Zoobenthos of Admiralty Bay, King George Island, South Shetland Islands

(Zoobenthos I Abundance I sublittoral ecosystems I Admiralty Bay)

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INTRODUCTION

Facilities created by the foundation of Polish and Brazilian Antarctic Stations ("Henryk Arctowski" founded in 1977 and "Comandante Ferraz" in 1984) have enabled scientists of many nations to study the biology of Admiralty Bay in details. Interest of a number of biologists focused on the rich benthic fauna. In the last decade a rich literature has been produced discussing the faunistic composition and structure of zoobenthos of Admiralty Bay, the basin that is predestined as a natural laboratory for studies on West Antarctic littoral and sublittoral ecosystems. This literature includes descriptions of particular species (Wägele, 1988; Brandt, 1988, 1989, 1990, 1991; Jażdżewski & De Broyer, 1990; Coleman & Barnard, 1991, Teodorczyk & Wägele, 1994), faunal lists (Arnaud *et al.*, 1986; Hartmann-Schröder & Rosenfeldt, 1988, 1989; Jażdżewski *et al.*, 1992; Sicinski, 1992; Presler, 1993; Sicinski & Janowska, 1993; Blażewicz & Jażdżewski, 1995, 1996; Jażdżewski, Weslawski & De Broyer, 1995; Wakabara *et al.*, 1995), and more general papers where quantitative aspects were discussed (Jażdżewski *et al.*, 1995), and more general papers where quantitative aspects were discussed (Jażdżewski *et al.*, 1986, 1991; Presler, 1986; Sicinski, 1986, 1993; Wägele & Brito, 1990; Jazdzewski & Sicinski, 1993). The preliminary list of over 200 benthic invertebrate taxa of Admiralty Bay published by Arnaud *et al.* (1986) has now nearly doubled due to more detailed studies on Amphipoda (Wakabara *et al.*, 1990, 1995; Jażdżewski *et al.*, 1991, 1992; Jażdżewski, Weslawski & De Broyer, 1995), Polychaeta (Sicinski, 1986, 1993; Hartmann-Schröder, 1988, 1989; Sicinski & Janowska, 1993) and Ophiuroidea (Presler, 1993); each of the two former groups alone now embrace over 100 taxa from this area. To this list, which still, unfortunately, lacks identification of some important groups (Porifera, Cnidaria, Ascidiacea) one should also add some 40 Bryozoa species found in Admiralty Bay by Moyano (1978).

At present, summarizing published and unpublished faunistic data, the following species numbers in particular animal groups were recorded for Admiralty Bay (Table I).

Polish quantitative studies in Admiralty Bay (Jażdżewski *et al.*, 1986) proved the presence of considerable abundance and biomass values of benthic fauna. Maximal abundance was over 36000 ind.m^{-2} with an average of ca. 6500 ind.m^{-2}, maximal biomass was over 2400 gm^{-2}, while the average exceeded 700 gm^{-2}. At a depth of 15 m bivalve molluscs were clearly dominant, constituting over 85% of all animals and nearly 58% of the total weight. At 30 m Bivalvia were still dominant in numbers but yielded to other groups in terms of biomass. At stations situated at 80, 150 and 250 m, Polychaeta were dominant in terms of abundance but with respect to biomass

TABLE I
Number of species in some better known animal groups of Admiralty Bay

Group	Number of species
Polychaeta	120
Amphipoda	119
Isopoda	60
Gastropoda	42
Bryozoa	40
Asteroidea	36
Bivalvia	27
Ophiuroidea	14
Mysidacea	13
Cumacea	12
Tanaidacea	5
Euphausiacea	4
Cephalopoda	4
Echinoidea	3
Decapoda	2
Polyplacophora	2

Ascidiacea, Echinoidea and Ophiuroidea were the leading animal groups. Amphipoda contributed significantly to benthic fauna abuncance at all depths, but were less important in terms of biomass. The biomass of Ascidiacea alone at a depth of 80 m surpassed 2000 gm^{-2}, and that of Bryozoa at depths of 30, 80 and 150 m was considerable.

