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Late Quaternary Ostracoda From a Core in the Weddell Sea, Antartica

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Abstract - Fifty-nine samples from a 560 cm gravity core of late Quaternary age (PS1003-2), collected at a depth of 2796 m in the Weddell Sea, were examined for Ostracoda. The fauna was sparse but, from a total of 556 valves, the rather low diversity fauna of 19 species belonging to 11 genera and 3 families was identified. The study is principally concerned with species diversity, originations and extinctions, inter-relationships between species and the relationship of the fauna to different water masses. With respect to species diversity and origination/extinction patterns, two distinct phases are apparent: an initial diversification (originations only), followed by a phase of overall stable diversity (originations approximately matched by extinctions). The ostracod fauna is closely comparable to that described by authors as typical of North Atlantic Deep Water but is actually from the Antarctic Bottom Water (AABW). Two of the principal constituent species *Henryhowella dasyderma* (Brady) and *H. asperrima* (Ruess) seem to be mutually exclusive within the core. Changes in the fauna through the core seem to be related to climatic cycles.

Key words - Ostracoda, late Quaternary, Weddell Sea

INTRODUCTION

The pioneering work on deep sea biology was undertaken by the "Challenger" expedition in the late 1880's and later expeditions up to the 1920's and these provided our first knowledge of Lower Bathyal and Abyssal Ostracoda. Research on fossil deep-sea Ostracoda began in earnest with the Deep-Sea Drilling Project (D.S.D.P.) in the late 1960's. It was not until 1987 that the Ocean Drilling Project (O.D.P.) reached Antarctic waters. Between January and March of that year, Leg 113 of the O.D.P. drilled sites 689 to 697 in the Weddell Sea, providing important geological information on Cainozoic strata, particularly sedimentology, geophysics and palaeontology. However, no study of the deep-sea Ostracoda from the area was forthcoming. Studies of the microfossils of short cores from elsewhere in the Antarctic have been confined to areas of shelf depth (i.e. Rathburn *et al.*, 1997).

The deep-sea environment is often regarded as an inhospitable, 'empty' environment with many features militating against the existence of a diverse fauna. Disadvantages of the abyssal and bathyal regions include cold temperatures (0-4°C for the abyss and 4-8°C for the bathos), high pressure, lack of light and possible dissolution of shell material (Whatley, 1983). Advantageous factors are the deep-sea's very stability, which is probably comparable with any other environment on Earth. Whatley (1983) also outlined the stable nature of the deep-sea; low energy levels, no diurnal or seasonal variations in temperature, salinity etc. and the almost constant rain of nutrient rich material from above. On the whole, the advantages seem somewhat to outweigh the disadvantages.

The Weddell Sea constitutes a large embayment of the Antarctic continent to the south of the Atlantic Ocean and off Queen Maude Land (Fig. 1). Its eastern part has been surveyed in detail by several expeditions of the German research vessel *Polarstern* (e.g. Fütterer, 1987, 1988; Miller & Oerter, 1990). As a consequence, the bottom topography is particularly well known. The slope is divisible into 5 major morphological units. The partly overdeepened continental shelf has a maximum water depth of between 300 and 400m and a distinct shelf break. The upper slope is very steep and narrow with inclinations up to 16°. The transition to a more gently inclined midslope bench occurs from west to east in decreasing water depths between 1700m and 1200m. The bench is about 50 to 100km wide and dips seaward at 1.5°. The lower slope is characterized by the steep, cliff-like Explora Escarpment.

Grobe *et al.*, (1990) and Grobe & Mackensen (1992) demonstrate from other Quaternary cores in the area that, in response to Pleistocene climatic cycles, the Quaternary sediments record changes in the hydrographical regime which were caused by the retreat and advances of ice shelves, changing sea ice cover and the injection of NADW (North Atlantic Deep Water) into the CDW (Circumpolar Deep Water). The present day sedimentary environment on the shelf is determined by the Antarctic Coastal Current which transports very cold, low salinity water masses southwestward as ESW (Eastern Shelf Water, Foldvik *et al.*, 1985). The upper slope, down to about 2000m, is bathed by the relatively warm Weddell Deep Water (WDW) and the modified WDW. In the general area of the core, the continental terrace and upper parts of the lower slope between about 2000m and 4000m are influenced by the Antarctic Bottom Water (AABW), wheras the colder Weddel Sea Bottom Water (WSBW) occurs below 4000m (Grobe *et al.*, 1990 and refs.)

