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A year round comparative study on the population structures of pelagic Ostracoda in Admiralty Bay (Southern Ocean)

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Abstract The population structures of the three dominant planktonic halocyprid Ostracoda species in Admiralty Bay (King George Island, Antarctic Peninsula) were followed throughout the course of a year in zooplankton samples collected once every three weeks from February 1993 to January 1994. The sampling was conducted at two stations: A in the central part of Admiralty Bay (400–0 m) and B in the entrance to the Bay from the Bransfield Strait (400–0 m). The samples were taken using a WP-2 net (square mouth opening of 0.196 m^2 and 200 μm mesh) hauled vertically from the bottom to the surface. Changes in the age structures of the populations of three species *Alacia belgicae*, *Alacia hettacra* and *Metaconchoecia isocheira* were tracked. Their population structures differed. The changes in *A. belgicae* suggested that it reproduces year-round, whereas both *A. hettacra* and *M. isocheira* probably complete their life cycles within a year. The cycle in *A. hettacra* probably starts earlier in the year than that of *M. isocheira*. Populations of *A. belgicae* and *M. isocheira* were more advanced in their development at station A, than at station B, but *A. hettacra* was more advanced at the latter. Advection appears to play a role in maintaining the populations in the shelf waters. Comparisons between populations in the shelf area (Admiralty Bay) and in open ocean waters (Croker Passage) show that the *M. isocheira* population is older in shelf water whereas the age structure of *A. belgicae* population is not influenced by the locality.

Keywords Antarctica · Admiralty Bay · Pelagic Ostracoda · Halocyprids · Life cycle · Seasonal changes

Introduction

Pelagic halocyprid Ostracoda are an important component of the mesozooplankton in Antarctic waters, locally occurring in high abundance (Boden, 1985; Fukuchi et al., 1985; Hopkins, 1985a; Boden & Parker, 1986; Foster, 1987, 1989; Blachowiak-Samolyk & Zmijewska, 1997). The importance of the role played by the pelagic Ostracoda in oceanic ecosystems, both in the Southern Ocean and other oceans has

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been not fully recognised. The geographical ranges of Southern Ocean Ostracoda and their vertical distributions are well described (Hillman, 1967; Deevey, 1978; Kock, 1992, 1993; Blachowiak-Samolyk & Zmijewska, 1995, 1997; Blachowiak-Samolyk, 1999; Blachowiak-Samolyk & Osowiecki, 2002; Chavtur & Kruk, 2003; Drapun, 2004; see also Blachowiak-Samolyk & Angel, 2004), but few studies have focused on their life cycles. Kock (1992, 1993) examined the population structure of halocyprids in the epipelagic zone near Antarctic Peninsula. Blachowiak-Samolyk (2001) reported on populations in deep water in the Croker Passage and Blachowiak-Samolyk & Osowiecki (2002) studied the influence of pack-ice on the age structure of the ostracods in the Scotia Sea.

Admiralty Bay is the site for an intensive international scientific programme, and the Antarctic Special Management Area is an appropriate basin for investigations of land-ocean interactions and their influence on the distributions and structure of coastal zone zooplankton communities. The inshore coastal areas are more productive and support more diverse pelagic communities than the open ocean waters, possibly because they are not subject to iron limitation (de Baar & Boyd, 2000). Previous zooplankton studies in Admiralty Bay have only examined copepods (Chojnacki & Weglenska, 1984; Zmijewska, 1993a) and krill (Kittel, 1980; Kittel & Presler, 1980; Rakusa-Suszczewski & Stepnik, 1980). Menshenina & Rakusa-Suszczewski (1992) presented a general overview of the seasonal cycles of the zooplankton communities based on a year-round investigation in the central basin. Freire et al. (1993) described the responses of the zooplankton communities of Admiralty Bay to the physical forcing of tides and winds. Kittel et al. (2001) examined the heterogeneity of zooplankton communities in the West Antarctic coastal ecosystem, and summarised the current state of knowledge of zooplankton in Admiralty Bay. Their studies were based on the same set of samples used in this study. However, the only previously published study of pelagic ostracods from Admiralty Bay was based on three samples collected in summer 1988/1989 (Blachowiak-Samolyk & Osowiecki, 2002).

These year-round samples from Admiralty Bay provide a unique opportunity to describe the annual life cycles of three dominant pelagic ostracod species - *Alacia belgicae, A. hettacra* and *Metaconchoecia isocheira*.