Quantitative studies of the bottom of Admiralty Bay (soft bottom of shallow sublittoral only) by SCUBA diving were undertaken in the austral summer of 1987/88 in parallel by Brazilian-German and Polish teams (Wägele & Brito, 1990; Jażdżewski *et al.*, 1991).

The first group operated mainly in the vicinity of Ferraz station (Martel Inlet) at depths of 3.5-25 m. The sampler for infauna had a sampling area covering 80 cm^2. Epifauna representatives and siphons of the deeply burrowing bivalve *Laternula elliptica* were counted by divers in an area of 1 m^2. Overall densities of benthic fauna calculated by Wägele & Brito (1990) ranged from about 1000 to over 33000 ind.m^{-2}, high abundancies were mainly due to small bivalves of the genus *Mysella* at depths of 7 and 13 m; and at 24 m to a polychaete *Tharyx cincinnatus*, and to Oligochaeta. Biomass was not estimated, but judging from the comparatively high abundance of the large bivalve *Laternula* at depths of 20-25 m (from ca. 40 to ca. 150 ind.m^{-2}), one can assume that the total benthic biomass here could reach several kg per sq.m. An important share in the biomass of benthic fauna can be attributed to the comparatively large crustacean, *Serolis polita*, observed in their hundreds by divers at depths of 7 and 13 m.

Polish divers operating near Arctowski station, in the main part of the bay close to Shag Point, used a Tvärminne-type bottom sampler (Kangas, 1972) of 565 cm^2 sampling area. Three replicate subsamples were collected at 7 stations situated at depths of 4 to 30 m in a section corresponding to transect studied by Jazdzewski *et al.* (1986). Only the top 5 cm of the sediment was sampled, and therefore deeper burrowing infauna such as *Laternula elliptica* were clearly underestimated. Leading animal groups were Polychaeta, Bivalvia and Amphipoda (Jażdżewski *et al.*, 1991b). Total animal abundance varied from 2000 to 25000 ind.m^{-2} and was comparable to the results of Wägele & Brito (1990). Also similar was a distinct dominance of bivalves, mostly of *Mysella charcoti*, at a depth of 6.5 m, as well as a high share of serolids (probably also *Serolis polita*) at depths of 4 and 6.5 m. A remarkable difference was observed in that there was a very share of Amphipoda at nearly all stations at Shag Point. This group was dominant in terms of abundance at depths from 10 to 25 m, constituting over 60% of all collected animals. In terms of biomass these crustaceans were less significant components of the zoobenthos yielding to other groups (Echinoidea, Polychaeta, Serolidae, Bryozoa) at various depths as a result of the generally small size of individuals.

Among Polychaeta in the shallow sublittoral zone at Shag Point, the most common and abundant were *Capitella capitata*, *Scoloplos marginatus*, *Microspio moorei* and *Travisia kerguelensis*. The latter species, due to its large individual weight, clearly dominated polychaetes in terms of biomass.

The above results can be supplemented by some new data. During the wintering of the IXth Polish Antarctic Expedition (1984/86) Sicinski collected some 20 additional Van Veen grab samples outside the transects of Jażdżewski *et al.* (1986). Joint elaboration of all our quantitative Van Veen samples is presented in Figure 1. An attempt was made to estimate the biomass of the benthic fauna in Admiralty Bay, calculating it at 50 m isobath intervals (Jażdżewski & Sicinski, 1993).

Some general ideas of the biomass of benthic invertebrates in Admiralty Bay can be drawn from the overall mean calculated from some 70 Van Veen grab samples (sampling area 0.09 m^2) covering almost the whole depth range (4-500 m). The mean amounts to around 700 gm^{-2} and its 95% confidence limits are 500 and 900 gm^{-2}. Means differ at particular depth ranges and their distribution shows a clear tendency: a rather low biomass in the shallow sublittoral (200-400 gm^{-2}) increases to a maximum mean of 1400 gm^{-2} at 100-200 m and then diminishes to about 300 gm^{-2} between 300 and 500 m.