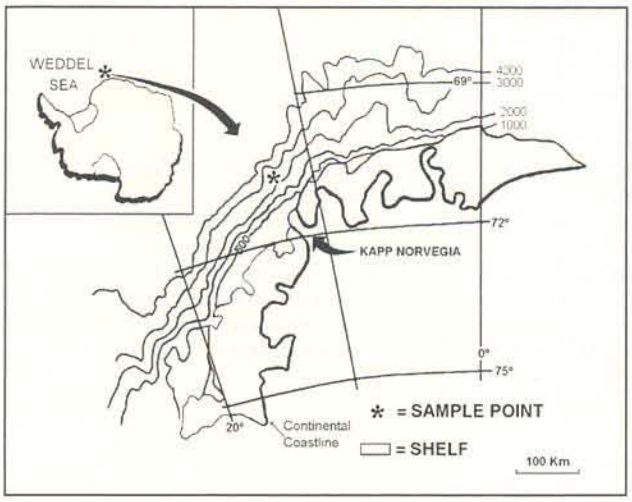

Figure 1. Map of the Kapp Norvegia region of the Weddell Sea with an inset of the Antarctic continent. Depth contours (in metres), with the location of gravity core PS1003-2 on the continental slope being indicated by an asterisk labelled 'sample point'. The gravity core was taken at 70° 36' 80" S, 13° 57' 80" W.

A major misconception concerning the deep sea is the supposed low diversity of its animal life. Work on deep-sea Ostracoda has not been prevalent until the last twenty years and then only confined to a small number of workers who often specialize. For example, Benson has largely concentrated on the ornate Trachyleberididae and Thaerocytheridae and, similarly, Peypouquet has given greatest emphasis to the Krithidae. In the past 18 years or so, however, there has been a shift by most ostracod workers towards wider studies of the whole fauna, including its diversity, distribution and evolution. Examples include Whatley (1983), Whatley and Ayress (1988), Coles (1990), Coles (1990) and Whatley (1993). It is due to these recent, more comprehensive studies that the true, surprisingly high, diversity of the Ostracoda of the deep benthos has become apparent.

Few studies of deep sea Recent or fossil benthonic Antarctic Ostracoda are available. Most of our knowledge of the Cainozoic and Recent ostracod faunas of this region are from deposits around the fringes of the Antarctic continent (Blaszyk, 1987; Briggs, 1979; Chapman, 1916, a, b, c; Gou & Li, 1985, Setty, 1984) or mainly from the continental shelf, (Benson, 1964; Brady, 1880, 1907; Chapman, 1919; Daday, 1908, 1913; dell, 1972; Hartmann, 1985, 1986, 1987, 1988, 1989, a, 1990, 1991, 1992, 1993, 1994, 1997; Maddocks, 1990; Müller, 1908, 1912; Neale, 1967, Osorio, 1985; Schornikov, 1982, 1987; Scott, 1912; Sissingh, 1970; Whatley *et al* 1987, 1988, in press). Among these papers relatively few deal with the deep sea, such as Whatley *et al.*, (1987, in press) and Hartmann (1988, 1994).

Certain studies of Atlantic Cainozoic deep sea Ostracoda, such as those by Benson & Peypouquet, (1983); Whatley & Coles, (1987); Coles & Whatley, (XXX); Balman, (1998) and works concerning the relationship of ostracods to water mass in the Atlantic (Dingle *et al.*, 1989; Dingle & Lord, 1990) and the Pacific (Rathburn *et al*, 1997, Ayress *et al.* 1997).

The study concentrates on analyses of the following four aspects of the fauna:

i. Changes in the specific diversity.
ii. Significance of first and last appearences within the core.
iii.Inter-relationships between different species.
iv. Relationship of the Ostracoda to water mass.

