Bollettino della Società Paleontologica Italiana, 55 (1), 2016. Modena

A morphospace for the Eocene fish assemblage of Bolca, Italy: a window into the diversification and ecological rise to dominance of modern tropical marine fishes

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SUPPLEMENTARY ONLINE MATERIAL

Dataset list

Tab. S1 - Dataset list of all Recent taxa in each ecosystem. GBR, Great Barrier Reef; RS, Red Sea; EBS, East Brazil Shelf; CS, Caribbean Sea. For each ecosystem '1' indicates the presence of the taxon, '0' indicates its absence.

Clade	Family	Taxon	Ecosystem			
			GBR	RS	EBS	CS
Albuliformes	Albulidae	*Albula*	1	1	1	1
Anguilliformes	Anguillidae	*Anguilla*	0	1	1	1
	Chlopsidae	*Chilorhinus*	0	0	1	1
		Chlopsis	0	0	1	1
		Kaupichthys	1	0	0	1
	Congridae	*Ariosoma*	1	1	1	1
		Bathyuroconger	0	0	1	0
		Conger	1	1	1	1
		Diploconger	0	1	0	0
		Gorgasia	1	1	0	0
		Heteroconger	1	1	1	1
		Paraconger	0	0	1	1
		Rhynchoconger	0	0	1	1
		Uroconger	0	1	1	0
	Heterenchelyidae	*Pythonichthys*	0	0	0	1
	Moringuidae	*Moringua*	1	0	1	1
		Neoconger	0	0	1	1
	Muraenesocidae	*Congresox*	0	1	0	0
		Cynoponticus	0	0	1	1
		Muraenesox	0	1	0	0
	Muraenidae	*Anarchias*	1	0	1	1
		Channomuraena	0	0	0	1
		Echidna	1	1	1	1
		Enchelycore	1	1	1	1
		Enchelynassa	1	0	0	0
		Gymnomuraena	1	1	0	0
		Gymnothorax	1	1	1	1

		Monopenchelys	0	0	0	1
		Muraena	0	1	0	1
		Strophidon	0	1	0	0
		Uropterygius	1	1	1	1
	Nettastomatidae	*Hoplunnis*	0	0	1	0
		Saurenchelys	0	1	0	0
	Ophichthidae	*Ahlia*	0	0	1	1
		Aplatophis	0	0	1	1
		Aprognathodon	0	0	0	1
		Apterichtus	1	0	0	1
		Bascanichthys	1	0	0	0
		Brachysomophis	1	1	0	0
		Callechelys	1	1	1	1
		Caralophia	0	0	0	1
		Echiophis	0	0	1	1
		Gordiichthys	0	0	0	1
		Hyphalophis	0	0	0	1
		Ichthyapus	0	0	0	1
		Lamnostoma	0	1	0	0
		Leiuranus	1	0	0	0
		Letharchus	0	0	0	1
		Muraenichthys	0	1	0	0
		Myrichthys	1	1	0	1
		Myrophis	1	1	1	1
		Neechelys	0	1	0	0
		Ophichthus	1	1	1	1
		Phyllophichthus	1	1	0	0
		Pisodonophis	1	1	0	0
		Quassiremus	0	0	1	1
		Schismorhynchus	1	0	0	0
		Schultzidia	1	0	0	0
		Scolecenchelys	1	1	0	0
		Skythrenchelys	0	1	0	0
		Xestochilus	0	1	0	0
		Yirrkala	0	1	0	0
	Synaphobranchidae	*Dysomma*	0	0	0	1
Atheriniformes	Atherinidae	*Atherinomorus*	1	1	1	1
		Atherion	1	0	0	0
		Dentatherina	1	0	0	0
		Hypoatherina	1	1	0	1
	Atherinopsidae	*Atherinella*	0	0	1	1
		Melanorhinus	0	0	0	1
		Membras	0	0	0	1
		Odontesthes	0	0	1	0
Aulopiformes	Chlorophthalmidae	*Parasudis*	0	0	0	1
	Synodontidae	*Saurida*	1	1	1	1
		Synodus	1	1	1	1

Batrachoidiformes	Batrachoididae	*Amphichthys*	0	0	1	1
		Barchatus	0	1	0	0
		Batrachoides	0	0	1	1
		Halophryne	1	0	0	0
		Opsanus	0	0	0	1
		Porichthys	0	0	1	1
		Sanopus	0	0	0	1
		Thalassophryne	0	0	1	1
		Vladichthys	0	0	0	1
Beloniformes	Belonidae	*Ablennes*	1	1	1	1
		Platybelone	1	1	1	1
		Strongylura	1	0	1	1
		Tylosurus	1	1	1	1
	Exocoetidae	*Cheilopogon*	1	1	1	1
		Cypselurus	0	1	0	0
		Exocoetus	0	1	1	1
		Hirundichthys	1	1	1	1
		Parexocoetus	1	1	1	1
		Prognichthys	0	0	0	1
	Hemiramphidae	*Chriodorus*	0	0	0	1
		Euleptorhamphus	0	1	1	1
		Hemiramphus	1	1	1	1
		Hyporhamphus	1	1	1	1
		Oxyporhamphus	0	0	0	1
	Scomberesocidae	*Scomberesox*	0	1	0	1
	Zenarchopteridae	*Zenarchopterus*	1	0	0	0
Beryciformes	Anomalopidae	*Anomalops*	1	0	0	0
		Kryptophanaron	0	0	0	1
		Photoblepharon	1	1	0	0
	Holocentridae	*Corniger*	0	0	1	1
		Holocentrus	0	0	1	1
		Myripristis	1	1	1	1
		Neoniphon	1	1	0	1
		Ostiichthys	0	1	1	1
		Plectrypops	1	0	1	1
		Sargocentron	1	0	1	1
	Monocentridae	*Cleidopus*	1	0	0	0
		Monocentris	0	1	0	0
	Polymixiidae	*Polymixia*	1	0	0	0
Clupeiformes	Chirocentridae	*Chirocentrus*	1	1	0	0
	Clupeidae	*Amblygaster*	1	1	0	0
		Brevoortia	0	0	1	0
		Dorosoma	0	0	0	1
		Dussumieria	1	1	0	0
		Etrumeus	0	1	0	1
		Harengula	1	1	0	0
		Herklotsichthys	0	1	0	0

		Hilsa	0	0	1	1
		Jenkinsia	0	0	0	1
		Lile	0	0	1	1
		Opisthonema	0	0	1	0
		Sardinella	1	1	0	0
		Spratelloides	0	0	1	1
	Engraulidae	*Anchoa*	0	0	1	1
		Anchovia	0	0	1	1
		Anchoviella	0	0	1	1
		Cetengraulis	0	0	1	1
		Encrasicholina	1	1	0	0
		Engraulis	0	1	1	0
		Lycengraulis	0	0	1	1
		Stolephorus	1	1	0	0
		Thryssina	1	1	0	0
	Pristigasteridae	*Chirocentrodon*	0	0	1	1
		Neoopisthopterus	0	0	0	1
		Odontognathus	0	0	1	1
		Pellona	1	0	1	1
		Pliosteostoma	0	0	0	1
Elopiformes	Elopidae	*Elops*	0	1	1	1
	Megalopidae	*Megalops*	0	1	1	1
Gonorynchiformes	Chanidae	*Chanos*	1	1	0	0
Lophiiformes	Antennariidae	*Antennarius*	1	1	1	1
		Antennatus	1	1	0	1
		Fowlerichthys	0	0	0	1
		Histrio	1	1	1	1
		Lophiocharon	1	0	0	0
		Tathicarpus	1	0	0	0
	Lophiidae	*Lophiomus*	0	1	0	0
	Ogcocephalidae	*Halieutichthys*	0	0	1	1
		Ogcocephalus	0	0	1	1
		Zalieutes	0	0	1	1
Ophidiiformes	Bythitidae	*Alionematichthys*	1	0	0	0
		Brosmophyciops	1	1	0	0
		Calamopterix	0	0	0	1
		Diancistrus	1	0	0	0
		Dinematichthys	0	1	0	0
		Grammonus	0	0	0	1
		Lucifuga	0	0	0	1
		Microbrotula	1	1	0	0
		Ogilbia	0	0	0	1
		Ogilbilichthys	0	0	0	1
		Pseudogilbia	0	0	0	1
		Saccogaster	0	0	0	1
		Stygnobrotula	0	0	0	1
	Carapidae	*Carapus*	1	1	0	1