One should take into consideration however that quantitative studies published to date, scarcely consider the locally rich phytal Zone of Admiralty Bay. As noted by Zielinski (1981, 1990) and by Furmanczyk & Zielinski (1982), a considerable part of the bottom of Admiralty Bay to a depth of some 90 m constitutes the phytal zone, with brown algae such as *Desmarestia*, *Cystosphaera* or *Himantothallus* as the most distinctive components of the phytobenthos. These parts of the bottom are less well known from a faunal point of view, and quantitative information on phytal zoobenthos in particular is lacking because quantitative sampling methods in dense stands of *Desmarestia*, or in areas covered by giant thalli of *Himantothallus* are not developed. Dredging and diving observations indicate that the phytal zone is extremely rich in animals and is heavily populated by vagile crustaceans of the orders Isopoda and Amphipoda. The author's unpublished data also indicate that holdfasts of brown algae serve as a very special habitat for numerous polychaete and crustacean species that are not so abundant in other biotopes. These communities also have a rather patchy distribution; between patches of dense algal stands there are wide areas of bare, soft or mixed bottom (SCUBA diving personal observation). The actual area covered by algae is clearly smaller than suggested by the maps of Zielinski (1990). Nevertheless, the fauna in the phytal zone differs from that on the soft bottom. One can also assume that it is richer in terms of species diversity, abundance and biomass. Particular phytal zones distinguished by Furmanczyk & Zielinski (1982) and by Zielinski (1990) are, without doubt, inhabited by different zoocenoses. It may be reasonable to suspect that the average biomass values given for the first three depth zones in Figure 1 are an underestimate.

Another special habitat in Admiralty Bay is offered by a hard, rocky substrate. Also, this is usually covered by Phaetophyta, mainly *Desmarestia*, which below 20 m depth is replaced by *Cystosphaera*. A classic example of such a habitat is Napier Rock, a steep stony column rising to the surface from a depth of some 90 m, a mile or so south of "Arctowski" station. The patellid gastropod *Nacella concinna* which ranges from the supralittoral to upper sublittoral is numerous here, and various large amphipods shelter in crevices (*Paraceradocus*, *Bovallia*, *Eurymera*). The rock is encrusted by *Litothamnium* and *Halidona*. There are tubes of sessile Polychaeta (Sabellidae and Spirorbidae), and between 6 and 15 m a wealth of other suspension feeders such as Porifera, Hydrozoa, Bryozoa and Ascidiacea, are attached to the surface. Among them the beautiful pink octocorallians catch the eye, along with the cucumarian Holothurioidea, a common asteroid *Odomaster*, and representatives of the Opistobranchia, Isopoda and Pantopoda.

Similar observations from the same place are recorded by Wägele & Brito (1990), whereas Rauschert (1991) reported the same benthic assemblages on rocky substrata in the neighbouring Maxwell Bay.

A distinct feature of the Admiralty Bay zoobenthos is its patchy distribution. In some depth zones the differences between the extreme biomass values taken by particular grab hauls were two orders of magnitude. Even in closely situated areas the biomass of the benthic fauna varied between tens of grams to kilograms per sq.m. In some places where Ascidiacea were very abundant, maximal values obtained approached 7 kg wet weight per sq.m. Confidence limits (95%) were widest for the depths of 100-200 m. At these depths the degree of patchiness and mean zoobenthos biomass were highest.

