Vol. 25(4):653-662 | Ocean and Polar Research | December 2003

Review

Functioning of the Geoecosystem for the West Side of Admiralty Bay (King George Island, Antarctica): Outline of Research at Arctowski Station

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Abstract : Changes in the area of geo-ecosystem (62°09'S, 58°31'W) reflect climatic changes in the South Shetland Islands. Air temperature and deglaciation will increase. The ice-free space area at the SSSS 8 - (ASPA 121) site has enlarged threefold during the last 21 years, thus creating conditions for inhabitation and succession. Wind, water and snow play important roles in transportation of geochemical components. They distribute nutrients, mineral substances, seeds, fragments of plants and animals, etc. Plant and animal colonization is patchy and it happens at random in an "island" - like manner. The colonization pattern is dependant, to a high degree on physical factors. The newly uncovered ice-free areas are at first inhabited by a vascular plant known as the *Deschampsia antarctica.* The border of the land-oasis with Admiralty Bay is the place where the processes related to animal feeding at the sea and reproduction on the land take place. Bird colonies and pinniped lairs form centers of fertilization surrounded by high chemical gradients dependent on the direction of the flow of nutrients (e.g. NH_4). During the last 25 years, the numbers of penguins in this region have decreased, and thus the amount of materials excreted on land has diminished. The numbers of fur seals change in multi-annual cycles, and their migration into this area is related to the El Niño phenomenon. The numbers of elephant seals in the area did not change. Organic matter deposited by the sea onto the shore are a source of nutrients and deficient chemical elements on land. Mineral matter is washed out into the waters of Admiralty Bay. These processes change seasonally, and multi annually. Negative effects on the environment at Arctowski Station induced by man are slight, but noticeable nevertheless. Physical processes have the largest influence on the living conditions and distribution of plants and animals, and as a consequence, on the functioning of the geo-ecosystem in the coastal-shore zone of the Maritime Antarctic.

Key words : meteo-hydrographical conditions, flora, fauna, global and local changes

1. State of the geo-ecosystem

King George Island 62°09'S, 58°31'W (Fig. 1), is of volcanic origin. The Thomas Point oasis and Arctowski Station are situated on the west shore of Admiralty Bay. It is an area of moraines and Holocene accumulation terraces that stretch into the island interior up to 65 m above sea level. Still higher areas, up to 125-255 m, are the elevated marine terraces and Pleistocene moraines (Birkenmajer 1997, 2003). Nine percent of the island is cover with ice, spotted in some places by the protruding nunatacs. The ice-free land, both in glacial and hydrological watershed areas encompassed about 21 km^2 in earlier records (Rakusa-Suszczewski 1980, 1993b). According to the recent measurements, however the area of ice-free land has increased to 38 km^2 over the last 23 years (Braun *et al.* 2001) The borders of the oasis extending into the island territory are marked by the edges of ice-land domes and the shore area of Admiralty Bay. Ice that reaches the shores of Admiralty Bay in different places forms either propped up or submerged ice barriers.

The region of Thomas Point oasis is geologically relatively

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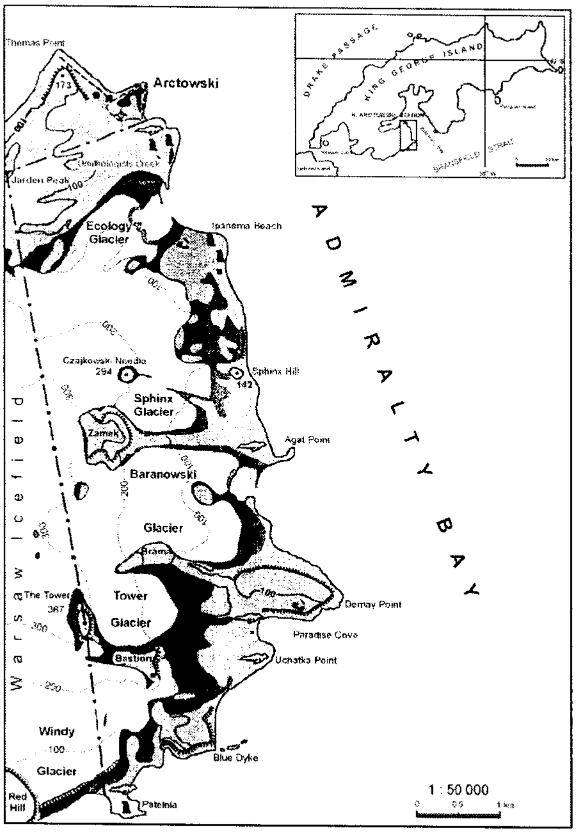

