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SOME OBSERVATIONS ON THE MASS MORTALITY OF FISH AT ORMARA (EAST BAY), BALOCHISTAN IN OCTOBER 2016

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ABSTRACT: Mass mortality of fish and shellfish species was recorded from Ormara (East Bay) in October 2016. Initially a few dead fishes were observed to be floating in the open sea in the East Bay area. With the passage of time, mass mortality was observed on the south-western part of the East Bay and heaps of fish were found floating in the area. This event of mass mortality was only confined to the Oramara (East Bay) and not spread to other parts of Oramara coast. In order to determine the dynamic of the fish mortality and its spread in the area, sampling of the water of the area was collected on regular intervals. It was observed that *Noctiluca scintillans* (Macartney) Kofoid & Swezy, 1921 was present in extremely large numbers (highest recorded concentration 13 cells/ml) which led to depletion of oxygen in the area resulting in mortality of large number of fishes. In this fish kill demersal (bottom dwelling) as well as pelagic species (surface dwelling) were found dead in the area in large numbers. Groupers (*Epinephelus* spp.), Chinese pomfrets (*Pampus chinensis*), mullets, shrimp (*Penaeus* spp.) and crabs (*Portunus* spp.) were dominated in the dead fishes and shellfishes. Oxygen depletion was observed to confine to south-western part of the Ormara Bay where highest number of dead fishes were observed. The phenomenon of mortality of fishes continued for 8 days whereas normal condition started prevailing in 15 days and no mortality was observed after 20 days since the start of the mortality phenomenon.

KEYWORDS: Mass mortality, *Noctiluca scintillans*, Ormara (East Bay), oxygen

INTRODUCTION

Fish kills or mass mortalities of fish have been reported from Pakistan on many occasions but there are only a few scientifically documented records. A fish kill was reported near the Indus by Ahmad Ibn Magid, Arab navigator of the XV century (Aleem, 1968) whereas Brongersma-Sanders (1967) reported mass mortality of fish about 400 miles west-southwest of Karachi on 5 December, 1945 which followed earthquake (of 27 November, 1945). In this instance, a large number of dead fish were seen in a circular area in the sea, observed from an aeroplane by Lieut. Cdr. (A) G. F. Venema. Rabbani *et al.* (1990) reported mortality of a large number of fishes in November 1987 in Gwadar, Balochistan which was caused by toxic dinoflagellate (*Protocentrum micans*) bloom. Although *Noctiluca* has been reported from Pakistan by Saifullah (1979), Chughtai and Saifullah (2006); Saifullah and Chaghtai (1990) and Munir *et al*., (2013) but no mortality associated with these event of occurrence of *Noctiluca* were reported.

In third week of October, 2016 fishermen reported mortality of some fishes in the offshore waters near the Ormara (East Bay) on account of red tide (locally known as "bad-aab"). A team of Fisheries Department, Government of Balochistan was dispatched

to investigate the issue but theydid not observed any discoloration of water, however, reported mortality of some fishes at the entrance of the Ormara (East Bay). In next four days, the phenomenon of fish mortality was observed to be spreading and almost covering the entire southwest part of the Ormara (East Bay). Considering the gravity of the situation, it was decided to undertake a study to investigate the cause and extent of fish mortality in the area. Present paper reports the details a mass mortality of fishes and shellfishes from Ormara (East Bay) during October 2016.

MATERIALS AND METHOD

Ormara is a tombolo located along Balochistan coast (Fig.1) having two bays; East Bay (or Demi Zur) and West Bay (or Pedi Zur). Whereas Pedi Zur is exposed to comparatively more intense wave action but the wave action is comparatively moderate in East Bay. The Ormara (East Bay) is an important fish landing centre and also have a large naval base. Fishing activity in the East Bay is carried out by gillnets, cast nets or handline. In the Ormara (West Bay) fishing activities are limited to only pelagic gillnets.

