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DNA BARCODING OF FISH SPECIES FROM THE MEDITERRANEAN COAST OF ISRAEL

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Supplementary Data

DNA barcoding of fish species from the Mediterranean coast of Israel A. SHIRAK, L. DOR, E. SEROUSSI, M. RON, G. HULATA and D. GOLANI

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Table S1. Fish samples by collection date.

Species No.	Taxonomic classification	Common name	Collection dates				Total
			Feb 2009	Sep 2009	Jan 2010	Jun 2014	
1	Pagrus caeruleostictus	Bluespotted seabream	6	0	0	0	6
2	Lithognathus mormyrus	Striped seabream	6	0	1	0	7
3	Atherina boyeri	Big-scale sand smelt	5	0	1	0	6
4	Decapterus russelli	Indian scad	5	3	6	0	14
5	Arnoglossus spp		2	3	3	0	8
6	Pagellus erythrinus	Common pandora	2	6	6	0	14
7	Pagellus acarne	Axillary seabream	1	4	5	6	16
8	Citharus linguatula	Atlantic spotted flounder	4	5	6	3	18
9	Spicara maena	Blotched picarel	6	0	1	5	12
10	Spicara smaris		2	0	2	0	4
11	Solea spp		1	0	0	0	1
12	Equulites klunzingeri		6	6	1	6	19
13	Diplodus annularis	Annular seabream	4	6	1	0	11
14	Upeneus pori	Por's goatfish	6	2	5	0	13
15	Ariosoma balearicum	Bandtooth conger	1	0	5	6	12
16	Nemipterus randalli	Randall's threadfin bream	5	3	6	6	20
17	Callionymus filamentosus	Blotchfin dragonet	6	0	6	6	18
18	Lagocephalus sceleratus	Silverstripe blaasop	2	0	0	0	2
19	Saurida undosquamis	Brushtooth lizardfish	2	0	6	6	14
20	Cynoglossus sinusarabici	Pelada Del Mar Rojo	5	4	4	6	19
21	Bothus podas	Wide-eyed flounder	6	0	6	6	18
22	Apogon smithi		3	6	6	6	21
23	Stephanolepis diaspros	Reticulated leatherjacket	6	6	4	5	21
24	Boops boops	Bogue	6	6	3	3	18
25	Lagocephalus guntheri	Half-smooth golden pufferfish	5	6	4	2	17
26	Lagocephalus suezensis		6	6	6	6	24
27	Plotosus lineatus	Striped eel catfish	5	6	6	6	23
28	Oxyurichthys petersii		0	1	0	0	1
29	Mullus barbatus	Red mullet	0	6	0	0	6
30	Sardinella aurita	Round sardinella	0	6	0	0	6
31	Serranus hepatus	Brown comber	0	5	5	6	16
32	Sphyræna chrysotaenia	Green-and-gold barracuda	0	1	0	0	1
33	Trachurus mediterraneus	Mediterranean scad	0	6	0	6	12
34	Herklotsichthys punctatus	Spotback herring	0	0	6	0	6
35	Trichiurus lepturus	Largehead hairtail	0	0	1	0	1
36	Serranus cabrilla	Comber	0	0	6	1	7
38	Uranoscopus scaber	Atlantic stargazer	0	0	4	0	4
39	Trigloporus lastoviza	Streaked gurnard	0	0	1	0	1
40	Upeneus moluccensis	Gold band goatfish	0	0	0	2	2
41	Gobius niger	Black goby	0	0	0	1	1
42	Siganus rivulatus	Rabbitfish	0	0	0	2	2
43	Torquigener flavimaculosus	Yellowspotted puffer	0	0	0	4	4
44	Apogonichthyoides pharaonis		0	0	0	1	1
46	Ostorhinchus fasciatus	Broadbanded cardinalfish	0	0	0	6	6
47	Raja miraletus	Twineye Skate	0	0	0	4	4
48	Torpedo torpedo	Eyed electric ray	0	0	0	2	2
49	Synodus saurus	Atlantic lizardfish	0	0	0	1	1
50	Scomber colias	Atlantic chub mackerel	0	0	0	6	6
51	Pomadasys stridens	Striped grunt	0	0	0	2	2

Table S2. Sample accession numbers in BOLD and GenBank.