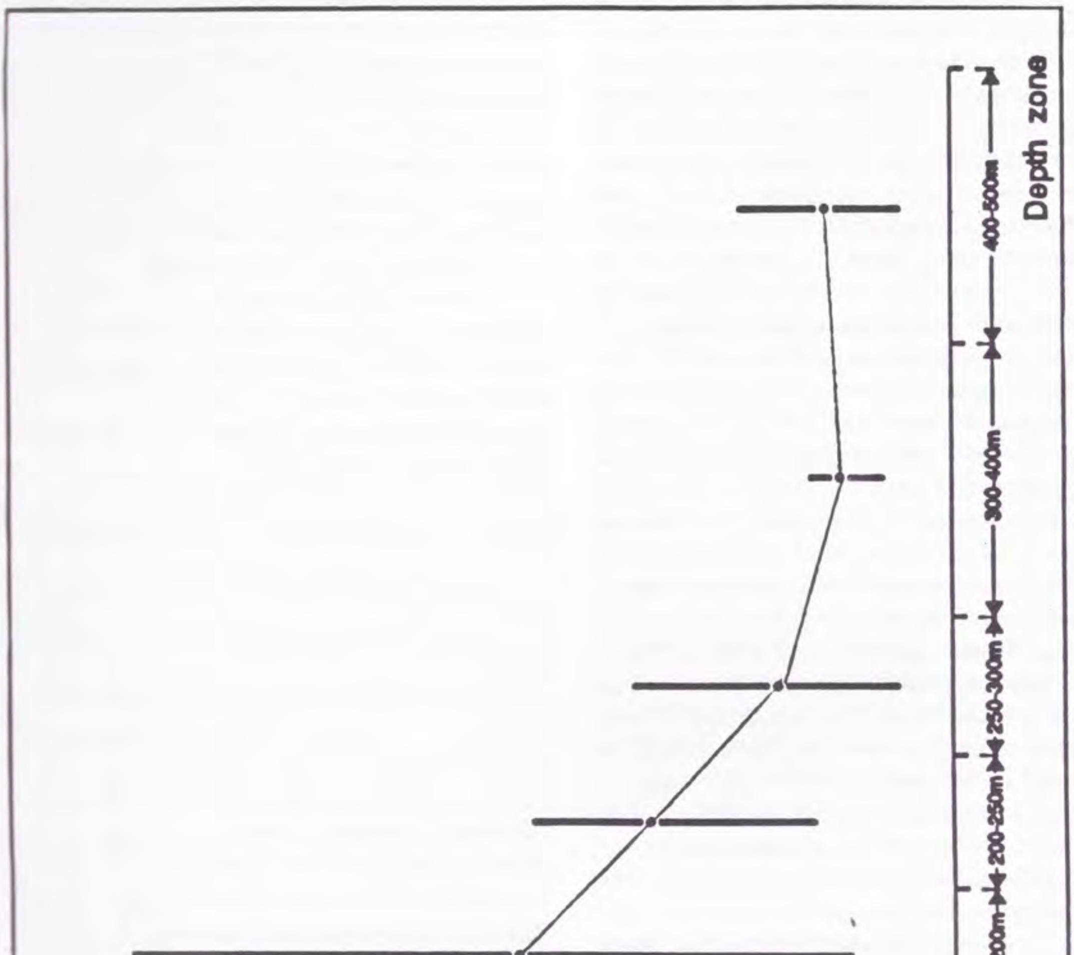

Fig. 1 — Zoobenthos biomass in Admiralty Bay. Data based on some 70 Van Veen grab samples. According to Jazdzewski & Sicinski (1993). Average values and 95% confidence limits are indicated.

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Biomass values recorded for zoobenthos inhabiting the fine sediments in Ezcurra Inlet are distinctly lower than those for the central part of Admiralty Bay, especially those calculated for samples taken in the deepest parts of this inlet.