Fig. 1. King George Island, West side of Admiralty Bay as example of coastal/shelf area of Maritime Antarctic sea ice zone.

young, with the age of the lowest terraces estimated to be 500 years B.P. (Birkenmajer 1997. The age of the fossil soil in the valley of the Ornithologists Creek at 59 cm depth has been estimated to be 6870 ± 150 years B.P. (Zieliński 1998). Birkenmajer and others (1985) assessed the age of the Penguin Ridge peat bogs to be about 4090 years B.P. The peat bogs in the Llano Point area have been estimated at 4090 B.P. (Fabiszewski and Wojtuń 1993), while those in the vicinity of Arctowski Station are estimated at 2420 B.P. In this area of the youngest Holocene, Rachlewicz (1999) has distinguished three Ice Age advances that occurred during the 4-3 KBP, 2-1 KBP, and 1,50 A.D. This region was colonized by vascular plants already a few thousand years ago (Zarzycki 1993), which helped the formation of peat and soil in different places.

Different types of soil have been distinguished in the area of the Point Thomas Oasis (Fabiszewski and Wojtuń 1993, Kühne 1997). Characteristically, they do not contain carbonates, but they form a strong skeleton (Zieliński 1998). The largest surface area is being taken by the initial soils, the litosols and regosols formed of loose waste materials as a result of frost weathering. The formation of ornithogenic and paleo-ornothogenic soils is associated with both the present and former penguin colonies and with penguin excretion areas (Tatur and Myrcha 1984). In the area of the oasis, there are also mineral-humus and peat-clay soils, while at the creeks outlets newly flow-deposited soils are formed (Zieliński 1998). Soil profiles in this area show different composition; at Arctowski and Llano Point the *Calliergidium austro-stramineum* moss is dominant down to a depth of 80 cm, while at the Puchalski Pass, growth consists mainly loam and clay (Fabiszewski and Wojtuń 1993). The C/N ratio in this area varies from 4 (for the initial- original soil) to 10 (in places enriched by penguin guano), and up to 20 in the vegetation covered soils (Jahns 1996). The soils in some spots are covered by rich vegetation dominated by lichens (Olech 1993) with the epilitic forms contributing 65% of the total vegetation. Ornithocoprofilic lichens contribute 25%, and epibryophytic ones 20%. Liverworts on King George are represented by 11 species (Bednarek-Ochyra *et al.*, 2000). Of the Antarctic Islands, this island is also the richest in the species of mosses with 56 of them occurring in Admiralty Bay (Ochyra 1998). The highest biomass and productivity levels were found for *Polytrichastrum alpinum*; (3,438 and 897 g dry weight/m^2) respectively, and *Sanionia georgico-unicinata*; (2,687 and 309 g dry weight/m^2).

For *S. uncinata* biomass and productivity values were 1,336 and 387 g dry weight/m^2; for *Brachythecium austrosalebrosum* they were 1,139 and 364 g dry weight/m^2 respectively (Barcikowski and Gurtowska 1999, Barcikowski *et al.*, 1999, Barcikowski and Loro 1999).

Vascular plants are represented by three species. The grass *Deschampsia Antarctica* is widely distributed over the island, up to 330 m above sea level. At 0°C, this species may utilize as much as 30% of its maximal production ability (Lewis-Smith 2001). The occurrence of the green plant *Colobanthus quitensis* is limited to the low near shore terraces, far from penguin colonies. For many years now, a new species of grass has appeared in the vicinity of Arctowski Station, namely the *Poa sp.* introduced accidentally by man.