MATERIALS AND METHODS

The material comprised samples from a 560cm gravity core (PS1003-2) taken at 70° 36' 80" S, 13° 57' 80" W, off Kap Norvegica at a depth of 2796m, at about mid-slope. The material was collected during a cruise of the Polarstern in the southern summer of 1983 by workers studying palaeoclimatic changes at the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven Germany. The material was provided as sieved sediment fractions from samples that had been taken at regular 10cm intervals (apart from 248cm, 254cm, 262cm, 388cm and 395cm). Each sample had been sieved into five different size fractions:

	Sieve Sizes (approx.)	
1	2000-1000 µm	16
2	1000-500 µm	30
3	500-250 µm	60
4	250-125 µm	120
5	125-63 µm	240

The samples were basically of pelagic material with some benthonic Foraminifera, Ostracoda and dropstones. No lithological variations were noted in the samples and the lack of lithological variation in the core is noted by Grobe (lit. comm., 1994). Fractions 3 and 4 were picked totally for Ostracoda; while fractions 1 and 2 were mostly dropstones and 5 was too fine and was barren.

An Excel Graphics package was used to construct the graphs and tables and specimen identification was aided by the use of a Cambridge 120 S.E.M. and a Projectina microscope and all specimens are deposited in the Micropalaeontology Museum of the Geology Department, University of Wales Aberystwyth under the catalogue numbers prefixed RGR.WEDDELL.

THE AGE OF THE CORE

To the knowledge of the authors, no geochronological dating was attempted on core PS 1003-2. The low levels of calcium carbonate in the cores are the reason given by Grobe and Mackensen (1992) for the general absence of dating of cores taken in this area. However, they quote a core (PS1388), which is from Lat. 69°033'S; Long. 5°883' W and from a PDWD of 2517m and which contained enough foraminiferal tests to elucidate its stable isotope record. Although the core suffered somewhat from diagenesis, it is the only one to that date from the Antarctic continental margin spanning the last 300,000 years which can be correlated in detail with the global isotope stratigraphy. Other cores suffer from insufficient calcium carbonate and/or from high levels of diagenetic dissolution.

In the present core no lithological changes were noted, although in cores from the same general area and from similar water depths, lithological changes were noted which Grobe & Mackensen (1992) related to isotope events and were thus able to provide a stratigraphy and geochronology for each core on this basis, aided by calculations concerning rate of sedimentation. Sedimentation rates are generally highest near the continent and diminish downslope and oceanwards.

Grobe (lit. comm. 1994) reveals that, by comparison with other cores taken in the area (none of which contained Ostracoda), PS1003-2 contains the entire Quaternary without any major hiatuses. He goes on to state that "... As the corresponding ODP-sites have shown (Leg 113, Site 693), carbonate of that amount is found only in Quaternary sediments, the content varying with the climatic cycles. In PS1003-2 sedimentation rate is too low (about 3-4mm/ka) to show these variations or to give a good isotope signal, also because of the mean sampling distance of 10 cm. Thus only a general stratigraphic range can be given...".

RESULTS

556 valves were found but no articulated carapaces. The number of valves of each species were counted, regardless of their sex and age and, of the fifty-nine samples, five were barren: 50cm, 80cm, 460cm, 500cm and 510cm. Due to the small number of specimens, the number of valves counted for each species includes males, females and juveniles. From these data, the results are presented in a number of different ways to illustrate different characteristics of the fauna. Figure 2 illustrates the stratigraphical distribution of the taxa, providing information on, for example, the range of the species and first and last appearances within the core. The genus *Krithe* was not speciated due to the presence of dominantly juveniles with undeveloped vestibula (classification is partly based on the vestibulum) and opaque valves which rendered speciation impossible.

A list of the species encountered in the study is given below:

Aversovalva hydrodynamica Whatley and Coles, 1987
Henryhowella asperrima (Reuss, 1850)
Cytheropteron antarcticum Chapman, 1916
Henryhowella dasyderma (Brady, 1880)
Cytheropteron carolinae Whatley and Coles, 1987
Legitimocythere acanthoderma (Brady, 1880)
Cytheropteron paucipunctatum Whatley and Coles 1987
Pennyella dorsoserrata (Brady, 1880)
Cytheropteron porterae Whatley and Coles, 1987
Pelecocythere galleta Whatley *et al.*, 1988
Cytheropteron tressleri Whatley and Coles, 1987
Poseidonamicus pintoi Benson, 1972
Dutoitella suhmi (Brady, 1880)
P. anteropunctatus Whatley *et al.*, 1986
Eucytherura calabra Cololongo and Passini, 1980
Pterygocythere mucronolatum (Brady, 1880)
Echinocythereis sp.
Saida sp.
Krithe spp.

