



LATE QUATERNARY RECORD OF BULIMINIDS FROM THE EASTERN ARABIAN SEA (OFF GOA) AND ITS SIGNIFICANCE IN PALAEOCEANOGRAPHIC RECONSTRUCTION

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ABSTRACT

Benthic foraminiferal assemblages of closely spaced samples of a 9.65 m long sediment core retrieved from 1230 m water depth off Goa were analysed both qualitatively and quantitatively. The buliminid group, which is considered to be sensitive to ocean bottom environment represents a quantitatively most important component of the benthic population in the examined samples. All eight recorded species constituting the buliminid group are briefly described and illustrated. The down-core distribution pattern of total buliminids shows major fluctuations on millennial scale in the last 70 kyr. Based on the modern ecological data of buliminid taxa encountered in this investigation, it is suggested that the temporal variation in buliminids is associated with the variation in surface primary productivity and dissolved oxygen level. However, sensitive response of individual taxa to changes in these oceanographic parameters is variable.

Keywords: Benthic foraminifera, buliminids, palaeoceanography, Arabian Sea

INTRODUCTION

Benthic foraminifera have long been recognised for their potential use in reconstructing history of past changes in various oceanographic parameters mainly water mass properties, dissolved oxygen content, trophic condition on the ocean floor and bathymetry. Several studies have suggested the deep sea benthic foraminiferal assemblages to be correlated to the water mass characteristics (such as temperature, salinity, oxygen content, nutrients and carbonate saturation), rather than to the regional water depth (e.g. Streeter, 1973; Schnitker, 1974; Schroder, 1974; Culver and Buzas, 1981, 1982; Petersen, 1984; Hermelin and Shimmield, 1990; Jorissen *et al.*, 2007). Previous studies on benthic foraminiferal assemblages of the continental slope environments revealed bottom water oxygen condition and sedimentary organic matter flux are the important factors controlling the composition of benthic foraminifera (e.g. Douglas and Heitman, 1979; Van der Zwaan, 1982; Lutze and Coulbourn, 1984; Bernhard, 1986; Altenbach and Sarnthein, 1989; Loubere, 1991; Gooday, 1994; Cannariato and Kennett, 1999; Altenbach *et al.*, 1999, 2003). Since the early 1990's much progress has been made in benthic foraminiferal ecology and it has become increasingly clear that oxygen and food supply are the main factors controlling the spatial and in-sediment distribution of benthic foraminifera in open ocean environment (Bernhard, 1989; Bernhard and Reimers, 1991; Sen Gupta and Machain-Castillo, 1993; Loubere *et al.*, 1993; Alve, 1994; Gooday, 1994; Rathburn and Corliss, 1994; Loubere, 1996; Jorissen *et al.*, 1992, 1995, 1998, 2007; Altenbach *et al.*, 1999, 2003; Levin *et al.*, 2001, Gooday and Hughes, 2002). In recent years, attempts have been made to investigate the temporal variation of benthic foraminiferal assemblages in order to reconstruct history of pattern variability of the monsoon induced productivity, Oxygen Minimum Zone (OMZ) intensity and deep water circulation in the Arabian Sea (Hermelin and Shimmield, 1995; Von Rad *et al.*, 1999; den Dulk *et al.*, 1998, 2000; Kurbjewitz *et al.*, 2000; Schmiedl and Leuschner, 2005), the Gulf of Aden (Locke and

Thunell, 1988) and the Red Sea (Almogi-Labin *et al.*, 2000). The previous benthic foraminiferal investigations in the Arabian Sea were based on the sediment cores from the western and northern regions. Little is known about deep benthic foraminiferal assemblages in the sediment records from the western continental slope of India (eastern Arabian Sea). Previous studies were focused mainly to the near-shore and shelf regions (Nigam, 1888, 1993; Nigam *et al.*, 1992; Khare *et al.*, 1995; Nigam and Khare, 1999; Singh *et al.*, 2007).

We carried out detailed qualitative and quantitative analyses of benthic foraminiferal assemblages of closely spaced samples of dated sediment core (MD76-131) from the central part of the upper continental slope of India (Ivanochko, 2004). This paper presents the high resolution late Quaternary record of buliminids, the dominant constituent of the benthic foraminiferal assemblages in the examined sediment core. The buliminids are considered to be sensitive to changes in ocean bottom environment, mainly flux of organic matter to the sediment and oxygen condition. The present study also evaluates the applicability of this microfaunal group in reconstruction of the paleoceanography of the eastern Arabian Sea.

CORE LOCATION AND OCEANOGRAPHIC SETTING

A 9.65 m long piston core (MD76-131) was raised from 1230 m water depth of central part of the western Indian margin (off Goa: Lat 15° 31.8' N; Long 72° 34.1' E) by R/V Marion Dufrense in 1976 (Fig.1). The core site is situated at the base of the present day oxygen minimum zone (OMZ) situated between 150 and 1250 m water depth. The sediment core in general is characterised by dark coloured indistinctly laminated sediments with intermittently light coloured homogenous facies. The narrow homogenous intervals are lithologically in sharp contact with the laminated strata. The core provides an uninterrupted sedimentary sequence (commonly hemi-pelagic mud), free of turbiditic (or mass flow) deposition and reworking. The core was sampled at 1 to 2 cm intervals. In this work,

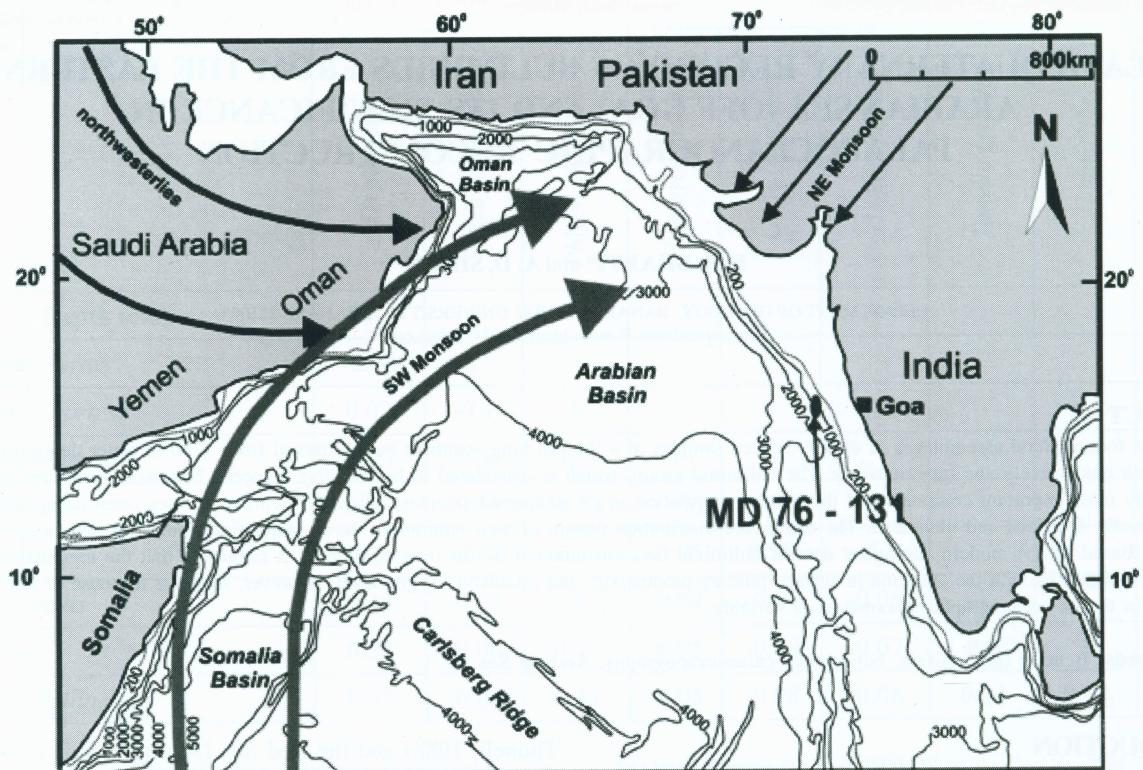


Fig. 2. Down-core variations in relative abundances of total Buliminids, *B. aculeata*, *B. costata* and *B. alazanensis* ($>125 \mu\text{m}$). Shaded intervals showing high productivity and low oxygen condition. MIS 1-4 represent the Marine Isotope Stages. Age model of the core is after Ivanochko (2004).

samples from 2 to 4 cm intervals were used. Benthic foraminiferal assemblages of a total of 332 samples were analysed both qualitatively and quantitatively.

