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RESEARCH ARTICLE

Novel occurrence and relative abundance of fiddler crabs *Uca lactea, Uca rosea* and *Uca annulipes* at East coast of India

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Abstract

Fiddler crabs are common in the many parts of the globe. However no report has been found on the occurrence and relative abundance of fiddler crab species viz. *Uca annulipes*, *Uca lactea* and *Uca rosea* in the mudflat of Balasore, East coast of India. We studied the occurrence as total population and percentage relative abundance of individual species. Among these three species, *Uca lactea* was not found but only *Uca annulipes* and *Uca rosea* were recorded in control area. A moderately declining population of individual species and percentage relative abundance was recorded in experimental area may be due to high human interference and pollution load as an established fishing port, in comparison to control area. The present results indicate that the moderate occurrence of these three species may be a suitable tolerant indicator for pollution monitoring in the mudflat and may be used for bioremediation.

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Introduction

Fiddler crabs (genus Uca) are common in the intertidal mudflats and mangroves in tropical and subtropical regions (Crane, 1975). About 100 species have already been recognized for this genus (Crane, 1975; Beinlich and von Hagen, 2006; Ng et al., 2008). It is also the only large brachyuran genus in which a large proportion of the species have been studied phylogenetically (Rosenberg, 2001). Crane's (1975) milestone monograph on fiddler crabs revised in detail the taxonomy of Uca from the globe, and remains a landmark reference for all students of the group. Unfortunately, some of her names are junior synonyms of taxa, which Bott (1973) described only a few years earlier (von Hagen, 1976; Rosenberg, 2001; Beinlich and von Hagen, 2006) while Crane's classification is not always in line with modern systematic thinking, many of her groupings are still useful, as is her *Uca lactea* complex, "subspecies" under *U. lactea* (Crane, 1975, Shih et al., 2009), According to Shih et al. (1999), "Uca thalassuca" is equal to *Uca gelasimus* (left-handed taxa, except for *U. formosensis*), and *Uca afruca* for *U. tangeri* (Spivak and Cuesta, 2009), and Australian fiddler crabs as five species assemblages have recorded by George and Jones (1982). Crane (1975) substantially stabilized the taxonomy of Uca and only six species have been added since 1975: three from North America, one from South America and two from Australia (Rosenberg 2001); the latest new species being by von Hagen (1987).

Generally crabs are most predominant species in the mudflat of mangrove forests. They comprise about 80% of the macrofaunal biomass and can reach densities of 80-90 m^{-2}. The crabs depend directly on mudflats of mangrove areas

for survival, and leaves and litter feeding to form detritus, nutrient recycling and maintaining the dynamics of mangrove ecosystem. These crabs help to enhance aeration and capillary action in the soil of mudflat by their digging behavior (Soundarapandian et al., 2008). The diversity study of crabs are very scanty in Indian mangrove and mudflat ecosystem (Joel et al., 1985; Chakroborthy and Choudhury, 1992; Subramanian, 2000; Soundarapandian et al., 2008; Chowdhury et al., 2012) but very few studies have been carried out internationally with the other species of fiddler crab especially taxonomical features (Shih et al., 1999; Rosenberg 2001; Shih et al. 2010) and behavioural ecology (Koga et al., 1995; McLain et al., 2003; Ord and Martins, 2006; Muramatsu, 2010; Perez et al., 2012) and no one has attempted the occurrence and prevalence study of fiddler crab, *Uca lactea*, *Uca rosea* and *Uca annulipes* in the mudflat of river Burhabalanga and Subernarekha, Balasore, India and also it was studied that the presence of these three species in river Burhabalanga and two species Subernarekha have not yet reported earlier.

The present study aims to know the occurrence of fiddler crabs, *Uca lactea*, *Uca rosea* and *Uca annulipes* and to report their prevalence in the mudflat of river Burhabalanga and Subernarekha, Balasore, India.

MATERIALS AND METHODS

Study Area

The study areas were selected as per mudflat (latitude = 21° 28′ N and longitude = 87° 03′ E) is located at the bank of river Burhabalanga, Balasore, Odhissa, India as having high troller movement, maintenance and fish transportation by automobile vans as experimental area and another site (latitude = 21° 36′ N and longitude = 87° 27′ E) of river Subernarekha, Balasore, Odhissa, India as control area because of no above-mentioned interference. The study area is the eastern part of the Bay of Bengal, called as East coast. The both rivers finally meet to the Bay of Bengal. The satellite image is depicting the study area (Fig 1).