COMPOSTION OF THE FAUNA

Nineteen species, belonging to 13 genera and 3 families (Trachyleberididae, Cytheruridae, Cytheridae) were identified and illustrated from the 556 valves counted. Fourteen species make up less than 5% of the total fauna with only 4 'species': *P. pintoi, H. asperrima, H. dasyderma* and *Krithe spp.*, each contributing more than 10%. The species are indicative of the deep-sea, having all been found at lower bathyal and abyssal depths in other studies. The Trachyleberididae are by far the most dominant family, with 8 species contributing 78.1% of the 556 valves, while the Cytheruridae, although, equally diverse, contributing 8 species belonging to .4 genera, have a much lower incidence of individuals.

SPECIES DIVERSITY

The diversity of an assemblage can be measured either as the total number of species present in the sample, or as diversity indices (e.g. Shannon-Weaver and Simpson's indices) when comparing assemblages from different sample sizes. The differences in volume between samples for this study were so negligible that diversity can, therefore, be counted simply as the number of species, i.e. Simple Species Diversity. Species diversity can be illustrated in two fundamentally different ways. Figure 2 illustrates the distribution of the various species through the core and shows how some species appear, disappear and then reappear. It is due to the presence of these Lazarus taxa, that there is a distinction between cumulative diversity and recorded diversity (Fig. 3). Cumulative diversity ignores any transitory absences, however long, so that a species is included at all intervening depths within its particular range whether it is actually present or not; i.e. cumulative diversity includes both Lazarus and recorded taxa. Recorded species diversity, on the other hand, only registers those species actually present in a sample.

With samples and data from the deep-sea, whichoften reflect low ostracod abundance, cumulative diversity is probably a better overall representation of species diversity trends than is recorded diversity (Whatley & Coles, 1991). It probably also minimises biases produced by variable sedimentary dilution, sample size and post-mortem changes. Both types of diversity have been plotted (Fig. 3) and the fundamental difference between them is immediately apparent. Note that in the following discussion, 1) diversity is described from the bottom of the core upwards and, 2) that had it been possible to speciate *Krithe*, then species diversity would have been higher throughout most of the core.

The recorded diversity at 560cm will obviously be the same as the cumulative diversity as it is the lowest sample. Following this, recorded diversity falls sharply and then continues to rise and fall due to the appearances, disappearances and reappearances of the Lazarus taxa, although with no readily discernable pattern. Cumulative diversity, however, gives a clearer picture of the diversity trends (Whatley & Coles, 1991) and the following discussion, therefore, only considers cumulative diversity. Following the sample at 560cm, there is a stepped increase in diversity with the appearance of *Dutoitella suhmi, Poseidonamicus pintoi* and *Henryhowella asperrima* at 480cm and *Krithe* spp, *Pelecocythere galleta* and *Cytheropteron antarcticum* at 395cm, 360cm and 290cm respectively. A diversity acme is reached between 290cm and 270cm, after which species begin to disappear, but these extinctions are offset by the appearances of new species which lead to a near plateau of species diversity.

