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# FLOW OF MATTER IN THE ADMIRALTY BAY AREA, KING GEORGE ISLAND, MARITIME ANTARCTIC

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***Abstract:*** Amounts of organic and inorganic matter in Admiralty Bay over the period of a year were calculated with data accumulated mainly by Polish scientists. The main routes of matter transport between the shore of Admiralty Bay and a coastal and shelf waters are discussed in terms of physical forces, trophic relations, and fluctuations over long time scales.

## 1. Introduction

King George Island (in the South Shetland Islands) is (Fig. 1a, b) situated in the transition zone between Antarctic and sub-Antarctic climates. The features, however, are predominantly those of the Maritime Antarctic (MARSZ and RAKUSA-SUSZCZEWSKI, 1987). The climate is mainly influenced by cyclones moving from West to East. The estimated mean air temperature at Arctowski Station in the past decade 1978–1987 was $-1.8°C$; and compared with previous decades it has risen by 0.2 to 0.6°C (MARTIANOV and RAKUSA-SUSZCZEWSKI (1990). It seems that this increase has promoted deglaciation on land and retreat of glaciers on the Admiralty Bay shores, a process particularly evident during the past 16 years of our observations from Henryk Arctowski Station.

Admiralty Bay is the largest of the King George Island bays. It has 122.08 $km^2$ surface area, 24.24 $km^3$ volume, 201.7 mean depth and 83.4 km shoreline. The ice shore is 38.91 km long. Ice-free shores cover 44.49 km of which sandy/stony areas account for 42.69 km, and rock cliffs for 1.8 km. The drainage basin of Admiralty Bay covers an area of *ca.* 361 $km^2$ (RAKUSA-SUSZCZEWSKI, 1980a, b, 1987; MARSZ and RAKUSA-SUSZCZEWSKI, 1987; BATTKE, 1990). Admiralty Bay is fiord like in nature and opens widely to the south facing Bransfield Strait.

A full year of observation of the movement of icebergs in front of the entrance to Admiralty Bay (MADEJSKI and RAKUSA-SUSZCZEWSKI, 1990) indicated the presence of a permanent current flowing NE and ENE with velocity 10 to 90 $cm\,s^{-1}$. Through Bransfield Strait these waters can also flow into Admiralty Bay. In the eastern part of Admiralty Bay the tidal current may attain a surface velocity of 150 $cm\,s^{-1}$. In the absence of winds in Admiralty Bay, water flows out of the bay at the surface and inward in deeper layers (PRUSZAK, 1980). Producers and consumers in Admiralty Bay, where land and sea closely interact, create trophic relationships and matter transport routes which differ quantitatively from those in the open sea (*cf.*