Field Study

The field study was carried out in the month of June 2014 and August 2014 (monsoon season) during low tide in the southern side of mudflat of river Burhabalanga as experimental site and river Subernarekha as control site. The study was done weekly twice for total eight days in a whole month. The study site was observed without mangroves but there were patches of Griha Sag (S*aeuda meritima*). The study site was selected of about $60m^2$ area for experimental and control area separately. The qualitative and quantitative assessment of fiddler crabs, *Uca lactea*, *Uca rosea* and *Uca annulipes* were recorded by random quadrant each measuring $1m^2$ size (Krebs, 1989). The quadrates were laid 15 times randomly on the mudflat and these three species were observed as per their burrow density as followed by the methods of Jones (1984). Identification was done by visual observation, image capture, and specimen collection in this study.

Statistical Interpretation by Relative Abundance

Relative Abundance (RA) for crab species in the study area was calculated using the following statistical formula (Stiling, 1999):

Relative abundance (Pi)

$Pi = Ni / N$

Where, Ni is the number of Individuals of a species, and N is total population of crabs.

RESULTS AND DISCUSSION

The present results clearly indicate that the fiddler crabs, *Uca lactea*, *Uca rosea* and *Uca annulipes* are very much abundant in numbers on the mudflat of Burhabalanga river bank (Fig 2 and 3). Three different species of fiddler crabs are documented in Fig 4, 5 and 6.

The occurrence of fiddler crab species as total population of individual species and percentage relative abundance were calculated. Interestingly, no other crab species were observed in this particular area except these three species of fiddler crabs.

Fig 2 show the cumulative data of *Uca lactea* for total population of 153 nos., 156 nos., 166 nos. and 170 nos. in 1st, 2nd, 3rd and 4th day respectively while in case of *Uca rosea*, total population of 95 nos., 97 nos., 100 nos. and

94 nos. in 1st, 2nd, 3rd and 4th day respectively. But in case of *Uca annulipes*, total population of 178 nos., 191 nos., 210 nos. and 230 nos. in 1st, 2nd, 3rd and 4th day respectively. For experimental site whereas in control area, no species of *Uca lactea* were observed but it was estimated the cumulative data for total population in case of *Uca annulipes* of 425 nos., 448 nos., 441 nos. and 438 nos. in 1st, 2nd, 3rd, and 4th day respectively while in case of *Uca rosea*, total population of 75 nos., 75 nos. 68 nos. 89 nos. in 1st, 2nd, 3rd and 4th day respectively.

Fig 3 show in the cumulative data of *Uca lactea* in percentage of relative abundance of 35.9, 35.1, 34.8 and 34.4 in 1st, 2nd, 3rd and 4th day respectively. The data were collected in two separate experiments. *Uca rosea*, total percentage of relative abundance of 22.3, 21.8, 21.0 and 19.0 in 1st, 2nd, 3rd and 4th day respectively. But in case of *Uca annulipes*, total percentage of relative abundance of 41.7, 43.0, 44.1 and 46.5 in 1st, 2nd, 3rd and 4th day respectively for experimental area. In control area, no species of *Uca lactea* was observed. In case of *Uca annulipes* the cumulative data for total percentage of relative abundance of 85.0, 85.6, 86.3 and 82.4 respectively and for *Uca rosea* of 15.0, 25.3, 13.3 and 17.6 respectively. Experiments were done in duplicate.

It was observed that total population was decreased by 230 and 170 nos for *Uca annulipes* and *Uca lactea* while increased by 100 nos for *Uca rosea*. The relative abundance values were highest as 46.5 for *Uca annulipes* followed by 35.9 for *Uca lactea* and lower as 22.3 for *Uca rosea* in experimental area, when compared with control group of population, no species of *Uca lactea* was observed but highest population was 448 nos for *Uca annulipes* while lowest as 89 nos for *Uca rosea*. The relative abundance values were highest as 86.3 for *Uca annulipes* and lowest as 25.3 for *Uca rosea* in control area (Fig 2 and 3).

