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## Organic carbon (DOC and POC) in waters of the Admiralty Bay (King George Island, South Shetland Islands)\*)

**ABSTRACT:** Studies on the quantity and distribution of organic carbon (DOC and POC) in the water of the Admiralty Bay were conducted between 20 December 1978 and 15 February 1979. The C org. content ranged from 1.62 to 3.22 mg·l<sup>-1</sup> for DOC and from 0.22 to 0.65 mg·l<sup>-1</sup> for POC. Maximal DOC amounts were observed at the depth 25—50 m (on average about 2.50 mg·l<sup>-1</sup>) and in chosen regions of surface waters of the Admiralty Bay, among others, in the vicinity of a large penguin colony.

Mean content of DOC in waters of the Admiralty Bay (about 2.26 mg·l<sup>-1</sup>) is lower as compared to mean DOC content in waters of the Bransfield Strait (about 4.12 mg·l<sup>-1</sup>).

**Key words:** Antarctic, Admiralty Bay, dissolved and particulate carbon

### 1. Introduction

Organic carbon content in oceans is estimated as about 1.5 mg C·l<sup>-1</sup>, of which 80—95% is DOC (Bogdanov, Lisicin and Romankevič 1971, Strickland 1965). In closed seas and in highly productive coastal waters mean amounts of organic carbon increase 3—4 times and even more (Menzel and Vaccaro 1964, Bogdanov, Lisicin and Romankevič 1971, Skopincev 1971, Lucarev 1972, Peçherzewski and Ławacz 1975 etc.).

Recently there is more studies conducted on Antarctic waters, including those on contents and distribution of organic carbon. According to data of Menzel and Ryther (1968), Rakusa-Suszczewski (1972), Artemev and Melnikov (1974), Peçherzewski (1978) the DOC content in Antarctic waters fluctuates from 0.70 to 5.26 mg·l<sup>-1</sup> and is on average 2—3 times higher than the DOC content in oceans, whereas the POC content

\*) Studies were conducted within the problem MR II. — 16/A of the Third Antarctic Expedition of Polish Academy of Sciences on the Arctowski Station — 1978/1979.