Phytogeographically this area is intermediate between continental and subantarctic regions.

The total quantity of *Deschampsia Antarctia* in the areas of water and nutrients inflow is high, ranging from 498 to 2232 g/m^2 dry weight, for mosses ranging from 309 to 897 g/m^2 (Zarzycki 1993, Barcikowski *et al.*, 1999, Barcikowski and Gurtowska 1999). However, these are only small patches in relation to the naked, vegetation free moraines and terraces located higher up, and not enriched with organic matter.

The fauna of invertebrates is in the study area poor compared to the Spitsbergen regions (Janiec 1996a) This is the result of both the young age and isolation of this area. Nematods, tartigrades, and rotifers are represented by eleven species each. Fresh water crustaceans are represented by one species of copepods (*Pseudoboeckella poppei*) and one species of branchiopods (*Branchinecta gaini*). The lack of predators in fresh water creeks and reservoirs causes a high abundance of these two phyto and detritophagus species. Of the land microfauna there are the representatives of Acarina and a few from the Chironimidae family.

Vertebrates are represented by marine birds and pinnipeds. In the oasis, there are three nesting species of penguins and 9 species of flying birds. The estimated biomass of the penguins, *Pygosceli adeliae, P. antarctica,* and *P. papua* in the oasis was: 182, 38, 28 tons respectively; and that for flying birds only 4.7 tons (Rakusa-Suszczewski 1993b).

The dominance in the oasis of *P. adeliae* is not typical for the whole of King George Island, which is mainly inhabited by *P. antarctica.* This indicates the intermediate character of this region which includes both continental and subantarctic species. Sporadic records were made of another 16 species of birds found on this island, indicated as coming from the Antarctic continent and South America (Myrcha 1993).

Five species of pinnipeds occur in the area of Admiralty Bay. It is the northern limit for the distribution of the Weddell seal, and is the southern limit in Antarctica of the occurrence of the Elephant seal and the Fur seal (Rakusa-Suszczewski 1993a; Ciaputa 1996, Salwicka and Rakusa-Suszczewski 2002). Elephant seal populations (*Mirounga leonina*) occur during the entire year in varying degrees of abundance. Its biomass has been estimated at 1326 tons as compared to the much lower biomass (43 tons) for Weddell seals (*Leptonychotes weddelli*). Fur seals (*Arctocephalus gazelle*) are encountered over ten months of the year (estimated biomass 67 tons; Rakusa-Suszczewski 1993a.). They are mainly young males from South Georgia that enter the area of Admiralty Bay during their autumnal migrations. The crabeater (*Lobodon carcinophagus*) and Leopard seal (*Hydurga leptonyx*) visit the bay irregularly together with the inflowing ice packs. The pinniped species composition also indicates the intermediate character of this region in terms of zoogeography.

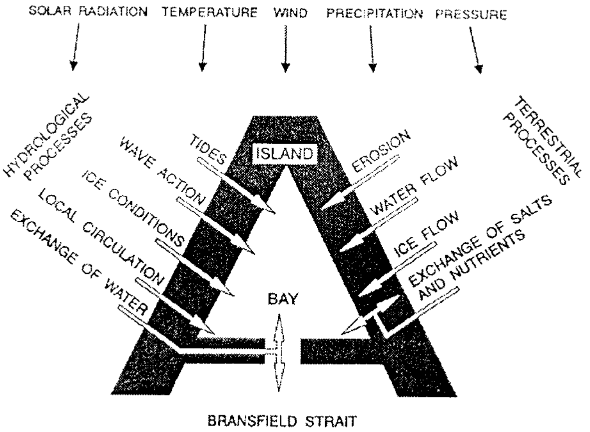

Fig. 2. Environmental processes which influence the functioning of the coastal and shelf ecosystem (Admiralty Bay, King George Is., South Shetlands Iss).