In discussion, the present study investigates on abundance of fiddler crab *Uca annulipes*, *Uca lactea* and *Uca rosea* in the mudflat of Burhabalanga river (Fig 4 – 6). These three species of crabs belong to the family Ocypodidae. Generally crabs help in nutrient cycling, plant materials decaying and litter processing and also good accumulator of hydrocarbons, pesticides and other heavy metals (Burns, 1976). Soundarapandian et al. (2008) has reported that crab population is very high during monsoon season and the physico-chemical factors viz. low salinity, temperature, organic carbon etc. enhanced the abundance of crabs. The present results reveal that no other crab species were observed in this particular control and experimental area except these three species of fiddler crabs.

No report has been found yet for the occurrence of these three species in the mudflat of Burhabalanga river and two species in river Subernarekha, Balasore, India. In the Vellar estuary of south coast part of India, two species of fiddler crabs, *Uca lactea annulipes* and *Uca triangularis bengali* among other crab population have been recorded by Soundarapandian et al., (2008). Shih et al. (2009) have recognized genetic evidence of two fiddler crabs, *Uca iranica* and *U. albimana* from the northwestern Indian Ocean, with notes on the *U. lactea* species-complex.

It was also observed that these three fiddler crab species inhabited without mangrove but presence of patches of Griha Sag (S*aeuda meritima*). It is interesting to note that in the present findings, plant patches of S*aeuda meritima* majorly support one species of fiddler crab, *Uca lactea* in the experimental site. However both plants and crabs were absent in control site. The present results have similarities with other research works on *Uca pugnax* (Smith and Tyrrell, 2012), where salt marsh plant species like *Spartina alterniflora* and *Suaeda maritima* developed by the help of nutrient cycling of fiddler crab. There might be the chance of enhanced burrow digging by fiddler crabs when increasing rate of stress to the habitat occurred. This burrow digging activities may help nutrient cycling, which in turn supports germination of seeds of salt marsh plant species as reported by Alberti et al. 2011. Moreover these fiddler crabs also assist in enhancing aeration and capillary action in the soil of mudflat by their digging behavior (Soundarapandian et al., 2008). These three fiddler crab species were dominating in nature and may be stress tolerant. It was observed the inhabiting species were found near fish catching troller maintenance area. Among these three species, *Uca rosea* may be stress tolerant and might have potent detoxifying mechanisms but the population of *Uca annulipes* decreased when compared to control group of population. Subramanian (2000) has also observed that the population of crab species decreased due to stress of water pollution by aquaculture practice near mangrove ecosystem. According Chowdhury et al. (2012), fiddler crabs' diversity and abundance are depending upon physical structure of soil, which indicates the higher energy domain for these fiddler crabs. It was reported that the Sundarban delta is mostly made up of mudflat and the soil is mainly clayey in nature (clayey haploquepts) and the population of *Uca rosea* has been reported higher while the present study area indicates less abundance of *Uca rosea* may be due to prevalence of silty soil both the area (Sanyal, 2009). In other words, the declining population of two fiddler crab species in experimental area compared to control area may be due to the oil and presence of other pollutants, which an evidence of other research works on hydrocarbon sensitivity on the other species of fiddler crab, *Uca pugnax* to metabolize foreign hydrocarbons partially accounts for its sensitivity to oil pollution in the environment (Burns,

1976). It has already been documented that chemical contaminants can drastically reduce populations of fiddler crabs in the marsh (Krebs et al., 1974). Meanwhile the occurrence and abundance of three species at experimental area may indicate the sensitivity of hydrocarbons, pesticides and other heavy metals as biosensor (Krebs et al., 1974; Burns, 1976) and might have the capacity to accumulate and detoxify hydrocarbon like other marine animals and arthropods as biofilter by their moderate abundance in experimental area instead of vanishing population (Page et al., 2005; Crane et al., 2008).