The aim of this paper is to verify the hypothesis that there are substantial differences between the populations of the three dominant halocyprid species inhabiting the central (station A) and outlet regions (station B) of Admiralty Bay. We also compare the age structures of the two species sampled from the shelf area of Admiralty Bay and open oceanic waters of the Croker Passage using published data (Blachowiak-Samolyk, 2001).

Study area

Admiralty Bay (area 120 km^2, maximum depth ~500 m) is the largest bay of King George Island. It opens into the Bransfield Strait via an eight km wide outlet. The Bay is fjordic in character and connects to a system of smaller inlets - the Ezcurra Inlet, the MacKellar Inlet and the Martel Inlet (Kittel et al., 2001). Pruszak (1980) and Lipski (1987) have described the physico-chemical environment of Admiralty Bay. The water in the Bay is well-mixed and lacks any well-defined halocline or thermocline (Szafranski & Lipski, 1982). However, close to the ice barriers, the upper 15–40 m of water column has relatively low salinity and temperature, and a higher oxygen content (Szafranski & Lipski, 1982). In summer surface salinities are low near the glaciers and freshwater inflows. Physical circulation in the Bay is driven by exchanges with the open water of the Bransfield Strait via deep inflows and surface outflows. The upper 100 m of the water column is exchanged every 1–2 weeks (Pruszak, 1980). In the centre of the Bay the seabed is rather even and depth increases steadily towards the outlet to >500 m. There are some ridges mostly at the entrances to the inlets. These are important features because they generate eddies in the inflows from the Bransfield Strait and cause of some localised upwelling.

Materials and methods

About 54 zooplankton samples were collected during the XVII Polish Antarctic Expedition of Polish Academy of Sciences to the *Arctowski* Station (1992–1994), using a WP-2 net (0.25 m^2 square mouth opening and 200 μm mesh). Zooplankton samples were collected at four locations within the Bay, with distinctive hydrological regimes (Fig. 1). Samples from two of these stations were selected for populations studies of the ostracods: station A in the central part of Admiralty Bay (62°08′ S; 58°26′ W) where the depth was 400 m and station B in the opening from the Bay into the Bransfield (62°12′30″ S; 58°22′ W, depth > 500 m) (Fig. 1).

The other two stations were sampled, H—a glacial lagoon in Herve Cove (62°11′ S; 58°32′20″ W) with depth 18 m (see Sicinski et al., 1996) and C, in Cardozo Cove inside Ezcurra Inlet (62°10′S; 58°35′ W), where the maximum depth was 150 m. The samples contained too few ostracods, and although they have been analysed the data provide no innovative insights.

At stations A and B 400–0 m vertical hauls were collected every three weeks, between February 1993 and January 1994 (except for July). Each haul represented the zooplankton filtered from a nominal 100 m^3. All samples were preserved immediately in 4% seawater formalin buffered with sodium borate.

In the laboratory, all specimens of Ostracoda were sorted and identified from the samples. Determinations were based on the papers of Müller (1912), Sars (1928), Hillman (1969), Deevey (1978, 1982), Angel (1981) and Kock (1992), and sorted into development stages according to Hartmann (1968). All the species belonged to the family Halocyprididae, and have a life cycle consisting of six juvenile instars and a single adult stage. According to Hartmann (1968) these are designated increasingly A-6, A-5,...,A-1 and Ad (adult). The sexes of the three eldest instars, A-2, A-1 and Ad were determined. The age structures of the two most abundant species were compared by calculating the "mean population stage" index for each season. The index $\overline{S}$ modified by Kock (1992)