For separation of foraminiferal tests, sediment samples were processed following the conventional micropaleontological techniques. About 5 g of dried sediment of each sample was soaked in 5% Hydrogen Peroxide solution for twelve hours and boiled for 2-3 minutes before wet screening. Samples were washed over a 63 μm screen. Dry residues larger than 63 μm were sieved again over a 125 μm screen. Following previous benthic foraminiferal studies in the Indo – Pacific Ocean (Herguera and Berger, 1991; Caralp *et al.*, 1993; Miao and Thunell, 1993, 1996; Naidu and Malmgren, 1995; Rathburn and Miao, 1995; den Dulk *et al.*, 1998, 2000; Almogi- Labin *et al.*, 2000), the coarse fraction ($>125 \mu\text{m}$) was used in the present study. For qualitative and quantitative benthic foraminiferal analyses, the processed samples were split using the Otto – Splitter to yield subsamples containing approximately 300 tests of benthic foraminifera. Specimens were identified and counted under a stereozoom binocular microscope (Wild M3Z). A detailed study of shell surface ultrastructures of benthic foraminiferal has been carried out with the Scanning Electron Microscope. The SEM study has enabled to confirm the identification of microfaunal taxa. For the identification and classification, species concepts proposed by Schwager (1877) revised by Srinivasan and Sharma (1980), Brady (1884) revised by Barker (1960), Le Roy (1941 and 1944), Hornbrook (1961), Belford (1966) and Loeblich and Tappan (1988, 1992) were mainly followed. A high – resolution chronological framework developed for the core MD76-131 by Ivanochko (2004) was adopted in this investigation.

Surface circulation and hydrography in the eastern Arabian Sea (EAS) are driven by the seasonal monsoon winds. During the summer monsoon season, the West Indian Coastal Current (WICC) flows southward along the eastern margin of the Arabian Sea. Weak upwelling occurs along the southwest coast of India during this season (Wyrtki, 1973). Excess of precipitation over evaporation and heavy runoff from the Western Ghats in the summer season creates a distinct low salinity plume in the offshore region south of 20°N. During the winter monsoon, the WICC reverses and the Northeast Monsoon Current (NMC) transports waters from the Bay of Bengal (BOB) into the eastern Arabian Sea. The influence of BOB low salinity water in the eastern Arabian Sea is most prevalent up to 13°N (Sarma, 2002). The strong northeasterly winds in winter cause upwelling (though weak) and vertical mixing offshore India north of 15°N (Bauer *et al.*, 1991; Madhupratap *et al.*, 1996). Strong northeasterly winds during winter monsoon season invoke deep mixing across the thermocline resulting high surface productivity in areas offshore India and Pakistan (Madhupratap *et al.*, 1996). High biological productivity results in severe oxygen depletion in intermediate waters at 150-1250 m water depth (Wyrtki, 1973).

RESULTS AND DISCUSSION

The benthic foraminiferal assemblages of core MD76-131 are composed mainly of the buliminids, cassidulinids, uvigerinids, cibicids, miliolids and fursenkoinids and other taxa (in decreasing order of relative abundance). The buliminids are the most dominant constituent of benthic assemblages in the examined core, and account for an average of 25% of benthic population in the examined core. The percentage abundance of this microfaunal group varies between a minimum of 1.7%

and a maximum of 73% (Appendix I). Species of the buliminid population are *Bulimina aculeata*, *B. alazanensis*, *B. costata*, *B. marginata*, *B. striata*, *Protoglobobulimina pacifica*, *Protoglobobulimina pupoides*, *Praeglobobulimina spinescens*. Systematic descriptions of all eight species are provided. The buliminid species are illustrated by scanning electron micrographs in Plate 1. Remarks on observed morphological features and already known ecological preferences of each taxon are briefly presented. The average estimate of the relative abundance of each species within the total benthic foraminiferal population is given.

SYSTEMATIC DESCRIPTION

Order Foraminiferida Eichwald, 1830

Family Buliminidae Jones, 1875

Subfamily Bulimininae Jones, 1875

Genus Bulimina d'Orbigny, 1826

Bulimina aculeata d' Orbigny

(Pl. 1, figs. 8a, b, c)

Remarks: Most of the specimens of *Bulimina aculeata* encountered in this study have thick – walled, inflated chambers along with delicate apical spines surrounded by tuft of short, fine spines. Although *Bulimina aculeata* and *Bulimina marginata* d' Orbigny are often considered to be the extreme end members of one continuous morphological cline, the authors have not come across a gradational series in the examined core samples. As differentiations between the two species based on external characteristics are possible (Hoeglund, 1947), both the species are treated as separate species in the present work. Specimens with a series of spines on outer margins of the chambers were included in *B. aculeata*, and specimens with serrate edges at the sharply undercut lower chamber margins were grouped in *B. marginata*.

Pflum and Frerichs (1976) reported *B. aculeata* as a species tolerant to the low oxygen condition and having a preference for clastic substrates in the Gulf of Mexico. According to Van der Zwaan (1982), *B. aculeata* is a mud dweller, distributed in wide range of environmental conditions and resistant to oxygen deficiency. This taxon has been found to be an important constituent of benthic foraminiferal population within the OMZ of the Arabian Sea (Hermelin and Shimmield, 1990; den Dulk et al., 2000).

B. aculeata is one of the most predominant *Bulimina* species of the benthic assemblages in the examined core with its peak abundance reaches > 45%.

Bulimina alazanensis Cushman

(Pl. 1, figs. 1a, b)

Remarks: *B. alazanensis* shows strong longitudinal costae which continue on the basal spine, whereas in *B. rostata* they rupture at the basal suture of the chambers (Hofker, 1956). Specimens recorded in the present study do not show any discontinuity at the suture.

Hess and Kuhnt (2005) reported *B. alazanensis* as shallow infaunal species related with enhanced organic matter input to the seafloor in the South China Sea. Loubere and Fariduddin (1999) found this species with its high abundance during high productivity and low seasonality. This is a common and well known taxon reported from the southern Pacific and seems to occupy the same niche as *Uvigerina peregrina* in the northern Pacific waters (Huang et al., 2003).

In the examined samples, *B. alazanensis* is less frequent and its peak abundance reaches upto 8.5%. It is completely

absent during the Holocene period.

Bulimina costata d' Orbigny

(Pl. 1, figs. 4a, b)

Remarks: Our specimens show close resemblance with *B. costata* d' Orbigny from north Pacific illustrated by Barker (1960). It differs from *B. striata* by possesing elongate test with a more elongate aperture.

According to Schmiedl et al. (1995) and Majumdar et al. (2003), *B. costata* is an index taxon of Oxygen Minimum Zone in the south Atlantic Ocean and the Arabian Sea, respectively. In the examined samples *B. costata* is the most abundant species and its maximum abundance is recorded at about 72%.

Bulimina marginata d'Orbigny

(Pl. 1, figs. 2a, b)

Remarks: The specimens recorded in the present investigation are identical to the form referred as *Bulimina marginata* by Belford (1966). The large number of studies demonstrates that *B. marginata* prefers high organic carbon flux tolerates low oxygen levels (Risdal, 1963; Sen Gupta and Machain-Castillo, 1993). Schumacher et al. (2007) reported this species from just below the OMZ in the Arabian Sea. Other studies have also suggested *B. marginata* having affinity towards specific substrate with high organic carbon (Scott et al., 2003).

In the studied samples, *B. marginata* shows sporadic distribution with a maximum abundance of 3%.

Bulimina striata d' Orbigny

(Pl. 1, Fig. 3)

Remarks : *Bulimina striata* resembles the forms described by Cushman (1922) as *Bulimina inflata* Seguenza var. *mexicana*, and referred by Cushman and Parker (1940, 1947) and Cushman and Todd (1945) to *B. striata* d'Orbigny var. *mexicana* Cushman. Cushman and Parker (1947) considered both *B. inflata* and *B. striata* as synonyms, but later separated them again (Cushman and Parker 1940).

According to Kaiho (1994), *B. striata* is an indicator species of suboxic condition. Akimoto (1994) suggested that the distribution of this species was influenced by the hydrogen sulphide gas content of the ambient seawater.

The maximum abundance of this taxon in the examined core is 8.7%.

Genus : Protoglobobulimina Hofker, 1951

Protoglobobulimina pacifica (Cushman)

(Pl. 1 Fig.6)

Remarks: *Protoglobobulimina pacifica* is characterised by a thin and transparent test with a oblique slit like aperture. According to Corliss (1985), *P. pacifica* is a deep infaunal species living at about 6 cm depth within the sediment and can survive low oxygen conditions. In the studied samples it is rather rare with maximum abundance of 3.6%.