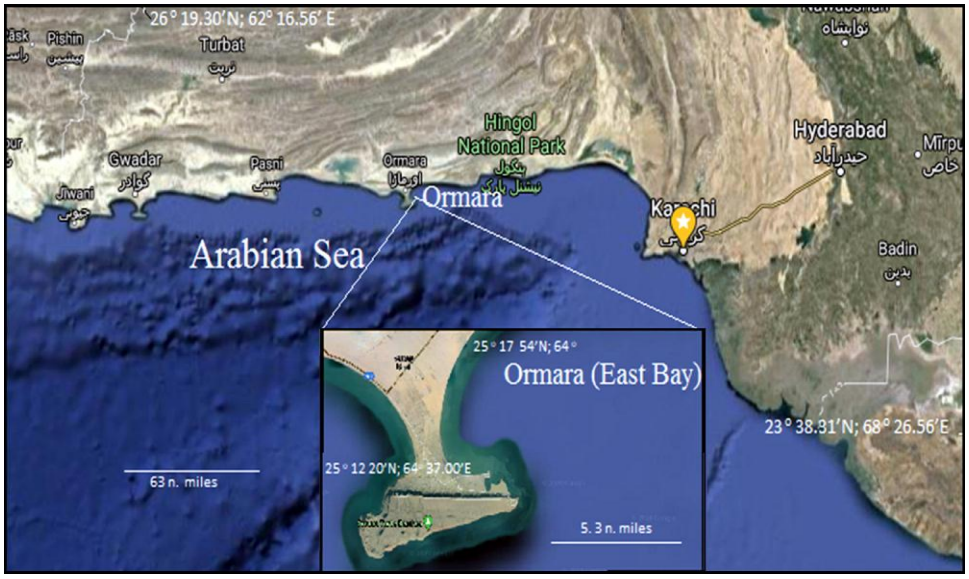

Fig. 1. Map of Pakistan showing location of Ormara.

In the last week of last week of October 2016, a major fish kill was reported from the area. An emergent investigation programme was initiated and samples of seawater were collected from the 9 stations mentioned in Fig. 2 on 27 October, 2016. In addition, samples of zooplanktons were made 1 m below the sea surface and also salinity and oxygen was recorded from surface water from each station using EDT FE 247 MICRO Dissolved Oxygen Meter. Samples of fishes were collected with the help of scoop net and identified using Psomadakis *et al.* (2015). Samples of the fishes were dissected to

determine the cause of their death. Because of wide dispersal in the area and patchy accumulation of dead fishes, it was not possible to determine the quantity of fish being found dead in the area. A relative abundance scale including abundant, common, less common and rare has been used in the study. Since only the relative abundance (in terms of A=abundant; C=common; LS=less common and R=rare) no detailed statistical analysis was carried out.

Fig. 2. Map of Ormara (East Bay) showing the area of fish mortality and sampling stations.

RESULTS AND DISCUSSION

Mass mortality of fish was observed in the coastal waters of Ormara in third and last week of October, 2016 which is attributed to phenomenon generally referred to red tide (Fig 3). Fish kill involves demersal (bottom dwelling) as well as pelagic species (surface dwelling). Although more than 148 species of fish and shellfish were found to be present in dead fishes but commercially important groupers (*Epinephelus* spp.), Chinese pomfrets (*Pampus chinensis*), mullets are dominating among fishes whereas shrimp (*Penaeus* spp.) and crabs (*Portunus* spp.) are dominating among shellfish.

According to the fishermen, the dead fishes were found to be present in the entire Ormara (East Bay) up to Had, however, during the study (27 October, 2016), the dead fishes were accumulated in south-western part of the Bay only (Fig. 4) This is mainly because wind was blowing from North-East Direction which forced the floating dead fishes to be accumulated in south-western part of the Ormara (East Bay).Water samples of the area were collected and examined which revealed that that *Noctiluca scintillans* (Macartney) Kofoid & Swezy, 1921 was present in extremely large numbers (Fig. 4).

Fig. 3. Fish mortality at Ormara (East Bay) Station-1.

Fig. 4. Fish mortality at Ormara (East Bay) Station-3.

