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Planktonic copepods from coastal and inshore waters of Tudor Creek, Mombasa

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SUMMARY

Fifty two free swimming planktonic copepod species were identified from the samples collected from three stations in Tudor Creek. This appears to be the first systematic account of copepods reported from the coastal and inshore waters of Kenya.

INTRODUCTION

Zooplankton is a source of food for many species which themselves serve as a basis for the artisanal fishery well known in East Africa. To understand the secondary and tertiary productivity, it is desirable that the systematics of the zooplankton is known. As copepods are quantitatively the most important group, research on this taxon is particularly significant. Although much work has been done in South Africa and in the Red Sea, the copepod fauna of East Africa is not well known, except for the work of Sewell (1929, 1932, 1947, 1948), and Smith and Lane (1981), who worked in the western Indian Ocean, but did not include creek waters. Wickstead (1965, 1968) reported on tropical plankton, while Okera (1974) reported on the zooplankton of the inshore waters of Tanzania.

Reay and Kimaro (1984) reported on the zooplankton from Tudor Creek. This study demonstrated the possibility of seasonal, lunar and tidal influences on the abundance and composition of zooplankton at the mouth of Tudor Creek. Apart from that no attempt has been made to study the marine copepod fauna in Kenya. The taxonomy of the free-swimming copepods of Kenya will also contribute to the knowledge of the zoogeography of this group.

MATERIALS AND METHODS

Study area

The coastline of East Africa comprises of fringing reef and tidal mangrove creeks. Tudor Creek is a tidal mangrove creek a short distance from Mombasa Port (fig 1). The three stations were chosen to represent creek mouth, creek channel and inner creek waters.

Tidal exchange in Tudor Creek is considerable and a tidal range of 4.0 m was recorded during a spring tide at Mombasa Port (Brakel 1982). The residence time for water in the creek is not yet known.

The temperature range during the study period was greatest in the upper estuary and varied between 30.0°C in December 1984 and 29.5°C in March 1985. In the mouth of the estuary temperatures varied between 29.0°C and 28.0°C. Depth at station 1 was 40 m and decreased gradually to 5m at station 3. Turbidity (measured as secchi depth) decreased from station 1 to station 3.

Salinities recorded at station 1 were constantly high and did not drop below 35 parts per thousand (figure 2). In the upper estuary and middle channel salinities were also high and varied between 34.5 and 30.0 parts per thousand. During the study period rainfall was below average.