Protoglobobulimina pupoides (d'Orbigny)

(Pl. 1, Fig. 7)

Remarks: The adult specimens of *P. pupoides* encountered in this study have chamber arrangement in four large whorls, of which the last one is formed out of three strongly overlapping chambers, occupying about one third of the total length of the test.

In core MD76-131, this taxon is rare on average, but reaches maximum abundance of about 5 % in distinct time intervals.

Genus : Praeglobobulimina Hofker, 1951

Praeglobobulimina spinescens (Brady)

(Pl. 1, figs. 5a,b)

Remarks: Specimens recorded in the examined core are similar to the species figured by Belford (1966) as *Praeglobobulimina spinescens* (Brady) from the Mio-Pliocene of New Guinea. *P. spinescens* differs from *Protoglobobulimina pupoides* by its more strongly overlapping chambers, which are ornamented at their lower margins by small spinose projections. Rare occurrence of this species with a maximum abundance of 2 % is observed in the examined core.

STRATIGRAPHIC DISTRIBUTION

B. costata, *B. aculeata* and *B. alazanensis* are the main taxa of the buliminid assemblage. Relative abundance of the total buliminids and the predominant taxa (in total benthic foraminiferal population) varies down-core (Fig. 2). The abundance pattern of total buliminids shows a prominent increase at ~ 14 kyr BP, and between 18 and 23 kyr BP (maximum at ~ 22.5 kyr BP). The abundance of buliminids during 23 to 70 kyr BP has been generally < 30%. However, percentage abundance increased significantly between 40 and 46 kyr BP and between 65 and 68 kyr BP. A prominent and rapid decline in the abundance of buliminids is recorded during 10 - 13 kyr BP, 15 - 17.5 kyr BP, 23-24 kyr BP, 38-40 kyr BP and 60 - 64 kyr BP (Fig. 2). In the Holocene, the abundance of buliminids is moderately high between 5 and 9 kyr BP with its maximum value at 7.5 kyr BP.

ECOLOGICAL INTERPRETATION

Buliminids possess tapered to cylindrical tests, and the morphological characteristics of benthic foraminifera are considered to be related with the depth habitat (Corliss, 1985; Corliss and Chen, 1988; Corliss and Fois, 1990 and Perez-Cruz and Machain-Castillo, 1990). The buliminids are known to prefer infaunal habitats (Corliss and Fois, 1990), and its distribution pattern is controlled by the organic matter content in sediment and dissolved oxygen concentration (Phleger and Soutar, 1973; Koutsoukos *et al.*, 1990 and Kaiho, 1994). According to Kaiho (1994), *Bulimina* species are commonly found in high productivity areas of the continental margins characterising low oxygen bottom environments. The benthic environment of upper continental slope in the eastern Arabian Sea is typified by low dissolved oxygen concentration and high organic matter content (Calvert *et al.*, 1995). The organic carbon (C_{org}) content in marine sediments is commonly considered to be related to surface primary productivity and preservation under reduced oxygen concentrations in the bottom water or a combination of both. Studies on the C_{org} distribution in the surficial sediments along the western continental margin suggested primary productivity as the main factor controlling the content of the organic carbon in sediments

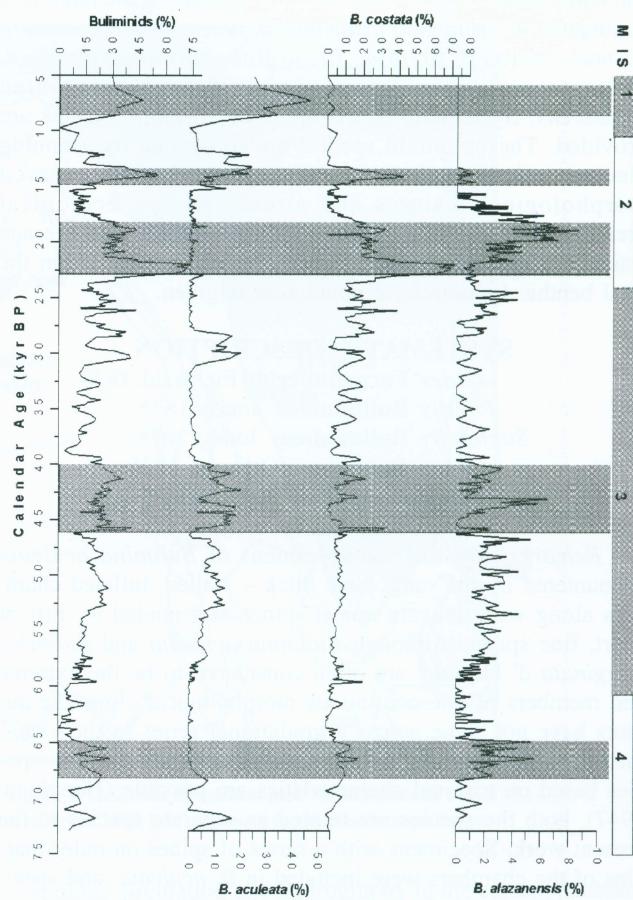


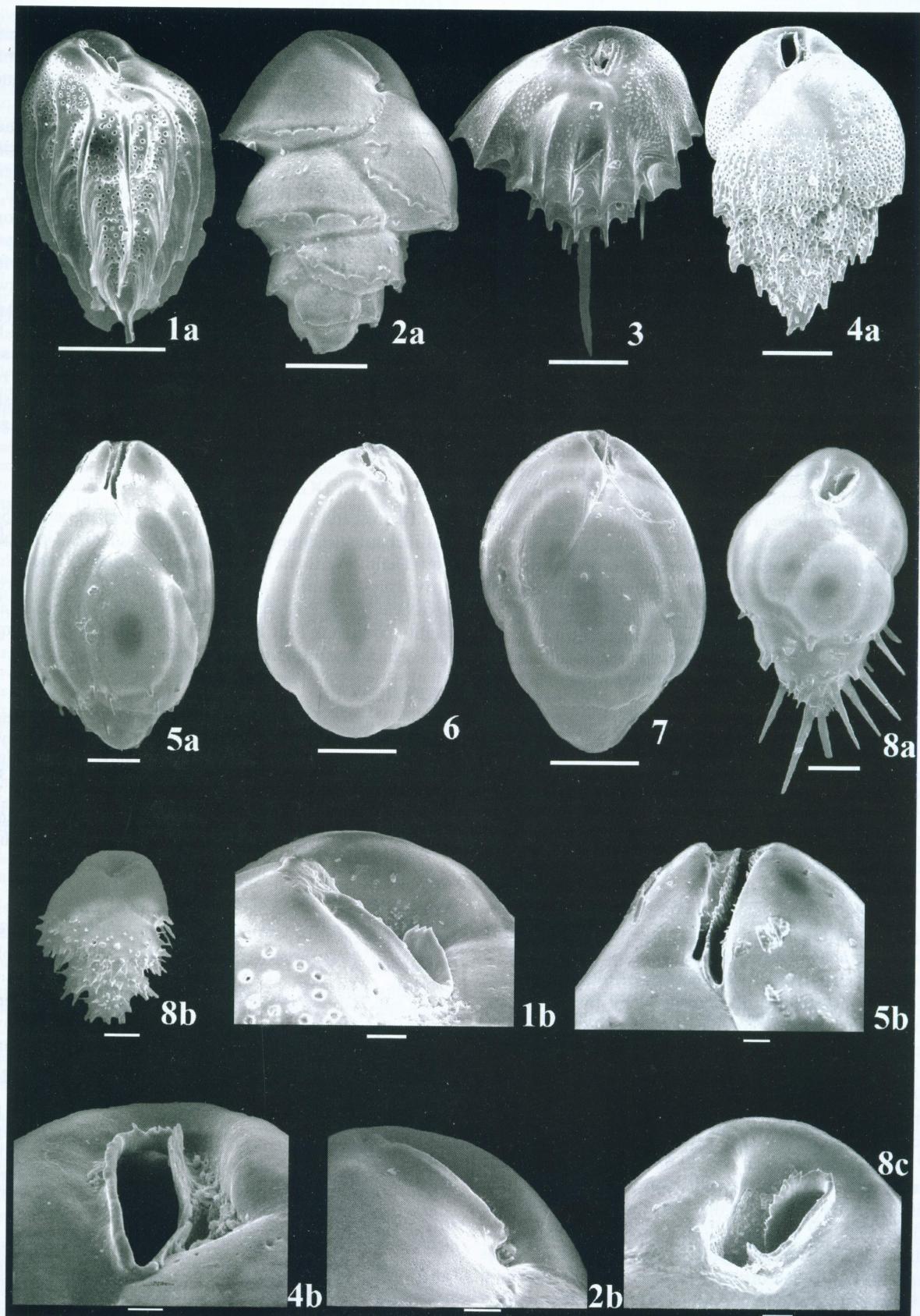
Fig. 2. Down-core variations in relative abundances of total Buliminids, *B. aculeata*, *B. costata* and *B. alazanensis* (>125 µm). Shaded intervals showing high productivity and low oxygen condition. MIS 1-4 represent the Marine Isotope Stages. Age model of the core is after Ivanochko (2004).