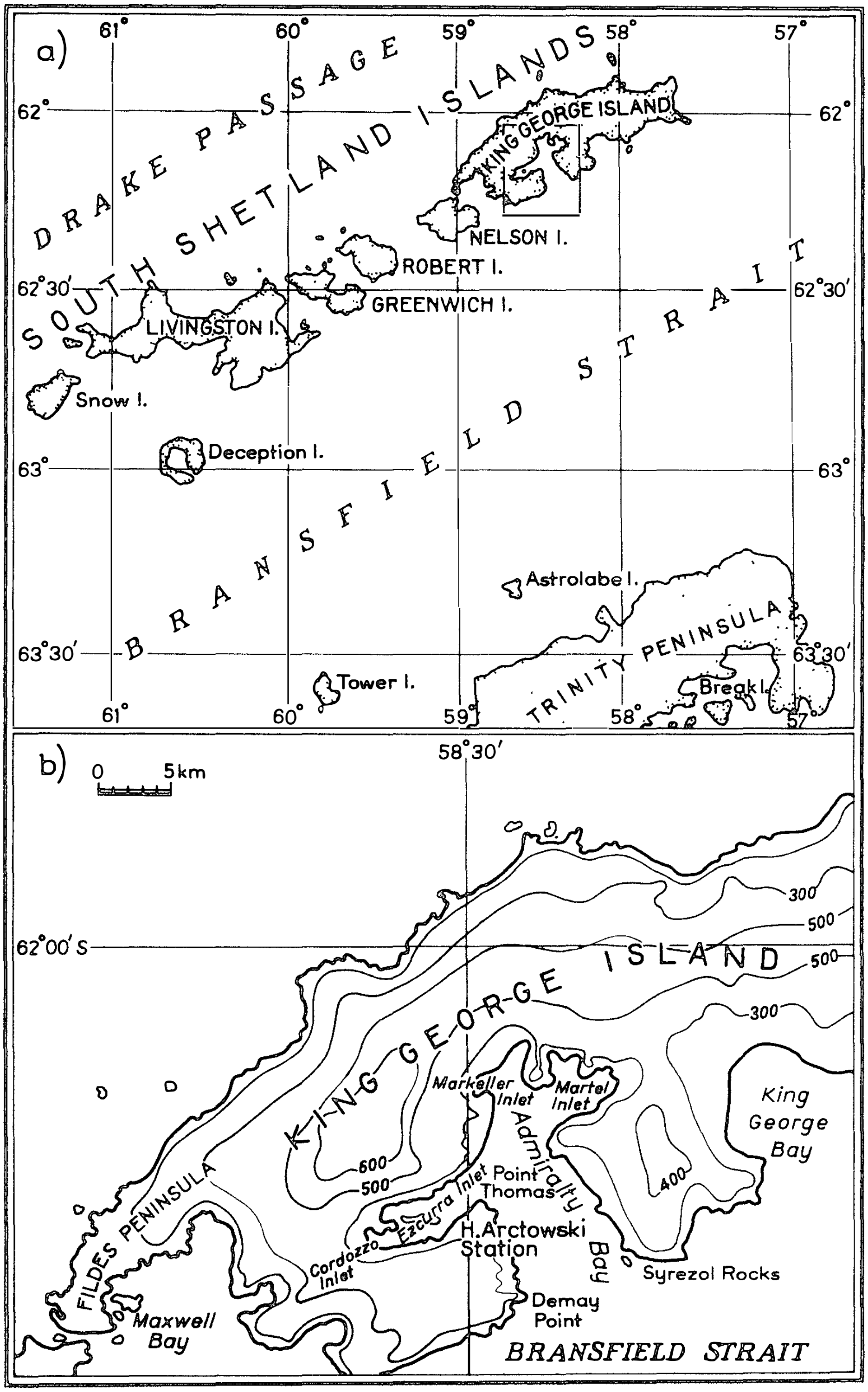


*Fig. 1. Admiralty Bay. Shelf (a) and coastal (b) areas of researches on flow matter.*

RAKUSA-SUSZCZEWSKI, 1980a, b, 1987).

The export of biogenic material from sea to land is mediated mainly by birds and mammals spending much of their time ashore, principally to breed. They produce great amounts of organic matter such as feces, urine, feathers, egg shells, hair, bodies of dead plants and animals, pellets regurgitated by birds, and shells.

Debris of macroalgae are also an important source.

The amount of matter deposited on land indicates the type of biological processes occurring in, as well as the state of, the nearshore ecosystem. The circulation of matter is mediated by physical interactions between land, sea, and atmosphere, with the amount of material thus transported reflecting, in turn, the intensity of prevailing physical forces. Matter transported among the shore, Admiralty Bay, and Bransfield Strait affects the functioning of the nearshore ecosystem and may well highlight short and long term fluctuations in this ecosystem (RAKUSA-SUSZCZEWSKI, 1980b, 1987).

As a result of mainly Polish extensive interdisciplinary research, the amounts of organic and inorganic matter in Admiralty Bay, including its shores and drainage basin, have been estimated. Further, the main routes of its transport can be specified. Estimated figures have large errors attached to them, but nevertheless give an idea of the structure and the fluxes within the land and sea ecosystem.

## 2. Results and Discussion

*Phytoplankton biomass and production*

Sources of primary production in the marine nearshore zone comprise the phytoplankton, ice algae, benthic and epiphytic microalgae (*cf.* HORNER and SCHRODER, 1982; LIGOWSKI, 1987a, b), and benthic macroalgae (ZIELINSKI, 1990).