2. Processes in the geo-ecosystem

King George Island (Fig. 2) is situated in the climate of the Maritime Antarctic at the latitude 62°S, which is indicated by the period of solar radiation. The longest day in the year lasts more than 19 hours, and the shortest night more than 4 hours. Solar radiation in the Thomas Point Oasis is higher than in the remaining parts of the island; it is the result of the combined effects of orography, west winds, and lower cloudiness caused by the catabatic winds phenomenon. (Rakusa-Suszczewski 1980) Ten years of continuous air temperature observation at Arctowski Station showed the warming of the climate in this region (Martianow and Rakusa-Suszczewski 1990, Rakusa-Suszczewski *et al.* 1993), also ground temperature at 100 cm depth showed a slight increase of +0.03°C per year Long term mean temperature of the soil layer down to a depth of 50 m did not follow any upward trend. The mean annual temperature of the ground is above zero, about 0.5°C; the highest (4.0°C) occurs in January, the lowest (–1.8°C) in August (Zwolska and Rakusa-Suszczewski 2002). The mean annual air temperature in the years 1978-2000 was –1.6°C with the annual range from –6.6°C in July to 2.5°C in January.

Surface stratum down to 5 cm in the moss growing area had minus temperatures over 192 days, and above zero temperatures for 157 days of the year, while temperatures during the remaining days stay around 0°C. As much as 23.9% of the temperature fluctuation takes place within the range +1°C and –0.9°C (Kejna 1999) thus at the border of water phase changes, water changes from liquid to solid.

The microclimate of the area shows considerable spatial variability. In April, the surface area of the ground at the penguin rookery in Point Thomas Oasis received 15.5 W/m^2 of solar radiation, while at the moraine the value was only 4 W/m^2 (Zieliński 1998). Glacial retreat on land causes denudation of different postglacial forms often deposited on dead ice. In this way, they are being conditioned thermally as substrates for the settlement of organisms and subsequent succession. Sporadically, in summer, the rock surface may warm up to reach temperatures above 30°C; surface layers of the shallow fresh water reservoirs may become higher than 20°C, while the rocky pools near the shores of Admiralty Bay may reach temperatures approximating 12°C (Rakusa-Suszczewski 1995a). During austral summers, the entire land area is warmer than the waters of the bay, and the reverse situation is observed in winter. In the vicinity of Admiralty Bay, and the considerable amount of overflow waters on land, reduce the 24-hour (day/night) temperature fluctuations in the area of the southernmost water-flooded marine terrace. In meso-scale, differences in the mean environmental temperatures in Thomas Point Oasis do not exceed a few degrees centigrade, while annual fluctuations over large land areas do not exceed 10°C. On a micro-scale, temperature differences between the various environments of the oasis range significantly on the centigrade scale.

Mean annual wind velocity in this region is 7 m/sec. However, with strong winds it may reach 74 m/sec (Kowalski and Wielbińska 1989). Strong winds disperse mineral deposits over the land, especially intensively during the autumn, and result in ablation of the ice surface. Wind transport from the west direction is strongest at the end of summer. As a result, the coastal water of Admiralty Bay receives several hundred tons of mineral matter (Rakusa-Suszczewski 1993b). Winds disperse organic debris of plant and animal origin (Janiec 1996a, b), mineral salts contained in marine aerosol, and sea spry (Juchnowicz-Bierbasz 1999), but also nitrogen in the form of NH_4, which is especially absorbed by the aquatic environment like pond water (Wodehouse and Parker 1981). In this region, 41% of the winds blow from N to E and continue in a southerly direction (Rakusa-Suszczewski *et al.*, 1993). The terrain to south and southwest is being uncovered from the layer of receding ice of the Ecology Glacier. During the last 21 years, the ice-free land surface area at the SSSI 8 (ASPA 121) site has increased threefold, and now stands at about 9 km^2 (Battke *et al.* 2001).