Species	Sample ID	BOLD	GenBank
Apogon smithi	ApSm22A-C	JFS084-09...JFS086-09	KM538174, 76, 77
	ApSm22G-L	JFS157-14...JFS162-14	KM538181-82, 87-89, 92
	ApSm22M-R	JFS289-14...JFS294-14	KM538175, 78-80, 83-84
	ApSm22S-X	JFS397-14...JFS402-14	KM538185-86, 90-91, 93-94
Apogonichthyoides pharaonis	ApPh44S	JFS447-14	KM538173
Ariosoma balearicum	ArBa15A	JFS057-09	KM538206
	ArBa15M-Q	JFS256-14...JFS260-14	KM538196-99
	ArBa15S-W	JFS361-14...JFS365-14	KM538200-204
	ArBa15X	JFS366-14	KM538205
Arnoglossus spp.	ArSp5A-B	JFS023-09...JFS024-09	KM538207, 214
	ArSp5G-I	JFS118-14...JFS120-14	KM538208, 212-213
	ArSp5M-O	JFS226-14...JFS228-14	KM538209-211
	AtBo3A-E	JFS013-09...JFS017-09	KM538215-17, 19, 20
Atherina boyeri	AtBo3M	JFS219-14	KM538218
	BoBo24A-F	JFS093-09...JFS098-09	KM538222-24,30,31,35
	BoBo24G-L	JFS169-14...JFS174-14	KM538221, 25-29
	BoBo24M-O	JFS299-14...JFS301-14	KM538236-38
Boops boops	BoBo24S-U	JFS408-14...JFS410-14	KM538232-34
	BoPo21A-F	JFS078-09...JFS083-09	KM538240-42, 44-45, 56
	BoPo21M-R	JFS283-14...JFS288-14	KM538239, 50-52, 54-55
	BoPo21S-X	JFS391-14...JFS396-14	KM538243, 46-49, 53
Callionymus filamentosus	CaFi17A-F	JFS063-09...JFS068-09	KM538258-63
	CaFi17M-R	JFS267-14...JFS272-14	KM538257, 70-74
	CaFi17S-X	JFS373-14...JFS378-14	KM538264-69
	CiLi8A-D	JFS028-09...JFS031-09	KM538275-78
Citharus linguatula	CiLi8G-K	JFS131-14...JFS135-14	KM538288-92
	CiLi8M-R	JFS240-14...JFS245-14	KM538279-80, 82-85
	CiLi8S-U	JFS347-14...JFS349-14	KM538281, 86-87
	CySi20A-E	JFS073-09...JFS077-09	KM538299-303
Cynoglossus sinuarebici	CySi20G-J	JFS153-14...JFS156-14	KM538304-07
	CySi20M-P	JFS279-14...JFS282-14	KM538308-11
	CySi20S-X	JFS385-14...JFS390-14	KM538293..98
	DeRu4A-E	JFS018-09...JFS022-09	KM538312-13, 19, 22-23
Decapterus russelli	DeRu4G-I	JFS115-14...JFS117-14	KM538316, 24-25
	DeRu4M-R	JFS220-14...JFS225-14	KM538314-15, 17-18, 20-21
	DiAn13A-D	JFS047-09...JFS050-09	KM538327-29, 35
	DiAn13G-L	JFS142-14...JFS147-14	KM538326, 31-34, 36
Diplodus annularis	DiAn13M	JFS250-14	KM538330
	EqKl12A-F	JFS041-09...JFS046-09	KM538337, 41, 45-46, 49-50
	EqKl12G-L	JFS136-14...JFS141-14	KM538340, 42-43, 47-48, 51
	EqKl12M	JFS249-14	KM538344
Equulites klunzingeri	EqKl12S-X	JFS355-14...JFS360-14	KM538338-39, 52-55
	GoNi41S	JFS440-14	KM538356
	HePu34M-R	JFS323-14...JFS328-14	KM538357-62
	LaSc18A-B	JFS069-09...JFS070-09	KM538363-64
Lagocephalus scleratus	LaSp25A-E	JFS099-09...JFS103-09	KM538365,68-71
	LaSp25G-L	JFS175-14...JFS180-14	KM538376-81
	LaSp25M-P	JFS302-14...JFS305-14	KM538372-75
	LaSp25S-T	JFS411-14...JFS412-14	KM538366-67
Lagocephalus spadiceus	LaSu26A-F	JFS104-09...JFS109-09	KM538389-90, 95, 98, 400, 403
	LaSu26G-L	JFS181-14...JFS186-14	KM538382-85, 404-405
	LaSu26M-R	JFS306-14...JFS311-14	KM538388, 91-94, 96
	LaSu26S-X	JFS413-14...JFS418-14	KM538386-87, 97, 99, 401-402
Lithognathus mormyrus	LiMo2A-F	JFS007-09...JFS012-09	KM538406-11
	LiMo2M	JFS218-14	KM538412
	MuBa29G-L	JFS194-14...JFS199-14	KM538413-18