Table. 1 indicates that there is a serious depletion of dissolved oxygen in the area which resulted in the mortality of fish. Low dissolved oxygen levels ranged from 0.27 to 2.82 ml/L. At station 1-4, which have accumulation of dead fishes, have highest concentration of *Noctiluca* cells and lowest dissolved oxygen level. At station 3 and 4, the concentrations of *Noctiluca* cells were 13 and 12 whereas dissolved levels were 0.29 and 0.27 ml/L respectively. In contrast, the stations located near the open sea (Station 5 and 7) have lower concentration of *Noctiluca* cells (4-5) and highest concentration of dissolved oxygen (2.62 and 2.82mg/L). No relationship was found with salinity and seawater temperature with density of *Noctiluca* cells and oxygen levels. Highest concentrations of dead fishes were observed at station 2, 3 and 4.

Table 1. Physical Parameters of the Seawater in Ormara (East Bay) on 27 October 2016.

Station No.	Sea water Temperature (^{o}C)	Salinity (‰)	Oxygen (ml/L)	*Noctiluca* cells/ml	Remarks
1	24.5	36.1	0.35	9	Sparse dead fish accumulation
2	24.6	36.2	0.33	11	Dense dead fish accumulation
3	24.2	36.1	0.29	13	Dense dead fish accumulation
4	24.3	35.6	0.27	12	Dense dead fish accumulation
5	22.4	36.3	2.62	4	Sparse dead fish accumulation
6	23.6	36.3	1.41	5	Few dead fish
7	22.1	36.2	2.82	5	Few dead fish
8	22.7	36.3	2.25	3	Few dead fish
9	22.4	36.3	2.16	1	Sparse dead fish accumulation

Among the dead animals, a number of invertebrates were also found to be present which includes shrimp (10 species), lobsters (4 species), crabs (5 species), bivalve (4 species), gastropod (2 species) and 1 species of cuttlefish (Table. 2). Almost all of these dead invertebrates were found to be casted on the beaches along the south-western part of the Ormara (East Bay) except *Sepia pharaonic* which was found floating with dead fishes. Among the invertebrates, *Penaeus (Fenneropenaeus) merguiensis, P. (Penaeus) monodon* and *P. (P.) semisulcatus* were the dominating. Among crab *Portunus segnis* and *Portunus sanguinolentus* were dominating.

Among fishes, a large number of demersal fishes were found to be affected (Table. 2). There were found floating in the major part of Ormara (East Bay) with dense

accumulation at station 1 to 5. Seven species of mullets were present in the dead fishes but *Chelon klunzingeri, Ellochelon vaigiensis, Moolgarda seheli* and *M. speigleri* were dominating species found among dead fishes. Large specimens of groupers (*Epinephelus coioides, E. diacanthus E. malabaricus* and *E. stoliczkae*) were also among the dominating species found to be dead in the Ormara (East Bay). A large number of juveniles and subadults of silver pomfret (*Pampus argenteus*) were also present among the dead fishes. Croakers represented by *Otolithes ruber, O. cuverii, Johnius dussumieri* and *Paranibea semiluctuosa* in the dead fishes.