Similar differences were observed for vagile components of the zoobenthos such as crustaceans and annelids. Amphipods which dominate in terms of abundance in the shallow sublittoral of the centre of the bay, clearly yielded to Cumacea, Tanaidacea and Oligochaeta (Jażdżewski *et al.*, 1986) in Ezcurra Inlet. Worth mentioning is the high abundance of Tanaidacea and Cumacea in muddy bottom of Ezcurra Inlet *versus* their much lower species diversity there in comparison with the main Admiralty Bay basin (Blazewicz & Jażdżwski, 1995, 1996). Among Polychaeta in Ezcurra Inlet, a leading role was played by species such as *Tharyx cincinnatus*, *Ophelina syringopyge* and *Leitoscoloplos kèrguelensis*, all typical inhabitants of fine sediments (Sicinski, 1986, 1993; Sicinski & Janowska, 1993). It is interesting that these very groups and/or species were mentioned by Wägele & Brito (1990) as typical in bottom sediments at depths below 20 m in Martel Inlet near Ferraz station, thus supporting the validity of our speculations concerning sedimentation rates in this inlet.

Although not fully studied, the benthic fauna of Admiralty Bay is a good example of the principles formulated to date concerning the Antarctic sublittoral. The qualitative and quantitative diversity of Antarctic zoobenthos often recorded and discussed (for review see Arnaud, 1974; Jazdzewski, 1983; White, 1984; Picken, 1985; Jazdzewski *et al.*, 1986; Gallardo, 1987; Mühlenhardt-Siegel, 1988; Gerdes *et al.*, 1992) is clearly evident in Admiralty Bay. The differing hydrological conditions in the various parts of this large and deep basin (Pecherzewski, 1980; Pruszak, 1980; Samp, 1980; Szafranski & Lipski, 1982; Lipski, 1987), and particularly the sedimentation and sediment characteristics, lead to a diverse zoobenthos in terms of species and assemblage biomass.

In general, one can find clear and close similarities of Admiralty Bay zoobenthos communities to those observed at the South Orkney Islands (Everson & White, 1969; Hardy, 1972; White & Robins, 1972; Picken, 1985), as well as with those recorded by Rauschert (1991) for Maxwell Bay. The zoobenthos in the sheltered embayments of Admiralty Bay resembles that in the sheltered areas of Arthur Harbor (Anvers Island, Palmer Archipelago) (Lowry, 1975; Richardson & Hedgpeth, 1977) and of Chile Bay, Greenwhich Island, South Shetlands (Gallardo & Castillo, 1969 and Gallardo *et al.*, 1977).

REFERENCES

ARNAUD, P. M., (1974), Contribution a la bionomie marine benthique des regions antarctiques et subantarctiques. *Tethys*, **6**: 465-656.

ARNAUD, P. M.; JAŻDŻEWSKI, K.; PRESLER, P. & SICINSKI, J., (1986), Preliminary survey of benthic invertebrates collected by Polish Antarctic Expeditions in Admiralty Bay (King George Island, South Shetlands, Antarctica). *Pol. Polar Res.*, **7**: 7-24.

BLAZEWICZ, M. & JAŻDŻEWSKI, K., 1995, Cumacea (Crustacea, Malacostraca) of Admiralty Bay, King George Island: a preliminary note. *Pol. Polar Res.*, **16**: 71-86.

BLAZEWICZ, M. & JAŻDŻEWSKI, K., (1996), Contribution to the knowledge of Tanaidacea (Crustacea, Malacostraca) of Admiralty Bay, King George Island, South Shetland Islands. *Pol. Polar Res.*, **17**.

BRANDT, A., (1988), Antarctic serolidae and Cirolanidae (Crustacea: Isopoda). *Theses Zoologicae*, **10**: 7-143.

BRANDT, A., (1989), Redescription of *Cymodocella tubicauda* Pfeffer, 1887 and *Exosphaeroma gigas* (Leach, 1818) (Crustacea, Isopoda, Sphaeromatidae). *Antarctic Science*, **1**: 205-214.

BRANDT, A., (1990), The deep sea isopod genus *Echinozone* Sars, 1897 and its occurrence on the continental shelf of Antarctica. *Antarctic Science*, **2**: 215-219.