		Encheliophis	1	1	0	0
		Onuxodon	1	0	0	0
	Ophidiidae	*Brotula*	1	1	1	1
		Genypterus	0	0	1	0
		Lepophidium	0	0	1	1
		Monomitopus	0	0	1	0
		Neobythites	0	0	0	1
		Ophidion	0	1	1	1
		Otophidium	0	0	1	1
		Parophiodon	0	0	1	1
		Petrotyx	0	0	0	1
		Raneya	0	0	1	0
		Sirembo	1	1	0	0
"perciforms"	Acanthuridae	*Acanthurus*	1	1	1	1
		Ctenochaetus	1	1	0	0
		Naso	1	1	0	0
		Paracanthurus	1	0	0	0
		Prionurus	1	0	0	0
		Zebrasoma	1	1	0	0
	Ambassidae	*Ambassis*	1	1	0	0
	Ammodytidae	*Brachaluteres*	0	1	0	0
	Apistidae	*Apistops*	1	0	0	0
		Apistus	0	1	0	0
	Aploactinidae	*Acathosphex*	1	0	0	0
		Adventor	1	0	0	0
		Aploactis	1	0	0	0
		Matsubarichthys	1	0	0	0
		Neoaploactis	1	0	0	0
		Paraploactis	1	0	0	0
		Pseudopataecus	1	0	0	0
		Ptarmus	0	1	0	0
	Apogonidae	*Apogon*	1	1	1	1
		Apogonichthyoides	1	1	0	0
		Apogonichthys	1	1	0	0
		Archamia	1	1	0	0
		Astrapogon	0	0	0	1
		Cercamia	1	1	0	0
		Cheilodipterus	1	1	0	0
		Foa	1	1	0	0
		Fowleria	1	1	0	0
		Gymnapogon	1	1	0	0
		Neamia	1	1	0	0
		Nectamia	1	1	0	0
		Ostorhinchus	1	1	0	0
		Phaeoptyx	0	0	1	1
		Pristiapogon	1	1	0	0
		Pristicon	1	0	0	0

	Pseudamia	1	1	0	0
	Pseudamiops	1	1	0	0
	Rhabdamia	1	1	0	0
	Siphamia	1	1	0	0
	Sphaeramia	1	1	0	0
	Taeniamia	0	1	0	0
	Zapogon	0	0	0	1
	Zoramia	1	1	0	0
Blenniidae	*Alloblennius*	0	1	0	0
	Alticus	0	1	0	0
	Antennablennius	0	1	0	0
	Aspidontus	1	1	0	0
	Atrosalarias	0	1	0	0
	Blenniella	1	1	0	0
	Cirripectes	1	1	0	0
	Crossosalarias	1	0	0	0
	Ecsenius	1	1	0	0
	Enchelyurus	1	1	0	0
	Entomacrodus	1	1	0	1
	Exallias	1	1	0	0
	Glyptoparus	1	0	0	0
	Hirculops	0	1	0	0
	Hypleurochilus	0	0	1	1
	Hypsoblennius	0	0	0	1
	Istiblennius	1	1	0	0
	Lupinoblennius	0	0	0	1
	Meiacanthus	1	1	0	0
	Mimoblennius	0	1	0	0
	Nannosalarias	1	0	0	0
	Omobranchus	1	1	0	0
	Ophioblennius	0	0	1	1
	Parablennius	0	1	1	1
	Parenchelyurus	1	0	0	0
	Petroscirtes	1	1	0	0
	Plagiotremus	1	1	0	0
	Rhabdoblennius	1	0	0	0
	Salarias	1	1	0	0
	Scartella	0	0	1	1
	Stanulus	1	0	0	0
	Xiphasia	1	1	0	0
Caesionidae	*Caesio*	1	1	0	0
	Dipterygonotus	1	0	0	0
	Gymnocaesio	0	1	0	0
	Pterocaesio	1	1	0	0
Callionymidae	*Callionymus*	1	1	0	1
	Diplogrammus	1	1	0	1
	Synchiropus	1	1	0	0

Caproidae	*Antigonia*	0	1	1	1
Carangidae	*Alectis*	1	1	1	1
	Alepes	1	1	0	0
	Atule	1	0	0	0
	Carangoides	1	1	1	1
	Caranx	1	1	1	1
	Chloroscombrus	0	0	1	1
	Decapterus	1	1	1	1
	Elagatis	1	1	1	1
	Gnathanodon	1	1	0	0
	Hemicaranx	0	0	1	1
	Megalaspis	1	1	0	0
	Naucrates	1	1	1	1
	Oligoplites	0	0	1	1
	Pantolabus	1	0	0	0
	Parastromateus	1	1	0	0
	Parona	0	0	1	0
	Pseudocaranx	1	0	0	0
	Scomberoides	1	1	0	0
	Selar	1	1	1	1
	Selaroides	1	0	0	0
	Selene	0	0	1	1
	Seriola	1	1	1	1
	Seriolina	1	1	0	0
	Trachinotus	1	1	1	1
	Trachurus	0	0	1	1
	Ulua	1	1	0	0
	Uraspis	0	1	1	1
Centropomidae	*Centropomus*	0	0	1	1
Cepolidae	*Acanthocepola*	1	0	0	0
Chaenopsidae	*Acanthemblemaria*	0	0	0	1
	Chaenopsis	0	0	0	1
	Coralliozetus	0	0	0	1
	Ekemblemaria	0	0	0	1
	Emblemaria	0	0	1	1
	Emblemariopsis	0	0	1	1
	Hemimblemaria	0	0	0	1
	Lucayablennius	0	0	0	1
	Protemblemaria	0	0	0	1
	Stathmonotus	0	0	0	1
Chaetodontidae	*Chaetodon*	1	1	1	1
	Chelmon	1	0	0	0
	Coradion	1	0	0	0
	Forcipiger	1	1	0	0
	Hemitaurichthys	1	0	0	0
	Heniochus	1	1	0	0
	Parachaetodon	1	0	0	0

	Prognathodes	0	0	1	1
	Roa	0	1	0	0
Cheilodactylidae	*Cheilodactylus*	1	0	0	0
	Nemadactylus	0	0	1	0
Cirrhitidae	*Amblycirrhitus*	1	0	1	1
	Cirrhithus	1	1	0	0
	Cirrhitichthys	1	1	0	0
	Cyprinocirrhites	1	0	0	0
	Neocirrhites	1	0	0	0
	Oxycirrhites	1	1	0	0
	Paracirrhites	1	1	0	0
Clinidae	*Ribeiroclinus*	0	0	1	0
Coryphaenidae	*Coryphaena*	1	1	1	1
Creediidae	*Limnichthys*	1	1	0	0
Dactylopteridae	*Dactyloptena*	1	1	0	0
	Dactylopterus	0	0	1	1
	Dactylagnus	0	0	0	1
	Dactyloscopus	0	0	1	1
	Gillellus	0	0	1	1
	Leurochilus	0	0	0	1
	Myxodagnus	0	0	0	1
	Platygillellus	0	0	0	1
Drepaneidae	*Drepane*	1	1	0	0
Echeneidae	*Echeneis*	1	1	1	1
	Phtheirichthys	1	0	0	0
	Remora	1	1	1	1
Eleotridae	*Calumia*	1	0	0	0
	Dormitator	0	0	1	1
	Eleotris	0	0	1	1
	Erotelis	0	0	1	1
	Gobiomorus	0	0	1	0
	Guavina	0	0	1	1
Emmelichthyidae	*Emmelichthys*	0	0	0	1
	Erythrocles	0	0	0	1
Ephippidae	*Chaetodipterus*	0	0	1	1
	Platax	1	1	0	0
	Tripterodon	0	1	0	0
	Zabidius	1	0	0	0
Epigonidae	*Epigonus*	0	1	0	0
Gempylidae	*Lepidocybium*	1	0	0	0
Gerreidae	*Diapterus*	0	0	1	1
	Eucinostromus	0	0	1	1
	Eugerres	0	0	1	1
	Gerres	1	1	1	1
	Ulaema	0	0	1	1
Gobiesocidae	*Acyrtops*	0	0	0	1
	Acyrtus	0	0	0	1