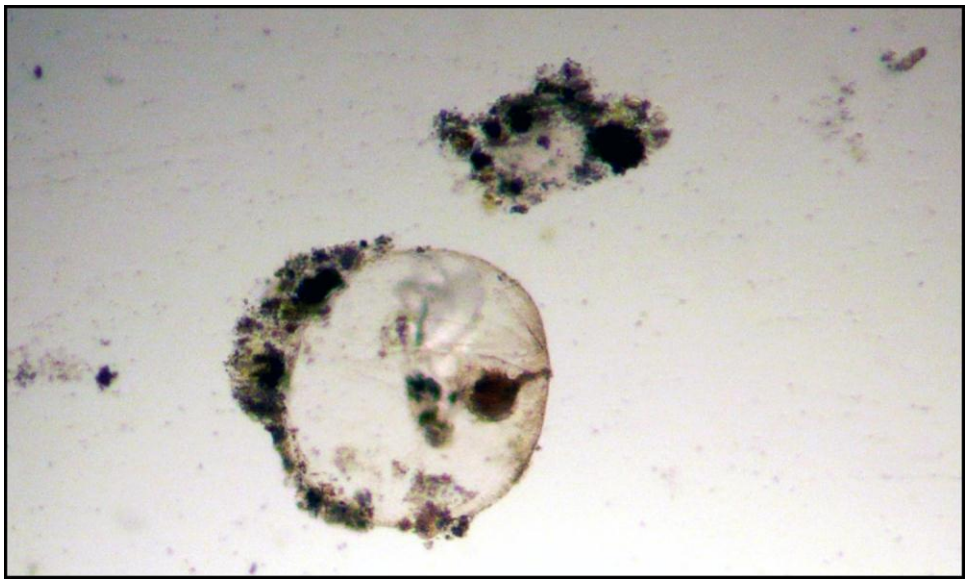

Fig. 5. *Noctiluca scintillans* the causative agent of fish mortality at Ormara (East Bay).

Most of the fishes were found to be floating in the sea whereas a few were casted in the beaches, the dominating among them were longfin snake-eel (*Pisodonophis cancrivorus*) which is usually found burrowing in the sandy and sandy-cum-muddy shores along Balochistan coast (Ajazuddin *et al.*, 1985). In addition, moray eels (*Echidna nebulosa, Gymnothorax pseudothyrsoideus* and *Strophidon sathete*) found to be casted on the shores along Oramara (East Bay). It may be noted that most of the species of fishes found to be dead are either demersal or small pelagic (Table. 2). There is no large pelagic that was observed among the dead fishes except *Scomberoides commersonnianus* and *Carangoides malabaricus* which are sometimes considered among large pelagic, however, these are also generally found with the Ormara (East Bay) and commercially harvested in some seasons.

A large number of fishes were dissected to find the cause of death but no apparent signs were visible. In most cases stomach contents do not show any unusual food items. The gills were also found to be cleaned and no accumulation of any material was notice. Considering that dissolved oxygen level was extremely low, therefore, it is safe to

assume that these fishes and other invertebrates were asphyxiated. No stench other than rotting fish was noticed in the area.

Table. 2. Species of fish and shellfish (invertebrates) observed during mass mortality in Ormara (East Bay) in October 2016 (A=abundant; C=common; LS=less common; R=rare).

Species	English Name	Abundance
SHRIMP (Penaeidae)		
Metapenaeus affinis	Jinga shrimp	LS
Metapenaeus brevicornis	Yellow shrimp	R
Metapenaeus monoceros	Speckled shrimp	LC
Parapenaeopsis (Mierspenaeopsis) sculptilis	Rainbow shrimp	LC
Parapenaeopsis (Parapenaeopsis) stylifera	Kiddi shrimp	LC
Penaeus (Fenneropenaeus) indicus	Indian white shrimp	C
Penaeus (Fenneropenaeus) merguiensis	Banana shrimp	A
Penaeus (Fenneropenaeus) penicillatus	Redtail shrimp	C
Penaeus (Penaeus) monodon	Giant tiger shrimp	C
Penaeus (Penaeus) semisulcatus	Green tiger shrimp	A
SPINY LOBSTERS (Palinuridae)		
Panulirus homarus	Scalloped spiny lobster	R
Panulirus ornatus	Ornate spiny lobster	R
Panulirus polyphagus	Mud spiny lobster	R
Slipper LOBSTERS (Scyllaridae)		
Thenus indicus	Indian flathead lobster	R
SWIMMING CRABS (Portunidae)		
Charybdis feriatus	Crucifix crab	LC
Portunus segnis	Arabian flower crab	A
Portunus sanguinolentus	Three spot swimming crab	A
MOON CRABS (Mutatidae)		
Ashtoret lunaris	Yellow moon crab	R
Matuta planipes	Flower moon crab	LC
BLOOD CLAMS (Arcidae)		
Anadara antiquate	Antique ark	C
Anadara inequivalvis	Unequal ark	C