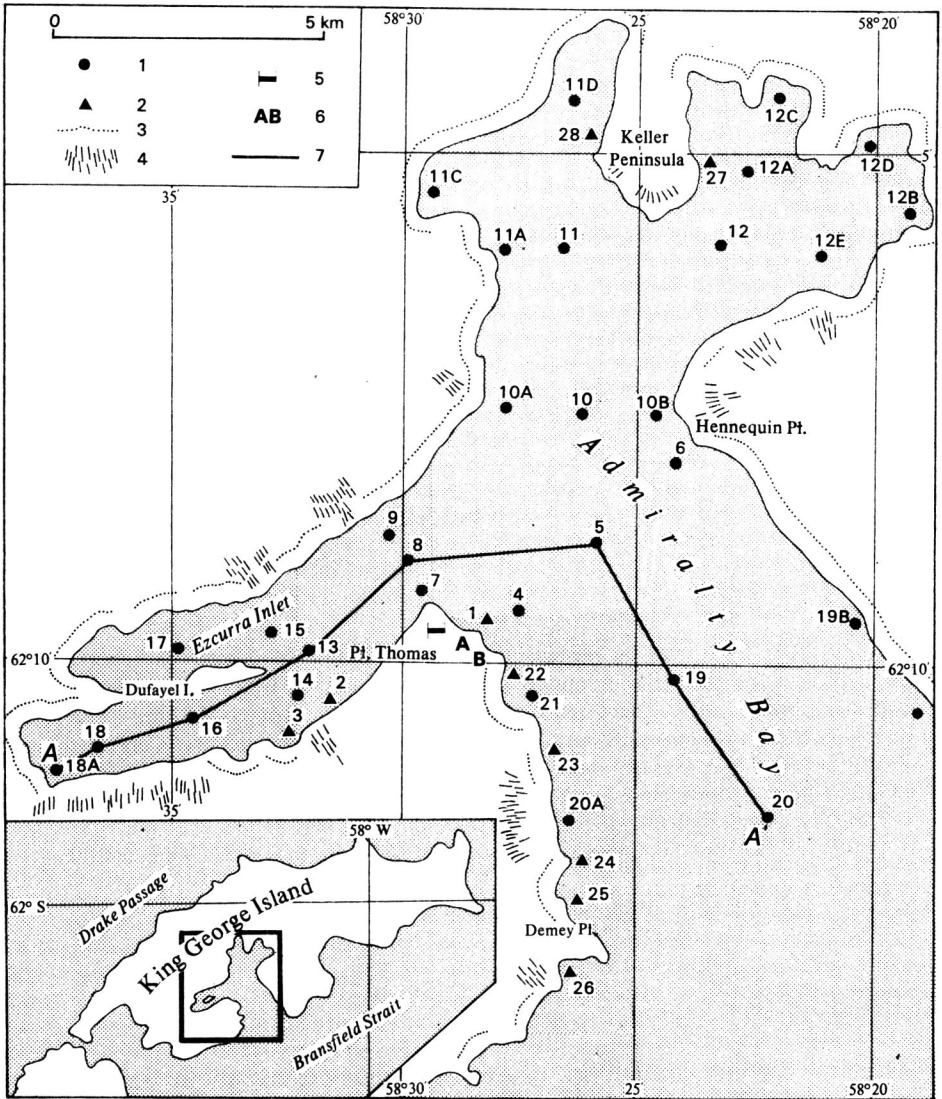


Fig. 1. Investigated area

1 — stations for taking water samples from a boat, 2 — shore stations, 3 — glaciers descending directly to the bay, 4 — mountain glaciers (over-hanging), 5 — Arctowski Station, 6 — fresh-water lakes (A — near the Station, B — penguin lake), 7 — line of AA' profile (for Fig. 3).

is Antarctic waters fluctuates from 0.20 to 0.52 mg·l<sup>-1</sup> and is also several times higher from the mean content of POC in open oceanic waters. The investigations show that maximal amounts of DOC and POC were found in subsurface Antarctic waters, from 20 down to 100 metres.

The aim of this paper is a presentation of data on the content and distribution of organic carbon in the waters of Admiralty Bay during the Antarctic summer.

## 2. Material and methods

Studies on the content and distribution of organic carbon (DOC and POC in  $\text{mg}\cdot\text{l}^{-1}$ ) in the Admiralty Bay — a fiord at the southern coast of King George Island — were carried out between 20 December 1978 and 15 February 1979. Samples of water were taken on 42 stations (Fig. 1) this including 10 shore stations and 2 on freshwater small lakes supplied with water from melting glaciers (lake "A" close to the Station and lake "B" also called Penguin Lake because of the neighbouring penguin colony).

Water samples were analysed after the return to Poland using the method elaborated by Menzel and Vaccaro (1964) and described in detail by Pęcherzewski and Ławacz (1975).

## 3. Results and discussion

In the surface waters of the Admiralty Bay the highest DOC content (over  $2.50 \text{ mg}\cdot\text{l}^{-1}$ ) and POC content (over  $0.50 \text{ mg}\cdot\text{l}^{-1}$ ) were recorded in coastal waters (Fig. 2) the shores of which are void of ice cover in the