	Arcos	0	0	0	1
	Chorisochismus	0	1	0	0
	Derilissus	0	0	0	1
	Diademichthys	1	0	0	0
	Gobiesox	0	0	1	1
	Lepadichthys	0	1	0	0
	Tomicodon	0	0	1	1
Gobiidae	*Acentrogobius*	1	1	0	0
	Amblyeleotris	1	1	0	0
	Amblygobius	1	1	0	0
	Amoya	0	1	0	0
	Ancistrogobius	0	1	0	0
	Asterropteryx	1	0	0	0
	Austrolethops	1	0	0	0
	Barbulifer	0	0	0	1
	Barbuligobius	1	0	0	0
	Bathygobius	1	1	1	1
	Bollmannia	0	0	0	1
	Bryaninops	1	1	0	0
	Cabillus	1	0	0	0
	Callogobius	1	1	0	0
	Chriolepis	0	0	0	1
	Corygalops	0	1	0	0
	Coryphopterus	0	0	1	1
	Cryptocentroides	0	1	0	0
	Cryptocentrus	1	1	0	0
	Ctenogobiops	1	1	0	0
	Ctenogobius	0	0	1	1
	Discordipinna	1	1	0	0
	Elactinus	0	0	0	1
	Evermannichthys	0	0	0	1
	Eviota	1	1	0	0
	Evorthodus	0	0	0	1
	Exyrias	1	1	0	0
	Favonigobius	1	1	0	0
	Feia	0	1	0	0
	Fusigobius	1	1	0	0
	Ginsburgellus	0	0	0	1
	Gladiogobius	0	1	0	0
	Glossogobius	0	1	0	0
	Gnatholepis	1	1	1	1
	Gobiodon	1	1	0	0
	Gobioides	0	0	1	1
	Gobionellus	0	0	0	1
	Gobiosoma	0	0	0	1
	Gobulus	0	0	0	1
	Hazeus	0	1	0	0

	Hetereleotris	0	1	0	0
	Istigobius	1	1	0	0
	Koumansetta	1	1	0	0
	Lobulogobius	0	1	0	0
	Lophogobius	0	0	0	1
	Lotilia	1	1	0	0
	Luposicya	1	1	0	0
	Lythrypnus	0	0	0	1
	Macrodontogobius	1	1	0	0
	Microgobius	0	0	0	1
	Minysicya	1	0	0	0
	Nes	0	0	0	1
	Oplopomus	1	1	0	0
	Oxyurichthys	0	1	0	1
	Palatogobius	0	0	0	1
	Palutrus	0	1	0	0
	Paragobiodon	1	1	0	0
	Parrella	0	0	0	1
	Periophthalmus	1	1	0	0
	Phyllogobius	1	0	0	0
	Pleurosicya	1	1	0	0
	Priolepis	1	1	1	1
	Psilogobius	1	1	0	0
	Psilotris	0	0	0	1
	Pycnomma	0	0	0	1
	Risor	0	0	1	1
	Sicydium	0	0	0	1
	Signigobius	1	0	0	0
	Silhouettea	0	1	0	0
	Stonogobiops	1	0	0	0
	Tigrigobius	0	0	0	1
	Tomiyamichthys	0	1	0	0
	Trimma	1	1	0	0
	Trimmatom	1	1	0	0
	Valenciennea	1	1	0	0
	Vanderhorstia	1	1	0	0
	Varicus	0	0	0	1
	Vomerogobius	0	0	0	1
Grammatidae	*Gramma*	0	0	0	1
	Lipogramma	0	0	0	1
Haemulidae	*Anisotremus*	0	0	1	1
	Boridia	0	0	1	0
	Conodon	0	0	1	1
	Diagramma	1	1	0	0
	Emmelichthyops	0	0	0	1
	Genyatremus	0	0	1	1
	Haemulon	0	0	1	1

	Orthopristis	0	0	1	1
	Plectorhinchus	1	1	0	0
	Pomadasys	0	0	1	1
Istiophoridae	*Istiompax*	1	1	0	0
	Istiophorus	1	1	1	1
	Kajikia	1	1	1	1
	Makaira	0	0	1	1
	Tetrapturus	0	0	1	1
Kraemeriidae	*Kraemeria*	0	1	0	0
Kuhliidae	*Kuhlia*	1	1	0	0
Kyphosidae	*Kyphosus*	1	1	1	1
	Microcanthus	1	0	0	0
Labridae	*Anampses*	1	1	0	0
	Bodianus	1	1	1	1
	Bolbometopon	1	1	0	0
	Calotomus	1	1	0	0
	Cetoscarus	1	1	0	0
	Cheilinus	1	0	0	0
	Cheilio	1	1	0	0
	Chlorurus	1	1	0	0
	Choerodon	1	1	0	0
	Cirrhilabrus	1	1	0	0
	Clepticus	0	0	0	1
	Coris	1	1	0	0
	Cryptotomus	0	0	1	1
	Cymolutes	1	0	0	0
	Decodon	0	0	0	1
	Diproctacanthus	1	0	0	0
	Doratonotus	0	0	0	1
	Epibulus	1	1	0	0
	Gomphosus	1	1	0	0
	Halichoeres	1	1	1	1
	Hemigymnus	1	1	0	0
	Hipposcarus	1	1	0	0
	Hologymnosus	1	1	0	0
	Iniistius	1	1	0	0
	Labrichthys	1	0	0	0
	Labroides	1	1	0	0
	Labropsis	1	0	0	0
	Lachnolaimus	0	0	1	1
	Larabicus	0	1	0	0
	Leptojulis	1	0	0	0
	Leptoscarus	1	1	0	0
	Macropharyngodon	1	1	0	0
	Minilabrus	0	1	0	0
	Nicholsina	0	0	1	1
	Novaculichthys	1	1	0	0

	Novaculoides	1	1	0	0
	Oxycheilinus	1	1	0	0
	Paracheilinus	1	1	0	0
	Pseudocheilinus	1	1	0	0
	Pseudocoris	1	0	0	0
	Pseudodax	1	1	0	0
	Pseudojuloides	1	0	0	0
	Pseudolabrus	1	0	0	0
	Pteragogus	1	1	0	0
	Scarus	1	1	1	1
	Sparisoma	0	0	0	1
	Stethojulis	1	1	0	0
	Suezichthys	1	1	0	0
	Thalassoma	1	1	0	1
	Wetmorella	1	1	0	0
	Xiphocheilus	1	0	0	0
	Xyrichtys	0	1	1	1
Labrisomidae	*Haptoclinus*	0	0	0	1
	Labrisomus	0	0	1	1
	Malacoctenus	0	0	1	1
	Paraclinus	0	0	1	1
	Starksia	0	0	1	1
Lactariidae	*Lactarius*	0	1	0	0
Latidae	*Lates*	1	0	0	0
	Psammoperca	1	0	0	0
Leiognathidae	*Aurigequula*	0	1	0	0
	Equulites	0	1	0	0
	Eubleekeria	0	1	0	0
	Gazza	0	1	0	0
	Leiognathus	0	1	0	0
	Photopectoralis	0	1	0	0
	Secutor	0	1	0	0
Lethrinidae	*Gnathodentex*	1	0	0	0
	Gymnocranius	1	1	0	0
	Letherinus	1	1	0	0
	Monotaxis	1	1	0	0
	Wattsia	1	0	0	0
Liparidae	*Liparis*	0	1	0	0
Lobotidae	*Lobotes*	1	1	1	0
Lutjanidae	*Aphareus*	1	1	0	0
	Aprion	1	0	0	0
	Apsilus	0	1	0	1
	Etelis	1	0	0	0
	Lipocheilus	1	0	0	0
	Lutjanus	1	1	1	1
	Macolor	1	1	0	0
	Ocyurus	0	0	1	1