With its large penguin rookeries and rich flora, Thomas Point Oasis provides the closest and most significant source of all kinds of organic matter, nutrients, grass seeds, lichens and moss fragments, which are all indispensable for inhabiting the icedenuded terrain and for the subsequent plant succession. Both wind direction and terrain configuration seem to be of basic importance in the zonal inhabiting of the ice-freed land fragments. Thus, it has been documented by Olech (1996), that in front of the Ecology Glacier, in the lower parts of the ice-freed moraines the dominant species are the grass *Deschampsia Antarctica,* Cyanobacteria, and aerophytic algae. In higher locations, the lichen *Usnea Antarctica* is dominant, while the contribution of epilitic and soil algae is minimal. This appears to be the effect, first of all, of the zonal settling resulting from wind movement from N to NE. Winds blowing from this direction are responsible for 15% of all the winds encountered there. The receding of glaciation submerged in Admiralty Bay helped in the formation of lagoons (Rakusa-Suszczewski 1995a). The water column structures of the lagoons, such as fresh water at the surface, salinity stratification, and oxygen deficiency at the bottom cause the assemblages of bottom fauna, plankton, and ichthyofauna in the lagoons to be different from those occurring in Admiralty Bay (Siciński *et al.*, 1996; Zadrożny 1996; Kittel *et al.*, 2001; Różycki 2001). The receding of ice between the oasis and the inshore zone denudes the terrains, which makes it convenient for the penguins and pinnipeds to come ashore. As a consequence, the areas inhabited by the penguins and pinnipeds have increased and this results in fertilization of the area.

Orography is responsible for hydrological conditions, such as the direction, length and velocity of flow, and for the watersheds. There are six creek watersheds in the Thomas Point Oasis area (Kozik 1982). Four of them are greatly enriched with bird excrement. The Rocky Forest watershed and its artificially flooded reservoir in the vicinity of Arctowski Station are enriched with the excrement of a large colony of flying birds of the species *Catharacta spp*. Penguin excrement enter the watershed of Ornothologist Creek, the Ecology Glacier and the Jasnorzewski Garden. The creeks are short and the flow velocity is high. During the snow melting period in spring, and sometimes in winter during sudden warming periods (Rachlewicz 1997), large over-flooded reservoirs are formed, which help to level off the local differences in nutrient concentrations occurring in creeks and pools during summer when penguins are present. Orography also affects the movement of ice greatly, which is an important factor in shaping the terrain. In addition, it is the major means of achieving mineral matter transportation, and is also a valuable source of water. The Ecology Glacier in Thomas Point Oasis has receded about 300 m during the last 20 years (Battke *et al.* 2001) uncovering moraines and forming a characteristic lagoon along its frontal edge.

The ground of Thomas Point Oasis contains permafrost, the occurrence of which is variable depending on the location. It does not occur in the near shore terraces. Permafrost limits the reach of infiltration waters, and it accelerates the surface runoff in the upper parts of the oasis, thus leading to water-induced erosion. Water runoffs originating from land covered by ice, snow, and permafrost in the watershed situated above Arctowski Station, take place throughout the year (Juchnowicz-Bierbasz 1999; Juchnowicz-Bierbasz and Rakusa-Suszczewski 2002). This is a typical hydrological-meteorological phenomenon in this region of Maritime Antarctic climate. Soil-ground waters are present even in winter in the area of the near-sea terrace. Water in the geo-ecosystem is important not only as a chemical compound itself, but also as a means of transportation, and as a carrier for minerals, nutrients, plants and animals. Water causes variability in the conditions of the microenvironment with regards to temperature and concentration of nutrients. Water is also a carrier of mineral matter. The summer inflow of mineral matter into Admiralty Bay amounts to more than 100 thousand tons, which contains a high amount of Fe (Juchnowicz-Bierbasz and Rakusa-Suszczewski 2002). These cations are important for primary production on shelf water near the island. In winter the amount of minerals flowing with water into the bay is several times lower and depend on temperature and precipitation. Freezing and de-freezing creates specific living conditions for the flora and fauna that thrive at the border of water phase changes (Rakusa-Suszczewski 1993b, 1999). Variability of the environmental conditions affects the distribution of bacteria, fungi, and vascular plants exhibiting different spectra of optimal requirements and enzymatic activity (Zdanowski and Węgleński 2001). Some of them, such as the grass *D. antarctica* exhibit a unique tolerance to extreme conditions (Bystrzejewska 2001; Lewis-Smith 2001). The sugars concentrated in the grass *D. antarctica* are a unique anti-freeze ingredient. The concentration of fructose, glucose, and saccharose in *D. antarctica* reach to 23, 18, 65 g/kg of dry green biomass, respectively (n=5) (Bielejewska personal information.).