(continued)

Supp. Table 2 (continued)

Species	Sample ID	BOLD	GenBank
Nemipterus randalli	NeRa16A-E	JFS058-09...JFS062-09	KM538420-21, 27-29
	NeRa16G-I	JFS150-14...JFS152-14	KM538422-23, 35
	NeRa16M-X	JFS261-14...JFS372-14	KM538419, 24-26, 30-34, 36-38
Ostorhinchus fasciatus	ApFa46S-X	JFS448-14...JFS453-14	KM538439-44
Oxyurichthys petersii	OxPe28G	JFS193-14	KM538445
	PaAc7A	JFS027-09	KM538456
	PaAc7G-J	JFS127-14...JFS130-14	KM538446, 53-55
Pagellus acarne	PaAc7M-Q	JFS235-14...JFS239-14	KM538457-61
	PaAc7S-X	JFS341-14...JFS346-14	KM538447-52
	PaEr6A-B	JFS025-09...JFS026-09	KM538474-75
Pagellus erythrinus	PaEr6G-L	JFS121-14...JFS126-14	KM538466, 68, 70-73
	PaEr6M-R	JFS229-14...JFS234-14	KM538462-65, 67, 69
	PaCo1A-F	JFS001-09...JFS006-09	KM538476-81
Pagrus caeruleostictus	PILi27A-E	JFS110-09...JFS114-09	KM538482, 01-504
	PILi27G-L	JFS187-14...JFS192-14	KM538495-500
	PILi27M-R	JFS312-14...JFS317-14	KM538489-94
Plotosus lineatus	PILi27S-X	JFS419-14...JFS424-14	KM538483-88
	PoSt51S-T	JFS467-14...JFS468-14	KM538505-06
	RaMi47S-V	JFS454-14...JFS457-14	KM538507-10
Pomadasys stridens	SaAu30G-L	JFS200-14...JFS205-14	KM538511-16
	SaUn19A-B	JFS071-09...JFS072-09	KM538526-27
	SaUn19M-R	JFS273-14...JFS278-14	KM538517, 20-21, 25, 29-30
Raja miraletus	SaUn19S-X	JFS379-14...JFS384-14	KM538518-19, 22-24, 28
	ScCo50S-X	JFS461-14...JFS466-14	KM538531-36
	SeCa36M-R	JFS330-14...JFS335-14	KM538537-39, 41-43
Sardinella aurita	SeCa36S	JFS437-14	KM538540
	SeHe31G-K	JFS206-14-FS210-14	KM538546, 49-51, 56
	SeHe31M-Q	JFS318-14...JFS322-14	KM538544-45, 47, 52-53
Saurida undosquamis	SeHe31S-X	JFS425-14...JFS430-14	KM538548, 54-55, 57-59
	SiRi42S-T	JFS441-14...JFS442-14	KM538560-61
	SoSp11A	JFS040-09	KM538562
Scomber colias	SpCh32G	JFS211-14	KM538563
	SpMa9A-F	JFS032-09...JFS037-09	KM538564-67, 70-71
	SpMa9M	JFS246-14	KM538569
Serranus cabrilla	SpMa9S-W	JFS350-14...JFS354-14	KM538568, 72-75
	SpSm10A-B	JFS038-09...JFS039-09	KM538577-78
	SpSm10M-N	JFS247-14...JFS248-14	KM538576, 79
Serranus hepatus	StDi23A-F	JFS087-09...JFS092-09	KM538593-98
	StDi23G-L	JFS163-14...JFS168-14	KM538580-83, 99, 600
	StDi23M-P	JFS295-14...JFS298-14	KM538584-87
Stephanolepis diaspros	StDi23S-W	JFS403-14...JFS407-14	KM538588-92
	SySa49S	JFS460-14	KM538601
	ToTo48S-T	JFS458-14...JFS459-14	KM538602-03
Synodus saurus	ToFl43S-V	JFS443-14...JFS446-14	KM538604-07
	TrMe33G-L	JFS212-14...JFS217-14	KM538608-10, 17-19
	TrMe33S-X	JFS431-14...JFS436-14	KM538611-16
Torpedo torpedo	TrLe35M	JFS329-14	KM538620
	TrLa39M	JFS340-14	KM538621
	UpMo40S-T	JFS438-14...JFS439-14	KM538622-23
Torquigener flavimaculosus	UpPo14A-F	JFS051-09...JFS056-09	KM538628-30, 34-36
	UpPo14G-H	JFS148-14...JFS149-14	KM538624, 31
	UpPo14M-Q	JFS251-14...JFS255-14	KM538625-27, 32-33
Trachurus mediterraneus	UrSc38M-P	JFS336-14...JFS339-14	KM538637-40
Trichiurus lepturus			
Trigloporus lastoviza			
Upeneus moluccensis			
Upeneus pori			
Uranoscopus scaber			