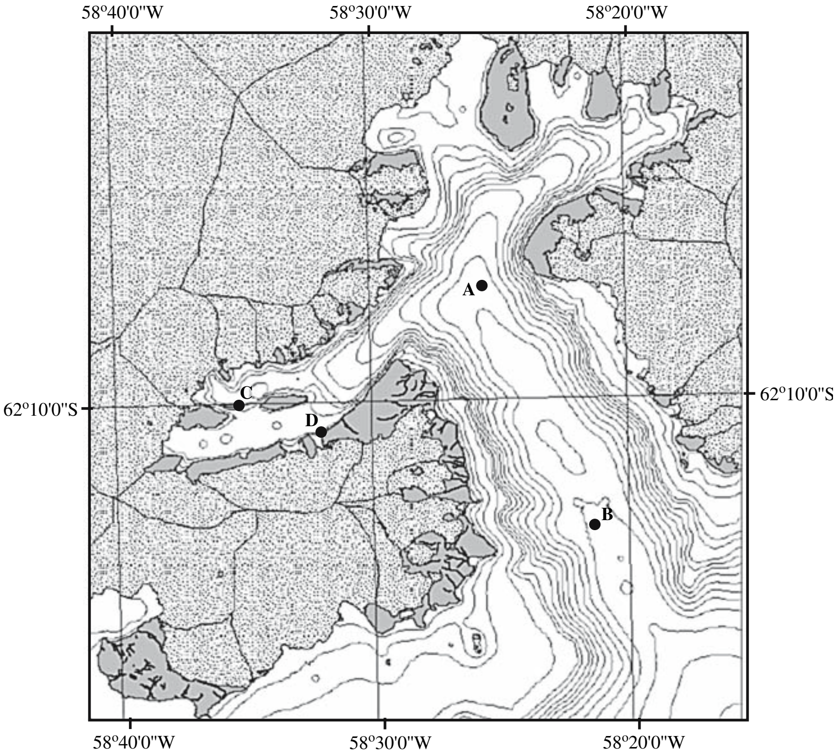

Fig. 1 Location of zooplankton sampling stations in Admiralty Bay

summarizes the relative abundances of developmental stages thus:

$$\overline{S} = \frac{N_{A-6} * 1 + N_{A-5} * 2 + N_{A-4} * 3 + N_{A-3} * 4 + N_{A-2} * 5 + N_{A-1} * 6 + N_{Ad} * 7}{N_{A-6} + N_{A-5} + N_{A-4} + N_{A-3} + N_{A-2} + N_{A-1} + N_{Ad}}$$

where $N_{A\text{-}6}$, $N_{A\text{-}5}$,..., N_{Ad} are the mean abundances of the discrete developmental stages. The ‘‘mean population stage’’ has a minimum of 1 when the whole population consists of the earliest A-6 instar and rises to a maximum of 7 when the population is entirely adult.

A multivariate analysis of the data matrix of indices for each species by season at the two stations has been conducted using the PRIMER package v.5 (Clarke, 1993). In addition Box Whiskers plots and the nonparametric Mann–Whitney *U*-test were carried out using the Statsoft software STATISTICA v. 6.

Results

The results focus principally on the population structures of three dominant species, *Alacia belgicae* (Müller, 1906), *A. hettacra* (Müller, 1906) and *Metaconchoecia isocheira* (Müller, 1906) (note Chavtur & Angel, in press are reclassifying the latter species in a monospecific genus) at stations A and B. All developmental stages except A-6 of *A. belgicae* and *A. hettacra* were sampled. Specimens of the earliest A-6 instar might have been extruded through the net's 200 µm mesh and so not retained. *Metaconchoecia isocheira* is even smaller and neither A-6 nor A-5 specimens were sampled. Herein instars A-6 to A-3 are referred to as the ‘‘younger’’ component of the population, and instars A-2 to Ad as the ‘‘older’’ component.

Seasonal changes:

(A) *Alacia belgicae* age structure

During autumn, winter and spring the population was dominated by the ‘‘younger’’ component (mainly A-3 instars) at both stations (Fig. 2). In summer, the ‘‘older’’ component of the population, consisting mainly of A-1 females dominated (~75%). Specimens of the A-5 instar were sampled at Station A, but the youngest instar sampled at station B was A-4.

(B) *Alacia hettacra* age structure

The *A. hettacra* population was dominated by the ‘‘older’’ component throughout the year (Fig. 2). In autumn, ~50% of the population at both A and B were A-2 females. The A-5 instar was only sampled at B in the autumn. In winter the proportions of the ‘‘older’’ component at A and B were respectively 75% and 70%. In spring only the older stages were present at station A and the species was absent from station B. During summer only developmental stages from A-3 to Ad occurred at station B (Fig. 2).

(C) *Metaconchoecia isocheira* age structure

The *M. isocheira* populations were dominated by adults (mainly females) in all seasons at both stations (Fig. 2). In autumn, the ‘‘older’’ component contributed 75% of the populations at both sites. In winter, the frequency of the pre-adult stage, A-1, increased at both stations. In spring and summer, the populations were dominated by adult females at both localities.

Dendrogram of double-root transformed abundances of each species' developmental stages in particular season distinguished two main groups: spring-summer and autumn-winter populations (Fig. 3). The only exception was spring (at station A) and summer (at station B) population structures of *A. belgicae*, which clustered together with autumn-winter populations of the three analysed species.