It was observed that mudflat of experimental site harbours many fish catching trollers for their maintenance and continuous movements of vehicles for fish transportation in comparison to control area. The soil contains black patches of oil and grease as visually observed while in control area few boats were observed for transport of the tourists and no maintenance was observed. This is a preliminary study of particular fiddler crab species occurrence and abundance in the mudflat of Burhabalanga river compared with Subernarekha river, Balasore, India. Further researches must be relevant in relation to biochemical and genetic level with the physico-chemical factors and stress tolerant detoxification mechanism. These three species can be used in oil accumulating mechanisms and potent hydrocarbon removal from soil and water as in bioremediation technique because marine animals exposed to PAHs may passively or actively release accumulated hydrocarbons back to the environment as ambient levels of PAH decline (Page et al., 2005).

Fig 1. Satellite image of the study area: A = Experimental site and B= Control site (Source: Google earth image)

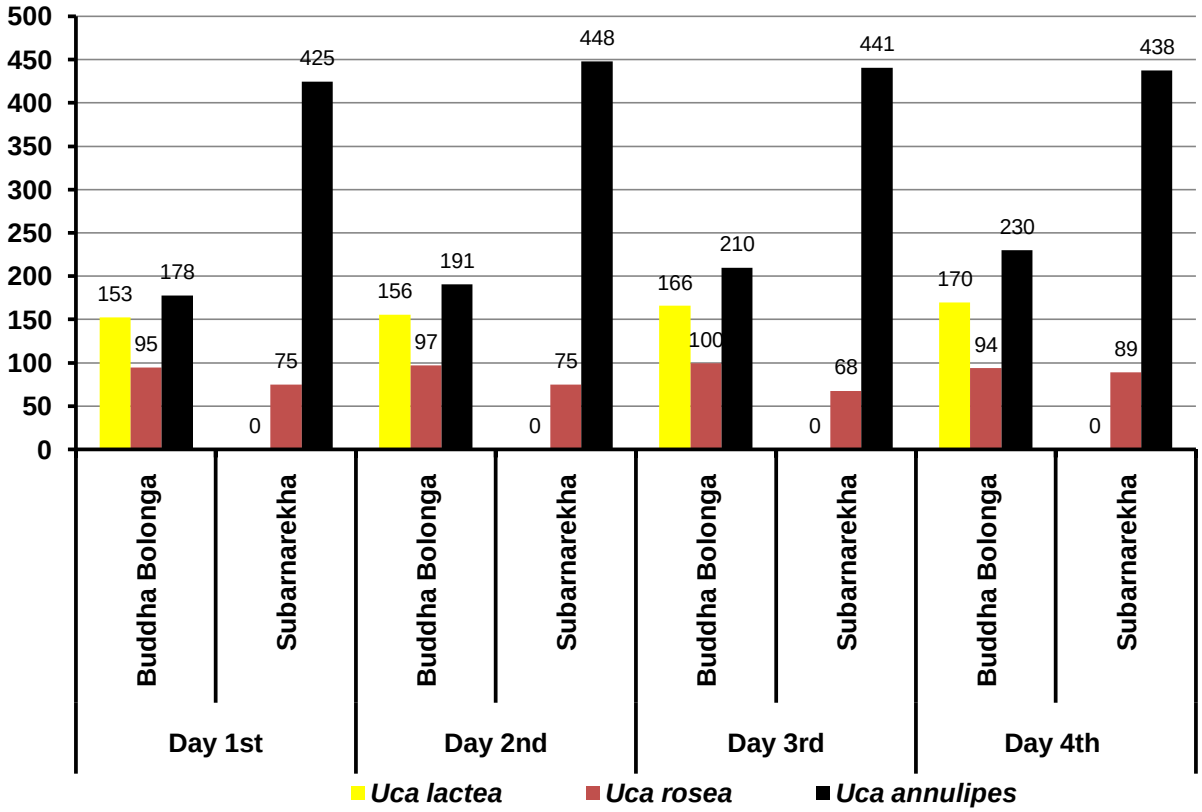

Fig 2. Graphical representation of total population between three fiddler crab species