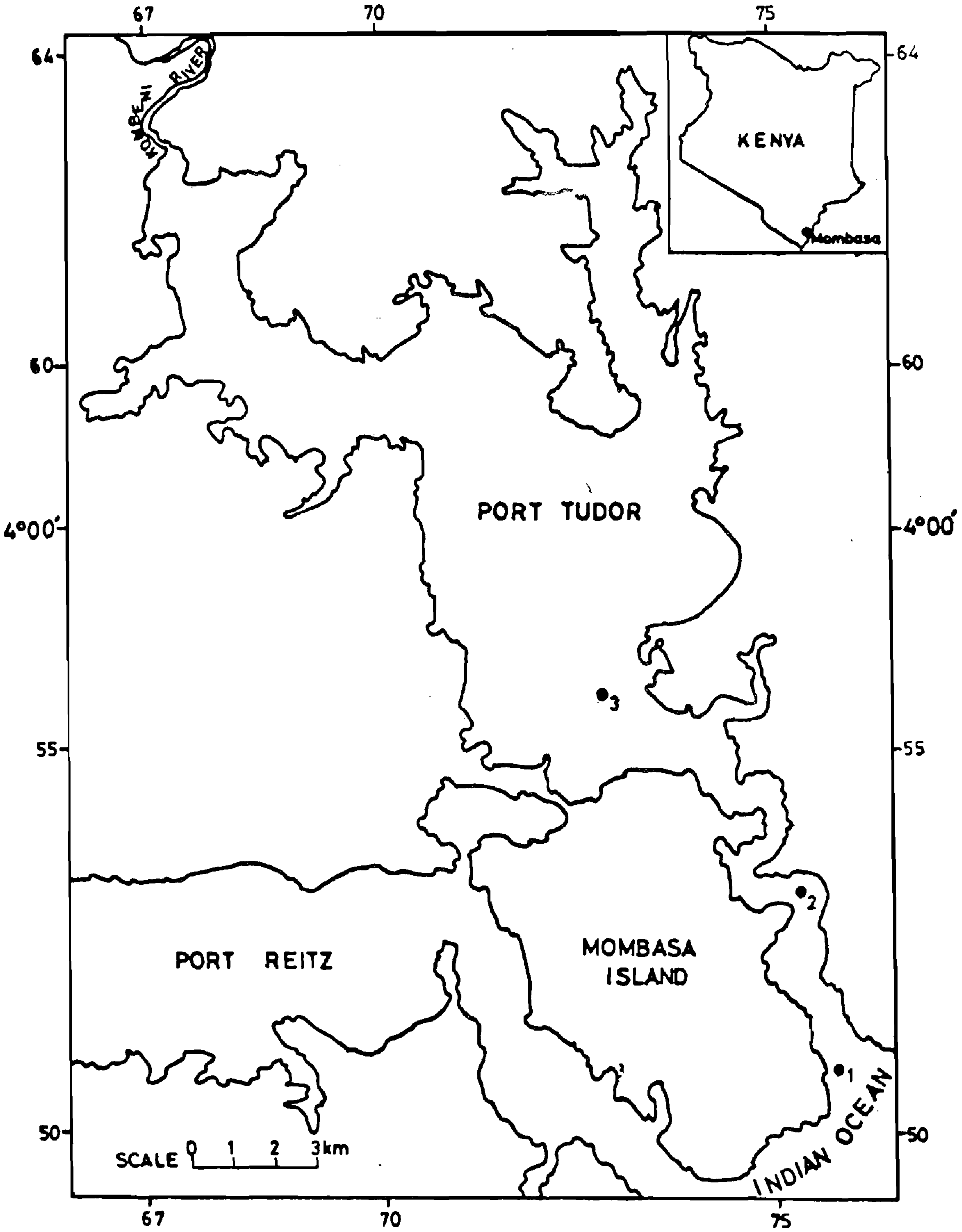

Figure 1: Map of Port Tudor showing sampling stations.