At the shallow station C (data not shown) the three species occurred seasonally—*M. isocheira* only during autumn and winter. The *A. belgicae* population was dominated by young instars, whereas the populations of *A. hettacra* and *M. isocheira* were predominantly older stages. Only single specimens of *A. belgicae* (from A-4 to Ad)

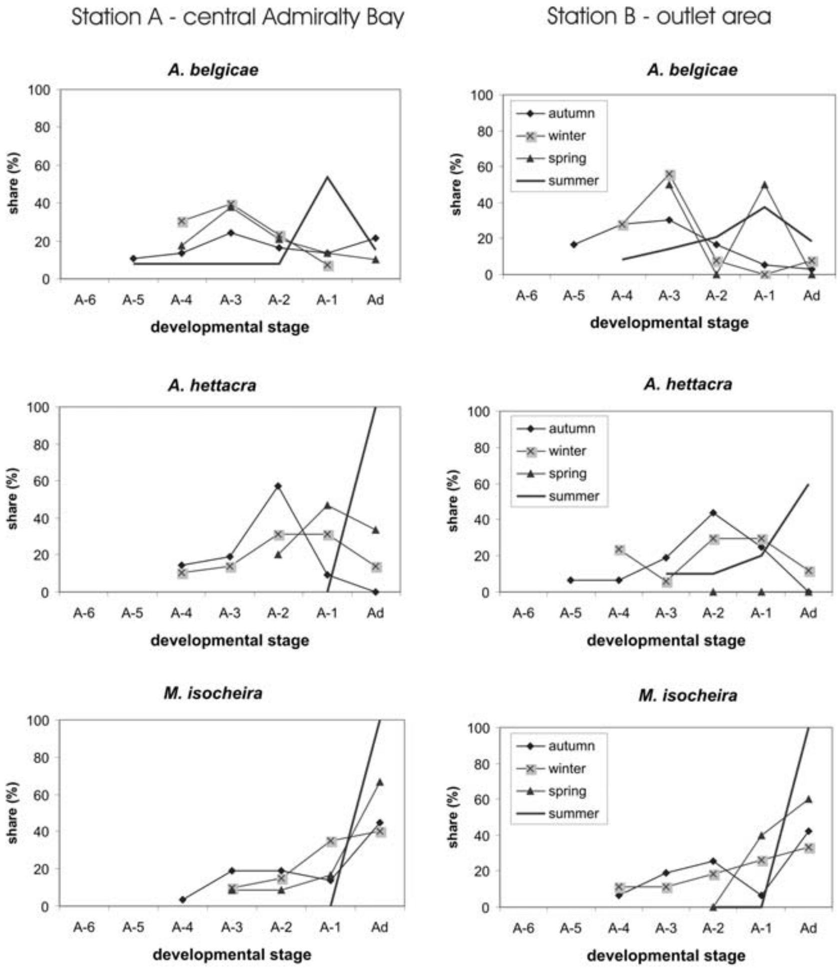

Fig. 2 Percentage composition of developmental stages in the populations of *Alacia belgicae*, *Alacia hettacra* and *Metaconchoecia isocheira* sampled at stations A and B in Admiralty Bay during various seasons

were sampled at station H in the winter-spring period.

‘‘Mean population stage’’ analysis

The ‘‘mean population stage’’ indices calculated for the populations of *A. belgicae, A. hettacra* and *M. isocheira* at the two main sites during each season are shown in Table 1.

The Box Whiskers plot (Fig. 4) illustrates the differences between the $\overline{\mathrm{S}}$ indices for the three species at the two sites during various seasons. The populations of *A. belgicae* and *M. isocheira* are older at the station A compared to those at B, whereas the opposite pattern emerges for *A. hettacra*.

The nonparametric Mann–Whitney *U*-test was used to verify whether ‘‘mean population stage’’ of the three species differs significantly between station A and station B. The results showed the differences are significant for all three species (*A. belgicae*: $P = 0.021$, $Z = -2.309$; *A. hettacra*: $P = 0.034$, $Z = -2.211$ and *M. isocheira*: $P = 0.029$, $Z = -2.165$).

