Barcoding of Indian Marine Fishes: For Identification and Conservation

V.S. Basheer, Labrechai Mog Chowdhury, C. Mohitha and K.K. Bineesh

Abstract India has a rich natural heritage and nurtures a unique bio-diversity, placing it among the 12 most biodiverse countries. Globally the number of valid fish species recorded so far is more than 31000, with the addition, at an average, of 100–150/year. Among these 2,508 are indigenous to Indian subcontinent (877 freshwater, 113 brackish water and 1,518 marine species). DNA barcoding is a molecular method for species identification and classification of biological organisms based on the analysis of short, standardized gene sequences. In most animals, the fragment of mitochondrial gene cytochrome c oxidase subunit I (COI) has been used as the target sequence. This novel system is designed to provide rapid, accurate, and automatable species identifications by using short, standardized gene regions as internal species tags. Of this rich natural biodiversity, comprising over 1518 native marine species, at present barcodes of about 500 marine fish species are available, which is approximately 33 % of total Indian marine fish diversity. Whereas major portion of registered marine fishes remain untouched. Hence more emphasis should be given to DNA barcoding, with mandate of barcoding all the species to establish global comprehensive reference libraries. The traditional taxonomists will play a vital role in completing such a global database; hence there is a pressing need to make a integration of DNA barcoding with traditional taxonomy. In a nutshell, it can be said that DNA barcoding can be taken up as pragmatic approach for resolving unambiguous identification of the fish fauna which can play a crucial role in biodiversity assessment and conservation of marine ecosystem of country.

Keywords Biodiversity · Conservation · DNA barcode · Fish · Marine fish species

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1 Introduction

Since the Convention of Biological Diversity summit at Rio-de-Janeiro in 1992, all over the world, there has been lot of interest in identification of biological resources. Identification of species in the classic way, using morphological characters takes longer time and manpower, hence scientists developed an alternative method in conjunction with the genetic make up of the species. DNA barcoding is a molecular method for species identification and classification of biological organisms based on the analysis of short, standardized gene sequences (Hebert et al. 2003). In most animals, the fragment of mitochondrial gene cytochrome c oxidase subunit I (COI) has been used as the target sequence. This novel system is designed to provide rapid, accurate, and automatable species identifications by using short, standardized gene regions as internal species tags. DNA barcoding is now gaining more attention in the field of assessment of cryptic species, taxon diagnosis, authentication and safety assessment of seafood, wildlife forensics, conservation genetics and detection of invasive alien species from whole fish, fillets, fins, fragments, juveniles, larvae, eggs, any properly preserved tissue or environment sample (Trivedi et al. 2016). The concerted global research FISH-BOL (Fish Barcode of Life) on DNA barcoding was launched in 2005, with the goal of collection and assembling specific DNA barcode sequences and associated voucher provenance data in accurate reference sequence library to aid the molecular identification of all fish species.

India has a rich natural heritage and nurtures a unique bio-diversity, placing it among the 12 biodiversity rich countries. Globally the number of valid fish species recorded so far is more than 31000, with the addition, at an average, of 100–150/year (Eschmeyer et al. 2010). Among these 2,508 are indigenous to Indian subcontinent (877 freshwater, 113 brackish water and 1,518 marine species) (NBFGR, 2013). Out of which about 500 marine species has been barcoded (Tables 1, 2 and Fig. 1), covering carangids, scombrids, serranids, scianids, polynemids, nemipterids, pomacanthids, gobiids, clupeids, mugilids, sharks, rays, skates and other taxonomically important groups, under national programme on DNA barcoding which was launched in 2005 with initiative of NBFGR and other research programmes. In view of the growing importance of fish DNA barcoding, Nagpure et al. (2012) developed Fish Barcode Information System (FBIS) database on Indian fishes. FBIS represent barcode sequences for Indian fishes, reported in India as well as from other countries. Presently, it comprises barcode sequence of 1083 marine, 349 Freshwater and 49 brackish water with 23429 specimen sequences (http://mail.nbfgr.res.in/fbis/) belonging to 213 families and 48 orders.

Table 1 List of Indian marine fish species barcoded (Bony fishes)

Sl. No.	Order	Family	Species	Acessions
1	Perciformes	Carangidae	*Carangoides armatus*	FJ459577
2			*Carangoides chrysophrys*	FJ237546
3			*Carangoides ferdau*	EU514505
4			*Carangoides malabaricus*	FJ347935
5			*Carangoides praeustus*	KC508506
6			*Carangoides talamparoides*	KC508507
7			*Caranx caranges*	EU514501
8			*Alectis indica*	FJ347894
9			*Alectis ciliaris*	EU514500
10			*Alepes djedaba*	EF609498
11			*Alepes kleinii*	FJ237545
12			*Atropus atropos*	EF609506
13			*Atule mate*	EU514511
14			*Parastromateus niger*	EF609570
15			*Megalaspis cordyla*	EF609548
16			*Caranx hippos*	FJ347906
17			*Caranx ignobilis*	EU014221
18			*Caranx sexfasciatus*	EU514509
19			*Gnathanodon speciosus*	EU148562
20			*Elagatis bipinnulata*	EU014215
21			*Decapterus russelli*	EF609508
22			*Decapterus macrosoma*	EU514515
23			*Decapterus macarellus*	EU514517
24			*Scomberoides lysan*	FJ347900
25			*Scomberoides commersonnianus*	EU514496
26			*Selar boops*	FJ347890
27			*Selar crumenophthalmus*	FJ347941
28			*Selaroides leptolepis*	EU514521
29			*Seriolina nigrofasciata*	EU014235
30			*Trachinotus blochii*	EU148559
31			*Uraspis helvola*	EU514510
32		Scombridae	*Auxis rochei*	FJ226520
33			*Auxis thazard*	FJ226525
34			*Euthynnus affinis*	EU148529
35			*Katsuwonus pelamis*	EU014258
36			*Rastrelliger brachysoma*	KJ590064
37			*Rastrelliger faughni*	KJ590073
38			*Rastrelliger kanagurta*	FJ237548

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
39			*Sarda orientalis*	EF609591
40			*Scomberomorus commerson*	KM677209
41			*Scomberomorus guttatus*	EU541328
42			*Thunnus albacares*	EF609629
43			*Thunnus tonggol*	FJ226524
44		Serranidae	*Aethaloperca rogaa*	KM226213
45			*Cephalopholis argus*	FJ237556
46			*Cephalopholis aurantia*	KM226217
47			*Cephalopholis boenak*	FJ237553
48			*Cephalopholis formosa*	KF268156
49			*Cephalopholis urodeta*	FJ459565
50			*Cephalopholis sonnerati*	FJ237541
51			*Cephalopholis miniata*	FJ237607
52			*Cephalopholis nigripinnis*	KM226226
53			*Chelidoperca investigatoris*	KP009558
54			*Chelidoperca occipitalis*	JX185306
55			*Chelidoperca maculicauda*	JX185308
56			*Liopropoma randalli*	KF814980
57			*Epinephelus areolatus*	JX674967
58			*Epinephelus bleekeri*	JX674971
59			*Epinephelus chlorostigma*	EU392203
60			*Epinephelus coeruleopunctatus*	KF268167
61			*Epinephelus coioides*	KJ755858
62			*Epinephelus diacanthus*	EF609517
63			*Epinephelus macrospilos*	JX675007
64			*Epinephelus longispinis*	HQ658119
65			*Epinephelus latifasciatus*	EU014219
66			*Epinephelus fuscoguttatus*	JX674997
67			*Epinephelus flavocaeruleus*	KM226266
68			*Epinephelus faveatus*	JX674974
69			*Epinephelus fasciatus*	EU392208
70			*Epinephelus malabaricus*	FJ237599
71			*Epinephelus merra*	FJ237598
72			*Epinephelus melanostigma*	KM226281