BRANDT, A., (1991), A revision of the Acanthaspididae Menzies, 1962 (Isopoda: Asellota). *Zool. J. Linn. Soc.*, **102**: 203-252.

COLEMAN, C. O. & BARNARD, J. L., (1991), A Review of the Genus *Pariphimedia* (Crustacea: Amphipoda: Iphimediidae) with Description of Two Species from the Southern Ocean. *Invertebr. Taxon*, **5**: 527-539.

EVERSON, I. & WHITE, M. G., (1969), Antarctic marine biological research methods involving diving. *Rep. Underwat. Ass.*, **4**: 91-95.

FURMANCZYK, K. & ZIELINSKI, K., (1982), Distribution of macroalgae groupings in shallow waters of Admiralty Bay (King George Island, South Shetlands, Antarctica). *Pol. Polar Res.*, **3**: 41-47.

GALLARDO, V. A., (1987), The sublittoral macrofaunal benthos of Antarctic shelf. *Env. Intern.*, **13**: 71-81.

GALLARDO, V. A. & CASTILLO, J. G., (1969), Quantitative benthic survey of the infauna of Chile Bay (Greenwich Island, South Shetlands). *Gayana*, **16**: 1-18.

GALLARDO, V. A.; CASTILLO, J. G.; RETAMAL, M. A.; YANEZ, A.; MOYANO, H. & HERMOSILLA, J. G., (1977), Quantitative studies on the soft-bottom macrobenthic animal communities of shallow Antarctic Bays. In: Llano, G. A. [Ed.] *Adaptations Within Antarctic Ecosystems*. Proc. 3rd SCAR Symp. Antarct. Biol., Smith. Inst. Wash., 361-367.

GERDES, D.; KLAGES, M.; ARNTZ, W. W.; HERMANN, R. L.; GALERON, J. & HAIN, S., (1992), Quantitative investigations on macrobenthos communities of the southern Weddell Sea shelf based on multibox corer samples. *Polar Biol.*, **12**: 291-301.

HARDY, O., (1972), Biomass estimates for some shallow-water infaunal communities at Signy Island, South Orkney Islands. *Br. Antarct. Sur. Bull.*, **31**: 93-106.

HARTMANN-SCHRÖDER, G. & ROSENFELDT, P., (1988), Die Polychaeten der "Polarstern" – Reise ANT III/2 in die Antarktis 1984, Teil 1: Euphrosinidae bis Chaetopteridae. *Mitt. hamb. zool. Mus. Inst.*, **85**: 25-72.

HARTMANN-SCHRÖDER, G. & ROSENFELDT, P., (1989), Die Polychaeten der "Polarstern" – Reise ANT III/2 in die Antarktis 1984, Teil 2: Cirratulidae bis Serpulidae. *Mitt. hamb. zool. Mus. Inst.*, **86**: 65-106.

JAŻDŻEWSKI, K., (1983), Benthic fauna of Antarctica and the role of Poles in its description [in Polish]. *Kosmos*, **32**: 231-250.

JAŻDŻEWSKI, K. & DE BROYER, C., (1990), Morphology and proper systematic position of the Antarctic and Subantarctic synopiid *Cardenio paurodactylus* Stebbing, 1888 (Crustacea, Smphipoda, Synopiidae). *Beaufortia*, **41**: 129-133.

JAŻDŻEWSKI, K.; DE BROYER, C.; TEODORCZYK, W. & KONOPACKA, A., (1992, 1991), Survey and distributional patterns of the amphipod fauna of Admiralty Bay, King George Island, South Shetland Islands. *Pol. Polar Res.*, **12**: 461-472.

JAŻDŻEWSKI, K.; JURASZ, W.; KITTEL, W.; PRESLER, E.; PRESLER, P. & SICINSKI, J., (1986), Abundance and biomass estimates of the benthic fauna in Admiralty Bay, King George Island, South Shetland Islands. *Polar Biol.*, **6**: 5-16.