Phytoplankton in Admiralty Bay show annual fluctuations in chlorophyll *a* content from 0.1 to 3.8 $mg\,m^{-3}$ (TOKARCZYK, 1986; LIPSKI, 1987). Considering that the total volume of water to a depth of 100 m (*e.g.* the productive layer) is 8.8 $km^3$, and on average Chla amounts to 0.5 $mg\,m^{-3}$ (LIPSKI, 1987), total chlorophyll *a* to this depth amounts to some 4.4 t. Assuming that Carbon to chlorophyll *a* equals 50 (TILZER *et al.*, 1985), then in Admiralty Bay there would be 220 t of Carbon. HAPTER *et al.* (1984) reported that phytoplankton production fluctuates in summer between 150 and 1500 $mg\,C\,m^{-2}\,d^{-1}$, averaging 665 $mg\,C\,m^{-2}\,d^{-1}$. DOMANOV and LIPSKI (1990) reported that primary production in the surface mixed layer average for the growth season can be described by the equation:

$$P(\mathrm{mg\,C\,m^{-3}\,d^{-1}}) = 11.47x + 1.48\ ,$$

$x$ — (concentration of chlorophyll *a* in $mg\,m^{-3}$), ($r=0.82$). It thus follows that the scale of production in the upper 100 m of Admiralty Bay is about 63.4 t of Carbon per day, and the value of $P:B$ (63.4 : 220) is 0.28.

Water exchange between Bransfield Strait and Admiralty Bay caused by tides and wind-driven currents induces intensive mixing, decreasing water column stability in the bay (LIPSKI, 1987; LIPSKI and RAKUSA-SUSZCZEWSKI, 1990). This in turn leads to large variations in phytoplankton primary productivity in the nearshore zone. Over period of days, the number of phytoplankton cells increase with water column stability during calm weather (KOPCZYNSKA, 1981, 1992).

If we further consider that one gramme of Carbon corresponds to approximate-

*Table 1. Total matter in Admiralty Bay and on its shore (in t, or t wet weight).*

| Matter type | Summer | Winter | Year |
|---|---|---|---|
| Nutrients in seawater | | | |
| $PO_4$ | 4354 | 3405 | |
| $NO_3$ | 34731 | 47725 | |
| Si | 61828 | 59542 | |
| Suspended mineral matter | | | |
| (fluvial origin) | 171000 | 32264 | |
| (aeolithic origin) | | | 1550 |
| Carbon | | | |
| DOC | 157680 | 38880 | |
| POC | 14880 | 1440 | |
| Phytoplankton in euphotic zone to 100 m depth | 6270 | | |
| Ice flora | | 5700 | |
| Microphytobenthos (diatoms) | 19095 | | |
| Shore microalgae | 285 | | |
| Macrophytobenthos (kelps) | | | 74000 |
| Zoobenthos | | | 67748–70000 |
| Zooplankton | 231 | | |
| net zooplankton (without krill) | 244 | | |
| copepods | 38–160 | | |
| krill | 115–780 | | 0 (winter 1990) |
| Fishes | 49 | | |
| Birds | | | |
| Adelie penguin | 182 | | |
| Chinstrap penguin | 38 | | |
| Gentoo penguin | 28 | | |
| others | 4.7 | | |
| Pinnipeds | | | |
| Elephant seals | | | 1326 |
| Crabeater seals | | | 340 |
| Fur seals | | | 67 |
| Weddell seals | | | 43 |
| Leopard seals | | | 7 |

ly 28.5 g (fresh weight) of phytoplankton, the total weight of phytoplankton in the euphotic zone of the bay amounts to some 6270 t, (Table 1), or 51 $g m^{-2}$. Such a value is within the range of net phytoplankton determinations performed in Admiralty Bay during 1983 by LIGOWSKI (1986). His measurements of wet settling volume of seston showing a range of 3–63 ($cm^3 dm^{-3}$) in a 100 m water column under 1 $m^2$ of sea surface.

*Ice flora*

In Admiralty Bay, ice occurs mainly in July, August, and September. There are, however, winters when ice cover is incomplete and/or of short duration. Pack ice, fast ice (formed mainly in Ezcurra Inlet) and ice deposited on the shore form habitats for algae, principally diatoms. The amount of chlorophyll *a* in sea-ice was estimated by LIGOWSKI (1992) for the year 1983 at *ca.* 4 t, a value which approaches that for phytoplankton in the 0–100 m layer calculated from the integrated mean yearly value. Using the conversion factors applied earlier for phytoplankton, the biomass of the ice flora in terms of Carbon can be estimated at *ca.* 200 t, or 5700 t, wet weight.