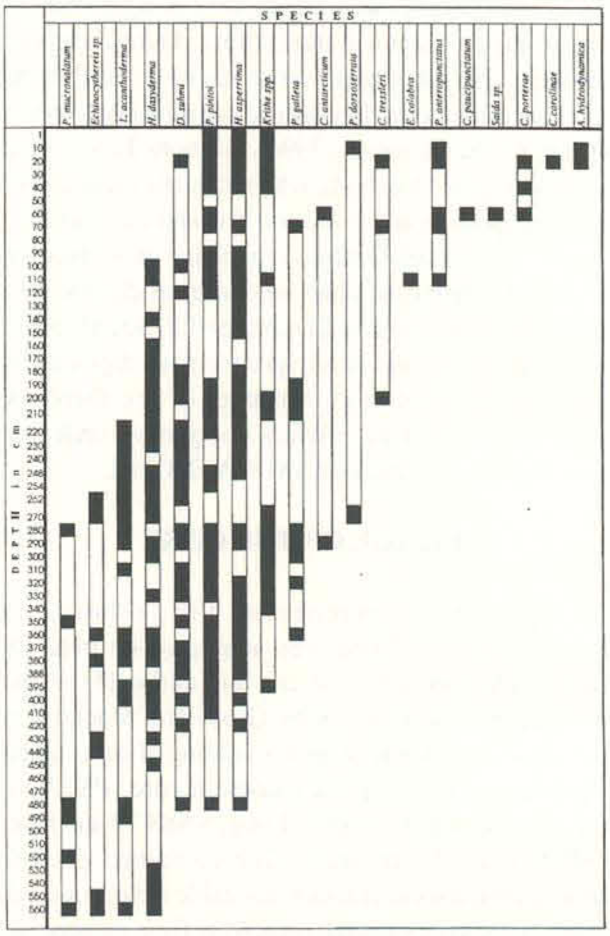

Figure 2 - Stratigraphical distribution of ostracod species within gravity core PS1003-2.

An initial and sustained rise in species diversity was also recorded in the Palaeogene of the North Atlantic by Whatley & Coles (1991) with a somewhat similar pattern of stepped increase. In the present study, the rise from an initial diversity of four species to an acme of ten occurs over 270cm, which equates to a relatively long time in the deep-sea, and is almost half the duration covered by this study. Sedimentation rates, of course, vary greatly. Since according to Grobe (lit. comm.1994), sedimentation rates in this core were between 3 and 4 cm per thousand years, at least 90,000

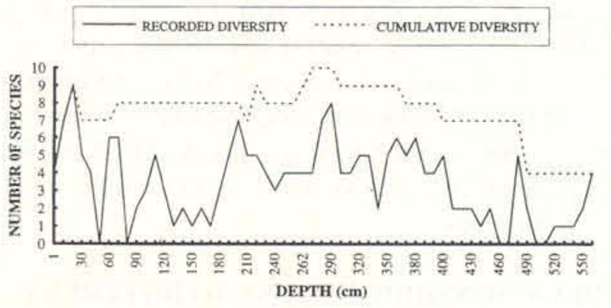

Figure 3 - Species diversity change within the core; both cumulative and recorded diversity.

years would be required for 270cm of largely biogenic sediment to be deposited. During this interval (560cm-290cm) no extinctions occured which, together with the increasing diversity suggests, as in the case of the Palaeogene of the North Atlantic (Whatley & Coles, 1991) the increasing exploitation by the Ostracoda of a newly available environment under relatively stable conditions. A diversity peak occurs near the mid-point of the core and the diversity patterns of the upper part of the core contrast markedly with those of the bottom half. Following the diversity acme, there are regular extinctions more or less equalled by originations, some of which, however, are the appearances of rare species in a single sample.

There are, therefore, two distinct phases of species diversity through the sequence. Initially, there is a steady rise in diversity from the bottom of the core to the acme at 290-270cm, which is followed by a phase of overall stable diversity. A number of species occur only in the second phase but these are rare and short ranging, while species such as *D. suhmi, P. pintoi, H. asperrima* and *Krithe* spp. range from the first phase to near the top of the core.

The cause of these two distinct diversity phases is unclear. What can bring about such species diversity change in deep sea ostracod faunas? Coles (1990) suggested two types of factors that can effect species diversity, "artificial" and "natural". Artificial factors include preferential preservation of thick ornate ostracods and the loss of more fragile taxa, varying sample size and different sampling methods. Natural factors are environmental controls and palaeoceanographical events. Of the environmental controls, temperature, depth, salinity and substrate are all primarily important factors. Diversity generally increases with higher temperatures, but the present study is confined to the mid slope where significant temperature variations during psychrospheric oceanic regimes are probably rather rare, although Chappel & Shackleton (1986) and Labeyrie *et al.* (1987) have produced evidence to suggest that bottom water temperatures in the abyss may vary between 1° to 3°C during glacial/interglacial cycles. We do not know, however, what effect this might have on the ostracod faunas, although from first principles one might argue for a diversity increase to be linked to temperature amelioration. However, the factors causing temperature change are likely also to be those responsible for changes in the nature and distribution of water masses which is discussed below.