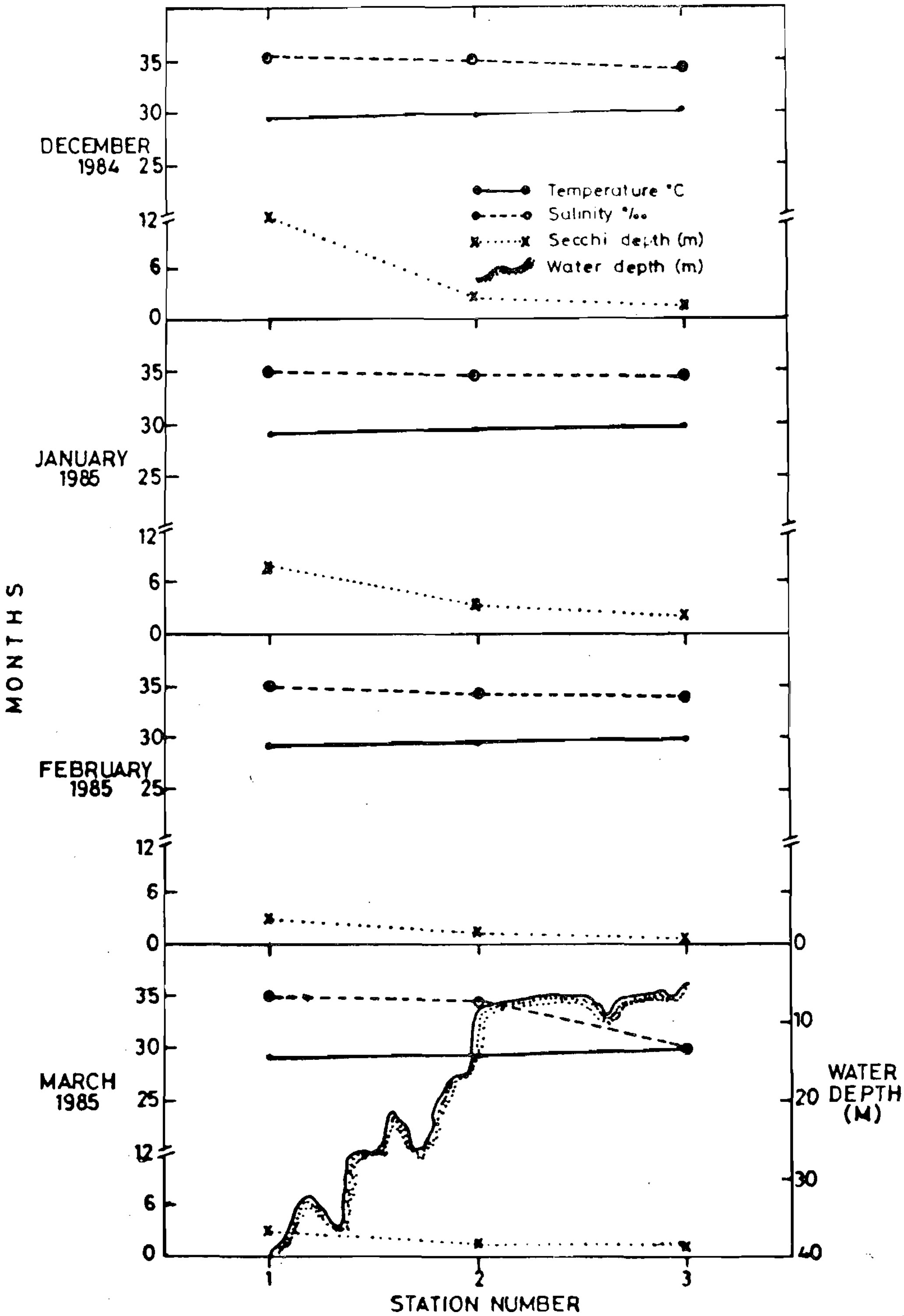

Figure 2: Changes in depth, turbidity (measured as secchi depth), mean surface temperature and salinity recorded on Tudor Creek December 1984-March 1985. Station 1 is the Creek mouth. Station 2 is the Creek channel and Station 3 is the uppermost station on the estuary.

Methods

The samples were obtained using a Bongo net fitted with a flow meter towed at 4.0m S^{-1} for 15 minutes from a research vessel with a 210 hp diesel-powered engine. The Bongo towing frame was fitted with two cylindrical-conical nets (Mesh diameters 335 μm and 500 μm), each 0.6 m in diameter, connected by a central yoke to which the towing wire is attached. All the tows were horizontal to the surface and samples were taken at a mean depth of 1.4 m. The sample was immediately stored in a 5% formalin solution. Samples from 335 μm net were analysed. Samples were taken only during day time, twice a month, between neap and spring tides. The work reported here covers the period between December 1984 and March 1985, the project is still in progress.

Laboratory Methods

The samples were passed through a 42 μm mesh sieve and the residue were placed in the petri dishes. The sub-samples were then sorted out under a binocular microscope and copepods were put separately in the petri dishes.

The copepods were identified to species level by dissecting the animal and drawing the antennae, antennules, mouth parts, thoracopods and furca. The keys and reference books by Giesbrecht (1892), Sars (1901), Scott (1909), Hulsemann (1965), Brodsky (1967), Sewell (1929, 1932, 1947 and 1948), Rose (1933), Bradford (1972), Decker De (1964), Wells (1976), Green Wood (1979), Owre and Foyo (1967), Frost and Fleminger (1968), and Fleminger (1973) were used.