	Paracaesio	1	1	0	0
	Parapristipomoides	1	0	0	0
	Pristipomoides	1	1	1	1
	Rhomboplites	0	0	1	1
	Symphorichthys	1	0	0	0
	Symphorus	1	0	0	0
	Pinjalo	0	1	0	0
Malacanthidae	*Branchiostegus*	1	1	0	0
	Caulolatilus	0	0	1	1
	Hoplolatilus	1	1	0	0
	Lopholatilus	0	0	1	1
	Malacanthus	1	1	1	1
Menidae	*Mene*	1	1	0	0
Microdesmidae	*Aioliops*	1	0	0	0
	Cerdale	0	0	0	1
	Gunnellichthys	1	1	0	0
	Microdesmus	0	0	0	1
	Nemateleotris	1	1	0	0
	Paragunnellichthys	1	1	0	0
	Parioglossus	1	0	0	0
	Ptereleotris	1	1	0	1
Monodactylidae	*Monodactylus*	0	1	0	0
Mugilidae	*Agonostomus*	0	0	0	1
	Chelon	1	1	0	0
	Crenimugil	1	1	0	0
	Ellochelon	1	1	0	0
	Liza	0	1	0	0
	Moolgarda	1	1	0	0
	Mugil	0	1	1	1
	Oedalechilus	0	1	0	0
Mullidae	*Mulloidichthys*	1	1	1	1
	Mullus	0	0	1	1
	Parupeneus	1	1	0	0
	Pseudupeneus	0	0	1	1
	Upeneus	1	1	1	1
Nemipteridae	*Nemipterus*	1	1	0	0
	Parascolopsis	0	1	0	0
	Pentapodus	1	0	0	0
	Scolopsis	1	1	0	0
Notograptidae	*Notograptus*	1	0	0	0
Opistognathidae	*Lonchopisthus*	0	0	0	1
	Opistignathus	0	0	1	0
	Opistognathus	1	1	1	1
	Stalix	1	1	0	0
Pempheridae	*Parapriacanthus*	1	1	0	0
	Pempheris	1	1	1	1
Pentacerotidae	*Histiopterus*	0	1	0	0

Percophidae	*Bembrops*	0	0	0	1
	Bleekeria	0	1	0	0
Pinguipedidae	*Parapercis*	1	1	0	0
	Pinguipes	0	0	1	0
	Pseudopercis	0	0	1	0
Platycephalidae	*Cociella*	1	1	0	0
	Cymbacephalus	1	0	0	0
	Grammoplites	0	1	0	0
	Inegocia	1	0	0	0
	Onigocia	1	1	0	0
	Papilloculiceps	0	1	0	0
	Platycephalus	1	1	0	0
	Rogadius	0	1	0	0
	Sorsogona	1	1	0	0
	Sunagocia	1	0	0	0
	Thysanophrys	1	1	0	0
Plesiopidae	*Assessor*	1	0	0	0
	Belonepterygion	1	0	0	0
	Calloplesiops	1	1	0	0
	Fraudella	1	0	0	0
	Paraplesiops	1	0	0	0
	Plesiops	1	1	0	0
	Steeneichthys	1	0	0	0
Polynemidae	*Polydactylus*	1	1	1	1
Polyprionidae	*Polyprion*	0	0	1	0
Pomacanthidae	*Apolemichthys*	1	0	0	0
	Centropyge	1	1	0	1
	Chaetodontoplus	1	0	0	0
	Genicanthus	1	1	0	0
	Holacanthus	0	0	1	1
	Paracentropyge	1	0	0	0
	Pomacanthus	1	1	1	1
	Pygoplites	1	1	0	0
Pomacentridae	*Abudefduf*	1	1	1	1
	Acanthochromis	1	0	0	0
	Amblyglyphidodon	1	1	0	0
	Amblypomacentrus	1	0	0	0
	Amphiprion	1	1	0	0
	Cheiloprion	1	0	0	0
	Chromis	1	1	1	1
	Chrysiptera	1	1	0	0
	Dascyllus	1	1	0	0
	Dischistodus	1	0	0	0
	Hemiglyphiodon	1	0	0	0
	Lepidozygus	1	0	0	0
	Microspathodon	0	0	1	1
	Neoglyphiododon	1	1	0	0

	Neopomaceentrus	1	1	0	0
	Parma	1	0	0	0
	Plectroglyphidodon	1	1	0	0
	Pomacentrus	1	1	0	0
	Pomachromis	1	0	0	0
	Premnas	1	0	0	0
	Pristotis	1	1	0	0
	Stegastes	1	1	1	1
	Teixeirichthys	0	1	0	0
Pomatomidae	*Pomatomus*	0	0	1	1
Priacanthidae	*Cookeolus*	1	0	1	1
	Heteropriacanthus	1	1	1	1
	Priacanthus	1	1	1	1
	Pristigenys	0	0	0	1
Pseudochromidae	*Amsichthys*	1	0	0	0
	Blennodesmus	1	0	0	0
	Chlidichthys	0	1	0	0
	Congrogadus	1	0	0	0
	Cypho	1	0	0	0
	Haliophis	0	1	0	0
	Lubbockichthys	1	0	0	0
	Manonichthys	1	0	0	0
	Oxycerichthys	1	0	0	0
	Pectinochromis	0	1	0	0
	Pictichromis	1	0	0	0
	Pseudochromis	1	1	0	0
	Pseudoplesiops	1	0	0	0
Rachycentridae	*Rachycentron*	1	1	1	1
Schindleriidae	*Schindleria*	1	0	0	0
Sciaenidae	*Bairdiella*	0	0	1	1
	Corvula	0	0	1	1
	Ctenosciaena	0	0	1	1
	Cynoscion	0	0	1	1
	Equetus	0	0	1	1
	Isopisthus	0	0	1	1
	Larimus	0	0	1	1
	Lonchurus	0	0	1	1
	Macrodon	0	0	1	1
	Menticirrhus	0	0	1	1
	Micropogonias	0	0	1	1
	Nebris	0	0	1	1
	Odontoscion	0	0	1	1
	Ophioscion	0	0	1	1
	Paralonchurus	0	0	1	1
	Pareques	0	0	1	1
	Pogonias	0	0	1	0
	Protosciaena	0	0	1	1

	Stellifer	0	0	1	1
	Umbrina	0	0	1	1
Scombridae	*Acanthocybium*	1	0	1	1
	Auxis	1	1	1	1
	Euthynnus	1	1	1	1
	Gasterochisma	0	0	1	0
	Grammatorcynus	1	1	0	0
	Gymnosarda	1	1	0	0
	Katsuwonus	1	1	1	1
	Rastrelliger	1	1	0	0
	Sarda	0	1	1	1
	Scomber	0	1	1	1
	Scomberomorus	1	1	1	1
	Thunnus	1	1	1	1
Scorpaenidae	*Ablabys*	1	0	0	0
	Brachypterois	0	1	0	0
	Caracanthus	1	0	0	0
	Cottapistus	1	0	0	0
	Dendrochirus	1	1	0	0
	Erosa	1	0	0	0
	Liocranium	1	0	0	0
	Minous	1	1	0	0
	Neomerinthe	0	0	0	1
	Parascopaena	1	1	0	0
	Pontinus	0	0	1	1
	Pteroidichthys	0	1	0	0
	Pterois	1	1	0	0
	Rhinopias	1	0	0	0
	Richardsonichthys	1	0	0	0
	Scorpaena	0	1	1	1
	Scorpaenodes	1	1	0	1
	Scorpaenopsis	1	1	0	0
	Sebastapistes	1	1	0	0
	Synanceia	1	1	0	0
	Taenianothus	1	0	0	0
Serranidae	*Acanthistius*	0	0	1	0
	Aethaloperca	1	1	0	0
	Alphestes	0	0	1	1
	Anthias	0	0	1	0
	Anyperodon	1	1	0	0
	Aporops	1	0	0	0
	Aulacocephalus	0	1	0	0
	Baldwinella	0	0	1	1
	Bathyanthias	0	0	1	1
	Belonoperca	1	0	0	0
	Centropristis	0	0	0	1
	Cephalopholis	1	1	0	1