Table S3. Morphology- and sequence-based classifications of fish samples and their geographic origin.

Morphology-based identification	Similarity score of 1 st and 2 nd thresholds, %* (# of sequences**)		Closely related species	Cluster***	Geographic origin of samples****	
					Israeli cluster	Other clusters
T. torpedo	99-100(8 ^a)	94-96(1 ^a ,7 ^b)	T. fuscomaculata	1	North Africa, PT, IT	-
R. miraletus	97-100(67 ^a)	93-94(24 ^a)		2	North Africa, PT, IT	South Africa
S. aurita	96-100(29 ^a ,43 ^c)	86(3 ^b ,3 ^c)	S. maderensis	2	IT	US, Argentina, Mexico
H. punctatus	99-100(7 ^a)	85(1 ^b)	Pseudocorynopoma doriae	1	-	-
A. balearicum	98-100(23 ^a)	97(4 ^a)		3	IT, Africa	USA, Mexico
S. undosquamis	99-100(14 ^a ,5 ^c)	93-95(28 ^a ,6 ^b)	S. grandisquamis	1	-	-
S. saurus	99-100(5 ^a)	95(1 ^a)	-	1	PT, IT	Bahamas
P. lineatus	99-100(28 ^a)	95-97(10 ^a)		1	-	-
A. boyeri	99-100(8 ^a)	88-89(12 ^a ,25 ^b ,9 ^c)	A. hepsetus	5	-	TR, Africa, PT
T. lastoviza	97-100(23 ^a)	93-94(45 ^b ,31 ^c)	Chelidonichthys cuculus	2	PT, UK, IT	Africa
S. hepatus	99-100(34 ^a)	88-89(23 ^b ,9 ^c)	S. scriba	1	PT, MT, IT	-
S. cabrilla	97-100(59 ^a ,12 ^c)	94(4 ^b)	S. atricauda	2	-	IL, PT, IT, ES
A. smithi	98-100(23 ^a)	95-96(11 ^a ,5 ^b)	A. ellioti	2	-	Australia
A. pharaonis	99-100(5 ^a)	90(9 ^b)	A. nigripinnis	1	-	-
O. fasciatus	99-100(23 ^a)	96-97(6 ^a ,4 ^b)	O. novemfasciatus	1	North Africa, India	-
D. russelli	98-100(38 ^a ,30 ^b ,7 ^c)	93(2 ^a ,5 ^b)	D. maruadsi	3	Africa	Malaysia, IR, India
T. mediterraneus	99-100(21 ^a)	98(1 ^a ,7 ^b ,3 ^c)	T. japonicus	2	TR, IT, ES	IL
E. klunzingeri	98-100(24 ^a ,11 ^b ,2 ^c)	94(3 ^b ,1 ^c)	E. leuciscus	2	-	ID, China
N. randalli	100(24 ^a)	99(6 ^b)	N. mesoprion	1	-	-
P. stridens	99-100(12 ^a)	87-88(7 ^b)	Isacia conceptionis	1	IR	-
P. caeruleostictus	99-100(16 ^a)	91-92(26 ^b ,1 ^c)	P. auriga	1	Atlantic Ocean	-
L. mormyrus	95-100(50 ^a)	88-89(37 ^b ,1 ^c)	Sparus aurata	4	IT	Africa, TR
P. erythrinus	99-100(54 ^a ,2 ^c)	94(3 ^b ,5 ^c)	P. natalensis	1	TR, ES, PT, IT	-
P. acarne	99-100(49 ^a ,2 ^b)	92-93(21 ^b ,1 ^c)	Oblada melanura	1	Africa, ES, PT, IT	-
D. annularis	99-100(18 ^a)	98(11 ^a)		2	TR, IT	TR, PT
B. boops	97-100(76 ^a ,2 ^c)	90(21 ^b)	Sarpa salpa	1	PT, IT, TR, Africa	-
S. maena	99-100(22 ^a ,1 ^c)	92-93(33 ^b ,4 ^a)	S. smararis	2	PT, IT	MT, FR
S. smararis	99-100(34 ^a)	92-93(26 ^b ,1 ^c)	S. maena	2	MT, IT	TR
U. pori	99-100(20 ^a ,8 ^c)	92-94(4 ^b ,6 ^c)	U. asymmetricus	2	North Africa	ID, India
M. barbatus	99-100(46 ^a)	89-91(2 ^a ,41 ^b)	M. surmuletus	1	PT, MT, TR, IT	-
U. moluccensis	98-100(48 ^a ,1 ^c)	93(3 ^b)	U. subvittatus	2	Africa, Far East	TR
U. scaber	99-100(10 ^a)	92(2 ^b)	U. polli	1	MT, IT, Africa	-
C. filamentosus	98-100(99 ^a)	nd	nd	nd	-	-
O. petersii	99-100(2 ^a ,1 ^b ,2 ^c)	96(4 ^b)	O. auchenolepis	1	-	-