(Calvert *et al.*, 1995). This implies that the abundance pattern of total buliminids in the examined core is related to the changes in primary productivity, organic carbon flux and oxygen level.

Present day, an enhancement in productivity is observed in the eastern Arabian Sea (north of 15 ° Lat.) during winter season (December to February) due to cooling of surface waters and enhanced evaporation associated with intensified winter monsoon winds (northeasterly) leading to high salinity condition and convective mixing, which brings cold and nutrient rich sub surface waters to photic zone (Madhupratap *et al.*, 1996). A weak upwelling is also reported during this season (Zhang, 1985). The process of upwelling and convective mixing slowly erodes the upper thermocline/nutricline and

EXPLANATION OF PLATE I

1. *Bulimina alazanensis*
 - 1a. Front view; X 230
 - 1b. Enlarged apertural view; X 1700
2. *Bulimina marginata*
 - 2a. Front view ; X 350
 - 2b. Enlarged apertural view; X 1600
3. *Bulimina striata* X 170
4. *Bulimina costata*
 - 4a. Front view; X 150
 - 4b. Enlarged apertural view ; X 150
5. *Praeglobobulimina spinescens*
 - 5a. Front view; X 110
 - 5b. Enlarged apertural view; X 550
6. *Protoglobobulimina pacifica* X 85
7. *Protoglobobulimina pupoides* X 95
8. *Bulimina aculeata*
 - 8a. Adult form; X 110
 - 8b. Juvenile form; X 300
 - 8c. Enlarged apertural view; X 650



elevates the nutrient levels in the mixed layer resulting in an enhancement of productivity. High biological productivity and increased flux of organic carbon invokes oxygen deficient condition within the water column and development of the oxygen minimum zone (OMZ). As the core site lies at the base of the present day OMZ, the benthic environment at this location is expected to vary with any fluctuation in the strength of the OMZ. Intensification or weakening of the OMZ would lead to create oxygen poor or oxygen rich bottom environment respectively and thus influencing the buliminid population. Hence, it can be suggested that temporal abundance variation of buliminids in the examined core is indicative of past oscillations in both productivity and oxygen minimum zone intensity linked with monsoonal climate. Abundance maxima of buliminids in core MD76-131 suggest high surface primary productivity and strong OMZ, whereas abundance minima point towards low productivity and a weak OMZ. The relative abundance pattern of buliminids indicates that the intervals between 5 and 9 kyr BP, ~14 kyr BP, between 18 and 23 kyr BP, 40 and 46 kyr BP, and between 65 and 68 kyr BP were the periods of high surface productivity and as a result intensification of the oxygen minimum zone in the eastern Arabian Sea (Fig. 2). On the contrary, the periods between 10 and 13 kyr BP, 15 and 17.5 kyr BP, 23 and 24 kyr BP, 38 and 40 kyr BP, and between 60 and 64 kyr BP were characterised by the low productivity and a weak oxygen minimum zone.

It is interesting to record that the predominant species of *Bulimina* in the examined core show variable temporal distribution (Fig. 2). *Bulimina aculeata*, a dominant taxon of the buliminid population shows major variation in its abundance down-core. Its peak abundance is observed between 5 and 8 kyr BP, 12 and 13 kyr BP, 27 and 29 kyr BP, and 40 and 45 kyr BP. During the periods between 15 and 27 kyr BP, 30 and 40 kyr BP, and between 57 and 67 kyr BP, this species is present in very low abundance (< 5%). *B. aculeata* is considered as a tolerant species to the low oxygen environments (Pflum and Frerichs, 1976; Van der Zwaan, 1982) and has been reported to be an important taxon of benthic foraminiferal fauna from the OMZ of the Arabian Sea (Hermelin and Shimmield, 1990; den Dulk *et al.*, 2000). *B. aculeata* has been also suggested to be sensitive to changes of primary productivity in the Gulf of Aden (Almogi-Labin *et al.*, 2000).

Temporal variation pattern of *B. costata* in core MD76-131 shows two major abundance maxima at ~ 14 kyr BP and ~ 22.5 kyr BP and generally follows the pattern of total buliminids except for the late Holocene period, when the buliminid population is predominantly composed of *B. aculeata* (Fig. 2). There are only a few reports available on the ecological aspects of *B. costata* which suggest its relation with the OMZ (Schmiedl *et al.* 1995; Majumdar *et al.*, 2003). The next important species of buliminid population, *B. alazanensis* shows its peak abundances between 17 and 21 kyr BP, at ~25 kyr BP, ~ 44 kyr BP, ~ 47 kyr BP, and between 65 and 68 kyr BP (Fig. 2). The Holocene samples are devoid of this species. Its distribution pattern is strikingly similar to the abundance pattern of the total buliminids. Hess and Kuhnt (2005) reported this species to be related with enhanced organic matter in sediment, thus primary productivity. The differences in down-core variation patterns among the various buliminid taxa probably suggest that although buliminid species in general are associated with the surface productivity and oxygen deficient environment,

their sensitive response to the changes in organic carbon and bottom oxygen condition is variable.

CONCLUSIONS

The high-resolution abundance record of buliminids for the last 70 kyr derived from a 9.65 m long sediment core off Goa shows variation on millennial scale. The abundance pattern of this microfaunal group provides record of changes in palaeoproductivity and oxygen minimum zone (OMZ) intensity at the examined core-site, because the buliminid species are known to be sensitive to changes in bottom oceanographic conditions, mainly trophic level and dissolved oxygen. High abundances of total buliminids in the examined core are indicative of high productivity conditions and a strong OMZ, whereas low abundances point towards low productivity and a weak OMZ. Our study indicates that the intervals between 5 and 9 kyr BP, ~14 kyr BP, between 18 and 23 kyr BP, 40 and 46 kyr BP, and between 65 and 68 kyr BP characterised by the predominance of buliminids, were the periods of high surface primary productivity and intensified oxygen minimum zone in the eastern Arabian Sea. Present study further suggests that sensitive response of individual taxa to changes in oceanographic parameters is variable.

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Appendix I: Relative abundance (%) of Bulimina and constituent species in total benthic foraminiferal population (125 µm) of core MD76-131