As a general rule, in marine environments, diversity decreases with increasing depth, although the more varied the available niches the higher the species diversity is likely to be. For example, shallow water environments have a variety of niches including plant and animal hosts along with varying inorganic substrates, whereas niches for deep-sea ostracods on or in monotonous, largely biogenic substrate, for example. are somewhat limited. Palaeoceanographical events which effect the deep-sea are related to water mass changes and the pattern of deep water circulation. Transgressive and regressive phases seem to have little effect on abyssal faunas Whatley (1988, 1990).

TURNOVER OF SPECIES

As measured by recording the appearance and dissapearance of species throughout the core, two different phases of activity are apparent from Figure 4. As with species diversity, the earlier phase occurs from the bottom of the core to 290-270cm, and the second from this point to the top of the core. It is important to bear in mind that these originations and extinctions are unlikely to mark *in situ* evolution of the species; at best they probably signal migration into or emigration from the area, it is more likely that they are due to oceanic environmental changes forcing local, small scale immigration and migration.

Considering the small scale nature of this study, and the factors mentioned above, how far can these events be utilised? It is probably best to combine the species diversity and faunal turnover evidence together in an attempt to understand how they relate to one another. The initial phase is characterised by a more or less regular increment of new species with no extinctions, and this pattern is reflected in the initial stepped rise in the species diversity graph (Fig. 3). In the second phase, originations continue at a steady rate but become associated with and approximately

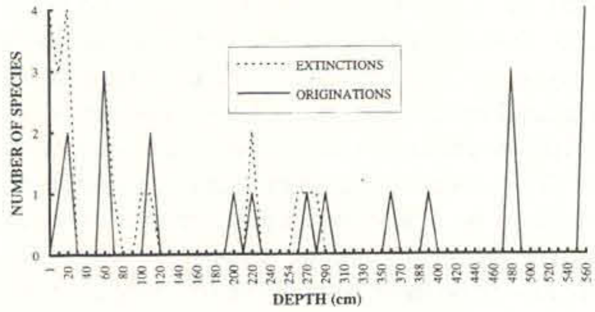

Figure 4 - Species originations and extinctions (appearances and disappearances) within the core.

balanced by extinctions, which coincide with or immediately follow the originations. Whatley & Coles (1987, 1991) and Whatley (1986, 1988), studying rather larger time intervals, noticed a lag effect in the relationship between origination and extinction peaks of deep-sea Ostracoda. The coincidence of these peaks is possibly related to the inabilty of existing species to survive alongside new species (Whatley & Coles, 1991) or the near instantaneous filling of a vacated niche. This second phase of combined originations and extinctions provides a better indication of what actually occurs in the top half of the core, with almost equal numbers of extinctions and originations.

RELATIONSHIP BETWEEN DIFFERENT SPECIES

The originations and extinctions discussed above and illustrated in Figure 4 were plotted using the total range, of the individual species encountered in this study. In Figure 5, a more detailed scrutiny is undertaken of temporary absences and possible interrelationships. In Figure 5 the relationship between *Henryhowella asperrima* and *Henryhowella dasyderma* has been plotted as the percentage constituted by each species of the total population in each sample. The first feature to note is the absence of *H. asperrima* from the bottom part of the core, where high percentages of *H. dasyderma* are recorded, while the opposite is seen in the upper part of the core. *H. dasyderma* occurs from the base of the core and disappears at 100cm while *H. asperrima* appears at 480cm and continues through to the top of the core. A second feature evident from the graph is the dominance of *H. dasyderma* when both species occur together in the same sample. *Henryhowella* occurs in forty-nine of the fifty-nine samples (76.3%) and *H. dasyderma* and *H. asperrima* occur together in only fourteen (23.7%), and in these fourteen samples *H. dasyderma* is usually dominant. From these data a mutually exclusive relationship between the two species is tentatively postulated. Neither author has encountered this phenomenon elsewhere, neither in practice nor in the literature surveyed to date. We regard these two taxa as distinct species rather than ecophenotypes.