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
73			*Epinephelus morrhua*	EU392189
74			*Epinephelus miliaris*	KM226282
75			*Epinephelus polylepis*	KM226288
76			*Epinephelus polyphekadion*	KM226293
77			*Epinephelus radiatus*	KM226297
78			*Epinephelus quoyanus*	KM226294
79			*Epinephelus spilotoceps*	KM226298
80			*Epinephelus tauvina*	EU148566
81			*Epinephelus undulosus*	JX675024
82			*Hyporthodus octofasciatus*	KM226304
83			*Odontanthias perumali*	KR105805
84			*Plectropomus areolatus*	KJ607966
85			*Plectropomus maculatus*	JX123681
86			*Plectropomus leopardus*	KM226309
87			*Plectropomus laevis*	KM226311
88			*Sacura boulengeri*	KR105842
89			*Variola louti*	FJ459559
90			*Variola albimarginata*	KM226312
91		Scianidae	*Dendrophysa russelii*	EU148580
92			*Johnius belangerii*	FJ347918
93			*Johnius borneensis*	FJ347922
94			*Johnius carutta*	FJ265843
95			*Johnius dussumieri*	FJ347915
96			*Johnius elongatus*	EF534123
97			*Nibea maculata*	EU014249
98			*Nibea soldado*	HQ219159
99			*Otolithes cuvieri*	FJ347924
100			*Otolithes ruber*	FJ237586
101			*Otolithoides biauritus*	EF534127
102			*Panna microdon*	JX983436
103			*Macrospinosa cuja*	JX260908
104			*Protonibea diacanthus*	EF528229
105		Sphyraendiae	*Sphyraena acutipinnis*	JX260977
106			*Sphyraena barracuda*	FJ265849
107			*Sphyraena jello*	EF609620
108			*Sphyraena obtusata*	FJ265848

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
109		Polynemidae	*Filimanus similis*	KJ468470
110			*Filimanus heptadactyla*	EF609523
111			*Leptomelanosoma indicum*	EF609539
112			*Polydactylus microstomus*	KJ468474
113			*Polydactylus plebeius*	KC576978
114			*Polydactylus sexfilis*	KJ468467
115			*Polydactylus sextarius*	EU392177
116			*Eleutheronema tetradactylum*	EF609512
117			*Polynemus paradiseus*	HQ219165
118		Leiognathidae	*Equulites leuciscus*	FJ265836
119			*Equulites lineolatus*	FJ237600
120			*Eubleekeria splendens*	FJ384712
121			*Gazza minuta*	EU148512
122			*Leiognathus equulus*	FJ347946
123			*Karalla daura*	EU392205
124			*Photopectoralis bindus*	EF609534
125			*Secutor ruconius*	EF609612
126			*Secutor insidiator*	FJ265837
127		Mullidae	*Parupeneus barberinus*	EU148577
128			*Parupeneus forsskali*	FJ347965
129			*Parupeneus macronemus*	KJ632829
130			*Parupeneus pleurostigma*	FJ237573
131			*Parupeneus trifasciatus*	FJ459576
132			*Upeneus sulphureus*	EF609637
133			*Upeneus vittatus*	FJ347944
134			*Mulloidichthys auriflamma*	EU014232
135		Nemipteridae	*Nemipterus bipunctatus*	HQ423413
136			*Nemipterus japonicus*	EF609554
137			*Nemipterus mesoprion*	EF609559
138			*Nemipterus nematophorus*	JN992286
139			*Nemipterus zysron*	JN992287
140			*Nemipterus hexodon*	EF609414
141			*Nemipterus furcosus*	EF609413
142			*Nemipterus virgatus*	EJ237835
143			*Nemipterus peronii*	EF609415
144			*Parascolopsis boesemani*	KR105824
145			*Parascolopsis eriomma*	KR105820
146			*Parascolopsis aspinosa*	KR105815

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
147		Apogonidae	*Pristiapogon kallopterus*	EU392192
148			*Apogon quadrifasciatus*	EU148585
149			*Apogon norfolcensis*	FJ237579
150		Chaetodontidae	*Chaetodon collare*	FJ237559
151			*Chaetodon decussatus*	FJ237562
152			*Chaetodon trifascialis*	FJ237610
153			*Heniochus singularius*	JX669540
154			*Heniochus acuminatus*	EU014239
155			*Roa jayakari*	KF268183
156		Gerreidae	*Gerres erythrourus*	KC774649
157			*Gerres filamentosus*	KC774650
158			*Gerres oyena*	JX260873
159			*Pentaprion longimanus*	EU392182
160		Lethrinidae	*Lethrinus conchyliatus*	EU148536
161			*Lethrinus miniatus*	EU148533
162		Lutjanidae	*Lutjanus bohar*	EU541340
163			*Lutjanus fulviflamma*	EU541339
164			*Lutjanus johnii*	EU148538
165			*Lutjanus kasmira*	HQ658118
166			*Lutjanus lutjanus*	EU148541
167			*Lutjanus malabaricus*	EU014231
168			*Lutjanus russellii*	EU148540
169			*Macolor niger*	KJ425304
170			*Pinjalo pinjalo*	EU541341
171			*Pristipomoides multidens*	FJ237568
172		Pomacentridae	*Amphiprion ephippium*	JX987299
173			*Amphiprion frenatus*	JX901062
174			*Amphiprion clarkii*	JX573169
175			*Amphiprion ocellaris*	JX454573
176			*Amphiprion polymnus*	JX975292
177			*Amphiprion sebae*	KJ397926
178			*Amphiprion percula*	JX573170
179			*Amphiprion nigripes*	JX573171
180			*Amphiprion melanopus*	JX548321
181			*Amphiprion sandaracinos*	JX548320
182			*Amphiprion perideraion*	JX548324
183			*Amphiprion akallopisos*	JX975291
184			*Premnas biaculeatus*	JX548322
185			*Abudefduf septemfasciatus*	KJ129002