	Chelidoperca	1	0	0	0
	Cromileptes	1	0	0	0
	Dermatolepis	0	1	1	1
	Diplectrum	0	0	1	1
	Diploprion	1	1	0	0
	Dules	0	0	1	0
	Epinephelus	1	1	1	1
	Gonioplectrus	0	0	1	1
	Gracila	1	0	0	0
	Grammistes	1	1	0	0
	Grammistops	1	0	0	0
	Hemanthias	0	0	1	1
	Hypoplectrus	0	0	0	1
	Hyporthodus	1	0	1	1
	Liopropoma	1	1	0	1
	Luzonichthys	1	0	0	0
	Mycteroperca	0	0	1	1
	Odontanthias	0	0	0	1
	Paralabrax	0	0	1	1
	Paranthias	0	0	1	1
	Parasphyraenops	0	0	0	1
	Plectranthias	1	1	0	1
	Plectropomus	1	1	0	0
	Pronotogrammus	0	0	1	1
	Pseudanthias	1	1	0	0
	Pseudogramma	1	1	0	1
	Rainfordia	1	0	0	0
	Rypticus	0	0	1	1
	Saloptia	1	0	0	0
	Schultzea	0	0	0	1
	Serraniculus	0	0	1	0
	Serranocirrhitus	1	0	0	0
	Serranus	0	1	1	1
	Suttonia	1	0	0	0
	Variola	1	1	0	0
Setarchidae	*Setarches*	0	1	0	1
Siganidae	*Siganus*	1	1	0	0
Sillaginidae	*Sillago*	1	1	0	0
Sparidae	*Acanthopagrus*	1	1	0	0
	Archosargus	0	0	1	1
	Argyrops	1	1	0	0
	Calamus	0	0	1	1
	Chrysophrys	1	0	0	0
	Diplodus	0	1	1	1
	Lagodon	0	0	0	1
	Lithognathus	0	1	0	0
	Pagrus	0	0	1	1

		Rhabdosargus	0	1	0	0
		Sparus	0	1	0	0
	Sphyraenidae	*Sphyraena*	1	1	1	1
	Synanceiidae	*Choridactylus*	0	1	0	0
		Inimicus	1	1	0	0
	Terapontidae	*Amniataba*	1	0	0	0
		Mesopristes	1	0	0	0
		Pelates	1	1	0	0
		Terapon	1	1	0	0
	Trichonotidae	*Trichonotus*	1	1	0	0
	Triglidae	*Bellator*	0	0	0	1
		Lepidotrigla	0	1	0	0
		Prionotus	0	0	1	1
	Tripterygiidae	*Ceratobregma*	1	0	0	0
		Enneanectes	0	0	0	1
		Enneapterygius	1	1	0	0
		Helcogramma	1	1	0	0
		Norfolkia	1	1	0	0
		Springerichthys	1	0	0	0
		Ucla	1	0	0	0
	Uranoscopidae	*Astroscopus*	0	0	1	0
		Ichthyscopus	1	0	0	0
		Uranoscopus	1	1	0	0
	Xenisthmidae	*Allomicrodesmus*	1	0	0	0
		Xenisthmus	1	1	0	0
	Xiphiidae	*Xiphias*	1	1	1	1
	Zanclidae	*Zanclus*	1	0	0	0
Pleuronectiformes	Achiridae	*Achirus*	0	0	1	1
		Gymnachirus	0	0	1	1
		Trinectes	0	0	1	1
	Bothidae	*Asterorhombus*	1	1	0	0
		Bothus	1	1	1	1
		Engyophrys	0	0	1	0
		Engyprosopon	1	1	0	0
		Parabothus	0	1	0	0
		Trichopsetta	0	0	1	1
	Cynoglossidae	*Cynoglossus*	0	1	0	0
		Paraplagusia	0	1	0	0
		Symphurus	0	0	1	1
	Paralichthyidae	*Ancylopsetta*	0	0	1	1
		Citharichthys	0	0	1	1
		Cyclopsetta	0	0	1	0
		Etropus	0	0	1	0
		Gastropsetta	0	0	0	1
		Paralichthys	0	0	1	1
		Pseudorhombus	0	1	0	0
		Syacium	0	0	1	1

	Pleuronectidae	*Oncopterus*	0	0	1	0
		Pleuronectes	0	1	0	0
	Psettodidae	*Psettodes*	0	1	0	0
	Samaridae	*Samaris*	0	1	0	0
		Samariscus	1	1	0	0
	Soleidae	*Aesopia*	0	1	0	0
		Aseraggodes	0	1	0	0
		Brachirus	0	1	0	0
		Pardachirus	1	1	0	0
		Soleichthys	0	1	0	0
		Zebrias	0	1	0	0
Syngnathiformes	Aulostomidae	*Aulostomus*	1	0	1	1
	Centriscidae	*Aeoliscus*	1	1	0	0
		Centriscus	1	1	0	0
		Macroramphosus	0	0	1	1
	Fistulariidae	*Fistularia*	1	1	1	1
	Pegasidae	*Eurypegasus*	1	1	0	0
	Solenostomidae	*Solenostomus*	1	1	0	0
	Syngnathidae	*Acentronura*	1	1	0	0
		Amphelikturus	0	0	0	1
		Anarchopterus	0	0	1	1
		Bryx	0	1	1	1
		Campichthys	1	0	0	0
		Choeroichthys	1	1	0	0
		Corythoichthys	1	1	0	0
		Cosmocampus	1	1	0	1
		Doryrhamphus	1	1	0	0
		Dunckerocampus	1	1	0	0
		Halicampus	1	1	0	0
		Haliichthys	1	0	0	0
		Hippichthys	0	1	0	0
		Hippocampus	1	1	1	1
		Kyonemichthys	0	1	0	0
		Lissocampus	0	1	0	0
		Micrognathus	1	1	1	1
		Microphis	0	0	0	1
		Minichthys	0	0	0	1
		Nannocampus	1	0	0	0
		Penetopteryx	0	0	0	1
		Phoxocampus	1	1	0	0
		Siokunichthys	1	1	0	0
		Solegnathus	1	0	0	0
		Syngnathoides	1	1	0	0
		Syngnathus	0	1	1	1
		Trachyrhamphus	1	1	0	0
Tetraodontiformes	Balistidae	*Abalistes*	1	1	0	0
		Balistapus	1	1	0	0

	Balistes	0	0	1	1
	Balistoides	1	1	0	0
	Canthidermis	0	1	1	1
	Melichthys	1	1	1	1
	Odonus	1	1	0	0
	Pseudobalistes	1	1	0	0
	Rhinecanthus	1	1	0	0
	Sufflamen	1	1	0	0
	Xanthichthys	1	0	1	1
Diodontidae	*Chilomycterus*	1	0	0	1
	Cyclichthys	1	1	0	0
	Diodon	1	1	1	1
	Tragulichthys	1	0	0	0
Monacanthidae	*Acreichthys*	1	0	0	0
	Aluterus	1	1	1	1
	Amanses	1	1	0	0
	Cantherines	1	1	1	1
	Cantheschenia	1	0	0	0
	Chaetodermis	1	0	0	0
	Monacanthus	1	0	1	1
	Oxymonacanthus	1	1	0	0
	Paraluteres	1	1	0	0
	Paramonacanthus	1	1	0	0
	Pervagor	1	1	0	0
	Pseudomonacanthus	1	1	0	0
	Rudarius	1	0	0	0
	Stephanolepis	0	0	1	1
	Thamnaconus	0	1	0	0
Ostraciidae	*Acanthostracion*	0	0	1	1
	Lactophrys	0	0	1	1
	Lactoria	1	1	0	0
	Ostracion	1	1	0	0
	Rhinesomus	0	0	1	1
	Rhynchostracion	1	0	0	0
	Tetrosomus	1	1	0	0
Tetraodontidae	*Arothron*	1	1	0	0
	Canthigaster	1	1	1	1
	Chelonodon	1	0	0	0
	Colomesus	0	0	0	1
	Lagocephalus	0	1	1	1
	Sphoeroides	0	0	1	1
	Torquigener	0	1	0	0
Triacanthodidae	*Parahollardia*	0	0	0	1

Tab. S2 - Dataset list of fossil taxa included for the analysis of the Bolca assemblage.