RESULTS AND DISCUSSIONS

A total of 96 net tows were taken during the study period, comprising 8 hauls per month at each station. The zooplankton is rich and abundant in the creek. Copepods were dominant and present in all stations sampled (table 1). From all stations, 52 species were identified. Forty one species were found at station 1, and 30 of those were specific to this station. In station 2, 20 species were found of which 7 were specific. In station 3 only 6 species were found, of which 2 were specific to the station and this supports the gradient

Table 1. Classified copepod species and their occurrence in three stations of Tudor Creek, Mombasa

Species	Station 1	Station 2	Station 3
CALANOIDA			
Fam. Calanidae Dana 1853			
Canthocalanus pauper (Giesbrecht 1888)	X	X	X
Undinula vulgaris (Decna 1849)	X	X	...
Fam. Eucalanidae Giesbrecht 1892			
Eucalanus spp.	X	X	...
Rhincalanus cornutus (Dana 1849)	X	X	...
Fam. Parcalanidae Giesbrecht 1892			
Acrocalanus longicornis Giesbrecht 1888	X	X	...
Paracalanus aculeatus Giesbrecht 1892	X	X	...
Fam. Pseudocalinidae Sars 1902			
Clausocalanus farrani Sewell 1929	...	X	...
Fam. Euchaetidae Sabs 1902			
Euchaeta marina (Prestandra 1933)	X	...	...
Euchaeta pubera Sars 1907	X	...	...
Euchaeta tenuis Esterly 1906	X	...	...
Fam. Scolecithricidae Sars 1902			
Scolecithrix danae (Lubbock 1856)	...	X	...

Species	Station 1	Station 2	Station 3
Fam . Temoridae Sars 1902			
Temora discaudata Giesbrecht 1888	X	...	...
Temóra stylifera Dana 1849	X	...	...
Temora turbinata Dana 1849	X	...	...
Fam. Metriidae			
Pleuromamma indica Wolfenden 1905	X	...	...
Pleuromamma piseki Farra 1929	X	...	...
Fam. Centropagidae Giesbrecht 1892			
Centropages brachiatus Dana 1849	X	...	...
Centropages furcatus Dana 1849	X	X	...
Centropages gracilis Dana 1849	X	...	...
Centropages orsinii Giesbrecht 1892	X	...	...
Fam. Lucicutiidae Sars 1902			
Lucicutia flavicornis (Claus 1863)	X	...	...
Fam. Candaciidae Giesbrecht 1892			
Candacia bispinosa Claus 1863	...	X	...
Candacia catula Giesbrecht 1892	...	X	...
Candacia longimana Claus 1863	X	...	...
Candacia magna Sewell 1912	X	...	...
Candacia pachydactyla Dana 1848	X	...	...
Candacia simplex Giesbrecht 1892	X	...	...
Fam. Pontellidae Sars 1902			
Calanopia elliptica Dana 1849	X	X	...
Labidocera acuta Giesbrecht 1892	...	...	X
Labidocera detruncatum Dana 1914	...	X	X
Labidocera kroyeri Brady 1883	...	X	X
Labidocera minuta Giesbrecht 1892	...	...	...
Pontellina plumata Dana 1848	X	...	...
Pontellopsis herdmani Thompson & Scott 1903	...	X	...
Fam. Acartia Sars 1903			
Acartia danae Giesbrecht 1889	X	...	...
Acartia bispinosa Carl 1907	X	X	X
Fam. Tortanidae Sars 1902			
Tortanus barbatus (Brady 1883)	...	...	X
POECILOSTOMATOIDA			
Fam. Corycaeidae Claus 1863			
Corycaeus spp.	X	X	...
Fam. Oncaeididae Giesbrecht 1892			
Oncaea mediterranea Claus 1863	X	...	...
Oncaea venusta Phillipi 1843	X	...	...
Fam. Sapphirinidae Thorell 1859			
Copilia mirabilis Dana 1849	X	X	...
Copilia quadrata Dana 1849	X	...	...
Sapphirina auritens Claus 1863-sinuicauda Brady 1883	X	...	...
Sapphirina nigromaculata Calus 1863	X	...	...
Sapphirina ovatolanceolata Dana 1849-gemma Dana 1849	X	...	...