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata</i>	<i>Praeglobobulimina spinescens</i>	<i>Praeglobobulimina pacifica</i>	<i>Protoglobobulimina pupoides</i>	<i>Protoglobobulimina ulimina</i> (%)	Total buliminids
19	5.151	25.00	0.00	3.13	1.56	0.00	0.00	0.00	0.00	0.00	29.69
27	6.082	27.27	0.00	0.00	0.00	3.64	0.00	0.00	0.00	0.00	30.91
33	6.781	40.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.91
37	7.247	46.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.67
43	7.946	28.57	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00	32.14
48	8.513	33.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.96
53	9.080	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.50
59	9.760	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	10.214	3.63	0.00	0.63	0.50	5.26	0.5	0.00	0.00	0.00	10.52
86	11.733	3.13	0.00	0.00	3.13	0.00	0.00	0.00	0.00	0.00	6.25
93	12.103	22.89	0.00	0.00	1.20	0.00	0.00	1.20	0.00	0.00	25.30
97	12.315	15.24	0.00	0.00	0.00	0.95	0.95	0.00	0.00	0.00	17.14
107	12.803	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.33
111	12.973	15.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	16.42
115	13.144	23.70	0.00	0.00	1.16	4.05	0.00	0.00	0.00	0.00	28.90
117	13.229	24.15	0.00	0.00	0.48	12.08	0.00	0.00	0.00	0.48	37.20
122	13.443	20.95	0.79	0.00	1.98	16.60	0.00	0.00	0.00	0.00	40.32
126	13.614	16.21	0.34	0.00	0.69	27.59	0.00	0.00	0.00	0.34	45.17
130	13.784	22.99	1.15	0.00	0.00	29.31	0.57	0.57	0.00	0.00	54.59
132	13.870	11.97	0.00	0.00	0.00	36.75	0.00	0.00	0.00	0.00	48.72
134	13.955	14.16	0.87	0.00	0.87	39.31	0.00	0.00	0.00	0.00	55.20
136	14.040	9.85	0.25	0.00	1.52	42.68	0.00	0.00	0.00	0.00	54.29
138	14.126	5.88	0.35	0.00	1.04	38.06	0.00	0.00	0.00	0.00	45.33
142	14.326	8.96	0.00	1.42	1.42	18.87	0.94	0.47	0.00	0.00	32.07
144	14.442	9.19	0.54	0.00	0.00	12.43	0.00	0.00	0.00	1.62	23.78
146	14.557	3.90	1.30	0.00	3.90	14.29	0.00	0.00	0.00	1.30	24.68
148	14.673	4.67	0.00	0.00	3.74	11.21	0.00	0.00	0.00	0.93	20.56
150	14.788	3.96	0.00	0.00	5.94	2.97	0.00	0.00	0.00	0.00	12.87
152	14.903	5.80	0.00	0.00	8.70	4.35	0.00	0.00	0.00	0.00	18.84
156	15.134	14.10	0.00	0.00	0.00	6.41	0.00	0.00	0.00	0.00	20.51
158	15.250	3.39	0.00	0.00	4.24	1.69	0.00	0.00	0.00	0.00	9.32
160	15.365	0.00	0.00	0.00	5.61	0.00	0.00	0.00	0.00	0.00	5.61
162	15.481	0.88	0.00	1.75	3.51	3.51	0.00	0.00	0.00	0.88	10.53
164	15.596	0.00	2.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	8.00
166	15.711	1.25	0.00	0.00	3.75	3.75	0.00	0.00	0.00	1.25	10.00
168	15.827	0.00	0.88	0.88	2.65	10.62	0.00	1.77	0.00	0.88	17.70
170	15.942	0.00	0.00	0.78	5.43	3.88	0.00	1.55	0.00	0.00	11.63
172	16.058	0.00	0.82	0.00	3.28	5.74	0.00	0.00	0.00	0.82	10.66
176	16.274	2.70	1.62	0.00	4.32	5.95	0.00	0.54	0.00	1.08	16.22
178	16.374	0.94	1.89	0.00	4.72	0.00	0.94	0.00	0.00	0.00	8.49
180	16.475	0.99	1.98	0.99	5.94	2.97	0.00	0.99	0.00	0.00	13.86
182	16.575	0.00	1.29	0.00	6.45	0.00	0.00	0.00	0.00	0.65	8.39
184	16.676	0.00	3.61	0.00	3.61	1.20	0.00	1.20	0.00	0.00	9.64
186	16.776	1.49	0.00	2.99	7.46	0.00	0.00	0.00	0.00	0.00	11.94
188	16.877	2.68	3.57	0.00	6.25	1.79	0.00	0.00	0.00	0.00	14.29
190	16.977	1.45	0.97	0.00	4.83	2.42	0.00	0.00	0.00	0.00	9.66
192	17.078	0.99	2.32	0.32	3.97	3.31	0.00	1.66	0.00	0.66	13.24
194	17.178	0.00	1.89	0.94	3.77	2.36	0.00	0.00	0.00	0.00	8.96
196	17.279	1.67	3.89	0.00	2.22	5.56	0.00	0.00	0.00	0.56	13.89
198	17.379	1.12	1.87	0.75	0.75	5.62	0.75	2.62	0.00	2.62	16.11
200	17.480	0.42	5.08	3.39	2.12	8.90	0.00	1.27	0.00	1.69	22.88
202	17.580	0.00	6.61	1.98	0.00	5.51	0.00	0.88	0.00	2.86	17.84
206	17.791	1.13	4.33	1.32	0.38	13.18	0.75	0.19	0.00	1.51	22.78
208	17.900	2.59	3.08	0.16	0.00	13.94	0.00	0.32	0.00	1.78	21.88
210	18.010	0.97	5.05	2.33	0.97	15.15	0.19	0.97	0.00	0.58	26.21
212	18.120	2.46	4.55	0.95	1.14	17.23	0.00	0.19	0.00	2.46	28.98

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata spinescens</i>	<i>Praeglobobulimina pacifica</i>	<i>Protoglobobulimina pupoides</i>	<i>Protoglobobulimina</i> (%)	Total buliminids
214	18.230	2.46	7.08	0.62	0.31	21.85	0.00	0.92	0.62	33.84
216	18.339	0.87	6.69	2.03	0.00	18.60	0.00	0.00	2.03	30.23
218	18.449	3.70	6.76	2.08	0.81	19.11	0.00	0.51	0.27	33.24
220	18.559	6.99	6.99	0.00	0.00	16.31	0.00	0.00	0.58	30.87
222	18.668	0.85	7.45	0.64	1.06	24.47	0.00	0.21	1.70	36.38
224	18.778	0.71	3.90	0.35	0.35	32.98	0.00	1.77	2.48	42.55
226	18.888	0.66	9.24	0.00	0.00	31.35	0.00	0.00	2.64	43.89
228	18.998	0.28	7.02	0.56	0.00	29.21	0.00	0.84	2.53	40.45
230	19.107	2.08	3.94	0.00	0.00	26.16	0.00	0.43	2.15	34.76
232	19.217	0.41	5.39	0.00	0.00	29.05	0.00	0.00	2.49	37.35
234	19.327	0.23	6.76	0.00	0.23	18.88	0.00	0.93	2.10	29.13
236	19.436	0.00	6.07	0.00	0.00	18.21	0.00	0.32	2.24	26.84
238	19.546	0.00	7.47	0.00	0.00	21.43	0.00	0.32	1.95	31.17
240	19.656	0.33	6.54	0.33	0.65	25.16	0.00	0.98	0.98	34.97
242	19.766	0.00	7.69	0.23	0.23	21.49	0.00	0.00	0.23	29.86
244	19.875	3.14	3.56	0.00	0.42	28.24	0.00	0.00	0.42	35.77
246	19.985	0.95	4.06	1.43	0.72	22.67	0.00	0.48	1.43	31.74
248	20.095	2.01	2.01	1.34	0.67	18.79	0.00	1.34	0.00	26.17
250	20.204	1.43	3.82	0.32	0.64	24.80	0.00	0.00	1.11	32.11
252	20.314	0.60	5.00	0.80	0.20	24.80	0.00	0.20	0.60	32.20
254	20.424	0.38	2.68	0.96	0.19	19.31	0.00	0.38	0.57	24.47
256	20.534	1.52	4.41	0.00	0.30	21.61	0.00	0.00	0.46	28.31
258	20.643	0.45	2.48	1.01	0.00	25.68	0.00	0.00	0.56	30.18
260	20.753	0.66	3.28	0.66	0.00	25.76	0.00	0.00	0.44	30.79
262	20.863	2.02	4.60	0.18	0.83	27.94	0.00	0.18	1.92	37.67
264	20.972	0.14	3.54	1.09	0.00	23.40	0.00	0.14	0.41	28.71
266	21.082	0.54	3.81	0.28	0.00	19.18	0.00	0.14	1.09	25.04
268	21.192	1.61	2.12	0.00	0.00	18.95	0.00	0.11	0.96	23.75
270	21.302	0.19	2.80	0.19	0.00	21.68	0.00	0.19	1.50	26.54
272	21.411	0.42	3.95	0.42	0.62	31.60	0.00	0.00	1.25	38.25
274	21.521	1.37	2.29	0.00	0.46	37.76	0.00	0.23	2.29	44.39
276	21.631	0.40	4.23	0.40	0.60	35.01	0.00	0.20	1.01	41.85
278	21.740	0.21	2.34	0.42	0.42	40.13	0.00	0.21	1.06	44.80
280	21.850	0.48	1.59	0.32	0.00	60.10	0.00	0.16	1.11	63.75
282	21.960	0.17	1.12	0.09	0.00	71.81	0.00	0.17	0.43	73.79
284	22.070	0.21	1.87	0.83	0.10	67.53	0.00	0.10	0.83	71.47
286	22.179	0.63	1.52	0.13	0.13	63.03	0.00	0.06	0.69	66.19
288	22.289	0.53	0.85	0.00	0.00	69.44	0.00	0.11	0.96	71.90
290	22.522	0.39	1.83	0.26	0.07	67.39	0.00	0.26	0.33	70.53
292	22.756	0.30	1.41	0.71	1.31	60.20	0.00	0.00	0.81	64.75
294	22.989	5.30	1.35	0.23	0.11	38.83	0.00	0.92	1.56	48.31
296	23.223	2.07	0.73	1.22	0.49	26.61	0.00	0.00	0.61	31.71
298	23.456	0.22	1.73	0.87	0.22	26.84	0.00	0.43	1.52	31.82
300	23.690	1.94	1.29	0.00	0.65	10.65	0.00	0.00	1.94	16.45
302	23.923	0.31	1.54	0.62	0.62	11.42	0.00	0.31	1.54	16.36
304	24.157	0.99	1.23	0.00	0.74	14.04	0.00	0.25	2.22	19.46
306	24.319	0.00	1.48	0.00	0.89	9.76	0.00	0.59	0.00	12.72
308	24.481	1.36	4.36	0.27	0.00	14.99	0.00	0.00	1.63	22.62
310	24.643	0.25	3.34	0.00	0.37	16.34	0.00	0.00	0.74	21.04
312	24.805	3.06	3.06	0.35	0.51	20.03	0.00	0.17	0.68	27.85
314	24.967	0.67	1.68	1.68	1.35	16.84	0.00	0.34	1.01	23.57
316	25.129	0.00	4.50	0.00	1.80	13.13	0.00	0.72	2.52	22.66
318	25.291	0.00	2.99	0.00	0.60	26.65	0.00	0.30	1.80	32.34
320	25.453	0.00	2.37	0.00	2.11	19.47	0.00	0.00	1.05	25.00
322	25.615	0.00	1.25	0.00	0.50	19.75	0.00	0.25	1.25	23.00
324	25.777	0.94	2.11	0.00	0.94	19.67	0.00	0.70	1.64	26.00
326	25.939	0.00	1.74	1.05	0.35	5.92	0.00	0.35	2.79	12.20
328	26.101	0.40	1.85	0.13	0.00	39.34	0.00	0.40	1.46	43.58

