagos	6	5	5	0.933 +/- 0.122	0.012 +/- 0.003
Marquesas	2	2	1	1 +/- 0.500	0.008 +/- 0.004
Revillagigedo	8	3	2	0.679 +/- 0.122	0.006 +/- 0.002
Cortez	12	6	4	0.803 +/- 0.096	0.013 +/- 0.002
Mexican	16	7	5	0.858 +/- 0.057	0.012 +/- 0.002
Panamic	6	3	3	0.0463 +/- 0.215	0.011 +/- 0.004
Cocos	4	3	3	0.833 +/- 0.222	0.014 +/- 0.004
Clipperton	10	4	3	0.711 +/- 0.117	0.007 +/- 0.002
Galapagos	2	1	0	0	0

Note. *N*, number of individuals per Haplogroup; *hn*, number of haplotypes; *SS*, segregating sites; *h*, haplotype diversity; π , Nucleotide diversity.