An analogous Box Whiskers plot was calculated comparing data from Admiralty Bay (stations A & B) with those from the Croker Passage (station C) (Fig. 5). This analysis compares only

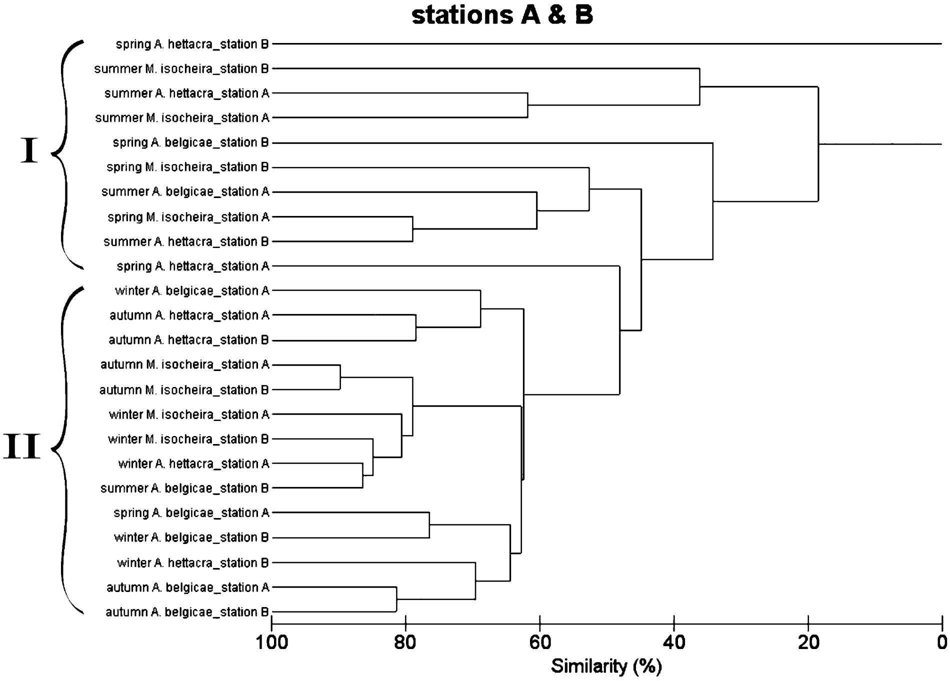

Fig. 3 Dendrogram (cluster) of double-root transformed data with two main groups: (**I**) spring-summer and (**II**) autumn-winter populations of *Alacia belgicae, Alacia hettacra* and *Metaconchoecia isocheira* at stations A and B of Admiralty Bay

A. belgicae and *M. isocheira*, which were described in the Croker Passage in autumn, winter and summer. It shows that the $\overline{S}$ indices increase towards shelf stations for *M. isocheira* whereas average $\overline{S}$ values were similar for *A. belgicae* in Admiralty Bay (station A) and the Croker Passage but lower at station B.

Table 1 "Mean population stage" for *A. belgicae, A. hettacra* and *M. isocheira* at stations A and B in Admiralty Bay

Investigated area	season	$\overline{S}$		
		A. belgicae	*A. hettacra*	*M. isocheira*
station A	autumn	4.7	4.6	5.8
	winter	4.1	5.2	6.1
	spring	4.6	6.1	6.4
	summer	5.4	–	7.0
station B	autumn	3.8	4.8	5.6
	winter	4.0	5.0	5.6
	spring	5.0	–	6.6
	summer	5.4	6.3	7.0

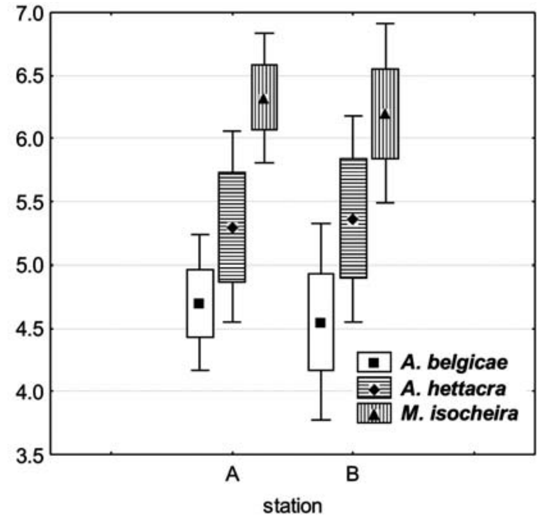

Fig. 4 Box Whiskers plot with differences of the $\overline{S}$ values for *A. belgicae*, *A. hettacra* and *M. isocheira* at the two sites (stations A and B) of Admiralty Bay. In this type of Box Whiskers plot, the smallest box in the plot represents the mean (central tendency) of the $\overline{S}$ values, while the dispersion (variability) among seasons is represented by ± 1 times the standard error (large box) and ± 1 times the standard deviation (SD) about the mean ("whiskers")