RELATIONSHIP OF FAUNA TO DIFFERENT WATER MASSES

Foraminiferal assemblages have been recognised which are thought to be characteristic of particular deep water masses (Murray *et al.*, 1986). Attempts have subsequently been made to correlate ostracod faunas to water masses by Dingle *et al* (1989, 1990) and Dingle & Lord (1990), who studied faunas from the S.E. Atlantic Ocean and (from the literature), the entire Atlantic. Ayress *et al.* (1997) have studied the SW Pacific, and Southern oceans and compared them with the Atlantic.

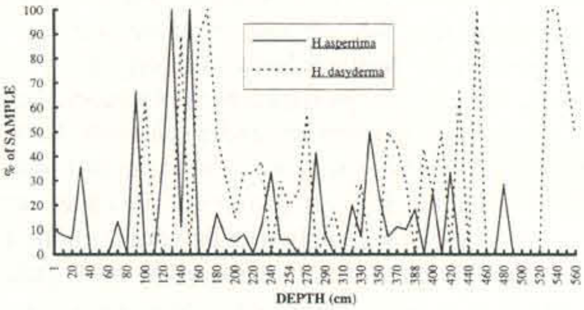

Figure 5 - Graph showing the stratigraphical distribution of *Henryhowella. asperrima* and *H. dasyderma* throughout the core, suggesting a possible relationship of mutual exclusion between the two species.

Dingle *et al.* (1990) used appearances, disappearances and changes in abundance to suggest faunal breaks which were then correlated to water masses. Although they suggested that the similarities in vertical structuring of the deep oceans were sufficient to allow a similar depth related ostracod succession world-wide, care must be taken because, as they indeed mentioned, the depth of faunal boundaries between assemblages varies according to the local structure of the water column. Whatley (1996) similarly warned that there was considerable local and regional variation in the depth distribution of individual species and Ayress *et al.*(1997) showed that, although the faunal relationships at the five localities they studied in the SW Pacific and Southern oceans exhibit certain similarities with those of the Atlantic (Dingle & Lord, 1990), very considerable discepancies were encountered with respect to the upper depth range of many of the taxa between one area and another. Ayress *et al.* (1997, p. 287) show that no single taxon is confined to a single water mass and state that "these differences must be taken into account if deep-sea ostracods are to be used as a reliable means to trace modern or reconstruct ancient watermass pathways between ocean basins."

Dingle & Lord (1990) proposed characteristic ostracod assemblages for the Antarctic Bottom Water (AABW) and the North Atlantic Deep Water (NADW). Using their data, the present ostracod fauna most closely resembles that of their NADW, notwithstanding the fact that it is actually the product of the Antarctic Bottom Water. The characteristics of the NADW fauna as determined by Dingle & Lord (1990) are shown below:

i. At all localities there was a threefold vertical subdivision of the fauna.

(a) Upper NADW *Krithe* Fauna: numerically dominated by *Krithe,* with *Henryhowella* and *Echinocythereis.*

(b)Lower NADW (upper part) *Poseidonamicus-Bosquetina* (=*Pterygocythere*) Fauna: same as (a) with addition of *Pterygocythere* and/or *Poseidonamicus.*

(c) Lower NADW (lower part) *Dutoitella* Fauna: same as (b) but with the addition of *Dutoitella.*

ii. *Krithe* usually dominant and *Henryhowella, Echinocythereis* or *Poseidonamicus* occupying secondary roles.

Dingle & Lord (1990) also listed other characteristic NADW species, and those species that are also found in the present core from the Weddell Sea are noted below:

Cytheropteron carolinae
Dutoitella suhmi
Cytheropteron paucipunctatum
Pennyella dorsoserrata
Cytheropteron porterae
Eucytherura calabra
Cytheropteron tressleri
Henryhowella asperrima
L.egitimocythyere acanthoderma
Krithe spp.
Poseidonamicus spp.

Although our Weddell Sea fauna is comparable to the NADW fauna of Dingle & Lord (1990), especially to the Lower NADW (lower part) *Dutoitella* Fauna, it is debatable whether NADW reaches as far south as this study (70° 36'S) except in interglacial intervals. The Weddell Sea is one of the primary sources of cold, dense bottom water for the world's oceans (Johnson, 1982). This AABW flows northwards into all the major basins of the Atlantic. In the South Atlantic the NADW lies between 1500-4000m and the AABW below 4000m, but in the Weddell Sea, where the AABW originates, it occurs at shallower depths (2000 to 4000m) which would embrace the range of water depth in which the sediments forming the present Quaternary core were deposited.