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata</i>	<i>Praeglobobulimina spinescens</i>	<i>Protoglobobulimina pacifica</i>	<i>Protoglobobulimina pupoides</i>	<i>Protoglobobulimina ulimina</i> (%)	Total buliminids
330	26.263	1.14	2.44	0.16	0.16	26.46	0.00	0.16	2.27	32.79	
332	26.424	0.26	3.26	0.13	0.00	16.32	0.00	0.00	1.44	21.41	
334	26.586	0.29	1.46	0.15	0.00	15.37	0.00	0.15	1.46	18.89	
336	26.748	0.00	1.88	0.00	0.00	10.36	0.00	0.19	2.45	14.88	
338	26.910	0.00	1.26	0.00	0.00	11.17	0.00	0.00	1.96	14.39	
340	27.072	0.00	0.29	0.29	0.00	11.95	0.00	0.00	2.62	15.16	
342	27.234	0.62	0.00	0.00	0.00	16.72	0.00	0.00	0.62	17.96	
344	27.396	1.32	0.53	0.53	0.53	21.37	0.00	0.26	1.58	26.12	
346	27.558	0.27	0.53	0.00	0.00	20.21	0.00	0.00	0.53	21.54	
348	27.720	1.79	2.08	0.30	0.00	17.86	0.00	0.00	1.19	23.21	
350	27.882	1.96	1.63	0.33	0.33	23.37	0.00	0.16	1.14	28.92	
352	28.044	6.74	1.89	0.27	0.54	26.42	0.00	0.00	1.89	37.74	
354	28.206	13.90	1.74	0.16	0.00	15.96	0.00	0.00	0.47	32.23	
356	28.368	16.61	0.00	0.33	0.33	17.92	0.00	0.00	0.33	35.50	
358	28.530	15.46	0.00	0.00	0.23	4.92	0.00	0.00	0.23	20.84	
362	29.217	10.63	0.48	0.00	0.00	3.14	0.00	0.72	0.00	14.98	
364	29.388	14.47	0.26	0.00	0.00	1.03	0.00	0.52	0.00	16.28	
366	29.560	13.55	0.00	0.00	0.65	5.16	0.00	0.65	0.32	20.32	
368	29.731	8.74	0.64	0.00	0.64	20.90	0.00	0.21	0.00	31.13	
370	29.903	20.06	1.95	0.28	0.56	10.86	0.00	0.00	1.11	34.82	
372	30.074	18.11	1.23	0.00	1.03	18.72	0.00	0.21	0.41	39.71	
374	30.417	15.97	0.96	0.00	1.60	21.73	0.00	0.00	0.32	40.58	
76	30.760	7.47	0.26	0.26	1.55	14.18	0.00	0.77	0.52	25.00	
378	31.103	2.56	0.51	0.00	0.77	9.72	0.00	0.00	0.77	14.32	
380	31.425	1.34	2.46	0.67	2.01	6.49	0.00	0.00	0.22	13.20	
382	31.746	0.38	1.15	0.00	2.29	7.25	0.00	0.00	0.76	11.83	
384	32.068	0.88	0.70	0.00	0.35	10.16	0.00	0.18	0.35	12.61	
386	32.389	0.00	0.50	0.00	2.75	12.25	0.50	0.50	0.50	17.00	
388	32.679	0.88	0.88	0.00	2.65	17.99	0.00	0.00	0.88	23.30	
390	32.970	1.04	0.00	0.00	0.26	20.31	0.52	0.67	0.40	23.20	
392	33.260	0.18	0.00	0.18	1.71	9.63	0.00	0.67	1.71	14.08	
394	33.449	0.66	0.00	0.00	0.99	7.62	0.00	0.33	0.65	10.26	
396	33.637	0.80	0.27	0.00	1.33	6.38	0.00	0.27	1.33	10.37	
398	33.826	0.30	0.30	2.19	0.60	10.12	0.00	0.79	1.19	15.48	
400	34.015	0.71	1.42	0.00	1.77	13.83	0.00	0.35	0.00	18.09	
402	34.203	1.15	0.38	0.00	1.76	19.85	0.00	0.38	0.15	23.67	
404	34.392	1.30	0.43	0.65	4.11	8.23	0.00	0.22	1.30	16.23	
406	34.581	1.50	0.50	0.00	6.00	5.75	0.00	0.75	0.50	15.00	
408	34.770	0.62	1.03	0.00	1.03	4.52	0.00	0.00	0.41	7.60	
410	34.958	0.33	1.33	0.66	1.99	5.65	0.00	0.00	1.66	11.63	
412	35.147	0.97	0.97	0.00	0.97	7.42	0.00	0.32	0.32	10.97	
414	35.494	2.79	1.05	0.00	0.70	12.54	0.00	0.35	0.70	18.12	
416	35.840	0.75	0.00	0.00	2.49	16.67	0.00	0.25	1.00	21.14	
418	36.187	0.74	0.50	0.25	4.96	13.15	0.00	0.00	0.25	19.85	
422	36.572	1.06	1.60	0.00	4.79	2.66	0.00	0.00	2.66	12.77	
424	36.764	1.40	2.34	0.00	1.87	5.14	0.00	0.00	1.87	12.62	
426	36.957	1.81	2.09	0.00	2.61	3.82	0.00	0.40	0.60	11.32	
428	37.149	2.68	2.49	0.89	1.49	5.65	0.00	0.19	2.68	11.07	
430	37.342	2.09	1.96	0.25	1.23	3.56	0.00	0.00	2.09	11.17	
432	37.534	2.35	0.98	1.39	2.74	2.52	0.00	0.78	0.78	11.54	
434	37.727	2.44	0.98	0.24	1.96	4.40	0.00	0.73	1.22	11.98	
436	37.919	4.10	1.02	0.20	1.64	4.92	0.00	0.20	0.61	12.70	
438	38.242	1.27	1.01	0.00	0.76	7.59	0.00	0.00	0.00	5.35	
440	38.565	1.23	0.00	0.00	0.41	3.70	0.00	0.00	0.00	3.17	
442	38.809	0.00	0.00	0.00	0.79	2.38	0.00	0.00	0.00	7.05	
444	39.054	0.96	0.96	0.00	0.96	3.85	0.00	0.32	0.00	23.67	
446	39.298	2.37	2.37	0.00	0.59	16.57	0.00	1.18	0.59	24.62	
448	39.542	1.82	0.61	0.91	0.91	19.15	0.00	0.61	0.61	18.36	
450	39.787	5.45	1.15	1.43	0.14	8.90	0.00	0.00	1.29		