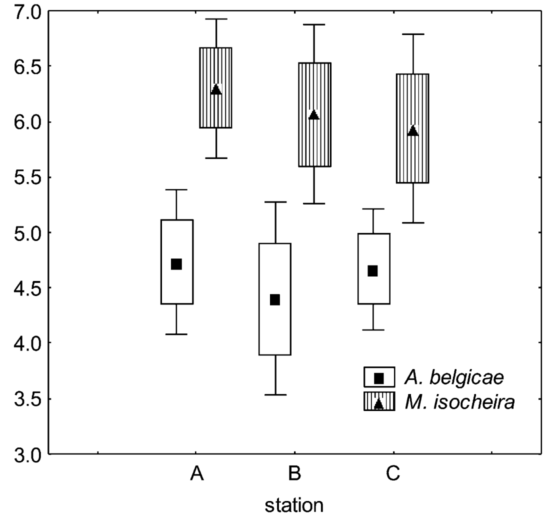

Fig. 5 Box Whiskers plot comparison between the $\overline{S}$ values for *A. belgicae* and *M. isocheira* at the two sites (stations A and B) of Admiralty Bay and Croker Passage (station C). For details see the explanation given for Fig. 4

Discussion

The only previous report of pelagic Ostracoda in Admiralty Bay was in general comments about zooplankton composition (Kittel et al., 2001). They found that the ostracods never attained very high abundances between February 1992 and January 1993, even so the group ranked third after Copepoda and Chaetognatha, in abundance and often in biomass. Frequencies of occurrence of both *A. belgicae* and *M. isocheira* oscillated between 92% and 93% in the upper 400 m at stations A and B, but were slightly lower for *A. hettacra* (71% and 53% at A and B respectively (Kittel et al., 2001). At station C, where the maximum depth was ~150 m, their frequencies were lower (*A. belgicae*, 57%, *A. hettacra* 38% and *M. isocheira* 36%). At the shallowest station H (depth ~20 m), only *A. belgicae* (38%) and *A. hettacra* (8%) occurred. Kock (1993) suggested that *A. belgicae* has a preference for the neritic zone, which is consistent with this species' high frequency of occurrences in Admiralty Bay. It is worth noting that this species was first described from samples collected through holes in pack ice during both the *Belgica* expedition (Müller, 1906) and the first *Discovery* expedition (Brady, 1907—identified as *C. inominata*). Plots of its geographical distribution based on all published data (Blachowiak-Samolyk & Angel, 2004) show that its range is closely associated with pack ice. Previous studies on distribution of *A. hettacra* (Siegel et al., 1992; Blachowiak-Samolyk & Zmijewska, 1995) have shown that it has a distinct preference for open oceanic waters, so its occurrence in rather low abundances in the shelf area of Admiralty Bay may be the result of advection of oceanic waters into the Bay. The higher frequency of *M. isocheira*, relative to *A. hettacra*, may result from its lack of any clear preference for a particular water mass (Deevey, 1982; Kock, 1993; Blachowiak-Samolyk, 1999). There are only about half the number of published records of *M. isocheira* compared to *A. hettacra* (see charts of Blachowiak-Samolyk & Angel, 2004) probably because of its much smaller size.

Only the upper 400-m of the water column could be sampled in Admiralty Bay, and this may have contributed to the three species' relatively low abundances and frequencies since they all have marked preferences for deeper water (Deevey, 1978, 1982). Kock (1992), sampling from 300–0 m, reported that the Ostracoda were inhabiting the lower epi- and upper mesopelagial. Whereas studies in the Bransfield Strait (Blachowiak-Samolyk, 1999) and the Croker Passage (Blachowiak-Samolyk & Zmijewska, 1997) have shown that all three species prefer mesopelagic depths (down to about 700 m).

A common characteristic of the bathymetric ranges of Ostracoda at high latitudes is their absence in the surface waters (Angel & Fasham, 1975, Moguilevsky & Angel, 1975). The rarity of Ostracoda at the two shallowest stations C and H in Admiralty Bay supports these observations. However, halocyprids do occur quite abundantly in the epipelagial and neuston at low latitudes (e.g. Moguilevsky & Angel, 1975).