Order	**Family**	**Taxon**
Acanthomorpha incertae sedis		*Pietschellus*
		Protaulopsis
		Xiphopterus
Anguilliformes	Anguillidae	*Eoanguilla*
	Anguilliformes incertae sedis	*Bolcanguilla*
		Gazolapodus
	Anguilloididae	*Anguilloides*
		Veronanguilla
	Chlopsidae	*Whitapodus*
	Congridae	*Bolcyrus*
		Paracongroides
		Voltaconger
	Milananguillidae	*Milananguilla*
	Ophichthyidae	*Goslinophis*
	Paranguillidae	*Dalpiaziella*
		Paranguilla
	Patavichthyidae	*Patavichthys*
	Proteomyridae	*Proteomyrus*
Anotophysi	Anotophysi incertae sedis	*Coelogaster*
Atheriniformes	Atherinidae	'*Atherina*'
	Mesogasteridae	*Latellagnathus*
		Mesogaster
	Rhamphognathidae	*Rhamphognathus*
Aulopiformes	Paralepididae	*Holosteus*
Beloniformes	Exocoetidae	Exocoetidae gen. et sp. indet
		Rhamphoexocoetus
	Hemiramphidae	*Hemiramphus*
Beryciformes	Holocentridae	*Berybolcensis*
		Eoholocentrum
		Tenuicentrum
Clupeiformes	Clupeidae	*Bolcaichthys*
		Trollichthys
	Engraulidae	*Eoengraulis*
Crossognathiformes	Pachyrhizodontidae	*Platinx*
Dactylopteriformes	Pterygocephalidae	*Pterygocephalus*
Lampridiformes	Bajaichthyidae	*Bajaichthys*
	Veliferidae	*'Velifer'*
		Veronavelifer
Lophiiformes	Antennariidae	*Eophryne*
	Brachionichthyidae	*Histionotophorus*
		Orrichthys
	Lophiidae	*Caruso*
		Sharfia
	Ogcocephalidae	*Tarkus*

Ophidiiformes	Ophidiidae	*'Ophidium'*
Osteoglossiformes	Arapaimidae	*Thrissopterus*
	Foreyichthyidae	*Foreyichthys*
	Osteoglossiformes incertae sedis	*Monopteros*
Otophysi	Chanoididae	*Chanoides*
Perciformes	Acanthonemidae	*Acanthonemus*
	Acanthuridae	*Acanthuroides*
		Eorandallius
		Frigosorbinia
		Gazolaichthys
		Lehmanichthys
		Metacanthurus
		Metaspisurus
		Padovathurus
		Pesciarichthys
		Proacanthurus
		Protozebrasoma
		Tauichthys
		Tylerichthys
	Acropomatidae	*Acropoma*
	Apogonidae	*Apogoniscus*
		Bolcapogon
		Eoapogon
		Eosphaeramia
	Blochiidae	*Blochius*
	Callipterygidae	*Callipteryx*
	Caproidae	*Eoantigonia*
	Carangidae	*Ceratoichthys*
		Eastmanalepes
		Lichia
		Paratrachinotus
		Seriola
		Trachicaranx
		Vomeropsis
	Carangodidae	*Carangodes*
	Centrolophidae	*Zorzinia*
	Ductoridae	*Ductor*
	Eocottidae	*Bassanichthys*
		Eocottus
	Ephippidae	*Archaephippus*
		Eoplatax
	Euzaphlegidae	*Veronaphleges*
	Exellidae	*Exellia*
	Gerreidae	*Aspesiperca*
	Labridae	*Bellwoodlabrus*
		Eocoris
		Phyllopharyngodon

Labroidei incertae sedis	*Sorbinia*
Latidae	*Eolates*
Leiognathidae	*Eoleiognathus*
Lutjanidae	*Goujetia*
	Lessinia
	Ottaviania
	Veranichthys
Massalongiidae	*Massalongius*
Menidae	*Mene*
Monodactylidae	*Psettopsis*
Palaeorhynchidae	*Palaeorhyncus*
Percichthydae	*Cyclopoma*
Percoidei incertae sedis	*Blotichthys*
	Bradyurus
	Frigoichthys
	Frippia
	Gillidia
	Jimtylerius
	Malacopygaeus
	Montepostalia
	Parapelates
	Pavarottia
	'Pygaeus'
	Quasicichla
	Squamibolcoides
	Veronabrax
	Voltamulloides
Pomacentridae	*Lorenzichthys*
	Palaeopomacentrus
Pomatomidae	*Carangopsis*
Priacanthidae	*Pristigenys*
Quasimullidae	*Quasimullus*
Robertanniidae	*Hendrixella*
	Robertannia
Scatophagidae	*Eoscatophagus*
Scombridae	*Auxides*
	Godsilia
	Pseudaxides
	Thunnoscomberoides
Siganidae	*Acanthopygaeus*
	Aspesiganus
	Ruffoichthys
Sorbinipercidae	*Sorbinicapros*
	Sorbiniperca
Sparidae	*Abromasta*
	Dentex
	Ellaserrata

		Pseudosparnodus
		Sparnodus
	Sphyraenidae	*Sphyraena*
	Tortonesidae	*Tortonesia*
	Zanclidae	*Eozanclus*
	Zorzinichthyidae	*Zorzinichthys*
Pleuronectiformes	Amphistiidae	*Amphistium*
		Heteronectes
	Pleuronectiformes incertae sedis	*Eobothus*
Pycnodontiformes	Pycnodontidae	*Abdobalistum*
		Nursallia
		Palaeobalistum
		Pycnodus
Syngnathiformes	Aulorhamphidae	*Aulorhamphus*
		Pesciarhamphus
		Veronarhamphus
	Aulostomidae	*Eoaulostomus*
		Jurgersenichthys
		Macraulostomus
		Synhypuralis
	Aulostomoidea incertae sedis	*Aulostomoides*
	Centriscidae	*Aeoliscoides*
		Paramphisile
	Fistularioididae	*Fistularoides*
		Pseudosyngnathus
	Paraeoliscidae	*Paraeoliscus*
	Parasynarcualidae	*Parasynarcualis*
	Ramphosidae	*Rhamphosus*
	Solenostomidae	*Solenorhynchus*
	Syngnathidae	*Prosolenostomus*
		Syngnanthus
	Syngnathoidei incertae sedis	*Calamostoma*
	Urosphenidae	*Urosphen*
Tetraodontiformes	Aracanidae	*Proaracana*
	Bolcabalistidae	*Bolcabalistes*
	Diodontidae	*Heptadiodon*
		Prodiodon
		Zignodon
	Eoplectidae	*Eoplectus*
	Ostraciidae	*Eolactoria*
	Protobalistidae	*Protobalistum*
		Spinacanthus
	Tetraodontidae	*Eotetraodon*
	Triacanthidae	*Protacanthodes*
	Zignoichthyidae	*Zignoichthys*