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MUSSELS (Mytilade)		
Pernaviridis	Green mussel	C
CLAMS (Veneridae)		
Meretrix casta	Backwater hard clam	LC
GASTROPODS (Muricidae)		
Indothais lacera	Carinate rock shell	C
WHELKS (Babylonidae)		
Babylonia spirata	Spiral ivory whelk	C
CUTTLEFISH (Sepiidae)		
Sepia pharaonis	Pharaoh cuttlefish	LC
SLEEPER RAYS (Narkidae)		
Narke dipterygias	Spottail sleeper ray	R
ELECTRIC RAYS (Torpedinidae)		
Torpedo panthera	Panther electric ray	R
Torpedo sinuspersici	Variable electric ray	R
GUITARFISH (Rhinobatidae)		
Glaucostegus halavi	Halavi guitarfish	R
Rhinobatos annandalei	Annandale guitarfish	R
STINGRAYS (Dasyatidae)		
Himantura gerrardi	White spotted whipray	LC
Himantura randalli	Arabian banded whipray	R
Himantura bleekeri	Bleeker'swhipray	R
BUTTERFLY RAYS (Gymnuridae)		
Gymnura poecilura	Longtailed butterfly ray	R
MORAY EELS (Muranidae)		
Echidna nebulosa	Snowflake moray	LC
Gymnothorax phasmatodes	Ghost moray	R
Gymnothorax pseudothyrsoideus	Highfin moray	LC
Strophidon sathete	Slender giant moray	LC
SNAKE EEL (Ophichthidae)		
Pisodonophis cancrivorus	Longfin snake- eel	C
CONGER EELS (Congridae)		
Bathymyrus echinorhynchus	Rough nose conger	R
PIKE CONGER (Muraenosocidae)		
Muraenesox cinereus	Dagger-tooth pike conger	R

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SHAD, SARDINES (Clupeidae)		
Anodontostoma chacunda	Chacunda gizzard shad	LC
Escualosa thoracata	White sardine	C
Hilsa kelee	Kelee shad	C
Nematalosa nasus	Bloch's gizzard shad	LC
Sardinella albella	White sardinella	LC
Stolephorus commersonnii	Commerson's anchovy	LC
Stolephorus indicus	Indian anchovy	LC
Thryssa dussumieri	Dussumier's thryssa	C
Thryssa hamiltonii	Hamilton's thryssa	LC
Thryssa vitrirostris	Orange mouth thryssa	LC
ILLISHA (Pristigasteridae)		
Ilisha megaloptera	Big-eye ilisha	R
Ilisha melastoma	Indian ilisha	R
Opisthopterus tardoore	Tardoore	R
MILKFISH (Chanidae)		
Chanos chanos	Milkfish	R
SEA CATFISHES (Ariidae)		
Arius maculatus	Spotted sea catfish	C
Batrachocephalus mino	Beardless sea catfish	R
Netum abilineata	Bronze sea catfish	C
Netuma thalassina	Giant sea catfish	C
Plicofollis dussumieri	Blacktip sea catfish	R
EEL CATFISH (Plotosidae)		
Plotosus limbatus	Darkfin eel catfish	R
Plotosus lineatus	Stripped eel catfish	R
NEEDLEFISHES (Belonidae)		
Ablennes hians	Flat needlefish	R
Strongylura leiura	Banded needlefish	R
HALFBEAKS (Hemiramphidae)		
Hemiramphus far	Black-beaked halfbeak	R
Hyporhamphus limbatus	Congaturi halfbeak	R
SCORPIONFISH (Scorpaenidae)		
Scorpaenopsis lactomaculata	Whiteblotched scorpionfish	C