Little attention has been paid to the life cycles of halocyprid ostracods in the Southern Ocean, because of a paucity of year-round sampling from a given area. Indeed very few such studies have been carried out anywhere. Ikeda & Imamura (1992) and Ikeda (1990, 1992) investigated the life cycle of a mesopelagic species *Conchoecia pseudodiscophora* in the Sea of Japan. Hartmann

(1968), Hillman (1969), Kock (1992), Blachowiak-Samolyk (1999, 2001) and Blachowiak-Samolyk & Osowiecki (2002) studied their developmental patterns in the Southern Ocean. Kock's (1992) study was the most thorough, and he based his interpretations on analyses of the ontogenetic migrations of Antarctic euphausiids, chaetognaths and copepods. He developed a model of life cycles of *Alacia belgicae* and *A. hettacra*, based on samples collected mainly from 200–0 m. The net he used had a relatively large mesh size (320 μm) so his samples did not collect the youngest instars (A-6, A-5). He observed that the mature stages, particularly adult females, were more abundant over deeper water. He hypothesized that, like many other high latitude species, the ostracods undertake both ontogenetic and seasonal vertical migrations. Angel (1977, 1979) observed the bathymetric ranges of adult females of several species North Atlantic halocyprids extended far deeper than other stages and postulated this could be the result of ontogenetic migrations.

Kock's (1992) model linked the distributions he observed with circulation in the vicinity of the Antarctic shelf. The maturing instars of *A. belgicae* and *A. hettacra* migrate up into shallower water in spring, where they are advected offshore by the general drift of the Antarctic Surface Waters. In autumn the process is reversed; the animals migrate down into deep water to overwinter as juvenile instars, where they are advected onshore in the deep circulation. In autumn in the Croker Passage the younger instars of *A. belgicae* and *M. isocheira* are almost entirely restricted to the deepest layers confirming the ontogenetic migrations of these species (Blachowiak-Samolyk, 2001). However, Kock's model may prove to be simplistic because it fails to take into account the presence of *A. belgicae* at shallow depths (<30 m) under pack-ice in winter (Müller, 1906; Brady, 1907).

The year-round age structure of *A. belgicae* populations in Admiralty Bay suggests it breeds throughout the year, hence the predominance of the younger instars during all seasons, except summer. During the autumn *A. belgicae* populations are dominated by younger instars both in Admiralty Bay (at station B - this study) and in the Croker Passage (Blachowiak-Samolyk, 2001). In winter the younger instars of *A. belgicae* continued to dominate in both areas. However the percentage of adults increased in the open waters (Blachowiak-Samolyk, 2001), but remained low in the shelf area (this study). In spring, at station A the population structure of *A. belgicae* was similar to that in winter, but the frequency of adults increased. This is consistent with earlier observations in the centre of the Bransfield Strait in spring 1986 (Blachowiak-Samolyk, 1999), and also near the Antarctic Peninsula in spring 1987 (Kock, 1992). The previous conclusion that *A. belgicae* reproduces year-round was based on observations in the open waters of the Croker Passage (Blachowiak-Samolyk, 2001), and is confirmed for the shelf zone of Admiralty Bay by the constant relatively low "mean population stage" indices observed throughout the year (Table 1 and Fig. 5) as well as by clustering spring-summer population of *A. belgicae* together with autumn-winter populations of all three analysed species (Fig. 3).

Zmijewska (1993b) concluded that the omnivorous copepod *Metridia gerlachei* also reproduces continuously, and its trophic flexibility (Hopkins, 1985b) enables it to maintain large populations in Antarctic waters. Hopkins showed that in the Croker Passage (1985b) the ostracods are mostly omnivorous, detritus-feeding animals making them independent of any single food source.

Relatively little is known about the population structure of *A. hettacra*. Throughout the year its age structure is dominated by the older instars confirming the observations of Kock (1993) in the 1989/1990 summer near the Antarctic Peninsula and in the Scotia Sea in the upper 300 m layer (Blachowiak-Samolyk & Osowiecki, 2002). As the distributional charts for this species suggest (Blachowiak-Samolyk & Angel, 2004), *A. hettacra* occurs throughout the oceanic regions of the Southern Ocean. So its presence in the coastal waters of Admiralty Bay probably results from, and hence indicates, advection of open ocean waters into the Bay (c.f. Pruszak, 1980). Thus its absence from station B in the spring may indicate there had been no recent influx of oceanic water into the Bay. Kock's (1992) model also implies that its seasonal absence from Admiralty Bay may result from the interaction between its life cycle and exchanges of water between the Bay and the open ocean. Box Whiskers plots (Fig. 4) also imply that *A. hettacra* might be influenced by Admiralty Bay (local) circulation more than the other two species. The high "mean population stage" of 6.3 observed in summer suggests that it was breeding at that time and that its life-cycle is essentially annual. A similar population index of 6.2 was observed both in the vicinity of Admiralty Bay in summer 1988/1989 (Blachowiak-Samolyk & Osowiecki, 2002) and near the Antarctic Peninsula in summer 1987 (Kock, 1992). However, in the same season in the Scotia Sea its index was 4.9 (Blachowiak-Samolyk & Osowiecki, 2002). Possibly maturation is slower in the open oceanic waters compared to shelf regions. If such a delay does occur, it could lead to separation of the breeding populations and hence become a mechanism for speciation. The lowest values of *A. hettacra* population indices (Table 1) were observed in autumn in Admiralty Bay, indicating recruitment by a new generation spawned in the summer. However, until information of the developmental rates for the various instars is available (c.f. those obtained by laboratory studies for *D. pseudodiscopora* by Ikeda (1992)), it will be difficult to interpret these data.