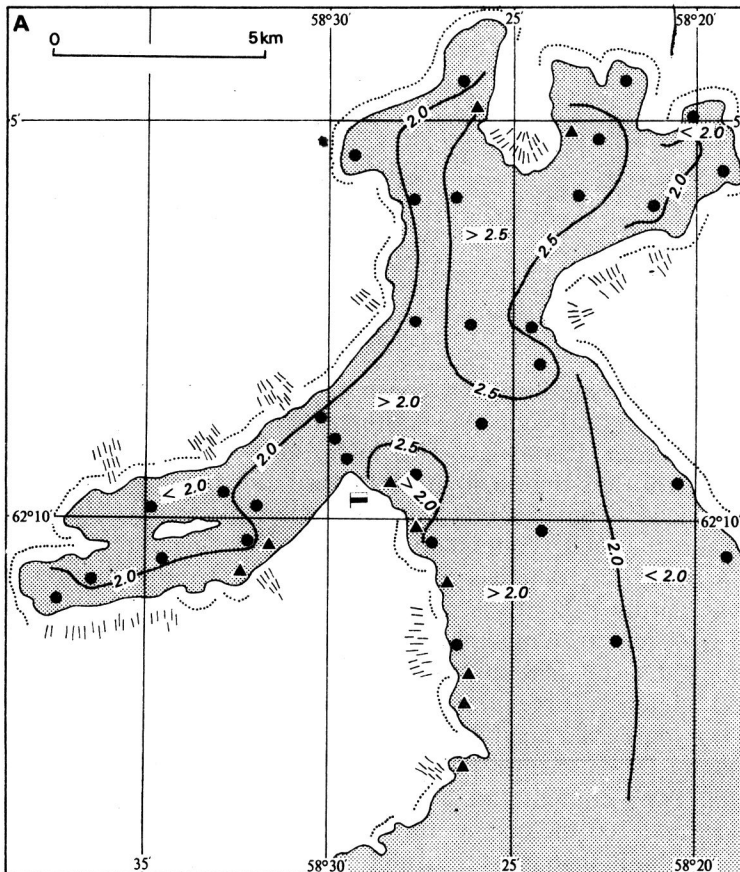


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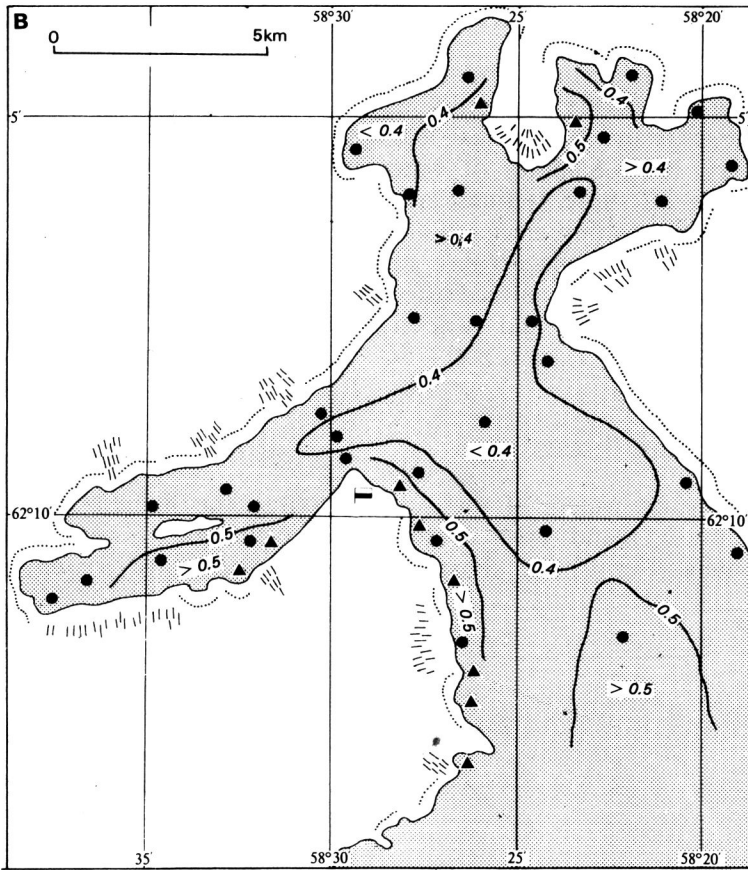


Fig. 2. Organic carbon (DOC — *A*, POC — *B*) content ( $\text{mg}\cdot\text{l}^{-1}$ ) in surface waters of the Admiralty Bay

summer. These are southwestern coast of the Admiralty Bay from Demay Peninsula to Thomas Peninsula, south-eastern coast of Ezcurra Inlet and the coast of Keller Peninsula. The DOC content (less than  $2.00 \text{ mg}\cdot\text{l}^{-1}$ ) and POC content (less than  $0.40 \text{ mg}\cdot\text{l}^{-1}$ ) were much smaller in surface waters close to the head of glacier reaching the water in the bay. For the purpose of comparison the DOC content in freshwater lake near the penguin colony exceeded  $6.10 \text{ mg}\cdot\text{l}^{-1}$ , whereas in the lake close to the Station the DOC content was hardly  $2.22 \text{ mg}\cdot\text{l}^{-1}$ . The POC content in the above mentioned lakes was  $0.92$  and  $0.26 \text{ mg}\cdot\text{l}^{-1}$ , respectively.