*Microphytobenthos*

The microphytobenthos develops in the shallow nearshore zone of Admiralty Bay. LIGOWSKI (1992) estimated the chlorophyll *a* content in these algae to be of the order of 200 kg, and the benthic diatoms contain 13.4 t of chlorophyll *a*. The chlorophyll *a* content in epiphytic algae attached to macroalgae has not been estimated. In the microphytobenthos diatoms are dominant: Applying the same conversion factors as for the phytoplankton, diatom wet weight is estimated at 19095 t, and that of nearshore algae at 285 t. Direct measurements of wet weight of nearshore algae, performed in October and November of 1983 (LIGOWSKI, 1992) gave a value of 600 t.

*Macrophytobenthos*

Approximately 30% of the bottom of Admiralty Bay is covered with macroalgae, the wet weight of which has been estimated at 74000 t (ZIELINSKI, 1990). On the assumption that 0.4% of this wet weight is chlorophyll *a* (ZIELINSKI, personal commun.; CZERPAK *et al.*, 1981), the amount of chlorophyll *a* in these macroalgae should be 296 t; this exceeds by almost 14 times the amount in all remaining groups of primary producers (*i.e.* 21.6 t). Macroalgae are additionally a source of particulate and dissolved organic matter released to the waters of the bay (DAWSON *et al.*, 1985).

Approximately 104 kg of macroalgae were deposited on each meter along the shore line between February and November of 1979, amounting to some 279 t (dry weight) throughout the bay (RAKUSA-SUSZCZEWSKI, 1980b; ZIELINSKI, 1981). Some of this material decomposes and enriches soils with both organic and inorganic components, although it is a small amount in comparison with the amount of matter undergoing decomposition in the water. Bottom trawling for fish in the deepest parts of Admiralty Bay, (below 500 m) has encountered macroalgal holdfasts (pers. obs.).

*Nutrients*

Mean nutrient concentrations at 0 and 400 m depths vary respectively (Si from 84.2 to 94.2; PO from 1.8 to $-1.7$; NO from 26.5 to 31.2 mg at $dm^{-3}$) throughout the year (LIPSKI, 1987). The total amount of NO in the bay therefore ranges from 34731 to 47725 t throughout the bay's 24 km of water. Si ranges from 59542 t to 47725 t in spring and autumn, respectively, and PO from 3405 t in autumn to 4354 t in summer (*cf.* RAKUSA-SUSZCZEWSKI, 1987).

*Organic Carbon*

According to PECHERZEWSKI (1980) and DAWSON *et al.* (1985) the average Dissolved Organic Carbon (DOC) concentration in Admiralty Bay is 2.5 $g\,m^{-3}$.

Therefore the 24 $km^3$ of total water volume in the bay may amount to 60000 t of DOC. Particulate Organic Carbon (POC) reported by DAWSON *et al.* (1985) was 0.62 $g\,m^{-3}$ in summer, decreasing to 0.06 $g\,m^{-3}$ (ZDANOWSKI, 1992) in winter. Comparative values of POC observed in the fast ice zone close to the Antarctic Continent fluctuated from 0.001 to 0.136 $g\,m^{-2}$ (MATSUDA *et al.*, 1987). The large amounts of DOC and POC measured in Admiralty Bay compared to the open sea are testimony to the existence of additional sources such as the benthic community.

*Inorganic matter*

The concentration of inorganic suspensions in summer to a depth of 50 m average 44.1 $mg\,dm^{-3}$; from 50 to 100 m, 13.6 $mg\,dm^{-3}$; below 100 m depth, 5.5 mg $dm^{-3}$ (PECHERZEWSKI, 1980). Measurements performed throughout the year by GURGUL *et al.* (1992) showed similar values. Using average values the amount of inorganic suspensions in Admiralty Bay varies from 32264 to 171000 t, with minima in winter and maxima in late summer (February). According to PECHERZEWSKI (1987) the amount of inorganic material carried from land to the surface of Admiralty Bay by the wind amounts to *ca.* 1550 t per year. Similarly, KRAJEWSKI (1986) has calculated that during summer 22–8 g of inorganic matter is transported daily through a 1 $m^2$ area, at a height of 1.5 m.

Substantial export of inorganic matter by water from the land to the sea is characteristic of the Maritime Antarctic and is a result of the local climate where temperature in each month of the year can reach 0°C, snow melting and water outflow from land. This process is important for the formation of benthic sediments and in influencing the benthic habitat. Since these suspensions affect water transparency (HAPTER *et al.*, 1984) Secchi disc measurements may vary from 1 m in summer to 17 m in winter (STOCHMAL *et al.*, in prep.).