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
186			*Abudefduf vaigiensis*	FJ237570
187			*Chrysiptera unimaculata*	KF268162
188			*Dascyllus aruanus*	HQ589913
189		Pomacanthidae	*Apolemichthys xanthurus*	KC626014
190			*Pomacanthus annularis*	KF268138
191		Terapontidae	*Terapon puta*	KC774676
192			*Terapon theraps*	FJ347958
193			*Terapon jarbua*	FJ347885
194		Trichiuridae	*Lepturacanthus savala*	EF609542
195			*Trichiurus lepturus*	FJ347953
196			*Trichiurus russelli*	FJ265829
197			*Trichiurus auriga*	KR105923
198			*Aphanopus intermedius*	KP244485
199		Rachycentridae	*Rachycentron canadum*	EF609584
200		Scatophagidae	*Scatophagus argus*	EF609604
201		Priacanthidae	*Priacanthus hamrur*	EF609576
202			*Priacanthus prolixus*	KF815020
203			*Priacanthus tayenus*	FJ265857
204			*Pristigenys refulgens*	KF815040
205			*Priacanthus sagittarius*	KF815027
206			*Priacanthus blochii*	KF815022
207			*Cookeolus japonicus*	KF815042
208		Lactariidae	*Lactarius lactarius*	FJ347949
209		Ephippidae	*Ephippus orbis*	EU014240
210			*Platax teira*	KJ129011
211		Sparidae	*Acanthopagrus berda*	EU014244
212			*Acanthopagrus latus*	JX983210
213			*Argyrops spinifer*	EU541345
214		Ariommatidae	*Ariomma indicum*	KP244487
215		Blennidae	*Petroscirtes variabilis*	EU148523
216		Pempheridae	*Pempheris mangula*	KJ020193
217		Centrolophidae	*Psenopsis cyanea*	EU392194
218		Menidae	*Mene maculata*	FJ347939
219		Acanthuridae	*Acanthurus mata*	FJ459542
220			*Acanthurus triostegus*	KF434770
221		Gobiidae	*Acentrogobius chlorostigmatoides*	JX193727
222			*Acentrogobius audax*	JX193752
223			*Acrygobius baliurus*	JX193733
224			*Bathygobius fuscus*	JX193747

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
225			*Oxyurichthys ophthalmonema*	JX193748
226			*Oligolepis acutipennis*	JX193738
227			*Odontamblyopus rubicundus*	JX193743
228			*Obliquogobius cometes*	KP244597
229			*Exyrias puntang*	KC788177
230			*Periophthalmus novemradiatus*	KM229327
231			*Psammogobius biocellatus*	JX193732
232			*Trypauchen vagina*	JX193742
233			*Boleophthalmus boddarti*	KM229329
234			*Glossogobius giuris*	FJ459498
235		Labridae	*Halichoeres zeylonicus*	FJ158563
236			*Halichoeres timorensis*	KF422721
237			*Thalassoma lunare*	FJ237565
238			*Thalassoma jansenii*	FJ459567
239			*Thalassoma quinquevittatum*	FJ459571
240		Eleotridae	*Butis butis*	JX193740
241			*Eleotris fusca*	JX193751
242		Latidae	*Lates calcarifer*	FJ384689
243			*Psammoperca waigiensis*	FJ237578
244		Caesionidae	*Caesio caerulaurea*	FJ237594
245		Coryphaenidae	*Coryphaena hippurus*	FJ237540
246		Haemulidae	*Diagramma picta*	FJ237604
247			*Pomadasys kaakan*	JX260937
248		Drepaneidae	*Drepane longimana*	FJ459579
249			*Drepane punctata*	EU541347
250		Stromateidae	*Pampus argenteus*	FJ226532
251			*Pampus chinensis*	FJ226529
252		Siganidae	*Siganus canaliculatus*	KJ679902
253			*Siganus javus*	KJ679903
254		Sillaginidae	*Sillago sihama*	EF609615
255			*Sillago vincenti*	KC774673
256		Cepolidae	*Sphenanthias whiteheadi*	JN704806
257			*Acanthocepola indica*	KP244472
258		Bathyclupeidae	*Bathyclupea hoskynii*	KP244492
259		Emmelichthyidae	*Erythrocles acarina*	KP244547
260		Malacanthidae	*Hoplolatilus fronticinctus*	KC110755
261		Istiophoridae	*Istiophorus platypterus*	EF609527

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
262		Pinguipedidae	*Parapercis maculata*	KF876338
263		Gempylidae	*Ruvettus pretiosus*	HM990654
264			*Neoepinnula orientalis*	KP244591
265			*Promethichthys prometheus*	KP244604
266			*Lepidocybium flavobrunneum*	KP244579
267		Xiphiidae	*Xiphias gladius*	KJ739601
268		Percophidae	*Bembrops caudimacula*	KP244495
269		Symphysanodontidae	*Symphysanodon xanthopterygion*	KR105909
270		Ambassidae	*Ambassis ambassis*	KJ614388
271		Bramidae	*Brama dussumieri*	KJ020208
272	Clupeiformes	Clupeidae	*Hilsa kelee*	FJ158559
273			*Tenualosa toli*	EF609624
274			*Tenualosa ilisha*	JX260883
275			*Sardinella albella*	FJ237551
276			*Sardinella gibbosa*	FJ237613
277			*Sardinella longiceps*	EF609594
278			*Nematalosa nasus*	FJ384687
279			*Anodontostoma chacunda*	FJ347933
280		Engraulidae	*Encrasicholina heteroloba*	EU392186
281			*Stolephorus andhraensis*	EU541322
282			*Stolephorus commersonnii*	EU541323
283			*Stolephorus indicus*	FJ347957
284			*Thryssa dussumieri*	JX983289
285			*Thryssa hamiltonii*	EU148567
286			*Thryssa malabarica*	FJ347883
287			*Thryssa setirostris*	EU541324
288		Chirocentridae	*Chirocentrus dorab*	FJ347877
289		Pristigasteridae	*Pellona ditchela*	FJ347928
290		Dussumieriidae	*Dussumieria elopsoides*	FJ347962
291			*Dussumieria acuta*	EU014223
292		Nomeidae	*Psenes cyanophrys*	KJ020212
293			*Psenes arafurensis*	KJ020215
294			*Cubiceps whiteleggii*	KP244519

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
295	Mugiliformes	Mugilidae	*Ellochelon vaigiensis*	JQ045780
296			*Liza klunzingeri*	JX983355
297			*Liza subviridis*	JQ045782
298			*Valamugil speigleri*	JQ045778
299			*Liza macrolepis*	FJ347967
300			*Liza tade*	JQ045776
301			*Liza parsia*	JQ045779
302			*Liza planiceps*	JQ045784
303			*Mugil cephalus*	FJ347895
304			*Moolgarda cunnesius*	FJ384690
305			*Moolgarda seheli*	JQ045781
306	Siluriformes	Ariidae	*Arius arius*	KF010175
307			*Arius gagora*	JX260835
308			*Arius jella*	FJ265865
309			*Arius maculatus*	FJ869856
310			*Arius subrostratus*	EU148555
311			*Arius maculatus*	FJ403390
312			*Plicofollis platystomus*	KF824838
313			*Plicofollis tenuispinis*	KF824836
314			*Netuma thalassina*	EU014254
315			*Osteogeneiosus militaris*	EF609563
316		Plotosidae	*Plotosus limbatus*	KF824845
317			*Plotosus lineatus*	EU148554
318			*Plotosus canius*	KF824847
319	Pleuronectiformes	Cynoglsidae	*Cynoglossus dubius*	FJ347907
320			*Cynoglossus cynoglossus*	JX983282
321			*Cynoglossus bilineatus*	FJ384697
322			*Cynoglossus puncticeps*	EU541318
323			*Cynoglossus macrostomus*	FJ347954
324			*Cynoglossus lingua*	EU541316
325			*Cynoglossus carpenteri*	KP244525
326		Paralichthyidae	*Pseudorhombus arsius*	JX260939
327			*Pseudorhombus elevatus*	EU541314
328			*Pseudorhombus malayanus*	EU541312
329		Psettodidae	*Psettodes erumei*	EF609580
330		Bothidae	*Laeops macrophthalmus*	KP244572
331			*Chascanopsetta lugubris*	KP244514
332		Soleidae	*Zebrias synapturoides*	FJ347914