In the near shore zone, the lowest located terrace and the shore moss growths are saturated in seawater and showered with sea spray. This leads to a distinct salinity tolerance in the inhabiting plants and invertebrates like *Notholca salina* (Janiec 1993, 1996a). The shape of the shoreline of Admiralty Bay is the result of storms - deposited mounds are affected by tides, waves, and the presence in winter of sea ice. During austral summer, the presence of freshwater ice originating from the glacier is of essential importance. Ice causes both the scouring of the bottom surface, and for large movements of debris in the nearshore zone to become overgrown with macroalgae (Zieliński 1981; Rakusa-Suszczewski and Zieliński 1993). In Admiralty Bay, macroalgae reaches a depth of 100 m and covers 30% of the entire bottom surface (Zieliński 1990). Their biomass has been estimated as 74000 tons. Macroalgae is the source of organic and mineral matter deposited on shore amounting to about 279 tons in the period from February to November. Dry weight of macroalgae contains 30% ash, 22.3% carbon, and 2.7% nitrogen. These elements enrich local soils (Table 1). Some microelements, e.g. Cu, Zn, Fe, have high concentrations of macroalgae from seawater (Rakusa-Suszczewski and Zieliński 1993) and are transported with algal deposition onto land. These elements in the land environment have been wrongly evaluated so far as having their main source in anthropogenic contamination.

An inflow of organic matter in the form of penguin and mammal faeces is most important for the functioning of the near shore geo-ecosystem in the Maritime Antarctic. These processes are associated with the reproduction sequences of both vertebrate groups. Penguins are the first to arrive in the spring. During summer, they are the major suppliers of matter excreted on land. The most numerous in this area are elephant seals, which undergo molting during a period of almost three summer months and do not feed, and only their urine is excreted at the sites of animal concentrations. Following penguins departure in autumn, the next ones to appear on land are fur seals which consume about 12% (1464 tons) of the total food weight of all the pinnipeds in this region (Salwicka, unpub.data) Elephant seals consume 73% of the food; Weddell seals and Leopard seals use 4% and 1%, respectively. The sea is the major source of carbon, nitrogen, and various other chemical elements on land. Production and biomass in the sea in the vicinity of land undergo drastic seasonal and year-to-year changes. This especially concerns krills whose abundance decreases in warm years (Rakusa-Suszczewski 1988). It was confirmed by Loeb *et al.* (1997). The warm weather decreases the amount of pack ice under which krill hibernate during winter. As a consequence, the krill resources, which are the main food source for different consumers, are decreasing in relation to global warming.

Since the number of penguins, *P. adelia, P. antarctica* in this region decreased during the last 25 years (Ciaputa and Sierakowski 1999), the amount of faecal matter deposited on land has decreased to about 30% of the amount measured in the late 1970s (Rakusa-Suszczewski 1980, 1999). There has also been a change in the number of fur seals in the area of the South Shetland Islands. In Admiralty Bay peak numbers of this species appeared every 4-5 years (in 1991, 1995, 2000) (Sierakowski 1991; Rakusa-Suszczewski and Sierakowski 1993; Ciaputa 1996; Salwicka and Sierakowski 1998) indicating that these cyclical events might be related to 4-5 year oscillations in ENSO (Salwicka and Rakusa-Suszczewski 2002) Surface areas of pinniped colonies and lairs also underwent changes which lead to a significant spatial change in the fertilization and development of plant communities (Rakusa-Suszczewski 1999). It should be underlined that the land denuded of ice, accounts for only a small percentage of the total surface of this area. An enlargement of the surface areas inhabited by plants and animals intensifies the processes of circulation of matter and energy flow in this ecosystem (Fig. 3).