*Zooplankton, production and biomass*

Assuming that phytoplankton production in Admiralty Bay is 81.1 t of Carbon per day (2311 t wet weight), and that secondary production of phytophagous zooplankton represents 10% of this amount, the wet weight of zooplankton biomass can be estimated at 231 t. Of this, *Euphausia superba* DANA may account for 50%, with the remainder largely representing Copepoda (EVERSON, 1977). It follows that daily wet weight production of krill in Admiralty Bay during summer is *ca.* 115 t. Further, as $P:B$ for *E. superba* is equal to 1 (HEMPEL, 1970) the mean krill biomass in the bay can be estimated at 115 t, close to the 100 t reported by RAKUSA-SUSZCZEWSKI (1980b). In winter, the biomass of *E. superba* in the bay decreases several fold (RAKUSA-SUSZCZEWSKI, 1990); no krill were caught during regular trawls in the winter of 1990 (DONACHIE and SAPOTA, person. commun). If we consider $P:B=3$ for copepods, then their total biomass in Admiralty Bay would amount to only 38 t LIGOWSKI (1992) reports that *E. superba* may feed on ice flora and microbenthos in the bay; such an association will increase the nutritional base for zooplankton in nearshore waters.

During summer, GODLEWSKA (1992) estimated 630 and 780 t of krill biomass

CHOJNACKI and WEGLENSKA (1984) reported 6.6 mg $m^{-3}$ of mean wet weight of Copepod biomass amounting to almost 160 t. This is less than what was observed in Bransfield Strait (2 g $m^{-2}$) during FIBEX (RAKUSA-SUSZCZEWSKI, 1983). Water exchange between Admiralty Bay and Bransfield Strait occurs as a result of tides and wind driven currents (PRUSZAK, 1980; MADEJSKI and RAKUSA-SUSZCZEWSKI, 1990) affecting zooplankton biomass inside the bay. Therefore, the occurence of krill in the bay depends on both hydrological conditions and multi-year changes in the stocks in Bransfield Strait. In fact, krill was reported to be more abundant outside strait during summers following colder winters (RAKUSA-SUSZCZEWSKI, 1988). This is a consequence of different atmospheric conditions, whereby waters flowing into Bransfield Strait block the flow of water from the west, *i.e.* from the Bellingshausen Sea, which is the main source of krill to the strait. It should be mentioned that summers with high krill biomass are not necessarily followed by summers poor in krill biomass, and vice versa (RAKUSA-SUSZCZEWSKI, 1988). It appears that extreme fluctuations occur over periods longer than two years.

*Zoobenthos*

Zoobenthos biomass in Admiralty Bay was estimated at *ca.* 68000 t (JAZDZEWSKI *et al.*, 1986; JAZDZEWSKI, 1992). According to FILCEK (1992) the mean biomass of Patellidae in the intertidal zone of the bay amounts to some 120 g m, and JAZDZEWSKI (1992) estimated that biomass of amphipoda to a depth of 30 m amounted to 20 g m. These groups represent the highest amounts of matter exported from the nearshore benthic zone on shores. Amphipoda occur frequently in stomach contents of penguins (TRIVELPIECE *et al.*, 1990), and sometimes it may constitute 10–20% of the penguin diet by weight. The Patellid Nacella concinna serves as food for birds, principally *Larus dominicanus*, *Catharacta maccormicki*, *C. antarctica*, and *Phalacrocorax atriceps* (WAGELE and BRITO, 1990; FILCEK, 1992). According to FILCEK (1992), the population of *L. dominicanus* in Admiralty Bay, estimated at 537 individuals, consumes *ca.* 57 kg of limpets per day in summer. This corresponds to 44.4 kg wet weight of limpet tissue and 12.6 kg of shell material carried to the shore daily.

*Fish*

Fish biomass within Admiralty Bay is *ca.* one tenth of that of the South Shetlands shelf (SKORA, 1992; SKORA and NEYELOV, 1992). This relatively poor fish stock may result in food (mainly krill) competition with penguins and pinnipeds. EVERSON (1970) has estimated that mean fish biomass in nearshore zones amounts to *ca.* 0.4 t km (0.4 g $m^{-2}$), which in turn suggests a fish biomass of the order of 50 t within Admiralty Bay. In comparison, Weddell Sea fish stocks amount to some 0.1 to 1 g m (HUBOLD, 1992).