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
333	Beloniformes	Hemiramphidae	*Hemiramphus far*	EU148546
334			*Hyporhamphus dussumieri*	JX983320
335			*Hyporhamphus xanthopterus*	EU148545
336			*Rhynchorhamphus georgii*	JX983484
337			*Rhynchorhamphus malabaricus*	KJ641743
338		Belonidae	*Strongylura leiura*	FJ237566
339			*Strongylura strongylura*	EU014257
340	Aulopiformes	Synodontidae	*Harpadon nehereus*	EU148582
341			*Saurida pseudotumbil*	KF876337
342			*Saurida nebulosa*	KF876020
343			*Saurida tumbil*	EF609603
344			*Saurida undosquamis*	FJ347930
345			*Synodus variegatus*	FJ265846
346			*Saurida* cf. *micropectoralis*	KR105884
347			*Saurida longimanus*	KR105853
348			*Trachinocephalus myops*	EF609630
349		Chlorophthalmidae	*Chlorophthalmus acutifrons*	JX944228
350			*Chlorophthalmus corniger*	JX944224
351	Tetraodontiformes	Tetraodontidae	*Arothron hispidus*	KC409391
352			*Arothron immaculatus*	KC409372
353			*Arothron leopardus*	KJ093731
354			*Arothron stellatus*	KC409388
355			*Chelonodon patoca*	KC409363
356			*Lagocephalus guentheri*	KC409371
357			*Lagocephalus inermis*	JX995942
358			*Lagocephalus spadiceus*	FJ384711
359		Ostraciidae	*Lactoria cornuta*	FJ237606
360			*Tetrosomus gibbosus*	KF268149
361		Balistidae	*Odonus niger*	FJ459554
362			*Rhinecanthus rectangulus*	FJ459548
363		Monacanthidae	*Anacanthus barbatus*	FJ541074

(continued)

Table 1 (continued)

Sl. No.	Order	Family	Species	Acessions
364	Anguilliformes	Muraenidae	*Gymnothorax undulatus*	KF297588
365			*Gymnothorax punctatus*	KF297589
366			*Gymnothorax pictus*	KF297590
367			*Strophidon sathete*	FJ384683
368		Muraenesocidae	*Muraenesox cinereus*	KF297592
369		Nemichthyidae	*Nemichthys acanthonotus*	KP244586
370		Scaridae	*Scarus quoyi*	KF930376
371	Syngnathiformes	Syngnathidae	*Hippocampus trimaculatus*	EU930320
372			*Hippocampus kuda*	FJ541049
373			*Hippocampus kelloggi*	GQ502149
374		Centriscidae	*Centriscus scutatus*	FJ265863
375		Fistulariidae	*Fistularia petimba*	FJ541073
376	Scorpaeniformes	Scorpaenidae	*Pterois russelii*	KF268175
377			*Ebosia falcata*	KP244540
378			*Pontinus nigerimum*	KR105829
379		Dactylopteridae	*Dactyloptena orientalis*	EU148590
380		Peristediidae	*Satyrichthys adeni*	KR105846
381		Setarchidae	*Setarches guentheri*	KR105907
382		Berycidae	*Beryx mollis*	KP244504
383	Beryciformes	Holocentridae	*Myripristis murdjan*	FJ459546
384			*Sargocentron rubrum*	KF442242
385			*Ostichthys kaianus*	KR105810
386		Trachichthyidae	*Gephyroberyx darwinii*	KP244553
387	Gonorynchiformes	Chanidae	*Chanos chanos*	JX260845
388	Lophiiformes	Diceratiidae	*Bufoceratias thele*	KP244512
389		Lophiidae	*Lophiodes lugubris*	KP244581
390			*Lophius indicus*	KP244583
391	Perciformes	Pentacerotidae	*Histiopterus typus*	KP244559
392	Notacanthiformes	Notacanthidae	*Notacanthus indicus*	KR105800
393			*Notacanthus* sp. A	KR105803
394	Ophidiiformes	Ophidiidae	*Neobythites steatiticus*	KP244588
395	Osmeriformes	Platytroctidae	*Normichthys yahganorum*	KR105797
396		Alepocephalidae	*Alepocephalus bicolor*	KP244479
397	Zeiformes	Parazenidae	*Cyttopsis rosea*	KP244533
398		Zeidae	*Zenopsis conchifer*	KR105931

Table 2 List of Indian marine fish species barcoded (Cartilaginous fishes)

Sl No.	Order	Family	*Species*	Acc. No.
1	Chimaeriformes		*Neoharriotta pinnata*	HM239670
2			*Hydrolagus africanus*	KF89952
3	Hexanchiformes	Hexanchidae	*Heptranchias perlo*	HM239668
4			*Hexanchus griseus*	KF899463
5	Echinorhiniformes	Echinorhinidae	*Echinorhinus brucus*	HM467790
6	Orectolobiformes	Hemiscylliidae	*Chiloscyllium griseum*	KF899626
7		Stegostomatidae	*Stegostoma fasciatum*	KF899644
8		Ginglymostomatidae	*Nebrius ferrugineus*	KM973183
9		Rhincodontidae	*Rhincodon typus*	KF899634
10	Lamniformes	Alopiidae	*Alopias pelagicus*	HM239672
11			*Alopias superciliosus*	KF899554
12			*Alopias vulpinus*	KF899558
13			*Isurus oxyrinchus*	KF899536
14		Odontaspididae	*Odontaspis noronhai*	KF899559
15		Lamnidae	*Isurus oxyrinchus*	KF899541
16			*Isurus paucus*	KF899542
17		Pseudocarchariidae	*Pseudocarcharias kamoharai*	KF899532
18	Carcharhiniformes	Carcharhinidae	*Carcharhinus macloti*	KF913242
19			*Carcharhinus longimanus*	KF899777
20			*Carcharhinus limbatus*	KF899814
21			*Carcharhinus falciformis*	KF899803
22			*Carcharhinus brevipinna*	KF899802
23			*Carcharhinus amboinensis*	KF899796
24			*Carcharhinus altimus*	KF899786
25			*Carcharhinus sorrah*	KF899821
26			*Carcharhinus amblyrhynchos*	KF899792
27			*Carcharhinus albimarginatus*	KF899782
28			*Carcharhinus leucas*	KF899812
29			*Carcharhinus melanopterus*	KF899824
30			*Lamiopsis temminckii*	KF899563
31			*Prionace glauca*	KF899653
32			*Rhizoprionodon acutus*	KF899687
33			*Galeocerdo cuvier*	KF899436
34			*Triaenodon obesus*	KF899768
35			*Scoliodon laticaudus*	KF899696
36		Sphyrnidae	*Sphyrna lewini*	KF899746
37			*Sphyrna zygaena*	KF899755
38		Scyliorhinidae	*Halaelurus quagga*	KF899715

(continued)

Table 2 (continued)

