Red-tide of *Mesodinium rubrum* (Lohmann, 1908) in Indian waters

During the regular environmental monitoring exercise, discrete red-coloured patches were observed in coastal waters of the Bay of Bengal, off Gopalpur Port on 24 April 2014. Water samples from the discoloured zone were collected and transferred into two separate containers. One sample (1 litre) was preserved with acidic Lugol's iodine–formalin solution and the other sample (1 litre) was left as such without any treatment. The reason for taking live samples is that it is easier to observe/identify delicate structures/ organisms. They were brought to the laboratory for further analysis. The causative organism for the discolouration of water was identified as the pigmented ciliate *Mesodinium rubrum* (Lohmann, 1908), synonymous with *Myrionecta rubra* (Figure 1). Examination of live (Figure 1 *a* and *b*) and preserved sample (Figure 1 *c*) showed that the cells in the latter have deformed. Such deformation of cells of *Mesodinium* with the addition of preservative was reported earlier and the same could be ascribed as the major reason for not encountering this organism in preserved plankton collections during the analysis. The difference in colour of water in the bloom and non-bloom areas suggests that the occurrence of the present bloom along Gopalpur coast is due to the huge aggregation of *M. rubrum* cells in the surface layers of coastal water. This is also supported by lesser abundance of *M. rubrum* in the non-bloom areas. Occurrence of the bloom due to *M. rubrum* in this region of the Bay of Bengal along the coast has not been reported earlier. The surface water discolouration due to growth of *M. rubrum* has also not been reported from any part of the Indian coast. However, instances of algal blooms along this coast have been reported earlier due to blooming of the dinoflagellate species *Noctiluca scintillans*[1] and the diatom species *Asterionella glacialis* (=*Asterionellopsis glacialis*)[2], which were mainly attributed to the effect of local upwelling that created favourable conditions for rapid multiplication of these species.

M. rubrum is a common phototrophic planktonic ciliate that forms red-tides in estuaries, brackish water bodies and coastal waters in several parts of the world[3,4]. This species is ubiquitous in distribution and found almost all over the globe as an inhabitant in estuaries, fjords and upwelling areas of the coastal ocean[5]. Dense blooms of *M. rubrum* often result in non-toxic red-tides and are associated with extremely high rates of primary production[6,7]. The intense red colour of the blooms is the result of dense surface or subsurface aggregations (>10^4 cells ml^{-1}) of *M. rubrum* cells[3,5]. From nutrition point of view, the cells of *Mesodinium* remain as obligate mixotrophs depending upon cryptophycean as their prey, and under favourable conditions and other environmental situations grow as autotrophs[8]. In the present study, their population was in the order of 10^3 cells ml^{-1} and the colour was not intense as was observed in Columbia River estuary. The cells of this blooming species are highly motile, phototactic and contain several phycoerythrin-rich chloroplasts of cryptophyte algal origin that lead to water discolouration[5].

M. rubrum has been known to be conspecific with organisms previously described as *Halteria rubra* and *Cyclotrichium meunieri*[3]. *Mesodinium*-like cells that lack oral tentacles have been named as *Myrionecta*[9], which was later considered invalid[10]. The marine forms associated with water discolouration usually have tentacles and have been named as the genus *Mesodinium*[11]. This red-tide forming ciliate is oval with a belt of cilia and ranges from 10 to 70 µm in size[3]; it may show seasonal changes in cell volume[4]. The cell size of the present organism collected from Gopalpur coast also falls within this range being measured from 12 to 20 µm (Figure 1). Functionally, it is considered as a phytoplankter because the highly modified algal endosymbiont promotes photosynthetic function[6]. The species contains numerous functional chloroplasts associated with non-ciliate mitochondria[3] and the chloroplasts are of cryptophycean origin[5]. It has been hypothesized that the availability and type of cryptophyte prey is an important factor for bloom formation by *M. rubrum* and that the acquisition of several cryptophytes at once by its cells may be indicative of its ability to gather and concentrate cryptophytes from the environment[12].

It has been noticed that the toxic marine dinoflagellates belonging to genus *Dinophysis* Ehrenberg, which are obligate mixotrophs in marine environment, feed upon the ciliate *M. rubrum*[13]. So the abundance of *M. rubrum* in coastal waters off Gopalpur may trigger the blooming of such toxic species