Species	Station 1	Station 2	Station 3
Fam. Clausidiidae Embleton 1901			
Saphirella tropica Wolfenden 1905	X	...	...
CYCLOPOIDA			
Fam. Oithonidae Sars 1913			
Oithona plumifera Baird 1843	X	...	...
Oithona setigera Dana 1849	X	...	...
HARPACTICOIDA			
Fam. Ectinosomatidae Moore 1878			
Microsetella rosea Dana 1849	...	X	...
Fam. Miracidae Dana 1846			
Macrosetella gracilis Dana 1849	...	X	...
Fam. Tachidiidae Sars 1909			
Euterpina acutifrons (Dana 1849)	X	...	...
Fam. Harpacticidae Dana 1846			
Harpacticella spp.	X	...	...
MONSTRILLOIDA			
Fam. Monstrillidae Sars 1911	X	...	...

hypothesis. Apparently, there exists a gradient in diversity and each station has a more or less characteristic copepod fauna. Species diversity is directly related to the number of species unique to the station. A number of species were represented by only one individual, suggesting that such species were present; but undetected at another station.

Information on the abiotic environment from the series of stations in Tudor Creek is given in figure 2. These demonstrated increasing temperature and turbidity, and decreasing water depth, from the mouth to the uppermost stations of the creek, with salinity remaining more or less constant.

Throughout the study period (December 1984-March 1985) temperature fluctuation of almost 3°C can be associated with a gradient of decreasing depth and the relative movement of 'creek' and 'coastal' waters in relation to the tides. The implication is that the abiotic characteristics at any of the three stations in the system is faced with a complex state of flux in relation to tidal movement. Therefore, depending on the extent to which copepods are affected by the variations in abiotic factors observed, then this state of flux is also likely to apply to their diversity and abundance. An ecological gradient observed in Tudor Creek can be related to the observed gradients of increasing temperature, decreasing depth and turbidity from the mouth inwards. It is interesting to observe that the diversity was high in station 1 and low in station 3.

Okera (1974) reported the presence in the inshore waters of Dar-es-Salaam, Tanzania, of *Rhincalanus cornutus, Acartia danae, Centro-pages gracilis* and *Temora discaudata.* Apparently there is a higher diversity in the Mombasa water than in Dar-es-Salaam waters. This may be attributed to the productivity of the areas. Ryther et al. (1966) mapped the western Indian Ocean and showed Mombasa to have a productivity of more than 1.00 g $C/m^2/day$. Since there is insufficient data on abiotic parameters, it is difficult to make definite conclusions. Plankton distribution can vary greatly over very small distances: it has a very "patchy" distribution. Their distribution varies considerably with depth and time.

Smith and Lane (1981) reported the occurence and distribution of *Paracalanus aculeatus, Acartia danae, Clausocalanus* *farrani, Centropages furcatus, Scolecithrix danae, Canthocalanus, Pleuromamma piseki, Pleuromamma indica, Rhincalanus cornutus* and *Macrosetella gracilis* in offshore waters of Somalia in the Indian Ocean. The copepod fauna at station 1 can be regarded as oceanic as defined by Smith and Lane (1981), and Sewell (1947, 1948). The species found by Smith and Lane (1981) and Okera (1974) were also found in the present study.

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REFERENCES

Bradford, J.M., (1972). Systematics and ecology of New Zealand central east coast plankton sampled at Kaikoura. *Bull. N.Z. Dept. Scient. Ind. Res.* 207: 1-89.