The characteristics of the AABW ostracod fauna of Dingle & Lord (1990) are very different from those the present study. Although the generic diversity is about equally low, in their fauna *Krithe* spp. and *P. mucronalatum* dominate, with poor representation of *Poseidonamicus* and *Dutoitella ,* which contrasts with this study. This is further evidence of the caution required when attempting to relate particular associations of Ostracoda to various water masses. The similarity between the present fauna from the AABW and that of the NAWD of Dingle and Lord and the dissimilarity of the present fauna and that alleged by those authors to be typical of the AABW, so complicates matters that, for example, in using ostracod associations as indices of water masses in the Tertiary, one could introduce grave errors into palaeoenvironmental reconstructions.

It is difficult to compare the present fauna with the AABW fauna of the Kerguelen Plateau of Ayress *et al.*, (1997) because their samples were washed over a 150μm sieve. However, their dominant taxa (they do not give a complete species list) were *Krithe* spp., *Philoneptunus* sp., *Legitimocythere acanthoderma, Henryhowella dasyderma, Poseidonamicus* spp., *Bathycythere audax, Dutiotella suhmi* and *Pterygocythere mucronalatum.* Of these, *Philoneptunus*, was hitherto thought to be restricted to Cainozoic to Recent shelf environments in Australasia (Whatley *et al.*, 1992) and, together with *Bathycythere audax*, is absent from the present fauna. The other notable difference is the absence from the AABW over the Kerguelen Plateau of *Henryhowella asperrima* which, although secondary to *H. dasyderma,* is nonetheless an important constituent of the Weddel Sea fauna.

DISCUSSION

On the basis of evidence from a single borehole, it is both difficult and rash to firmly attribute variation in the nature of the ostracod fauna throughout its length to environmental changes. This difficulty is exacerbated by the condensed nature of the sedimentary sequence in the core, where some 560cm represents the entire Quaternary, apparently without the presence of hiatuses. With a sedimentation rate of some 3 to 4mm per thousand years and a sampling interval of 10cm, it becomes virtually impossible to correlate ostracod 'events' in the core to palaeoclimatical/palaeoceanographical causes. None of the many other cores taken in the area have yielded Ostracoda in sufficient numbers to make their study worthwhile (Grobe, litt. comm., 19943), thereby precluding the possibility of correlating events from one core to another. It is not even possible to integrate the major features of change in the core with the models of late Quaternary climatic cycles in the area, as proposed by Grobe & Mackensen (1992).

The major features of the Ostracoda in the core are as follows:

1) The overall diversity is relatively low (but would have been higher if *Krithe* could have been speciated), with 19 species belonging to 11 genera and 13 families from a total of 556 specimens. The Trachyleberididae dominate with 8 species constituting 78% of the fauna.

2) Two phases in cumulative diversity are evident. The first phase, (560cm > 290cm), consists of a steady, stepped increase followed by a second phase of relatively stable diversity.

3) Two phases of different evolutionary activity are apparent from the originations and extinctions. The first phase consists of regular originations which is reflected by increasing species diversity. The second phase is one of almost equal numbers of originations and extinctions reflected in a more or less stable species diversity. The originations and extinctions are unlikely to mark *in situ* evolutionary activity, these 'events' are more likely to indicate local environmental changes and small scale migration in and out of the area.

4) A comparison of the distribution of *Henryhowlla. asperrima* and *H. dasyderma* suggests a mutually exclusive relationship between the species. The reason for this relationship is uncertain and has not been noted in any previous studies.

5) The Weddell Sea fauna is much more similar to the North Atlantic Deep Water (NADW) fauna of Dingle and Lord (1990), than it is to their Antarctic Bottom Water (AABW)> This is despite the fact that the present Weddell Sea fauna is a product of the Antarctic Bottom Water. This further questions the legitimacy of Dingle and Lord's (1990) typification of water masses by their ostracod faunas, especially when extended too far geographically and probably chronologically.

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