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STONEFISHES (Synanceiidae)		
Pseudosynanceia melanostigma	Blackfin stonefish	R
SPINY FLATHEADS (Platycephalidae)		
Platycephalus indicus	Bartail flathead	C
Sorsogona melanoptera	Obscure flathead	R
GROUPERS (Serranidae)		
Epinephelus coioides	Orange spotted grouper	A
Epinephelus diacanthus	Spinycheek grouper	A
Epinephelus malabaricus	Malabar grouper	A
Epinephelus stoliczkae	Epaulet grouper	C
TERAPONS (Teraponidae)		
Pelates quadrilineatus	Four-lined terapon	R
Terapon jarbua	Jarbuaterapon	C
Terapon puta	Small scaled terapon	LC
CARDINAL FISHES (Apogonidae)		
Apogonichthyoides enigmaticus	Short-toothed cardinal fish	R
Ostorhinchus fasciatus	Broad banded cardinal fish	R
SILLAGOS (Sillaginidae)		
Sillago sihama	Silver sillago	C
JACKS, SCADS (Carangidae)		
Alepes djedaba	Shrimp scad	R
Carangoides malabaricus	Malabar trevally	R
Decapterus russelli	Indian scad	C
Scomberoides commersonnianus	Talang queenfish	C
Trachinotus baillonii	Small spotted dart	LC
PONYFISHES (Leiognathidae)		
Aurigequula fasciata	Stripped ponyfish	LC
Equulites oblongus	Oblong ponyfish	LC
Gazza minuta	Toothed ponyfish	LC
Karalla daura	`Golden stripe ponyfish	LC
Leiognathus equula	Common ponyfish	LC
Nuchequula blochii	Two blotch ponyfish	LC
Photopectoralis bindus	Orangefish ponyfish	LC
Secutor. insidiator	Pugnose ponyfish	C
SNAPPERS (Lutjanidae)		
Lutjanus rivulatus	Blubberlip snapper	R

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SILVER BIDDIES (Gerreidae)		
Gerres filamentosus	Whipfin silverbiddy	R
Gerres phaiya	Strong-spine silver biddy	R
GRUNTS (Haemulidae)		
Plectorhinchus gaterinus	Black-spotted rubberlip	R
Plectorhinchus gibbosus	Harry hotlip	R
Plectorhinchus pictus	Trout sweetlip	R
Plectorhinchus sordidus	Sordid rubberlip	C
Pomadasys aheneus	Yellowback grunt	C
Pomadasys commersonnii	Small spotted grunt	R
Pomadasys maculatus	Saddle grunt	C
SEA BREAMS (Sparidae)		
Acanthopagrus arabicus	Arabian yellowfin seabream	C
Acanthopagrus berda	Goldsilk seabream	C
Acanthopagrus catenula	Bridled sea bream	C
Acanthopagrus sheim	Spotted yellow seabream	R
Crenidens indicus	Indian seabream	C
Diplodus capensis	White seabream	C
Rhabdosargus haffara	Haffara seabream	R
Rhabdosargus sarba	Gold-lined seabream	R
Sparidentex hasta	Sobaity seabream	R
EMPERRORS (Lerthrinidae)		
Lethrinus microdon	Smalltooth emperor	R
Lethrinus nebulosus	Spangled emperor	R
MONOCLE BREAM (Nemipteridae)		
Scolopsis vosmeri	Whitecheek monocle bream	LC
CROAKERS (Scianidae)		
Argyrosomus japonicus	Japanese meagre	R
Daysciaena albida	Bengal corvina	R
Dendrophysa russelii	Goatee croaker	R
Johnius amblycephalus	Bearded croaker	R
Johnius belangerii	Belanger’s croaker	C
Johnius carutta	Karut croaker	LC
Johnius dussumieri	Sin croaker	C
Johnius elongatus	Spindle croaker	R