Brakel, W.H. (1982). Tidal patterns on the East African Coast and their implications for the littoral biota. UNESCO/ALESKO *Symposium on the Coastal and Marine Environment of the Red Sea, Gulf of Aden & Trop. Western Indian Ocean.* The Red Sea and Gulf of Aden Environmental Programme, Jeddah: Vol. 2, pp. 403-418.

Brodsky, K.A., 1950 (1967). Calanoida of the far eastern and polar seas of the USSR. Zool. Inst. Acad. Sci. of the USSR, Fauna no 35: 37-87.

Decker De, A., 1964. Observations on the Ecology and distribution of Copepoda in the Marine Plankton of South Africa. Invest. Rep. Div. Sea Fish. South., 51: 1-67.

Fleminger, A. (1973). Pattern, number, variability and taxonomic significance of integumental organs (sensilla and glandular pores) in the genus Eucalanus (Copepoda, Calanoida). *Fish Bull.* 71: 965-1010.

Frost, B. and Fleminger, A. (1968). A revision of the genus Clausocalanus (Copepoda, Calanoida) with remarks on the distribution patterns in diagnostic characters. *Bull. Scripps Inst. Oceanogr.* 12: 1-235.

Giesbrecht, W. (1892). Systematik and Faunistik der pelagischen Copepoden des Golfes von Naepal und der angrenzenden meeresabschnitte. Fauna und flaura des Golfes von Naepal 19: 1-830.

Greenwood, J.G., 1979. Calanoid Copepods of Moreton Bay (Queensland). IV. Family Pontellidae. Proc. R. Soc. Qd., 89: 1-21.

Grice, G.D., 1964. Two new species of Calanoid Copepods from the Galapagos Islands, with remarks on the identity of three other species. Crustacae, 6: 255-264.

Hulsemann, K. 1965. A revision of the genus Lucicutia (Copepoda, Calanoida) with a key to its species. Bull. Mar. Sci., 16: 702-747.

Okera, W. (1974). The zooplankton of the inshore waters of Dar-es-Salaam (Tanzania, S.E. Africa) with observations on reactions to artificial light. *Mar. Biol.* 26: 13-25.

Owre, H.B. and Foyo, M. (1967). Copepods of the Florida current. *Fauna Caribbea* 1: 1-137.

Reay, P.J. and Kimaro, M.M. (1984). Surface zooplankton studies in Port Mombasa during the north east monsoon. *Kenya Journal of Science and Technology Series B* 5: 27-48.

Rose, M. (1933). Copepodes pelagiques. *Faune de France* 26: 1-374. Paris: Lechevalier.

Ryther, J.H., Hall, J.R. Pease, A.K., Bakun, A. and Jones, M.M. (1966). Primary organic production in relation to chemistry and hydrography of the western Indian Ocean. *Limnol. Oceanogr.* 2: 371-380.

Sars, G.O., (1901). *Copepoda Calanoida. An Account of the Crustacea of Norway,* 4: 1-28.

Sewell, R.B.S. (1929). The copepoda of Indian seas. Calanoida. *Mem. Indian Mus.* 10: 1-221.

——— (1932). The copepoda of Indian seas. Calanoida. *Mem.Indian Mus.* 10: 223-407.

——— (1947). The free-swimming planktonic Copepoda. Systematic account. *Sci. Rep. Murray Exped.* 8: 1-303.

——— (1948). The free-swimming planktonic Copepoda. Geographical distribution. *Sci. Rep. Murray Exped.* 3: 317-592.

Smith, S.L. and Lane, P.V.Z. (1981). *Biological oceanography of the Somali current data report.* Informal data report no 29098 Upton, N.Y., Brookhaven National Laboratory, 126p.

Wickstead, J.H. (1965). An introduction to the study of tropical plankton. London; Hutchinson and Co., 160p.

——— (1968). Temperate and tropical plankton; a quantitive comparison. *J. Zool. London* 155: 253-269.

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