Maximal DOC content (mean  $2.48$  and  $2.36 \text{ mg}\cdot\text{l}^{-1}$ ) occurred at depths  $25$  and  $50$  meters (Table I). As the depth increased the DOC content decreased to some  $2.00 \text{ mg}\cdot\text{l}^{-1}$  at the depth  $100$ – $200$  meters and to values below  $2.00 \text{ mg}\cdot\text{l}^{-1}$  in deeper parts of the bay ( $400$ – $480 \text{ m}$ ).

Maximal POC content (on average  $0.41$  and  $0.45 \text{ mg}\cdot\text{l}^{-1}$ ) was recorded at depths  $50$  and  $100$  meters; as the depth increased the mean POC content decreased to about  $0.36 \text{ mg}\cdot\text{l}^{-1}$  (Table I).

Analysis of the distribution of DOC and POC content in water depths

Table I

Organic carbon (DOC and POC) content ( $\text{mg}\cdot\text{l}^{-1}$ ) in waters of the Admiralty Bay  
(20 Dec. 1978—15 Jan. 1979)

Localization stations	Depth (m)	Number of measurement	DOC		POC	
			Range of values	Mean $\pm$ S.D.	Range of values	Mean $\pm$ S.D.
Inshore Zone of the Admiralty Bay	0	86	1.83–2.61	$2.24 \pm 0.31$	0.22–0.65	$0.41 \pm 0.16$
Open waters of the Admiralty Bay	0	27	1.94–2.91	$2.19 \pm 0.18$	0.22–0.56	$0.40 \pm 0.12$
	25	27	2.04–3.22	$2.48 \pm 0.22$	0.34–0.45	$0.39 \pm 0.03$
	50	24	1.94–2.82	$2.36 \pm 0.27$	0.32–0.53	$0.41 \pm 0.06$
	100	23	1.83–2.42	$2.08 \pm 0.18$	0.42–0.47	0.45
	200	16	1.83–2.22	$1.96 \pm 0.12$	0.39–0.43	0.39
	400	5	1.62–1.94	1.83	0.22–0.39	0.36
	480	3	1.83–1.94	1.94	0.36–0.39	0.37

along AA' profile (Fig. 1) indicates the occurrence of four different types of water in the Admiralty Bay (Fig. 3):

1. surface waters with DOC content below  $2.50 \text{ mg}\cdot\text{l}^{-1}$ ,
2. subsurface waters with maximal DOC content (over  $2.50 \text{ mg}\cdot\text{l}^{-1}$ ),
3. transitory waters,
4. distinct wedge of waters entering the Admiralty Bay from the Bransfield Strait having relatively low concentrations of DOC (some  $2.00 \text{ mg}\cdot\text{l}^{-1}$ ) forming the layer of deep or nearbottom waters in the Admiralty Bay and Ezcurra Inlet.

This structure of waters of the Admiralty Bay is confirmed by changes in organic carbon content on station 5 as a result of analyses of water samples taken at different depths on three different dates (Fig. 4). And so, in surface waters the DOC content ranged from 2.04 to  $2.42 \text{ mg}\cdot\text{l}^{-1}$ , at 25 m the maximum DOC content was attained —  $2.82 \text{ mg}\cdot\text{l}^{-1}$ . Then with further increase of depth the DOC content gradually decreased and at the depth of 400 m it was 1.73 to  $1.96 \text{ mg}\cdot\text{l}^{-1}$ .

The POC content at the same time and on the same level changed as follows:  $0.39\text{--}0.41 \text{ mg}\cdot\text{l}^{-1}$  for surface waters,  $0.33\text{--}0.37 \text{ mg}\cdot\text{l}^{-1}$  at the depth 25–30 meters,  $0.42\text{--}0.47 \text{ mg}\cdot\text{l}^{-1}$  at about 100 m and then decreased to  $0.22\text{--}0.39 \text{ mg}\cdot\text{l}^{-1}$  (Fig. 4).