Sl No.	Order	Family	*Species*	Acc. No.
39			*Cephaloscyllium silasi*	HM467791
40			*Bythaelurus hispidus*	KF899706
41			*Apristurus* sp. A	KF899717
42		Triakidae	*Iago omanensis*	KF899745
43			*Mustelus mosis*	KC175449
44		Proscylliidae	*Eridacnis radcliffei*	KF899425
45		Hemigaleidae	*Hemipristis elongata*	KF899453
46			*Paragaleus randalli*	KF913245
47	Squaliformes	Squalidae	*Squalus* sp. A	KR149162
48		Centrophoridae	*Centrophorus squamosus*	KF899385
49			*Centrophorus atromarginatus*	KF899387
50			*Centrophorus granulosus*	KF899391
51			*Centrophorus zeehaani*	KF899394
52			*Deania profundorum*	KF899382
53		Etmopteridae	*Etmopterus pusillus*	KF899426
54		Somniosidae	*Centroselachus crepidater*	KF899400
55			*Zameus squamulosus*	KF899769
56	Torpediniformes	Torpedinidae	*Torpedo sinuspersici*	KF899724
57			*Torpedo* sp. A	KF899725
58		Narcinidae	*Benthobatis moresbyi*	KJ768662
59			*Narcine oculifera*	KF899605
60			*Narcine maculata*	KF899600
61			*Narcine* sp. A	KF899601
62	Rajiformes	Rhinidae	*Rhina ancylostoma*	KF899663
63		Rhynchobatidae	*Rhynchobatus* cf. *laevis*	KF899693
64			*Rhynchobatus australiae*	JN108019
65		Rhinobatidae	*Glaucostegus obtusus*	KF899439
66			*Glaucostegus thouin*	KF899441
67			*Rhinobatos lionotus*	KF899672
68			*Rhinobatos punctifer*	KF899668
69			*Rhinobatos variegatus*	KF899673
70		Rajidae	*Okamejei powelli*	KF899616
71			*Dipturus* sp. A	KF899402
72			*Dipturus* sp. B	KF899416
73			*Dipturus* cf. *johannisdavisi*	KF899412
74			*Dipturus* cf. *gigas*	KR149208

(continued)

Table 2 (continued)

Sl No.	Order	Family	*Species*	Acc. No.
75	Myliobatiformes	Plesiobatidae	*Plesiobatis daviesi*	HM467801
76		Dasyatidae	*Dasyatis microps*	KJ749657
77			*Himantura undulata*	KF899506
78			*Himantura uarnacoides*	KF899499
79			*Himantura granulata*	KF899471
80			*Himantura leoparda*	KF899501
81			*Himantura jenkinsii*	KF913237
82			*Himantura fai*	KF899475
83			*Himantura bleekeri*	KC508511
84			*Himantura gerrardi*	KF899364
85			*Himantura imbricata*	KF899356
86			*Himantura uarnak*	KF899511
87			*Neotrygon kuhlii*	KF899609
88			*Taeniura meyeni*	HM467797
89			*Pastinachus sephen*	KF899368
90			*Pastinachus atrus*	KF899373
91			*Pteroplatytrygon violacea*	HM239671
92			*Urogymnus asperrimus*	KC508509
93		Gymnuridae	*Gymnura poecilura*	KF899445
94		Myliobatidae	*Aetobatus narinari*	JX978339
95			*Aetobatus ocellatus*	KF899589
96			*Aetomylaeus maculatus*	KF899587
97			*Aetomylaeus vespertilio*	KF899586
98			*Manta birostris*	KF899569
99			*Mobula japanica*	JX978334
100			*Mobula kuhlii*	KF899582
101			*Mobula tarapacana*	KF899580
102		Rhinopteridae	*Rhinoptera jayakari*	KF899683

1.1 Carangids

The family Carangidae comprises 30 genera with 146 species distributed throughout Atlantic, Indian and Pacific Oceans (http://www.fishbase.org). In India approximately 58 species are recorded. Carangids are considered as a most delicious and highly valued fish in India. This group of fishes is categorized into five sub groups i.e., black pomfrets, queen fishes, trevallies, scads, and pompanos. The group has emerged as one of the important resources along Indian coast. A total of 51 fish species, covering 18 genera were barcoded in India from Indian water. NBFGR has completed barcoding of 45 carangid species belonging to 16 genera. Analaysis show that longfin trevally, *Carangoides armatus* is a species complex,

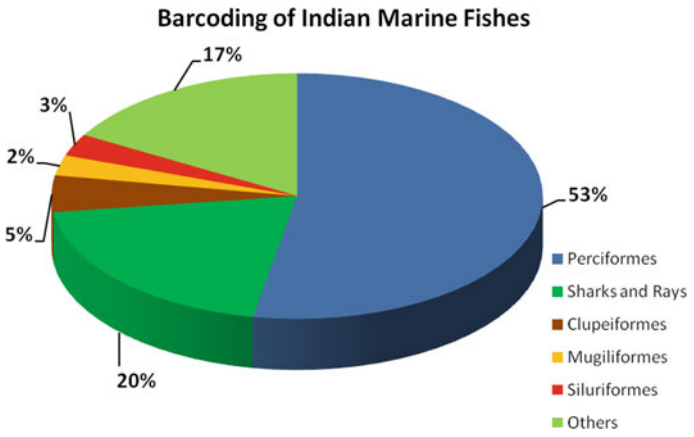

Fig. 1 Different groups of fishes barcoded in India

suggesting cryptic species within the complex. Persis et al. (2009) has carried out the phylogenetic study using COI for 28 carangids from Kakinada coast in India and revealed that all these fishes fall into three distinct groups which are genetically distant from each other and exhibited identical phylogenetic reservation. In addition to that 17 fish species from 13 genera were analysed by Lakra et al. (2011) who observed that the average genetic distance within species was 0.32 % whereas between species it was 16.1 %. The NJ tree also revealed distinct clusters for species of same genera with 94–100 % bootstrap values.

1.2 Sciaenids

The family Sciaenidae, known as croakers or drums, is distributed worldwide with approximately 70 genera and 300 species including about 40 species from Indian waters. This group contributes approximately 4.6 % to the total Indian marine fish production. Out of these 14 species were barcoded from Indian waters. Lakra et al. (2009) studied the phylogenetic relationships of six species of Indian sciaenids (*Otolithes cuvieri, O. ruber, Johnius borneensis, J. dussumieri, Dendrophysa russelii* and *Nibea maculata*) based on 16S rRNA and cytochrome c oxidase subunit I which revealed three genetic distinct groups. The average genetic distance within species was 0.28 % whereas the overall mean distance among the species was 18.20 %. The NJ tree clearly distinguished the species having same genus under one cluster with a bootstrap value of 96–100 %.

1.3 Scombrids

The family Scombridae consist of the mackerels, tunas, and bonitos, distributed worldwide in tropical and subtropical seas. The family consists of 15 genera and 54 species including 21 species from India. Out of which 12 fish comprising seven genera were barcodes from Indian waters. Based on the COI (655 bp) sequences genetic relationship of *Rastrelliger kanagurta*, *R. faugni* and *R. brachysoma* were carried out by Basheer et al. (2015) and it was observed that the mean genetic divergence between three mackerel species was 5 %. The pair-wise divergence between *R. kanagurta* and *R. faugni* was 0.08-0.09 and with *R. brachysoma* it was 0.03-0.04. *R. kanagurta* samples between Indian mainland and Andaman waters showed a divergence level of 1.2 %. Similar kind of work has been carried out by Lakra et al. (2011) covering five genera (*Auxis thazard, A. rochei, R. kanagurta, Thunus albacares, T. tonggol, Euthynnus affinis, Katsuwonus pelamis*) and revealed the 0.3 % genetic distance within species and 9.20 between the species. All the species were clearly separated into different clusters in the NJ tree with a bootstrap value ranging from 96 to 100 %.