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Nibea maculata	Kathala croaker	R
Otolithes cuvieri	Lesser tiger-toothed croaker	C
Otolithes ruber	Tiger-toothed croakers	C
Paranibea semiluctuosa	Half mourning croaker	C
THREADFINS (Polynemidae)		
Filimanus similis	Indian seven fingered threadfin	R
Leptomelanosoma indicum	Indian threadfin	R
Polydactylus mullani	Arabian blackspot threadfin	LC
GOATFISH (Mullidae)		
Parupeneus cyclostomus	Gold-saddle goatfish	R
Parupeneus indicus	Indian goatfish	R
Parupeneus rubescens	Rosy goatfish	R
Upeneus vittatus	Yellow stripped goatfish	R
SICKLEFISH (Drepanidae)		
Drepane punctata	Spotted sicklefish	C
MULLETS (Mugildae)		
Chelon klunzingeri	Klunzinger's mullet	A
Chelon macrolepis	Large-scaled mullets	C
Chelon parsia	Gold-spot mullets	C
Ellochelon vaigiensis	Square-tailed mullet	A
Liza subviridis	Greenback mullet	A
Moolgarda seheli	Blue spot mullet	A
Moolgarda speigleri	Speilgar's mullet	A
DAMSEL FISHES (Pomacentridae)		
Abudefduf vaigiensis	Indo-Pacific sergeant	C
Neopomacentrus sindensis	Arabian demoiselle	R
PARROTFISHES (Scaridae)		
Scarus arabicus	Arabian parrotfish	R
Scarus zufar	Dhofar's parrotfish	R
POMFRETS (Stromateidae)		
Pampus argenteus (Euphrasen, 1788)	Silver pomfret	A
FLATFISHES (Cynoglossidae)		
Cynoglossus bilineatus(Lacepede, 1802)	Fourlined tongesole	LC

According to fishermen of the area, the mortality of fish was stopped by 1 November, 2016 and by 15 November, 2016, the area were observed to be devoid of dead

fishes, as wave action and tidal flow has removed the dead fishes from the south-western part of the Ormara (East Bay). Dead shells of molluscs were, however, remained on the beaches for very long period.

Mass deaths of fish or other aquatic animals such as crabs or shrimps have been recorded in many parts of the world because of a number of reasons including both natural causes as well as because of anthropogenic activities. In Pakistan, there were two authentic reports of fish kill; Brongersma-Sanders (1967) reported mortality of fish off southwest of Karachi because of earthquake or tsunami of 1945. Rabbani *et al.* (1990) reported mortality of a large number ofdemersal fishes of genera such *Terapon*, Congresox, *Pomadasys* in November 1987 in Gwadar (East Bay), Balochistan because of red tide caused by *Protocentrum micans*. In addition, there were newspaper reports when dead fishes were found in Karachi Fish Harbour area or along Karachi coast; most of which were attributed either to red tide or because of pollution, however, no detailed investigations of these events were made (Ilyas, 2013).

The mortality reported from Ormara (East Bay) during present study is attributed to bloom of *Noctiluca scintillans* (Macartney) Kofoid & Swezy, 1921 (Fig. 4). The concentration of *Noctiluca* were observed to be as high as 13 cells/ml. *Noctiluca* has been reported from Pakistan by Saifullah (1979), Chughtai and Saifullah (2006); Saifullah and Chaghtai (1990), Munir *et al*., (2013). In addition, Gomes*et al.* (2014) reported bloom of *Noctiluca* in the Arabian Sea resulting in hypoxia whereas Thibodeau *et al.*, (2014) reported *Noctiluca miliaris* in the Arabian Sea by locating it through an optical proxy approach. Dwivedi, *et al.* (2012) studied ecological consequence of the bloom (*Noctiluca miliaris*) in off shore waters of the Northern Arabian Sea. It is worth mentioning in none of these studies mortality of fishes was reported from Pakistan coast.

Fish mortality is, however, reported from Omani water because of red tides by Al-Azri *et al*., (2007), Al Busaidi, *et al.*(2008), Al Gheilani *et al.* (2011) and Piontkovski, *et al.* (2012) as well as from middle (Gulf of Oman) and outer (Arabian Sea) ROPME Sea Area (RSA) recorded for over a decade since 1987 (Thangaraja, *et al*. 2007). A number of studies have been undertaken on the discoloration of water, red tides and fish kills along Indian coast (Anantharaman, *et al*., 2010; Bhimachar and George, 1950; Devassy and Nair, 1987; Karunasagar, 1993; Karunasagar and Karunasagar, 1993; Karunasagar, *et al*., 1984, 1990, 1998; Naqvi, *et al.*, 1998; Parkash *et al.*, 2008; Venugopal, *et al.*, 1979).