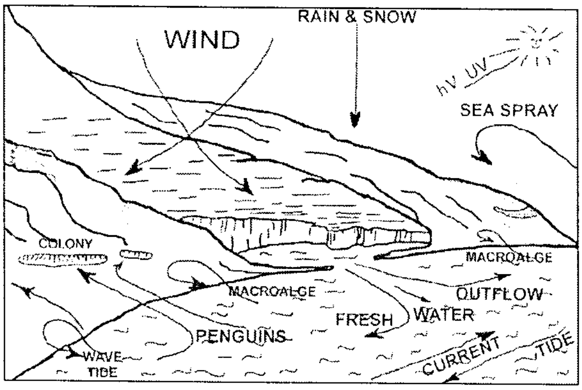

Fig. 3. Direction of matter transportation between coastal and shelf zones.

The distance from feeding places to penguin nesting sites and pinniped lairs is of a great importance. Organic matter originating in the sea is transported onto land mainly by penguins and pinnipeds in the form of faeces. However dead animal bodies, feathers, dawn, egg and mollusk shells (Rakusa-Suszczewski 1987, 1993b), fragment of macroalgae, krill and dead whales (Rakusa-Suszczewski and Nędzarek 2002) undergo the processes of decomposition and also provide a source of nutrient salts of different elements, such as K, Na, Mg, and Ca. These are essential elements that enrich the locally deficient land geo-ecosystem (Birkenmajer *et al.* 1989). Elements of organic origin, such as K and P are components of ornithogenic soils, and in the past, of paleo-ornithogenic soils (Fabiszewski and Wojtuń 2000). The cations from soil and soil solution-like Fe (Table 1) enrich the sea near the island (Martin *et al.* 1990), which is important for the phytoplankton primary production of neritic and shelf water.

It is interesting to note that fluoride is highly accumulated in penguin rookeries. It is thought that the high concentration in penguin rookeries is related to its promotion in the food chain. In support of this, the concentration in krill shells &

Table 1. The concentrations of cations in the soil, groundwater, inshore offshore waters and macroalgae near Arctowski Station.

Cations	Soil solutions near Arctowski station*mean values mg. x l^{-1}	Soil around the roots of *D. antarctica** mean values mg. x kg^{-1}	Iron distribution in Southern Ocean** m*l* x l^{-1}		Macroalgae mixture from seashore*** mg. x kg^{-1}
			inshore	offshore	
K	9.8	3950	5-7	0.1-0.9	33806
Na	27.7	6503			39057
Cu		67			13.3
Zn		148			109.2
Mg	14.3	7940			9059
P		2740			10910
Ca	16.14	16233			3468
Fe	0.28	36753	0.00028	0.0000056	271.2
			0.00039	0.00005	

*Juchnowicz-Bierbasz M., Rakusa-Suszczewski S. 2002.
**Martin *et al.* 1990.
***Zieliński 1990, Rakusa-Suszczewski S., Zieliński 1993.

carapaces is (2840 mg/kg), in penguin bones (7350 m/kg), and seal bones (5700 mg/kg) (Schneppenhaim 1980). In sea water, fluoride content does not exceed 1 mg/*l*.

Locally, animals in the study area exert negative influences on the vegetation as a result of over-fertilization and also by tramping plants down. The negative impacts of vertebrates on vegetation are as follows: Pinnipeds change their lairs, which are burnt by urine and faeces, and after these places recover with flourishing plants. When the number of animals is high, the results of the mechanical destruction of plants might be irreversible. South Georgia Island, and the history of Antarctic fur seals provide an example of such a situation, where a total destruction of vegetation in the area of fur seal occurrence has been noted (cf. Boyd 1993). Although, this species does not reproduce on King George Island at present, one can anticipate such events in the near future with the consequences for vegetation being similar to those on South Georgia Island.