1.4 Serranids

The family serranidae consist of 537 species, under 75 genera including 70 known species from India. Serranids are distributed throughout tropical and temperate oceans and it is represents one of the most important resources targeted by coastal fisheries in country. A total of 47 species of Serenade family were barcoded from Indian water by NBFGR and other agencies. Traditionally serranid fishes are identified based on visible morphological, meristic, and anatomical characters (Roy and Gopalakrishnan 2011). Sachithanandam et al. (2011) has shown the utility of COI divergences in identifying all the *Plectropomus maculatus* fishes in Andaman Islands with minimum base pair (133 bp). A molecular phylogeny study using COI sequences has shown that the overall mean distance among the species is 12.60 % and within species 0.24 %. In the NJ tree all the species were under one clad with bootstrap values of 94–98 % (Lakra et al. 2011).

At NBFGR, we barcoded 36 grouper species, including seven species listed in the IUCN red list under threatened category. Barcodes from six genera *Aetheloperca*, *Cephalopholis, Epinephelus, Hyporthodus, Plectropomus* and *Variola* were developed out of which *E. polylepis* and *E. miliaris* were developed for the first time. A comparison of the sequences generated were done with sequences available in NCBI to authenticate the species identification and resolve taxonomic ambiguity. Upon the sequence analysis, taxonomic ambiguity exists in *E. polylepis* and *E. cholorostigma. E. polylepis* has a distribution in northwest Indian Ocean (Craig et al. 2011) and there is no further report of the species after the description by Randall and Heemstra (1991) from India. It may be misidentification by earlier workers and reported as *E. chlorostigma*. Phylogenetic analysis using neighbour joining tree is given in Fig. 2.

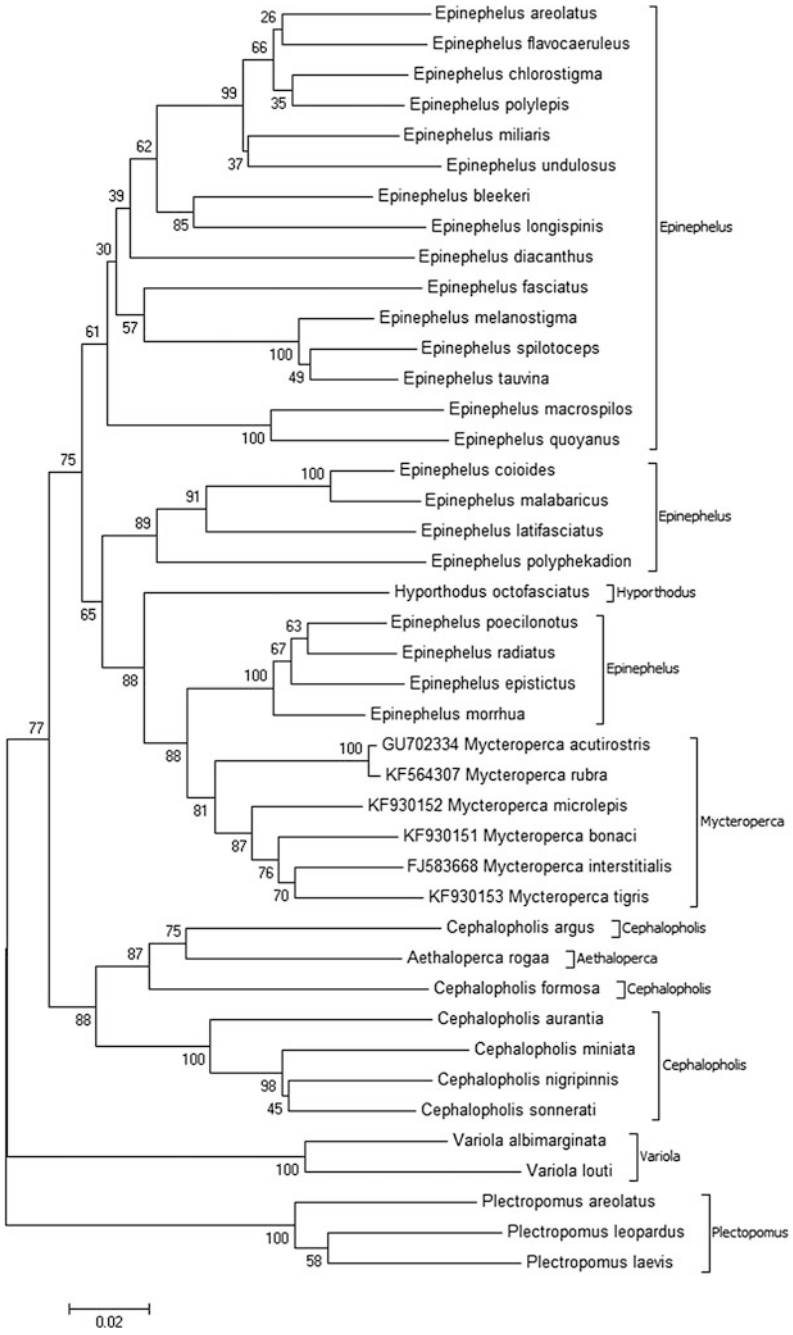

Fig. 2 NJ tree of COI gene sequences computed by using K2P distance of the groupers barcoded

1.5 Nemipterids

Species belonging to the family nemipteridae are known as threadfin, whiptail breams and false snappers, widely distributed in tropical waters of the Indian and Western Pacific Oceans. The family consists of 67 species, under 5 genera. So far 30 species are reported from India, out of which 13 species were barcoded. Under this family most species are benthic carnivores in nature. Ravichandirane et al. (2012), distinguish nine *Nemipterus* species, using COI gene and revealed all the nine species are genetically distant from each other and exhibited identical phylogenetic reservation. The overall mean Kimura two parameter (K2P) distances between the nine species was 0.109. The intra species K2P distance was high in *N. japonicus* (0.069) followed by *N. peronii* (0.050) and *N. mesoprion* (0.002).

1.6 Polynemids

Polynemids are known as threadfins, they are abundantly distributed in tropical to subtropical waters throughout the world. The polynemidae consist of 8 genera and 43 species, a total of 14 species are reported from the East and West coast of India, of which a total of 10 species belonging to five genera (*Polydactylus, Polynemus, Eleutheronema, Leptomelanosoma* and *Filimanus*) were barcoded. The molecular study of polynemids, by Lakra et al. (2011) has revealed that the average K2P distance within species was 0.35 % and 16.30 % for interspecies distance. In NJ tree three clusters were formed. The genus *Polydactylus* and *Filimanus* shared the first and second cluster respectively, whereas the third cluster was formed by *Leptomelanosoma* and *Eleutheronema*, with a bootstrap value ranging from 92–100 %.

1.7 Leiognathids

Leiognathids, the silverbellies are common fishes of coastal and estuarine waters in the tropical and subtropical Indo-Pacific Ocean. The leiognathidae consist of 9 genera and 48 species. A total of 23 species are reported from Indian waters, out of which total of 9 species from 5 genera were barcoded. Molecular study using COI showed the average genetic distance within species was 0.20 %.