*Birds*

RAKUSA-SUSZCZEWSKI (1980b) estimated the nesting penguin biomass in Admiralty Bay to be of the order of 361 t, and that of flying birds at 4.7 t; these figures correspond to 2.9 g $m^{-2}$ of the surface area of the bay. The mean biomass of birds in the Antarctic, according to HOLDGATE (1967), amounts to 0.12 mg $m^{-2}$. The concentration of birds on the shores of Admiralty Bay is generally limited to the breeding season. Between 1982 and 1990 the mean numbers of penguins in the bay were 20261 Adelie penguin, 4836 chinstrap penguin and 2681 gentoo penguin, (MYRCHA, 1992). Adelie penguin and chinstrap penguin numbers may fluctuate by up to 20% from year to year, whereas gentoo penguin numbers are relatively stable. Taking into account these means and the mean body weight reported by PREVOST (1981) for these species (4.5, 4.0, and 5.5 kg respectively), the biomass of these birds in Admiralty Bay would amount to 182, 38, and 28 t, respectively.

*Consumption by birds*

The daily consumption of krill by penguins in Admiralty Bay was estimated by RAKUSA-SUSZCZEWSKI (1980b) at 50.18 t, and that by flying birds, at 2.24 t per day. In the light of more recent data regarding penguin numbers and food consumption (0.6 kg*l* $d^{-1}$ for *P. adeliae*, 0.46 kg $d^{-1}$ for *P. antarctica* (TRIVELPIECE *et al.*, 1987), and 1 kg $d^{-1}$ for *P. papua* (CROXAL *et al.*, 1985), the daily krill consumption by these penguins in Admiralty Bay should amount to 23, 3.6, and 4 t $d^{-1}$, respectively. Throughout the summer this amounts to 30.6 t daily. Such values are lower than those calculated for the end of the seventies (RAKUSA-SUSZCZEWSKI, 1980b) and reflect the downward trend in penguin numbers in this area (MYRCHA, 1992). The role that krill plays in each penguin species diet differs: 95.4% (by weight) of the food consumed by *P. adeliae* is krill. Equivalent figures for *P. antarctica* and *P. papua* are 83.6% and 75% respectively. Since fish may constitute 25% of the diet of males of *P. papua* (TRIVELPIECE *et al.*, 1990), those birds in Admiralty Bay will consume *ca.* 1 t of fish per day during the summer. Clearly the amount of krill in Admiralty Bay is too small to sustain the penguins nesting there. Consequently, the birds must forage beyond the immediate environs of the bay (RAKUSA-SUSZCZEWSKI, 1980b). Insufficient krill resources affect year to year changes in penguin numbers in rookeries situated at varying distances from Bransfield Strait (SIERAKOWSKI, 1991). The maximum distance travelled by foraging penguins from their rookeries in Admiralty Bay depends on species: 50 km for *P. adeliae*, 33 km for *P. antarctica*, and 24 km for *P. papua* (TRIVELPIECE *et al.*, 1987). Therefore these birds deposit organic matter on the shore of Admiralty Bay which does not necessarily have local origin.

Estimates for the amount of guano deposited on shore suggest some 3 t dry weight per day (RAKUSA-SUSZCZEWSKI, 1980b) or *ca.* 10 kg dry weight $m^{-2}$ within the penguin rookeries (TATUR and MYRCHA, 1984). This is the main source of nutrients for the terrestrial environment. Part of this matter undergoes mineralisation, being converted to ornithogenic phosphate soils (TATUR, 1992), with a second part decomposing and volatilizing in the form of ammonia which fertilizes terrestrial plant associations at some distance from the rookeries. The paleo-ornithogenic deposits in abandoned rookeries may also release substances important for development of vegetation (TATUR and MYRCHA, 1988).

*Pinniped biomass*

Six pinniped species are represented in Admiralty Bay including rare occurrences of the Ross seal (*Ommatophoca rossi*). Their biomass has been estimated using the mean individual body weights for each species, according to the BIOMASS program (1977), and the mean monthly pinniped numbers reported in the bay for 1988–90 (RAKUSA-SUSZCZEWSKI, 1992) show minima in June–July and maxima in December–January. The populations of elephant seal (*Mirounga leonina*) and theirregularly occurring crabeater seal (*Lobodon carcinophagous*) represent the greatest pinniped biomass in Admiralty Bay. Fur seal (*Arctocephalus gazella*) biomass has been increasing in recent years, but still is placed third behind those mentioned above. The Weddell seal (*Leptonychotes weddelli*) and the leopard seal (*Hydrurga leptonyx*) contribute less to the pinniped biomass of the bay throughout the year. Mean monthly biomasses of all species are shown in Table 1.