Landmark and semilandmark configuration

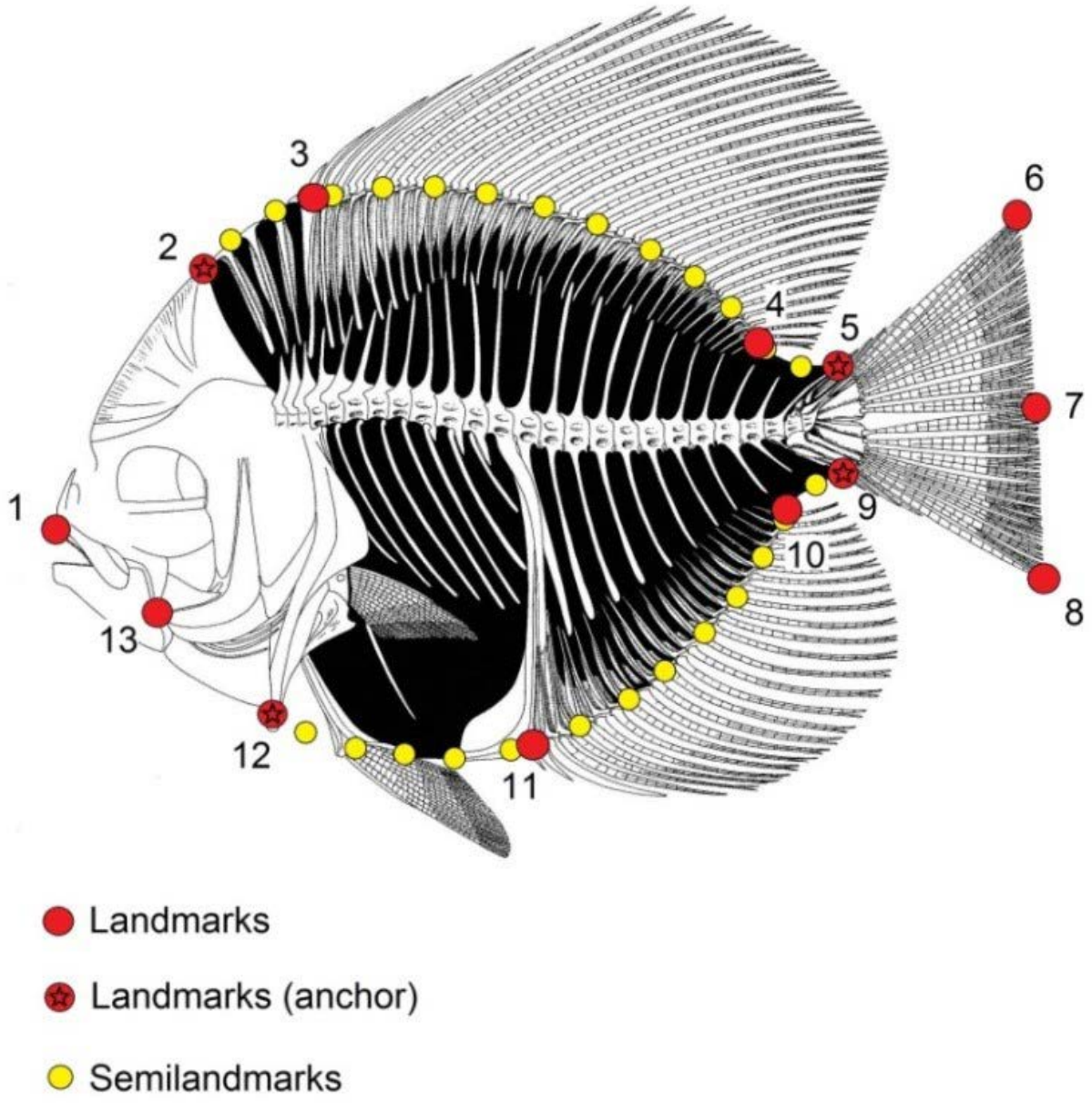

Fig. S1 - Landmarks and semilandmarks configuration (*Psettopsis* from the Eocene of Bolca in the example). Landmarks are represented by red circles with crescent numeration starting from snout; semilandmarks are represented by yellow circles; the stars indicate the landmarks that serve as anchor points for the semilandmarks imputing. 1 - Anterior tip of premaxilla; 2 - Postero-dorsal tip of the skull roof (supraoccipital); 3 - Anterior insertion of dorsal fin; 4 - Posterior insertion of dorsal fin; 5 - Dorsal insertion of caudal fin; 6 - Distal tip of the principal ray of dorsal lobe of caudal fin; 7 - Fork between dorsal and ventral lobe; 8 - Distal tip of the principal ray of ventral lobe of caudal fin; 9 - Ventral insertion of caudal fin; 10 - Posterior insertion of anal fin; 11 - Anterior insertion of anal fin; 12 - Ventral tip of pectoral girdle; 13 - Lower jaw joint.

Deformation grid plots

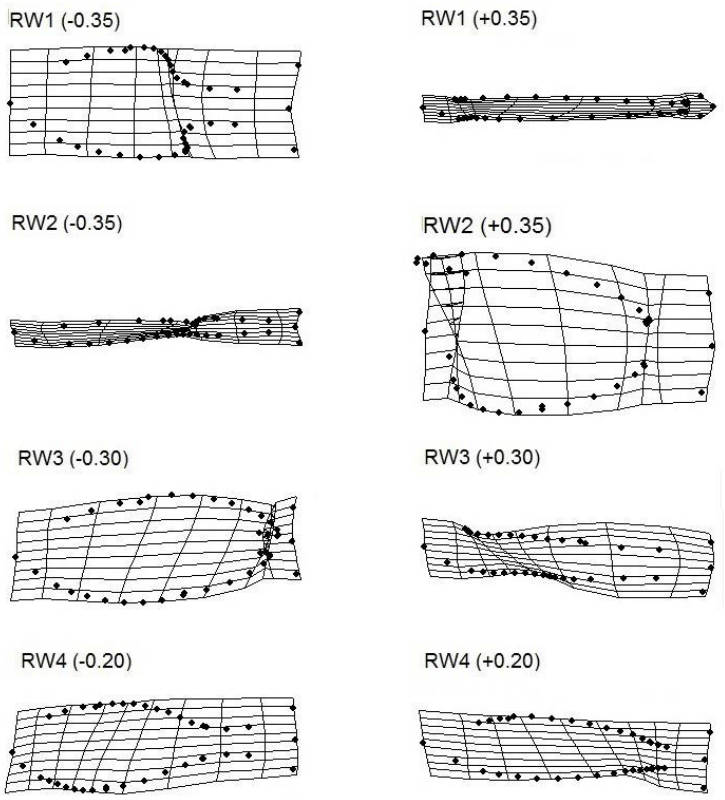

Fig. S2. Deformation grids of the first four relative warps axis (explaining over 86% of the total variance) shown as thin-plate splines for positive and negative scores along each axis. The first two RW axes (66.7% of overall variance) describe the correlation between elongation of fish and median fin length. Positive score of RW1 (39.4% of variance) is related to slender and elongate bodies with long median fins (e.g. Anguilliformes and Ophidiiformes), while negative values are related to deep-bodied fishes with short median fins (e.g. Tetraodontiformes). Positive score of RW2 (27.3% of total variance) is related to taxa with slender body and short dorsal and anal fins (e.g. Syngnathiformes), while on negative values lie deep-bodied fish with long median fins (e.g. Pleuronectiformes). The RW3 (12.7% of variance) describes caudal peduncle length (short at negative and long at positive scores) while the RW4 axis (6.9% of total variance) explains the preanal distance (short at negative and long at positive scores).

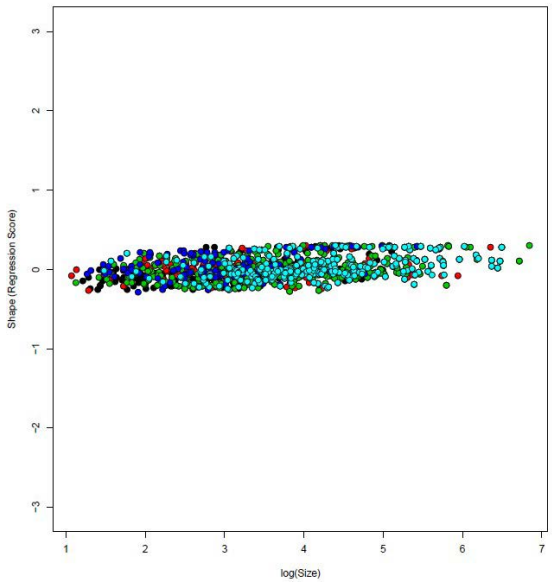

Fig. S3 - Log centroid size plotted on the shape scores of the genera, using the function of Drake & Klingenberg, 2008. Black = Bolca, Red = Great Barrier Reef, Green = Red Sea, Blue = Carribean Sea, Cyan = Brazilian Shelf.

	df	SS	MS	Rsq	F	Z	P value
log(Size)	1	3.918	3.9183	0.031192	59.7681	2.0385	0.16667
Ecosystem	1	0.155	0.1545	0.00123	2.3568	1.6462	0.16667
Residuals	1854	121.545	0.0656				
Total	1856	125.618					

Tab. S3 - Results of ANOVA for the regression between body size and shape in different ecosystems.