1.8 Mullids

The family Mullidae are commonly called goatfish. The family consist of 85 species, under 6 genera. So far 23 species reported from India, out of which 8 species comprising three genera have been barcoded. Molecular phylogeny study by Lakra et al. (2011) of six fish species showed the average genetic distance within species was 0.38 % whereas the overall mean distance among the species was 13.90 %. The NJ tree revealed that the genera *Parupeneus, Mulloidichthys* and *Upeneus* formed three separate clades with a boostrap value of 95–99 %.

1.9 Lutjanids

Snappers are of mainly marine but some are found in estuaries and fresh water. The family includes about 110 species in 17 genera, some of which are considered as important food fish. A total of 47 fishes are reported from Indian waters of which barcoding has been completed for only 10 species. By using COI Victor et al. (2009) has successfully identified the larvae and newly-settled juveniles of the Cubera Snapper (*Lutjanus cyanopterus*) and observed that the nearest neighbor species, *L. analis*, was more than 11 % divergent. Recently *Lutjanus johni*, *L.lutjanus, L. russelli*, and *L. malabaricus* has been identified using COI by Krishna et al. (2012) and Lakra et al. (2011).

1.10 Pomacentrids

The family pomacentridae comprises damselfishes and clownfishes. They are primarily marine, while a few species inhabit freshwater and brackish environments. About 385 species are classified in this family with 29 genera, and a total of 52 species have been reported from Indian waters. The barcodes for 18 species under 4 genera have been generated in India by Lakra et al. (2011), Dhaneesh et al. (2015) and Bamaniya et al. (2015). The cytochrome oxidase 1 (COI) sequence of 13 clownfish species was used for construction of phylogenetic relationship, and scrutinized species boundaries between four closely related species of the sub-genera *Phalerebus, Amphiprion and Paramphiprion* (Dhaneesh et al. 2015).

1.11 Gobiids

Gobiids constitute a major proportion of fish population in both tropical and temperate freshwater as well as marine ecosystem and is one of the largest families of

marine fishes containing 1718 species in 251 genera. Out of these a total of 100 species are reported from India. 14 species have been barcoded by Lakra et al. (2011), and Viswambharan et al. (2015). Due to their small size, cryptic ecology and ambiguous morphological characters, gobiid diversity was not documented completely. Viswambharan et al. (2015) generated COI barcode for 11 species of gobies for accurate species identification. The COI barcodes clearly distinguished all these species with higher interspecific genetic distance values than intraspecific values based on K2P (Kimura 2 Parameter) model. The average genetic distance (K2P model) within species, genus and family was 1.2 %, 22.2 % and 25.3 %, respectively.

1.12 Clupeids

Clupeidae include many of the most important food fishes in the world that includes herrings, shads, sardines, hilsa, and menhadens. The family comprises 198 species under 54 genera. A total of 27 species have been reported from India, of which 10 species have been barcoded by several workers (Lakra et al. 2011). The phylogenetic study of clupeids has been carried out by Lakra et al. (2011) using COI gene of seven species and observed that overall mean distance among the species was very high (20.30 %). The average genetic distance within species was 0.41 %.

1.13 Engraulids

Engraulids are mainly known as a Anchovies, they are schooling fishes, mostly of shallow coastal waters and estuaries in tropical and temperate regions. Some are estuarine in nature. They are widely distributed across Atlantic, Indian and Pacific Oceans. The family consists of 198 species in 54 genera of which 34 species are recorded from Indian waters. Anchovies are considered as a delicious and preferred fish in India. Despite their importance as one of the important fishery resources, only 8 species under this group have been barcoded from India covering three genera. Two species, *Thryssa purava* and *Thryssa setirostris* were barcoded from estuaries of River Krishna by Krishna et al. (2012). The molecular phylogenetic study has been carried out in selected species using COI sequence, and revealed the average genetic distance between *Stolephorus indicus* and *Stolephorus commersonnii* was 9.11 % (Khan et al. 2010) and the average genetic distance within species was 0.41 % (Lakra et al. 2011). In the neighbor-joining tree both the species fall into same clade with a bootstrap value of 98 % (Khan et al. 2010; Lakra et al. 2011).

1.14 Mugilids

Mugilidae, the mullets or grey mullets are distributed worldwide in coastal temperate and tropical waters, with some species in fresh water. Mullets serve as an important source of food in coastal areas. The family includes about 76 species in 20 genera, although half of the species are in just two genera (*Liza* and *Mugil*). A total of 17 species have been reported from Indian waters, of which 14 species were barcoded. Rahman et al. (2013) reported that Canonical Analysis of Principal Coordinates (CAP) failed to separate the 10 species collected from Southeast Coast of India, which were clearly identified and differentiated using COI gene.

1.15 Ariids

Ariidae is a family of catfish, which are marine and esturine in nature, widely distributed in tropical to warm temperate zones. The family comprise about 143 species which includes 24 species from India, of which barcoding of 10 species was completed. Lakra et al. (2011) carried out the COI based molecular study of the catfishes of three genera namely *Osteogeneiosus*, *Netuma* and *Arius* under the family and observed the 0.23 % average K2P distance within species and 8.10 % within family. The NJ tree revealed two clusters, where first cluster is of *Arius subrostratus* and *A. arius*. The second cluster was shared by *Netuma thalassinus* and *Osteogeneiosus militaris* with a bootstrap value of 90 to 99 %.

1.16 Sphyraenids

The barracuda are marine ray-finned pelagic predatory fish of the genus *Sphyraena*, the only genus in the family Sphyraenidae. Globally there are more than 22 species of barracuda, So far seven species have been reported from Indian waters viz., *S. barracuda, S. jello, S. putnamiae, S. qenie, S. forsteri, S. obtusata and S. novahollandae.* All the species from Arabian Sea were characterized by NBFGR using DNA barcodes. Among the species examined, one was confirmed as new species and named *Sphyraena arabiansis* sp. nov. (Abdussamad et al. 2015). The intraspecies genetic distance ranged from 0.000 to 0.007, while interspecies varied from 0.111 to 0.273. COI sequences of *Sphyraena barracuda* and *Sphyraena arabiansis* showed a clear barcode split (11.4 % divergence) congruent with morphological differences. The NJ tree revealed very distinct species clusters. The average interspecies distance among the seven species in the family sphyraenidae was 15.2 % (Jena et al. 2014).

1.17 Sharks and Rays

India is one of the leading Chondrichthyan fishing nations with an estimated landing of 46,471 tonnes (sharks 45.5 %, rays 49.5 % and skates 5 %) in 2013 that accounted for 1.23 % of the total marine fish landings in the country (CMFRI, 2013). Despite rich elasmobranch diversity, only a few detailed studies have been undertaken that makes their management and conservation very difficult. Ward et al. (2005) validated the efficacy of COI barcodes for identifying chondrichthyans by sequencing 61 species of sharks and rays from Australian waters. Recent taxonomic studies that use both morphological and molecular markers resulted in taxonomic resolution of many species complexes and discovery of many new species. A total barcode record of 109 species are available of which 104 species were barcoded by NBFGR, India, representing 10 orders and 33 families of chondrichthyans from Indian waters. This is the largest study using genetic barcodes approach to identify sharks and rays found in the Indian waters. The average Kimura 2 parameter (K2P) distance separating individuals within species observed was 0.32 %, and the average distance separating species within genera 6.73 %. There are 37 and 29 species sequences generated in the present study representing new sequences for GenBank and BOLD respectively. During this study seven species were suggested as putative new species requiring formal descriptions and eleven elasmobranch species were confirmed first records for Indian waters. The present study uncovered the presence of eight undescribed or unrecognized batoid species including three in the genus *Himantura*. Barcode analysis result shows the presence of unrecognized species and highlights the need for further detailed taxonomic examinations of several families of elasmobranchs from Indian waters. Six species of *Carcharinus* were barcoded and phylogentic tree is given in Fig. 3. Barcode analysis shows very clear cut differentiation between these 6 species.