Changes in DOC and POC content in the coastal waters of the Admiralty Bay (station 5) were analysed also in 4–6 January 1979 (Fig. 5). Twenty samples of water were taken in intervals of 2–7 hours. Results of these investigations showed that the DOC content changed from 2.51 to  $3.08 \text{ mg}\cdot\text{l}^{-1}$ , and the POC content from 0.48 to  $0.64 \text{ mg}\cdot\text{l}^{-1}$ . The data indicate the repeated in the daily cycle reduction in DOC and POC content between 10 p.m. and 5 a.m. of local time and the maximum values during the day. The daily fluctuations in the POC and DOC content are confirmed by the daily course of air temperature and by fluctuations of the total amount of suspension in water measured at the same time and on the same station (Fig. 5).

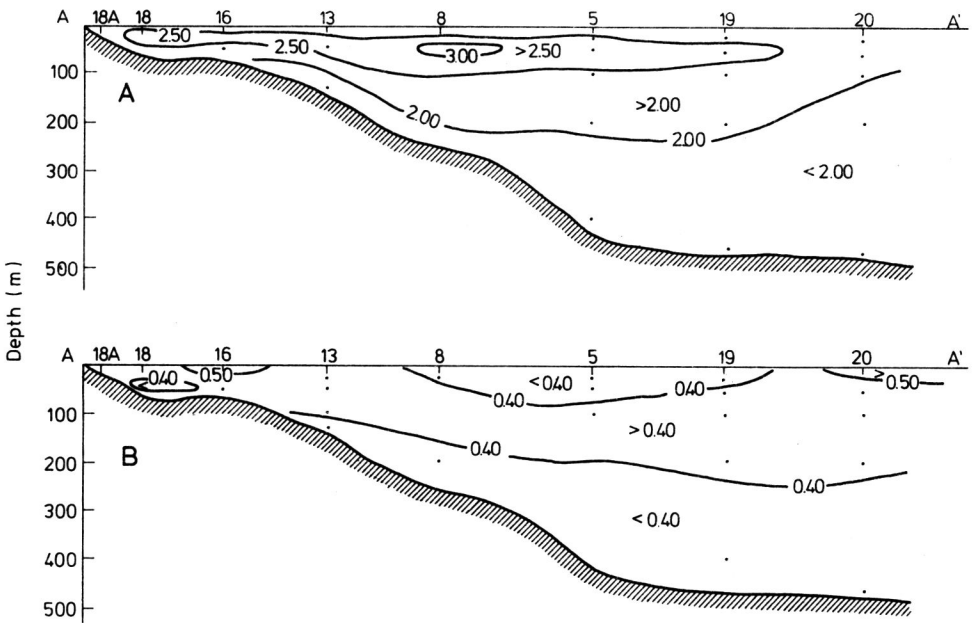


Fig. 3. Organic carbon (DOC — A, POC — B) content (mg·l<sup>-1</sup>) in waters of the Admiralty Bay along the AA' profile (Fig. 1)

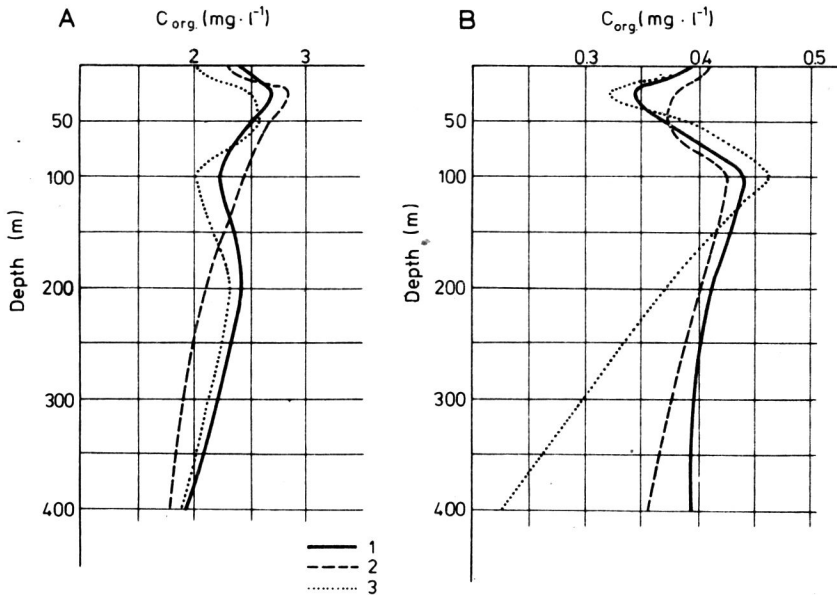


Fig. 4. Content of DOC (A) and POC (B) in waters of the Admiralty Bay (station 5) 1 — 30 December 1978, 2 — 10 January 1979, 3 — 29 January 1979.