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata spinescens</i>	<i>Praeglobobulimina pacifica</i>	<i>Protoglobobulimina pupoides</i>	<i>Protoglobobulimina</i> (%)	Total buliminids
452	40.031	9.89	1.94	1.08	0.00	11.61	0.00	0.00	1.51	26.02
454	40.275	7.33	4.23	0.33	0.00	11.89	0.00	0.00	1.30	25.08
456	40.520	7.88	2.86	1.95	0.91	11.69	0.00	0.00	2.39	27.68
458	40.764	16.08	2.27	1.70	0.00	8.69	0.00	0.00	1.67	30.42
460	41.008	13.08	2.08	0.00	0.00	14.98	0.00	0.00	1.23	31.37
462	41.252	8.03	2.68	0.73	0.24	22.38	0.00	0.00	2.19	36.25
464	41.474	12.74	3.49	0.85	0.00	9.96	0.00	0.00	2.49	29.54
466	41.683	11.04	0.80	0.00	0.00	13.05	0.00	0.00	0.60	25.50
468	41.869	13.43	2.68	0.99	0.00	4.48	0.00	0.00	2.97	24.55
470	42.055	14.00	1.87	1.87	0.00	5.27	0.00	0.00	1.53	24.54
472	42.241	19.95	0.23	0.23	0.00	7.86	0.00	0.00	1.39	29.66
474	42.427	14.87	2.55	0.00	0.09	7.57	0.00	0.00	1.38	26.46
476	42.613	9.05	1.99	1.16	0.00	8.07	0.00	0.45	0.33	21.05
478	42.799	8.43	2.86	0.00	0.00	15.29	0.00	0.86	0.43	27.86
480	42.985	4.76	1.27	0.32	0.00	17.46	0.00	0.63	0.63	25.07
482	43.116	4.14	6.51	0.00	0.00	8.28	0.00	0.00	1.18	20.12
484	43.247	6.98	4.65	0.33	0.33	9.63	0.00	0.33	0.66	22.92
486	43.379	4.44	4.44	0.00	0.00	6.77	0.00	0.00	0.85	16.49
488	43.510	12.26	6.83	0.35	0.00	2.45	0.00	0.00	0.70	22.59
490	43.641	11.53	4.82	0.59	0.00	1.06	0.00	0.12	0.24	18.36
492	43.773	18.36	4.62	0.13	0.26	1.98	0.00	0.13	0.53	26.02
494	43.904	16.94	2.49	0.59	0.22	1.14	0.00	0.22	0.57	22.18
496	44.035	17.60	2.62	0.61	0.00	3.40	0.00	0.00	0.50	24.73
498	44.167	17.97	2.36	0.00	0.00	2.87	0.00	1.06	0.72	24.98
500	44.298	4.43	3.04	0.75	0.00	2.71	0.00	0.00	1.61	12.54
502	44.429	15.63	1.76	0.76	0.00	3.51	0.00	0.00	2.45	24.12
504	44.561	18.89	1.92	1.08	0.00	3.17	0.00	0.67	1.18	26.91
506	44.692	13.61	1.87	1.75	0.00	3.27	0.61	0.00	1.75	22.85
508	44.823	15.51	0.30	0.99	0.00	2.91	0.00	0.90	1.68	22.27
510	44.954	13.49	1.26	1.26	0.00	3.33	0.00	1.26	1.44	22.03
512	45.086	16.50	0.16	1.16	0.00	7.94	0.00	1.84	1.96	29.57
514	45.217	13.36	1.10	1.41	0.00	9.94	0.00	0.71	0.92	27.45
516	45.348	16.06	1.00	1.20	0.00	8.84	0.00	0.00	1.81	28.91
518	45.480	11.62	0.10	2.63	0.00	8.24	0.00	0.91	0.96	24.46
520	45.611	9.52	0.26	1.26	0.00	7.88	0.00	1.00	1.60	21.53
522	45.694	5.29	2.64	0.44	0.00	30.40	0.00	0.88	1.76	41.41
524	45.778	2.82	1.06	0.00	0.00	32.39	0.00	0.00	1.41	37.68
526	45.861	3.88	2.71	0.00	0.39	29.84	0.00	0.00	1.16	37.98
528	45.944	3.10	1.69	0.28	0.28	13.80	0.00	0.28	1.97	21.41
530	46.027	3.38	2.82	0.26	0.26	10.13	0.00	0.56	0.78	18.18
532	46.111	1.06	1.06	0.00	0.27	9.04	0.00	0.53	0.80	12.76
534	46.194	0.83	0.00	0.00	0.41	6.64	0.00	0.00	0.83	8.71
536	46.376	0.42	1.27	0.00	0.00	11.39	0.00	0.00	0.42	13.50
538	46.558	1.38	3.69	0.00	0.46	8.29	0.00	0.00	0.00	13.82
540	46.740	8.41	5.31	0.00	0.88	4.87	0.00	0.00	1.77	21.24
542	46.922	8.93	1.98	1.40	1.19	5.16	0.00	0.00	0.99	19.65
544	47.104	8.33	3.23	0.25	0.12	4.47	0.00	0.36	0.12	16.89
546	47.286	8.86	1.71	1.00	0.29	6.57	0.00	0.00	1.71	20.14
548	47.468	10.33	2.25	0.72	0.00	4.50	0.00	1.26	0.40	19.47
550	47.741	11.91	2.14	0.00	0.00	6.19	0.00	0.00	0.53	20.77
552	48.014	12.25	1.61	1.41	0.00	7.63	0.00	0.40	1.80	25.10
554	48.287	10.26	3.56	1.85	0.28	5.27	0.00	0.99	1.71	23.93
556	48.560	7.34	2.91	0.28	0.14	7.48	0.00	0.28	0.97	19.39
558	48.833	6.10	2.20	0.00	0.24	7.07	0.00	0.00	0.24	15.85
560	49.106	8.61	1.66	0.00	0.33	8.61	0.00	0.00	1.66	20.86
562	49.379	6.67	2.63	0.00	0.18	8.07	0.00	0.00	0.53	18.07
564	49.632	6.09	4.68	0.00	0.00	9.13	0.00	0.23	0.70	20.84
566	49.885	11.40	2.59	0.26	0.00	6.48	0.00	0.26	0.00	20.98