JAŻDŻEWSKI, K. & SICINSKI, J., (1993), 12. Zoobenthos. 12.1. General remarks. In: Rakusa-Suszczewski, S. [Ed.] *The maritime Antarctic coastal ecosystem of Admiralty Bay*. Dept. Antarctic Biology, Pol. Acad. Sci., Warsaw, 83-95.

JAŻDŻEWSKI, K.; TEODORCZYK, W.; SICINSKI, J. & KONTEK, B., (1991), Amphipod crustaceans as an important component of zoobenthos of the shallow Antarctic sublittoral. *Hydrobiologia*, **223**: 105-117.

JAŻDŻEWSKI, K.; WESLAWSKI, J. M. & DE BROYER, C., (1995), A comparison of the amphipod faunal diversity in two polar fjords: Admiralty Bay, King George Island (Antarctic) and Hornsund, Spitsbergen (Arctic). In: Jazdzewski, K.; De Broyer, C.; Stock, J. H. [Eds.] Proceedings of the VIIIth International Colloquium on Amphipoda. Lód'z, Poland, 1994. *Pol. Arch. Hydrobiol.*, **42**: 367-384.

KANGAS, P., (1972), Quantitative sampling equipment for the littoral benthos. II. *IBP, Norden*, **10**: 9-16.

LIPSKI, M., (1987), Variations of physical conditions, nutrients and chlorophyll *a* contents in Admiralty Bay (King George Island, South Shetland Islands, 1979). *Pol. Polar Res.*, **8**: 307-332.

LOWRY, J. K., (1975), Soft bottom macrobenthic community of Arthur Harbor, Antarctica. *Antarctic Res. Ser.*, **23**: 1-19.

MOYANO, H. J., (1978), Bryozoa de Bahias Antarticas: algunos aspectos ecologicos. *INACH Ser. Cient.*, **24**: 35-60.

MÜHLENCHARDT-SIEGEL, U., (1988), Some results on quantitative investigations of macrozoobenthos in the Scotia Arc (Antarctica). *Polar Biol.*, **8**: 241-248.

PECHERZEWSKI, K., (1980), Distribution and quantity of suspensed matter in Admiralty Bay (King George Island, South Shetland Islands). *Pol. Polar Res.*, **1**: 75-82.

PICKEN, G. B., (1985), Marine Habitats – Benthos. In: Bonner, W. N.; Walton, D. W. H. *Key Environments: Antarctica*. Pergamon Press, 154-172.

PRESLER, P., (1986), Necrophagous invertebrates of the Admiralty Bay of King George Island (South Shetland Islands, Antarctica). *Pol. Polar Res.*, **7**: 25-61.

PRESLER, P., (1993), 12. Zoobenthos. 12.5. Ophiuroidea. In: Rakusa-Suszczewski, S. [Ed.] *The maritime Antarctic coastal ecosystem of Admiralty Bay*. Dept. Antarctic Biol., Pol. Acad. Sci., Warsaw, 117-119.

PRUSZAK, Z., (1980), Currents circulation in the waters of Admiralty Bay (region of "Arctowski" Station on King George Island). *Pol. Polar Res.*, **1**: 55-74.

RAUSCHERT, M., (1991), Ergebnisse der faunistischen Arbeiten im Benthal von King George Island (Südshetlandinseln, Antarktis). *Ber. Polarforsch.*, **76**: 1-76.

RICHARDSON, M. D. & HEDGPETH, J. W., (1977), Antarctic Soft Bottom Macrobenthic Community Adaptations to a Cold, Stable, Highly Production, Glacially Affected Environment. In: Llano, G. A. *Adaptations Within Antarctic Ecosystems*. Proc. III SCAR Symp. Antarct. Biol., Smith. Inst. Walsh., 181-196.

SAMP, R., (1980), Selected environmental factors in the waters of Admiralty Bay (King George Island, South Shetland Islands), December 1978-February 1979. *Pol. Polar Res.*, **1**: 53-66.