The populations of *M. isocheira* in Admiralty Bay were dominated by adults throughout the year. The dominance of adults in summer was in marked contrast to the two *Alacia* species. Similar population structures were observed in the upper 300 m of the Scotia Sea in summer 1988/1989 (Blachowiak-Samolyk & Osowiecki, 2002) and near the Antarctic Peninsula (Kock, 1992). In summer in the open waters of the Croker Passage, adults still dominated the populations but juvenile instars were also present (Blachowiak-Samolyk, 2001). The occurrence of A-4 and A-3 instars in autumn-winter in Admiralty Bay, suggests the species is reproducing there in summer. Along the Antarctic Peninsula Kock (1992) observed that adults were predominant at 500–300 m, but that stage A-2 were dominant at 700–500 m, implying a pattern of ontogenetic migration. The dominance of adult *M. isocheira* during winter in Admiralty Bay was consistent with wintertime observations at the 425–175 m depth interval in the Croker Passage (Blachowiak-Samolyk, 2001). Adults and A-1 individuals of *M. isocheira* reached their highest proportions in Admiralty Bay. In the spring of 1986 A-5 instars of *M. isocheira* were predominant at the centre of the Bransfield Strait (Blachowiak-Samolyk, 1999); at that time the stratified sampling showed that the mature component of the *M. isocheira* populations was at 1000–500 m, and the juvenile instars were in deeper waters (Blachowiak-Samolyk, 1999). Kock (1992) made similar observations off the Antarctic Peninsula. The mean population stage indices for *M. isocheira* in Admiralty Bay were highest in summer, implying that reproduction began during this season. The indices were similar in autumn and winter in Admiralty Bay, so either development is very slow or it had ceased possibly because the halocyprids entered a dormant state analogous to diapause in copepods. The mean population stage analysis implies that *M. isocheira* completes its life cycle within one year, and onset of its reproduction is delayed until summer in the Bay, whereas in the open waters of the Croker Passage it is initiated in spring (Blachowiak-Samolyk, 2001). The sequence of reproduction seems to be confirmed also by higher average $\overline{S}$ indices for *M. isocheira* at the shelf stations in comparison with open waters (Fig. 5).

Statistical analysis (the nonparametric Mann–Whitney *U*-test) demonstrates that the three halocyprids populations' indices differ significantly between the inner region (station A) and outlet (station B) of Admiralty Bay. On the other hand, Box Whiskers plots (Fig. 4) illustrate similar trends in the *A. belgicae* and *M. isocheira* populations (older populations at station A), contrary to *A. hettacra*.

Conclusions

1. The population structures of the three halocyprid species *A. belgicae*, *A. hettacra* and *M. isocheira* in Admiralty Bay differ between the two sites.
2. *Alacia belgicae* breeds continuously throughout the year, and its longevity probably exceeds one year.

3 *Alacia hettacra* and *M. isocheira* have similar life cycles that are most likely completed within one year, but reproduction of *A. hettacra* seems to be initiated in autumn, earlier than in *M. isocheira*.

4 Local factors play a role in breeding. At station A reproduction is initiated earlier in *A. belgicae* and *M. isocheira* than at station B, but advection also plays a role.

5 The seasonal absence of *A. hettacra* in spring in the outlet area towards the Bransfield Strait, and in summer in the central part of Admiralty Bay, implies that it is an expatriate species in shelf water.

6 Population development indices $\overline{S}$ indicate that in the shelf area of Admiralty Bay *M. isocheira* populations are older than in the open waters of the Croker Passage, whereas *A. belgicae* populations are similar (i.e. independent of locality).

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