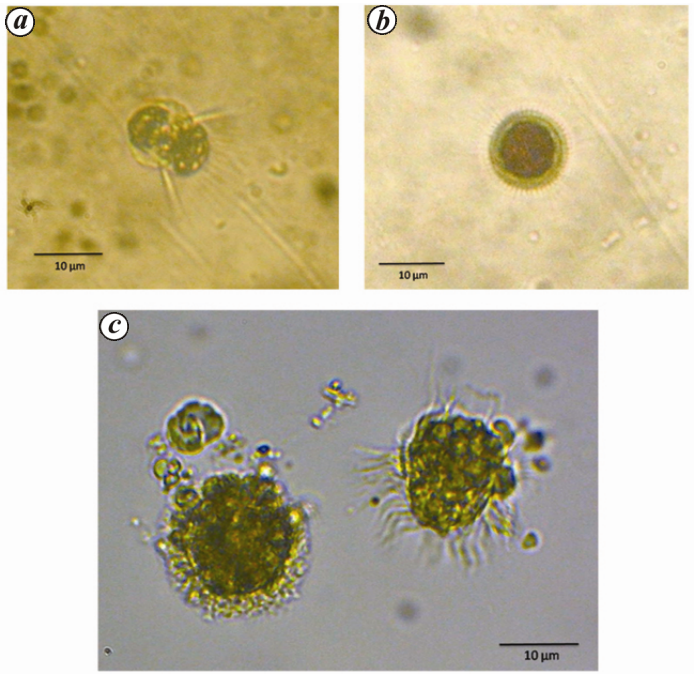

Figure 1. *Mesodinium rubrum*. ***a***, Lateral view; ***b***, apical view; ***c***, preserved sample.

(*Dinophysis* spp.), which form a component of harmful algal blooms.

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Karyotype of the Indian giant squirrel (*Ratufa indica*)

The Indian Giant squirrel syn. Malabar giant squirrel (*Ratufa indica*) is an upper-canopy dwelling mammal, endemic to southwestern, central and eastern peninsular India, found specifically in the Western Ghats, Satpuras and Eastern Ghats. It is seen at elevations of 180–2300 m and is widely distributed[1]. The species has been classified under the Class, Mammalia; Order, Rodentia; Suborder, Sciuromorpha; family, Sciuridae; subfamily, Ratufinae; Genus, Ratufa and species *Ratufa indica*[2]. According to the IUCN, ver 3.1, *R. indica* is classified under the 'Least Concern' category, but its population shows a decreasing trend due to habitat loss[3]. It is also listed under the Schedule II of the Indian Wildlife (Protection) act, 1972.

Karyotyping is an important source of genomic information from a species. Karyotype studies in wild species are confronted with difficulties. First, the habitats of wild animals are remote and away from lab facilities. Bone marrow cells and tissue samples for *in vitro* culture can be used only if available from fresh carcasses. Most often, the carcasses in the wild are noticed late after death and putrefied. Even if fresh, the cells extracted from bone marrow have to be processed immediately or transported within a very short duration. Other tissue samples have to be transported without exposure to extremes of temperature and under sterile conditions[4]. Whole blood in heparin is suitable in terms of handling, transport and maintenance of sterility, but collecting fresh blood from wild species is impractical. The procedures are

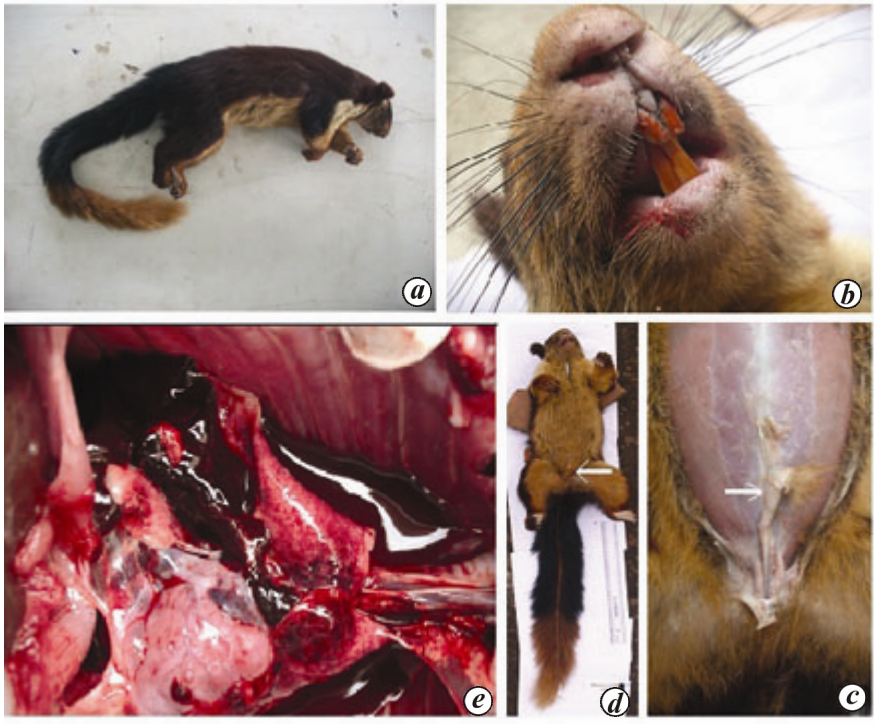

Figure 1. ***a***, Carcass of *Ratufa indica*; ***b***, Bleeding from mouth and nostrils; ***c***, ***d***, Arrows indicating male genitalia; ***e***, Unclotted blood in thoracic cavity.