SICINSKI, J., (1986) chosen region Island, South 63-78.

SICINSKI, J., (1993) Rakusa-Suszcz *coastal ecosys* Biol., Pol. Aca

SICINSKI, J. & JAN shallow sublit Island, South S

SZAFRANSKI, Z. & water temperat George Island during the aust 7-24.

TEODORCZYK, W. species of the Isopoda, Asell *Paris*, 4e ser., 1

WAKABARA, Y.; T. (1995), The a region (South In: Jażdżewski Proceedings of Amphipoda. *Hydrobiol.*, **42**:

SICINSKI, J., (1986), Benthic assemblages of Polychaeta in chosen region of the Admiralty Bay (King George Island, South Shetland Islands). *Pol. Polar Res.*, **7**: 63-78.

SICINSKI, J., (1993), 12. Zoobenthos. 12.3. Polychaeta. In: Rakusa-Suszczewski, S. [Ed.] *The maritime Antarctic coastal ecosystem of Admiralty Bay*. Dept. Antarctic Biol., Pol. Acad. Sci., Warsaw, 101-107.

SICINSKI, J. & JANOWSKA, E., (1993), Polychaetes of the shallow sublittoral of Admiralty Bay, King George Island, South Shetlands. *Antarctic Science*, 161-167.

SZAFRANSKI, Z. & LIPSKI, M., (1982), Characteristics of water temperature and salinity of Admiralty Bay (King George Island, South Shetland Islands, Antarctic) during the austral summer 1978/79. *Pol. Polar Res.*, **3**: 7-24.

TEODORCZYK, W. & WÄGELE, J.-W., (1994), On Antarctic species of the genus *Munna* Kröyer, 1839 (Crustacea, Isopoda, Asellota, Munnidae). *Bull. Mus. natl. Hist. nat. Paris*, 4^{e} ser., **16**: 111-201.

WAKABARA, Y.; TARARAM, A. S. & MIYAGI, V. K., (1995), The amphipod fauna of the West Antarctic region (South Shetland Islands and Bransfield Strait). In: Jażdżewski, K.; De Broyer, C.; Stock, J. H. [Eds.] Proceedings of the VIIIth International Colloquium on Amphipoda. Lód'z, Poland, 1994. *Pol. Arch. Hydrobiol.*, **42**: 347-365.

WAKABARA, Y.; TARARAM, A. S.; VALERIO-BERARDO, M. T. & OGIHARA, R. M., (1990), Records of Amphipoda collected during I and III Brazilian Antarctic Expeditions. *Relat. int. Inst. oceanogr. Univ. São Paulo*, **30**: 1-9.

WÄGELE, J.-W., (1988), Note on the Arcturidae from the Weddell Sea and the description of *Antarcturus hempeli* sp.n. (Crustacea, Isopoda, Valvifera). *Zoologica Scripta*, **17**: 115-211.

WÄGELE, J.-W. & BRITO, T. A. S., (1990), Die sublitorale Fauna der maritimen Antarktis. Erste Unterwasserbeobachtungen in der Admiralitätsbucht. *Natur und Museum*, **120**: 269-282.

WHITE, M. G., (1984), Marine benthos. In: Laws, R. [Ed.] *Antarctic ecology*, 2. Academic Press, London, 421-461.

WHITE, M. G. & ROBINS, M. W., (1972), Biomass estimates from Borge Bay, Signy Island, South Orkney Islands. *Br. Antarct. Surv. Bull.*, **31**: 45-50.

ZIELINSKI, K., (1981), Benthic macroalgae of Admiralty Bay (King George Island, South Shetland Islands) and circulation of algal matter between the water and the shore. *Pol. Polar Res.*, **2**: 71-94.

ZIELINSKI, K., (1990), Bottom macroalgae of Admiralty Bay (King George Island, South Shetland Islands, Antarctica). *Pol. Polar Res.*, **11**: 95-131.