1.18 Other Important Groups

Lizard fishes (Synodontidae), Puffers (Tetradontidae), Half beaks (Hemirahmphidae), Big eyes (Priacanthidae), Tongue fishes (Cynoglossidae), Butterfly fishes (Chaetodontidae), Mojarras (Gerreidae), Cutlass fishes (Trichuridae), Wrasses (Labridae), snake mackerels or escolars (Gempylidae), and Moray eels (Muraenidae) are some of the important groups of marine fishes, distributed along the coast of India. These groups of fishes contribute a substantial amount to total marine landing. The barcoding and species identification of this entire group using COI has already been taken up by several researchers, but in limited scale. Hence there is pressing need of DNA barcoding of all these groups along with other groups available in the country for effective conservation and management purpose.

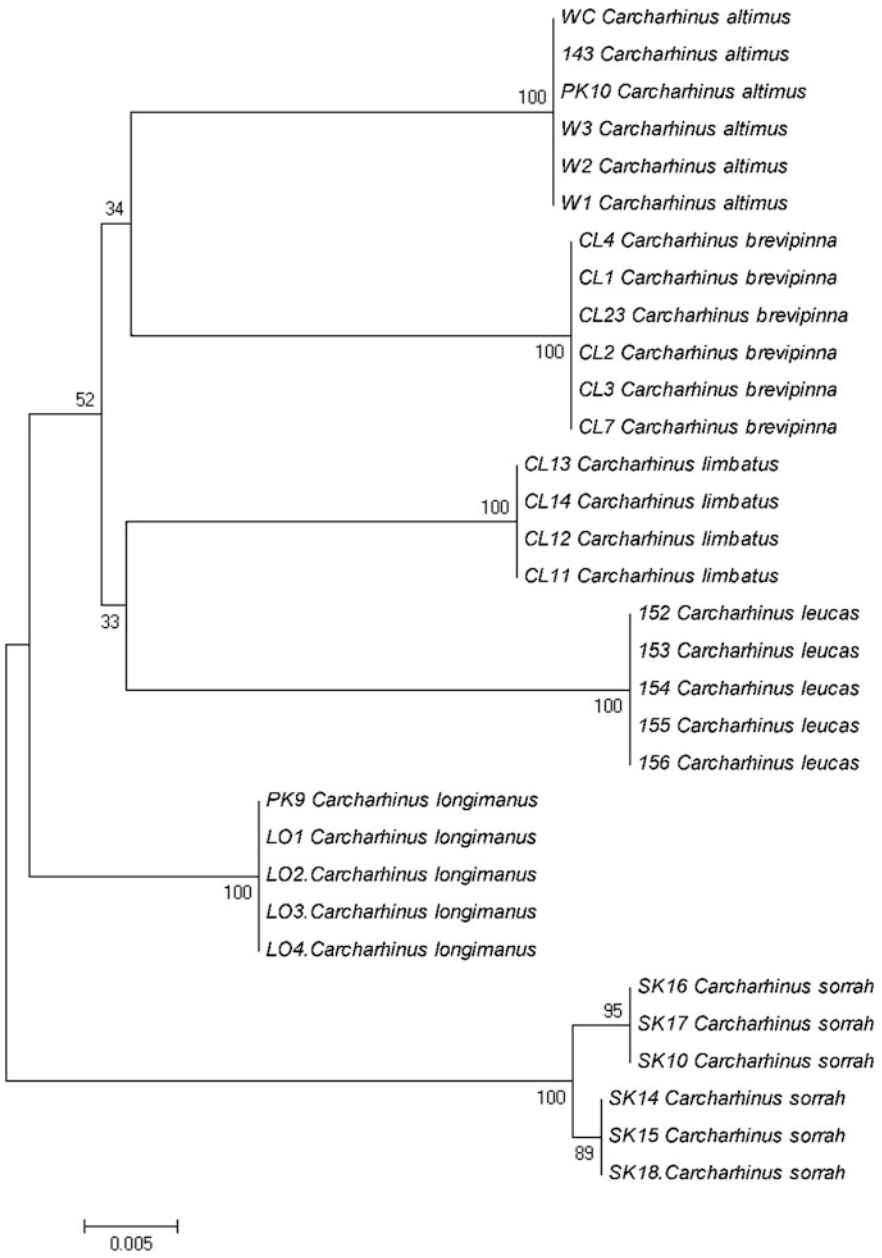

Fig. 3 K2P distance neighbor-joining tree of COI sequence from six species of *Carcharhinus*

2 Discussion

DNA barcoding has multiple implications in marine ecosystem; identification of species, cryptic species, larvae, new species, invasive species, illegal trade, biodiversity assessments, stock management, ecosystem monitoring, resolving taxonomic ambiguity and revisions of certain taxa, inference of phylogenetic relationships and speciation patterns (Hebert et al. 2003, 2004; Hogg and Hebert 2004; Jaafar et al. 2012; Trivedi et al. 2014; Trivedi et al. 2016). Molecular studies of selected species in the country using barcode sequences clearly discriminated taxonomic status of all the species examined and the NJ tree revealed identical phylogenetic relationship among the species. The phylogenetic relationship among the species was clearly established, and similar species were clustered under same clade while dissimilar species were clustered under separate clades with bootstrap values ranging from 90–100 %. Although barcode analysis seeks only to delineate species boundaries, there is clearly some phylogenetic signal in COI sequence data. Recent taxonomic research coupled with COI divergence analysis revealed discovery of many new marine fish species (Akhilesh et al. 2012; Bineesh et al. 2013; Greenfield et al. 2012). Sequence analysis of COI was used for resolution of taxonomic identity of many marine species in India (Bineesh et al. 2014). Based on COI sequence divergences a second species of Asian sea bass, *Lates calcarifer* is revealed (Ward et al. 2008; Vij et al. 2014). In addition to the species identification, DNA barcoding has been used for identification of protected whale shark, *Rhyncodon typus* (Sajeela et al. 2010). Barcoding is also being used for identifying processed seafood products (Nagalakshmi et al. 2016).

Despite rich natural biodiversity, comprising over 1518 native marine species, at present barcodes of just about 500 marine fish species are available, which is approximately 33 % of total Indian marine fish diversity. Whereas major portion of described marine fishes remain untouched. Hence more emphasis should be given to DNA barcoding, with mandate of barcoding all the species to establish global comprehensive reference libraries. The traditional taxonomists will play a vital role in completing such a global database; hence there is a pressing need to make a integration of DNA barcoding with traditional taxonomy. In nutshell it can be said that DNA barcoding can be taken up as pragmatic approach for resolving unambiguous identification of the fish fauna which can play a crucial role in biodiversity assessment and conservation of marine ecosystem of country.

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