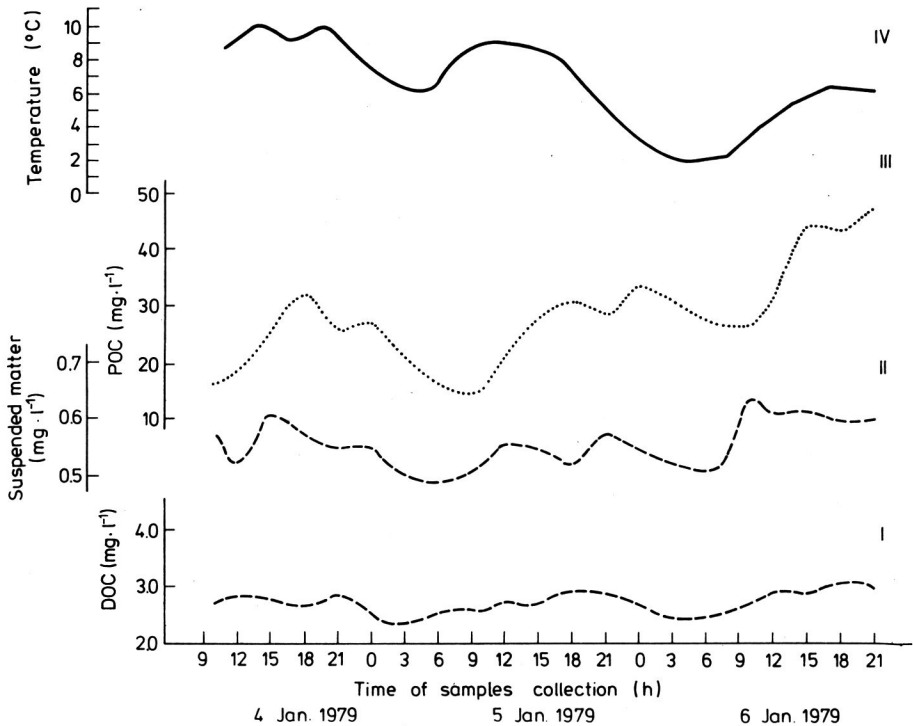


Fig. 5. Fluctuations in content of DOC (I) and POC (II), suspension (III) and temperature (IV) in surface waters of the Admiralty Bay (station 1) in 4–6 January 1979

One of the reasons for the observed daily changes in DOC and POC content are most probably the changing amounts of waters flowing from the slopes of melting glaciers which bring into the Admiralty Bay large amounts of suspension estimated as 200 tons per 24 hours (Pęcherzewski 1980). Also other factors should be taken into consideration such as the not well known yet so-called biochemical rhythms of the ecosystem discussed, the complex hydrochemical regime of waters of the Admiralty Bay etc.

The data presented here point to considerable differentiation of waters of the Admiralty Bay as concerns the distribution and content of DOC and POC. In future investigations special attention should be paid to the explanation of the character and origin of observed variability in the DOC and POC content against the environmental conditions in the Admiralty Bay.

#### 4. Summary

The content and distribution of organic carbon (DOC and POC) in the waters of Admiralty Bay were determined.

The organic carbon content ranged from 1.62 to 3.22 mg·l<sup>-1</sup> for DOC and from 0.22 to 0.65 mg·l<sup>-1</sup> for POC (Table I). It may serve as a comparison that the DOC content

in freshwater lake near the penguin colony exceeded  $6.10 \text{ mg}\cdot\text{l}^{-1}$ , whereas the POC content in this lake was  $0.92 \text{ mg}\cdot\text{l}^{-1}$ .

Maximal content of DOC (over  $2.50 \text{ mg}\cdot\text{l}^{-1}$ ) and POC (over  $0.50 \text{ mg}\cdot\text{l}^{-1}$ ) were recorded in subsurface waters of the Admiralty Bay (Table I) at depths 25–100 meters and also in coastal waters where the coasts are free of ice cover during the austral summer. Much smaller content of organic carbon (DOC and POC) were recorded in coastal waters near the head of glacier descending directly to the waters of the Admiralty Bay.