(continued)

Supp. Table 3 (continued)

Morphology-based identification	Similarity score of 1 st and 2 nd thresholds, %* (# of sequences**)		Closely related species	Cluster***	Geographic origin of samples****	
					Israeli cluster	Other clusters
<i>S. rivulatus</i>	98-100(7 ^a)	96-97(2 ^a , 26 ^b , 1 ^c)	<i>S. sutor</i>	1	Saudi Arabia	-
<i>S. chrysotaenia</i>	99-100(15 ^a)	94(3 ^b , 2 ^c)	<i>S. pinguis</i> var Indo	1	Africa	-
<i>T. lepturus</i>	100(1 ^a)	96(10 ^a)		1	-	-
<i>S. colias</i>	100(2 ^a)	99(26 ^a)		1	-	-
<i>C. linguatula</i>	97-100(60 ^a)	83(5 ^b , 3 ^c)	<i>Atherinomorus vaigiensis</i>	2	MT, PT, IT	TR
<i>Arnoglossus</i> sp. (<i>A. laterna</i>)	99-100(37 ^a)	85-86(10 ^b , 6 ^c)	<i>A. rueppelii</i>	1	PT, UK, Norway, FR	-
<i>Arnoglossus</i> sp. (<i>A. thori</i>)	98-100(8 ^a)	90-92(12 ^b , 6 ^c)	<i>A. capensis</i>	1	MT	-
<i>B. podas</i>	99-100(34 ^a)	90-91(5 ^b)	<i>B. mellessi</i>	2	IT, PT, Africa	UK
<i>Solea</i> spp (<i>B. luteum</i>)	98-100(23 ^a)	83-84(6 ^b , 9 ^c)	<i>Bathysolea profundicola</i>	1	North Sea, PT, UK	-
<i>C. sinusarabici</i>	99-100(23 ^a)	83-85(14 ^b , 13 ^c)	<i>C. kopsii</i>	1	-	-
<i>S. diaspros</i>	99-100(23 ^a , 2 ^c)	96-98(1 ^a , 21 ^b , 18 ^c)	<i>S. hispidus</i>	1	North Africa	-
<i>L. sceleratus</i>	99-100(11 ^a , 4 ^c)	89-91(9 ^a , 32 ^b)	<i>L. suezensis</i>	2	North Africa	Australia
<i>L. guntheri</i>	96-100(18 ^a , 22 ^c)	93-94(15 ^a , 5 ^b , 4 ^c)	<i>L. wheeleri</i>	3	-	India, IR, Taiwan, China
<i>L. suezensis</i>	98-100(28 ^a)	94-95(3 ^a , 9 ^b)	<i>L. sceleratus</i>	1	-	-
<i>T. flavimaculosus</i>	98-100(8 ^a , 8 ^c)	93(4 ^b , 1 ^c)	<i>T. brevipinnis</i>	2	Africa	IL, Africa, Australia

* Significant similarity score between thresholds by t-test ($p < 0.001$).** ^aMorphology-based classification, ^bclosely related species, and ^cother related species or not determined (nd).

*** No. of clusters based on phylogenetic cluster analysis.

**** Country codes: Israel IL, Turkey TR, Portugal PT, Italy IT, Iran IR, France FR, Spain ES, Malta MT, Indonesia ID.