Present study indicated that the mortality of fishes is not because of toxic bloom of *Noctiluca* or any other dinoflagellates. The mortality is because of the bloom of *Noctiluca* which cause hypoxia in the Ormara (East Bay). Gomes, *et al.* (2014) noted that massive outbreaks of *N. scintillans* during winter in the Arabian Sea resulted influx of oxygen deficient waters into the euphotic zone. In the present study, hypoxia is caused by very low dissolved oxygen levels which ranged between 0.27 and 2.76 ml/L.Elahi, *et al.* (2015) observed the dissolved oxygen along Balochistan coast ranged from 5.32 to 8.67! mg/L. Qari and Siddiqui (2006) recorded dissolved oxygen level at Paradise Point to between 5.33 to 9.61 ml/L whereas Qari and Khalid (2018) recorded comparatively low level of dissolved oxygen level in polluted area of Gwadar (East Bay) to be ranging between 1.7 to 2.84 mg/L. Extremely low dissolved oxygen observed in Ormara (East Bay) and this hypoxia resulted in the mortality of fish and shellfish in the area.

Okaichiand Nishio (1976) observed that the because of *Noctiluca miliaris* bloom ammonia contents to be varied from 6.6-68.9 mg NH3-N/g in Seto Inland Sea. They

attributed ichthyotoxicity to be closely related to ammonia contents in *N. miliaris* and concluded that most of the toxicity of *N. miliaris* was due to ammonia. During the present study, the ammonia level in the seawater could not be determined because of remoteness of the area and lack of analytical facilities.

Piontkovski *et al.,* (2012) reported 37 instances of *Noctiluca scintillans* blooms from Omani waters during 1988 and 2011; of these 6 were associated with fish kills. In some of the fish kills the dissolved oxygen level reached the critical concentrations (of about 1-2 mg l-1) and resulted in mortality of fish.Dwivedi, *et al.* (2012) reported bloom of *Noctiluca scintillans* from northern Arabian Sea. They noted that when decay of bloom occurs generally oxygen is consumed during the process of respiration and degeneration, however, they have not observed oxygen depletion to be not intense in the Northeastern Arabian Sea. They also observed that adverse effect of *Noctiluca* bloom in the Northwestern Arabian Sea may be because of increase of level of ammonia due to excretion of bloom organisms and degradation of *Noctiluca.*

Harrison *et al.,* (2011) reported two types of *Noctiluca scintillans;* green and red. Green *Noctiluca* is much more restricted to a temperature range of 25°C–30°C and mainly occurs in tropical waters of Southeast Asia, Bay of Bengal (east coast of India), in the eastern, western and northern Arabian Sea and Red Sea. They reported that the red and green *Noctiluca* do overlap in their distribution in the Arabian Sea with a seasonal shift from green *Noctiluca* in the cooler winter convective mixing, higher productivity season, to red *Noctiluca* in the more oligotrophic warmer summer season. No green discoloration was noticed during the present study and it seems that it was red *Noctiluca* (Fig. 5) which resulted in hypoxia leading to fish mortality.

In the light of the information gathered during the present study and review of the literature, it seems that *Noctilucascintillans* bloom which possibly developed offshore and moved into the shallow waters of Ormara (East Bay). Because of limited circulation in the Bay, the bloom concentrated in the southwestern part and resulted in hypoxia, as indicated by prevailing dissolved low oxygen in the area during the bloom which resulted in the mortality of demersal and small pelagic fish and shellfish of the Ormara (East Bay). There may be possibility of high ammonia concentration in the area because of degeneration of *Noctiluca* cells.

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