Considerable spatial differentiation of waters of the Admiralty Bay was observed as regards the DOC and POC content and distinct fluctuations in their content in the daily cycle (Fig. 5). Mean DOC content in the waters of the Admiralty Bay (about  $2.26 \text{ mg}\cdot\text{l}^{-1}$ ) is lower than mean DOC content in waters of the Bransfield Strait (about  $4.12 \text{ mg}\cdot\text{l}^{-1}$ ).

## 5. Резюме

Определено количество и распределение С орган. (DOC и POC) в водах Адмиральты Бей.

Количество С органического колебалось с  $1,62$  до  $3,22 \text{ мг}\cdot\text{л}^{-1}$  для DOC и с  $0,22$  до  $0,65 \text{ мг}\cdot\text{л}^{-1}$  для POC (таблица I). Для сравнения количество DOC в пресноводном небольшом озере расположенном в соседстве колонии пингвинов переходило  $6,10 \text{ мг}\cdot\text{л}^{-1}$ , а количество POC в водах этого озера равнялось  $0,92 \text{ мг}\cdot\text{л}^{-1}$ .

Максимальное количество DOC (свыше  $2,50 \text{ мг}\cdot\text{л}^{-1}$ ) и POC (свыше  $0,50 \text{ мг}\cdot\text{л}^{-1}$ ) констатировано в поверхностных водах Адмиральты Бей на глубине от около 25 до около 100 м, а также в прибрежных водах, которых побережья в период антарктического лета свободны от ледяного покрова. Значительно меньшее количество С органического (DOC и POC) обнаружено в водах прибрежных расположенных вблизи передней части ледников сходящих непосредственно в воды Адмиральты Бей.

Констатировано значительную дифференциацию вод Адмиральты Бей по отношению количества DOC и POC а также значительные колебания их количества в суточном цикле.

Средние количества DOC в водах Адмиральты Бей (около  $2,26 \text{ мг}\cdot\text{л}^{-1}$ ) нине средних количеств DOC (около  $4,12 \text{ мг}\cdot\text{л}^{-1}$ ) выступающих в водах Пролива Брансфильда.

## 6. Streszczenie

Określono ilości i rozmieszczenie С org. (DOC i POC) w wodach Zatoki Admiralicji.

Ilość С org. wahała się od  $1,62$  do  $3,22 \text{ mg}\cdot\text{l}^{-1}$  dla DOC i od  $0,22$  do  $0,65 \text{ mg}\cdot\text{l}^{-1}$  dla POC (tabela I). Dla porównania, ilość DOC w słodkowodnym jezioru położonym w sąsiedztwie kolonii pingwinów przekraczała  $6,10 \text{ mg}\cdot\text{l}^{-1}$ , natomiast ilość POC w wodach tego jeziora wynosiła  $0,92 \text{ mg}\cdot\text{l}^{-1}$ .

Maksymalne ilości DOC (ponad  $2,50 \text{ mg}\cdot\text{l}^{-1}$ ) i POC (ponad  $0,50 \text{ mg}\cdot\text{l}^{-1}$ ) stwierdzono w wodach podpowierzchniowych Zatoki Admiralicji, na głębokościach od ok. 25 do ok. 100 m, a także w wodach przybrzeżnych, których pobrzeża w okresie antarktycznego lata są wolne od pokrywy lodowej. Znacznie mniejsze ilości С org. (DOC i POC) stwierdzono w wodach przybrzeżnych, położonych w pobliżu czoła lodowców schodzących bezpośrednio do wód Zatoki Admiralicji.

Stwierdzono znaczne zróżnicowanie przestrzenne wód Zatoki Admiralicji pod względem ilości DOC i POC oraz wyraźne wahania ich ilości w cyklu dobowym.

Średnie ilości DOC w wodach Zatoki Admiralicji (około  $2,26 \text{ mg}\cdot\text{l}^{-1}$ ) są niższe od średnich ilości DOC (około  $4,12 \text{ mg}\cdot\text{l}^{-1}$ ) występujących w wodach Cieśniny Bransfielda.



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