Statistical significance of difference in morphospace occupation: PERMANOVA and ANOSIM

Statistical significance in morphospace occupation was calculated with the multivariate analysis of variance (PERMANOVA), a non-parametric test for significant difference between two or more group centroids (Anderson, 2001). The PERMANOVA calculates an F value analogue to the F value of ANOVA because Euclidean distance measures were used. The null hypothesis is the similarity of group centroids.

PERMANOVA	
Permutation n. 9999	
Total sum of squares	125.6
Within-group sum of squares	123.2
F	9.011
p(same)	0.0001*

F values	BOL	GBR	RS	EBS	CS
BOL		18.76	20.62	15.98	25.64
GBR	18.76		0.723	2.713	6.947
RS	20.62	0.723		1.785	3.832
EBS	15.98	2.713	1.785		1.513
CS	25.64	6.947	3.832	1.513	
Bonferroni-corrected p values	BOL	GBR	RS	EBS	CS
BOL		0.001*	0.001*	0.001*	0.001*
GBR	0.001*		1	0.296	0.002*
RS	0.001*	1		1	0.060
EBS	0.001*	0.296	1		1
CS	0.001*	0.002*	0.060	1	

Tab. S4 - Results of PERMANOVA test shown as post-hoc test. The significance is computed by permutation of group membership, with 9,999 replicates and the asterisk (*) indicates significant comparisons ($p < 0.05$) between fish assemblages. BOL = Bolca, GBR = Great Barrier Reef, EBS = East Brazil Shelf, CS = Carribean Sea, RS = Red Sea.

The analysis of similarities (ANOSIM; Clarke, 1993), tests for significant differences in the distribution of taxa in morphospace. In ANOSIM, comparison of pair-wise R values, measuring how separate groups are, on a scale of 0 (indistinguishable) to 1 (all similarities within groups are less than any similarity between groups).

The null hypothesis is the equal median and ranges for within-group ranked dissimilarities among ecosystems and in analogy with ANOVA the test is based on comparing distances between groups with distances within groups.

Large positive values of R ($R > 0.75$) mean high dissimilarity between groups. With $R > 0.5$ groups are overlapping but clearly different; with $R > 0.25$, groups are strongly overlapped and with $R < 0.25$ groups are barely distinguishable.

The significance is computed by permutation of group membership with 9,999 replicates. Alpha was set at 0.05.

ANOSIM					
Permutation n. 9999					
Mean rank within	8.307E05				
Mean rank between	1.8.704E05				
R	0.0461				
p(same)	0.0001*				
R values	BOL	GBR	RS	EBS	CS
BOL		0.1771	0.1543	0.1047	0.1494
GBR	0.1771		0.0023	0.0357	0.0285
RS	0.1543	0.0023		0.0152	0.0115
EBS	0.1047	0.0357	0.0152		0.0018
CS	0.1494	0.0285	0.0115	0.0018	
Bonferroni-corrected p values	BOL	GBR	RS	EBS	CS
BOL		0.001*	0.001*	0.001*	0.001*
GBR	0.001*		1	0.030*	0.001*
RS	0.001*	1		0.722	0.073
EBS	0.001*	0.030*	0.722		1
CS	0.001*	0.001*	0.073	1	

Tab. S5 - ANOSIM test shown as post-hoc test. The significance is computed by permutation of group membership, with 9,999 replicates and the asterisk (*) indicates significant comparisons ($p < 0.05$) between assemblages. BOL=Bolca, GBR = Great Barrier Reef, EBS = East Brazil Shelf, CS = Carribean Sea, RS = Red Sea.

Nearest neighbor analysis tests for clustering or overdispersion of points given as two-dimensional coordinate values (Davis, 1986). The null hypothesis is the random distribution of points (taxa). An R value < 1 indicates attraction between points and then clusterization, an R ˜ 1 indicates randomization of points and an R > 1 indicates repulsion between points and then overdispersion. Donnelly's correction was applied and alpha was set at 0.05.

RWs 1-2	**BOL**	**GBR**	**RS**	**EBS**	**CS**
N of points (taxa)	183	513	475	292	394
Area	0.3837	0.3631	0.3575	0.3580	0.3671
Mean density	477.0	1413	1328.5	815.7	1073.2
Mean distance	0.0212	0.0109	0.0114	0.0143	0.0127
Expected distance	0.0238	0.0136	0.0141	0.0181	0.0157
Z	-2.6667	-8.384	-7.5067	-6.4436	-6.8349
p (random)	0.0077	<0.0001	<0.0001	<0.0001	<0.0001
R value	0.8904	0.7979	0.8117	0.7920	0.8111

Tab. S6 - Basic statistics and values of nearest neighbour analysis for all morphospaces built on the first two RW axes. BOL = Bolca, GBR = Great Barrier Reef, EBS = East Brazil Shelf, CS = Carribean Sea, RS = Red Sea.

RWs 3-4	**BOL**	**GBR**	**RS**	**EBS**	**CS**
N of points (taxa)	183	513	475	292	394
Area	0.1566	0.1875	0.1935	0.1680	0.1970
Mean density	1168.5	2735.9	2454.7	1737.8	2000.3
Mean distance	0.0143	0.0079	0.0088	0.0110	0.0093
Expected distance	0.0152	0.0098	0.0103	0.0123	0.0115
Z	-1.2771	-8.1281	-6.0449	-3.4990	-6.9997
p (random)	0.2016	<0.0001	<0.0001	0.0005	<0.0001
R value	0.9477	0.8043	0.8486	0.8875	0.8070

Tab. S7 - Basic statistics and values of nearest neighbour analysis for all morphospaces built on the third and fourth RW axes. BOL = Bolca, GBR = Great Barrier Reef, EBS = East Brazil Shelf, CS = Carribean Sea, RS = Red Sea.

Morphological disparity

Morphological disparity (Foote, 1993) was calculated the sum of variances of all RW axes, which is insensitive to the sample size (Ciampaglio et al., 2001)

ECOSYSTEM	MD (observed)	MEAN (bootstrap)	SE (bootstrap)	Limits percentile of the confidence interval at 95%	
				2.5%	97.5%
BOL	0.0872	0.0868	0.0045	0.0779	0.09547
GBR	0.0600	0.0599	0.0025	0.0550	0.0647
RS	0.0641	0.0639	0.0025	0.0593	0.0691
CS	0.0675	0.0673	0.0026	0.0625	0.0727
EBS	0.0678	0.0676	0.0031	0.0617	0.0735

Tab. S8 - Morphological disparity calculated as sum of variances and summary of the results for the bootstrap analysis with 999 randomizations. BOL = Bolca, GBR = Great Barrier Reef, RS = Red Sea, CS = Carribean Sea, EBS = East Brazil Shelf.

SUPPLEMENTARY REFERENCES

Anderson M.J. (2001). A new method for non-parametric multivariate analysis of variance. Austral Ecology, 26: 32-46.

Ciampaglio C.N., Kemp M. & McShea D.W. (2001). Detecting changes in morphospace occupation patterns in the fossil record: characterization and analysis of measures of disparity. Paleobiology, 27: 695-715.

Clarke K.R. (1993). Non-parametric multivariate analysis of changes in community structure. Australian Journal of Ecology, 18: 117-143.

Davis J.C. (1986). Statistics and data analysis in geology. Wiley J. & Sons, Hoboken. 638 pp.

Drake A.G & Klingenberg C.P. (2008). The pace of morphological change: Historical transformation of shull shape in St Bernand dogs. Proceedings of the Royal Society B, Biological Sciences, 275: 71-76.

Foote M. (1993). Contributions of individual taxa to overall morphological disparity. Paleobiology, 19: 403-419.