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata spinescens</i>	<i>Praeglobobulima pacifica</i>	<i>Protoglobobulima pupoides</i>	<i>Protoglobobulima ulimina</i> (%)	Total buliminids
568	50.138	8.89	3.35	0.00	0.00	8.67	0.00	0.00	1.77	22.69
570	50.391	12.26	3.77	0.19	0.00	6.42	0.00	0.00	0.75	23.40
572	50.644	10.63	4.47	0.22	0.22	8.46	0.00	0.22	1.16	25.37
574	50.896	11.19	3.02	0.00	0.00	9.84	0.13	0.34	0.81	25.33
576	51.149	13.98	2.67	1.32	0.00	9.61	0.00	0.39	0.43	28.39
578	51.402	9.62	1.17	1.29	0.00	8.16	0.00	0.46	1.75	22.45
580	51.655	10.88	2.65	0.00	0.53	10.88	0.00	0.00	0.27	25.20
582	51.908	11.05	1.13	0.00	0.00	9.92	0.00	0.00	1.42	23.51
584	52.161	13.17	2.23	0.22	0.22	8.04	0.00	0.00	1.34	25.22
586	52.414	9.83	3.21	0.00	0.00	8.51	0.00	0.00	1.89	23.44
588	52.667	14.04	3.73	0.00	0.00	8.77	0.00	0.22	0.44	27.19
590	52.920	8.90	3.07	0.00	0.00	7.67	0.00	0.30	1.69	21.62
592	53.173	6.24	3.01	0.43	0.00	6.02	0.00	0.00	1.08	16.77
594	53.426	7.17	4.85	0.21	0.21	4.85	0.00	0.00	0.84	18.14
596	53.678	7.82	1.69	0.21	0.21	4.86	0.00	0.00	0.42	15.22
598	53.931	4.35	3.19	0.00	0.00	4.35	0.00	0.00	1.16	13.06
600	54.184	5.84	3.05	0.00	0.00	4.31	0.00	0.00	0.51	13.71
602	54.437	5.42	1.69	0.00	0.00	4.41	0.00	0.00	1.02	12.54
604	54.690	5.70	2.14	0.24	0.24	5.70	0.00	0.00	2.14	16.15
606	54.943	4.78	3.42	0.00	0.00	5.69	0.00	0.00	1.82	15.72
608	55.196	5.73	1.82	0.00	0.52	5.47	0.00	0.00	0.26	13.80
610	55.449	5.53	2.86	0.19	0.00	5.15	0.00	0.00	1.53	15.27
612	55.702	4.99	3.05	0.88	0.47	2.82	0.00	0.47	0.94	13.62
614	55.955	3.87	3.19	0.00	0.00	3.64	0.00	0.46	0.91	12.07
616	56.207	3.88	3.29	0.00	0.00	2.52	0.00	0.19	0.97	10.85
618	56.460	5.75	2.65	0.22	0.66	4.65	0.00	0.22	0.88	15.04
620	56.713	6.47	2.40	0.00	0.24	3.12	0.00	0.00	1.20	13.43
622	56.966	6.84	3.03	0.85	0.55	2.22	0.00	0.00	0.55	14.05
624	57.219	7.36	1.94	0.39	0.39	3.10	0.00	0.00	0.19	13.37
626	57.472	7.27	2.85	1.00	0.70	6.98	0.00	0.57	0.00	19.37
628	57.586	5.36	1.19	0.00	0.00	5.36	0.00	0.30	0.30	12.50
630	57.70	4.74	3.32	0.00	0.95	5.69	0.00	0.47	0.47	15.64
632	57.815	2.88	3.88	0.00	1.48	5.33	0.00	0.85	0.48	14.91
634	57.929	3.21	1.60	0.53	0.00	4.28	0.00	0.00	0.00	9.63
636	58.043	1.02	2.02	0.00	0.51	6.10	0.00	0.04	1.02	10.71
638	58.157	3.87	1.66	0.00	2.76	9.94	0.00	0.00	0.55	18.78
640	58.271	0.52	0.52	0.00	0.00	5.76	0.00	1.05	0.52	8.38
642	58.385	2.65	1.77	0.00	1.77	5.31	0.00	0.00	2.65	14.16
644	58.500	2.47	0.62	0.00	1.62	6.79	0.00	0.00	0.85	12.34
646	58.614	3.76	0.47	0.00	1.65	6.12	0.00	0.24	0.94	13.18
648	58.728	0.59	2.37	0.00	1.18	6.51	0.00	0.00	1.78	12.43
650	58.842	1.50	2.26	0.00	0.00	7.52	0.00	0.75	0.00	12.03
652	58.956	0.63	0.31	0.00	0.00	6.56	0.00	0.31	0.63	8.44
654	59.070	0.53	2.06	0.53	0.00	8.41	0.00	0.65	1.59	13.76
656	59.185	2.38	1.19	0.00	0.00	7.14	0.00	0.00	0.79	11.51
658	59.299	0.53	0.53	0.00	0.00	4.23	0.00	0.00	2.65	7.94
660	59.413	2.58	1.29	0.00	0.29	9.03	0.65	0.34	3.23	17.41
662	59.478	1.68	0.00	0.00	0.00	15.13	0.00	0.00	2.52	19.33
664	59.542	0.00	0.00	0.00	0.00	20.46	0.00	0.66	0.66	21.78
670	59.736	0.68	0.00	0.00	1.37	3.42	0.00	0.68	0.68	6.84
676	59.929	0.00	0.00	0.00	0.00	1.82	0.00	3.64	0.91	6.36
682	60.123	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.92	5.50
688	60.317	0.41	0.41	0.41	0.41	1.24	0.41	0.41	0.00	3.72
694	60.510	0.52	0.00	0.00	0.00	3.66	0.52	0.52	0.00	5.24
700	60.704	0.00	0.00	0.94	0.00	2.83	0.94	0.00	0.00	4.72
706	60.898	0.00	2.05	0.00	2.05	2.11	0.00	0.00	1.16	7.37
712	61.091	0.00	0.00	0.00	0.00	1.89	1.89	0.00	0.94	4.72
718	61.285	0.00	0.00	0.00	0.00	5.56	0.00	0.00	3.33	8.89

Core depth (cm)	Cal. Age (kyr BP)	<i>Bulimina aculeata</i>	<i>Bulimina alazanensis</i>	<i>Bulimina marginata</i>	<i>Bulimina striata</i>	<i>Bulimina costata</i>	<i>Praeglobobulimina spinescens</i>	<i>Protoglobobulimina pacifica</i>	<i>Protoglobobulimina pupoides</i>	<i>Protoglobobulimina (%)</i>	Total buliminids
724	61.479	0.00	0.47	0.47	3.77	9.43	0.00	0.00	0.94	15.09	
730	61.672	0.00	0.72	0.00	0.00	7.97	0.00	0.00	0.72	5.07	14.49
736	61.886	1.69	0.85	0.00	0.28	4.24	0.00	0.00	0.00	0.56	7.63
742	62.060	0.98	0.00	0.00	0.49	3.43	0.00	0.00	0.49	0.49	5.88
748	62.253	0.66	0.00	0.00	0.66	2.63	0.00	0.00	0.00	2.63	6.58
754	62.447	0.61	1.83	0.00	0.61	1.83	0.00	0.00	0.00	2.44	7.32
760	62.641	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.00	1.01	2.02
766	62.834	0.00	0.00	0.00	0.00	1.11	0.00	0.00	1.11	0.00	2.22
772	63.028	1.79	2.68	0.00	0.00	0.00	0.00	0.00	0.00	5.36	9.82
778	63.222	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.72	1.72
784	63.415	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.41	1.41
790	63.609	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
796	63.803	0.00	2.13	0.00	0.00	6.38	0.00	0.00	0.00	2.13	10.64
802	63.996	0.00	1.67	0.00	1.67	1.67	0.00	0.00	0.00	1.67	6.67
808	64.190	0.00	0.68	0.00	0.00	5.44	0.00	0.00	0.68	0.68	7.48
812	64.319	0.00	1.02	0.00	0.00	2.04	0.00	0.00	1.02	0.00	4.08
818	64.513	1.45	0.00	0.00	0.00	5.80	0.00	0.00	0.00	0.00	7.25
824	64.706	0.00	2.05	0.00	1.37	4.11	0.00	0.00	0.00	0.00	7.53
830	64.900	0.00	5.33	0.00	2.00	4.00	0.00	0.00	0.00	0.67	12.00
836	65.094	0.00	3.33	0.00	1.33	10.00	0.00	0.00	0.00	1.33	16.00
842	65.287	0.00	1.20	0.00	1.20	13.25	0.00	0.00	0.00	1.20	16.87
848	65.481	0.98	4.90	0.00	7.35	13.24	0.00	0.00	0.00	0.49	26.96
854	65.672	0.86	1.72	0.00	3.59	12.93	0.00	0.00	0.72	0.86	20.69
860	65.857	0.00	2.74	0.00	0.68	9.59	0.00	0.00	0.00	2.74	15.75
866	66.042	0.00	1.82	0.00	1.82	5.45	0.00	0.00	0.00	0.00	9.09
872	66.227	0.00	3.74	0.00	0.93	8.41	0.00	0.00	0.00	6.54	19.63
878	66.412	1.00	5.56	0.00	0.00	19.06	0.00	0.00	0.78	4.17	30.56
884	66.597	0.00	3.85	0.00	0.00	16.35	0.00	0.00	0.00	0.96	21.15
888	66.720	1.37	2.03	0.00	1.68	7.85	0.00	0.00	0.00	0.76	13.69
894	66.905	0.76	3.03	0.00	1.76	6.06	0.00	0.00	0.00	0.52	12.13
900	67.282	2.30	2.30	0.00	0.00	9.74	0.50	0.50	0.50	0.90	16.24
908	67.913	4.29	3.64	1.33	1.00	10.56	0.96	0.33	0.33	2.64	24.75
914	68.386	7.69	0.00	2.28	0.00	8.97	1.00	0.56	0.56	2.56	23.07
920	68.859	5.24	1.81	0.00	0.00	6.85	0.21	0.40	0.40	4.84	19.36
926	69.332	0.00	0.00	0.00	3.03	0.00	0.00	0.00	0.00	3.03	6.06
932	69.897	0.00	0.00	0.00	0.00	9.09	0.00	0.61	0.61	1.82	11.52
938	70.462	1.85	1.85	0.00	1.85	5.56	0.00	0.00	0.00	1.85	12.96
944	71.027	0.00	0.00	0.00	0.00	3.96	0.00	0.00	0.00	0.00	3.96
948	71.404	12.93	1.86	0.00	0.00	0.00	0.00	0.00	0.29	1.29	16.38
952	71.781	16.99	0.33	0.00	1.31	1.63	0.00	0.33	0.33	0.65	21.24
960	72.534	3.98	0.00	0.00	0.00	1.14	0.00	0.00	0.00	3.41	8.52
964	72.911	1.60	0.00	0.00	0.00	1.60	0.00	0.80	0.80	2.40	6.40