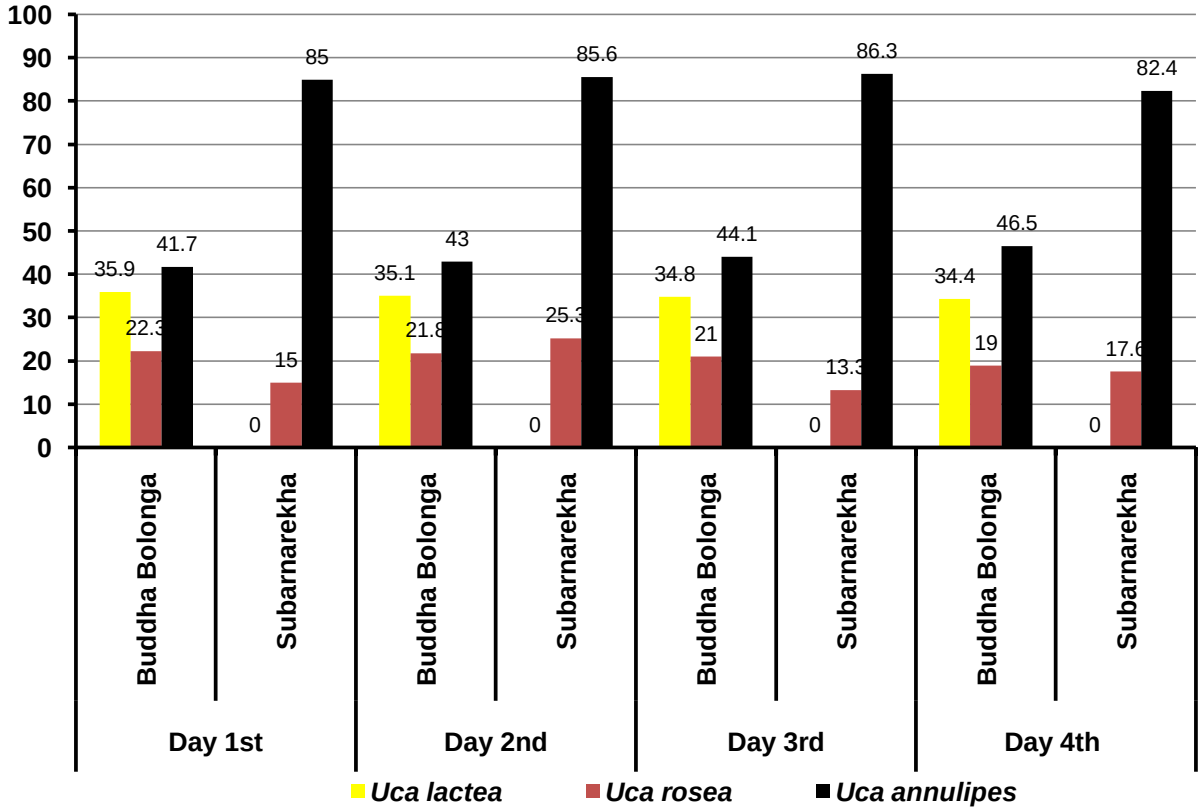

Fig 3. Graphical representation of total percentage of relative abundance between three fiddler crab species

Fig 4. Fiddler crab species *Uca lactea*: A= Dorsal view; B= Enlarge view of Cheliped; C= Ventral view

Fig 5. Fiddler crab species *Uca rosea*: A= Dorsal view; B= Closer view; C= Two Chelipeds; D= Enlarge view of Cheliped; E= Ventral view

Fig 6. Fiddler crab species *Uca annulipes*: A= Anterior view; B= Dorso-posterior view

CONCLUSION

In conclusion, the data indicate that the moderately declining population numbers and relative abundance of *Uca annulipes* followed by *Uca rosea* in Burhabalanga river, Balasore when compared to control area in river Subernarekha. We hypothesize the population study at experimental area may be a suitable tolerant indicator for monitoring the soil and effluent quality in the mudflat, therefore confirming the potential of this unreported taxonomic group in this particular geographical area. This is a preliminary observation after long term searching of these three species, to know the occurrence and abundance of fiddler crabs because no one has reported earlier in this geographical area. Further study might be relevant in relation to biochemical and genetic level study alongwith the physico-chemical properties of their habitat and stress tolerant detoxification mechanisms after exposure of oil and grease as well as antifouling paints in water and/or soil samples as the potent technique of bioremediation. These three fiddler crab species can be used in oil and grease breakdown mechanisms as well as potent hydrocarbon removal from soil and water as per work done by Crane et al. (2008) and Page et al. (2005).

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