*Consumption by pinnipeds*

Fur seals, the dominant pinnipeds in Admiralty Bay from February to March and from July to September, feed on krill, fish and cephalopods in equal proportions (LAWS, 1984). Crabeaters feed mainly on krill and are most numerous in the bay from August to October. The elephant seals, which consume fish and cephalopods (LAWS, 1984), do not feed during summer while breeding and moulting. Half of the weight of the leopard seal diet is composed of krill, with the remainder being made up of seals, fish, birds and cephalopods (LAWS, 1984; SINIFF and STONE, 1985). They occur most abundantly during the breeding seasons of crabeater seals and penguins, which constitute the principal part of their diet. Weddell seals are scarce in Admiralty Bay although they occur throughout the year, particularly in summer, feeding on fish, cephalopods and invertebrates other than krill. The food consumed daily by elephant seals amounts to 55 $g\,kg^{-1}$ body weight; by the fur seals 62 $g\,kg^{-1}$, and by the crabeater and leopard seals 64 $g\,kg^{-1}$ (LAWS, 1984). Therefore the amount of food consumed by the total fur seal population in Admiralty Bay may be *ca.* 80 t during the 70 days in which they are normally resident in the area. The amount of food consumed irregularly by the crabeaters amounts to 630 t over a period of 90 days, and that consumed solely by elephant seals to 1372 t over 300 days. The fur and the elephant seals normally reside in Admiralty Bay and therefore they consume together as much as *ca.* 1452 t of food over a period of one year. Based on the assumption that fish constitute 25% and 50% of the fur seal and elephant seal diets, respectively (*cf.* LAWS, 1984), these species consume *ca.* 700 t of fish annually. This considerably exceeds the amount of fish previously estimated for the bay, and clearly the seals must complete their diet also feeding outside the immediate vicinity of the bay.

*Matter transport*

Penguins represent the main way of transporting matter from sea to land in Admiralty Bay, particularly *P. adeliae*, which dominates. Throughout the South Shetlands, however, including King George Island, *P. antarctica* is numerically dominant. Krill are consumed by birds and pinnipeds during eight to ten months of the year in the bay, with the most intensive transport of organic matter to the land covering the breeding season. Competition for krill among species is reduced by their different time of commencing of breeding. The birds and pinniped species of the bay have different food reguirements and also attain peak numbers at different time of the year, reducing food competition. In Admiralty Bay *ca.* 47% of the food is consumed by pinnipeds and 53% by penguins (personal calculation). In contrast, 69% of the food consumed in the open ocean is taken by pinnipeds and 30.5% by penguins (*cf.* CROXALL *et al.*, 1985) Our estimates clearly show wide ranges in consumption. It would appear, however, that the amount of material transported ashore by penguins and other birds is comparable to that deposited in the form of macroalgal, krill, and salp remains due to physical processes, such as wind, waves and tides. The area of land occupied by the main penguin rookeries and pinniped breeding sites (from Point Thomas to Patelnia) covers approximately 0.3 km. The total amount of organic matter (penguin feces = 230 t; macroalgae + krill + salps = 280 t) supplied per year to this area from the sea then, amounts to *ca.* 1.7 $kg\,m^{-2}$. The presence of such large amounts of feces leads to a super-fertilisation of this area and accumulation of organic matter. The area is therefore characterised by ornithcoprophilic associations of terrestrial vegetation, within which plant biomass can attain 1500 $g\,m^{-2}$ dry weight, averaging 423 $g\,m^{-2}$ (ZARZYCKI, 1992). Within the drainage basin of Admiralty Bay, the daily transport of inorganic matter in summer from land to the bay amounts to *ca.* 1.4 $kg\,m^{-2}$, decreasing several times during winter. This illustrates perfectly the scale of matter transport by physical forces. The land ecosystem of the bay strongly depends on organic and inorganic matter, sea and freshwater ice, and salt and freshwater transported between the land, Admiralty Bay, and Bransfield Strait (RAKUSA-SUSZCZEWSKI, 1987).

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