In the area of Thomas Point Oasis, the surface area directly influenced by man encompasses 0.28 km^2 It is disturbed mainly mechanically by equipage and motor vehicles. In the vicinity, there is the area of moss tussocks of 0.12 km^2, which are protected by interior station regulations. Every year, the 12-person team staying on over winter at Arctowski Station utilizes about 538 tons of fresh water from local resources and about 25 tons of products and 150 tons of fuel. Some of these materials may remain and enter into the geo-ecosystem cycles of the ecosystem. The amount may be small. The possibility that toxic materials such as oil and grease remain in the environment is small because these materials are exported out of Antarctica according to environmental protection requirements.

3. Conclusions

In terms of the climatic conditions of the Maritime Antarctic where King George Island is located (62°09'S, 58°31'W), the geo-ecosystem in the near shore zone is dependent on the amount of matters circulating between the sea and land. This functioning varies with periodic cycles: the day/night, seasonal, annual and multi-annual variations. The geo-ecosystem causes variability and changes expressed as trends. In the entire scale of King George Island, the changes in the oasis reflect climatic changes in the entire region, and some of the observed processes indicate association with the global change. Climate in the region of West Antarctica is warming. An increase of temperatures is accompanied by deglaciation, which causes an increase in the water content, but it also leads to aridity in the terrain. It affects the thermal conditions in the area of the near shore terraces. The essential changes in the maritime Antarctic ecosystem were caused by man in the past years through the exploitation of fur seals and whales. This had changed for many tens of years the abundance of food resources, and the numbers of consumers. Changes and variability on a local scale depend on food accessibility, consumer numbers and their reproductive success. During the last 25 years, there has been a distinct trend toward a decrease in the number of penguins. Climate warming causes the lowering of the surface area of pack ice and thus of the abundance of krill which feed underneath the ice. One can observe the restoration process of the fur seal population, and 4-5 year migration cycles of this species from the area of the South Georgia Island, an occurrence related to the phenomenon of El Niño. Matter transportation on land undergoes quantitative changes in time and space. The amounts of faecal matter imported on land by penguins decreased by about one third as compared with the end of the 1970s when it was estimated as 230 tons. Intensive processes of deglaciation denuded moraines and mineral soil on land. They are not extensive on the island, but exceptionally large at the western shores of Admiralty Bay and at Thomas Point Oasis. During the last 21 years, the land surface area that is free of ice at the SSSI 8 (ASPA 121) site has increased threefold and presently covers 9 km^2 of the penguin rookeries, pinniped lairs and paleo-ornithogenic deposits are centers of fertilization surrounded by gradients of nutrient (e.g. NH_4) concentration depending on runoff and wind direction. The lowest terraces located near shore are also enriched with organic and mineral matter, and with nutrients originating from macroalgae deposited on shore, as well as whale bones and seawater. This leads to the enrichment of the forming soils which are poor in nutrients and elements such as K, Na, Mg, Ca. From the other side the cations from soil, like Fe and soil solutions enrich the seawater, which is important for phytoplankton primary production of shelf water near the island. Deglaciation and land denudation create conditions favorable for plant and animal settling and succession. Colonization is island-like in appearance and depends to a high degree, on physical factors, such as wind and water which carry and disperse nutrients, seeds, and fragment of plants and animals. The grass *Deschampsia antarctica*, the only representative of vascular plants is the first to inhabit the land area newly denuded of ice, only those protected from wind however. Wind carries not only fragments of lichens and mosses, but also sand and snow which mechanically limit the growth of plants (cutting them). The role of wind does not seem to be appreciated enough. Wind also carries nitrogen in the form of NH_4, and 41% of the winds blowing in this region from N to E to S has made Thomas Point Oasis the main center for the distribution of nutrients from the flora and fauna of the western shores of Admiralty Bay. Very powerful physical forces are shaping the living conditions and distribution of flora and fauna, and as a consequence, it affects the functioning of the geo-ecosystem in the near shore zone. The border area of land with Admiralty Bay is the demarcation point of important natural processes, both qualitative and quantitative, which are associated with the exchange of matter between the marine and land environment.

Acknowledgements

Thanks to Reviewers. Thanks are due to my colleagues in the Department of Antarctic Biology for their help in translating the manuscript.

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Received Jun. 15, 2003
Accepted Dec. 3, 2003