

An addendum to the previously submitted document (titled “the Antarctic Biological Prospecting Database”).

Submitted by the Belgian Federal Ministry of Environment to the **ATCM Intersessional Contact Group to Examine the Issue of Biological Prospecting in the Antarctic Treaty Area**

A summary of existing information on marine biological prospecting in Antarctica

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1. Introduction

The Antarctic Biological Prospecting Database provides details of research and commercialised products arising from biological samples that were sourced from the Antarctic region. A joint initiative of the Belgian Ministry of Environment and the United Nations Environment Programme (UNEP), the database has been developed by the United Nations University Institute of Advanced Studies (UNU-IAS). The database is online at <http://www.bioprospector.org/bioprospector/antarctica/search.jsp>. The present report provides a summary, prepared by UNU-IAS, of the marine-related content in that database.

2. Proportion of marine bioprospecting in Antarctica

The majority of the records in the Antarctic Biological Prospecting database relate to organisms collected from the marine environment. As can be seen in figure 1 below, 56% of the records in the database originate from the marine environment of the Southern Ocean.

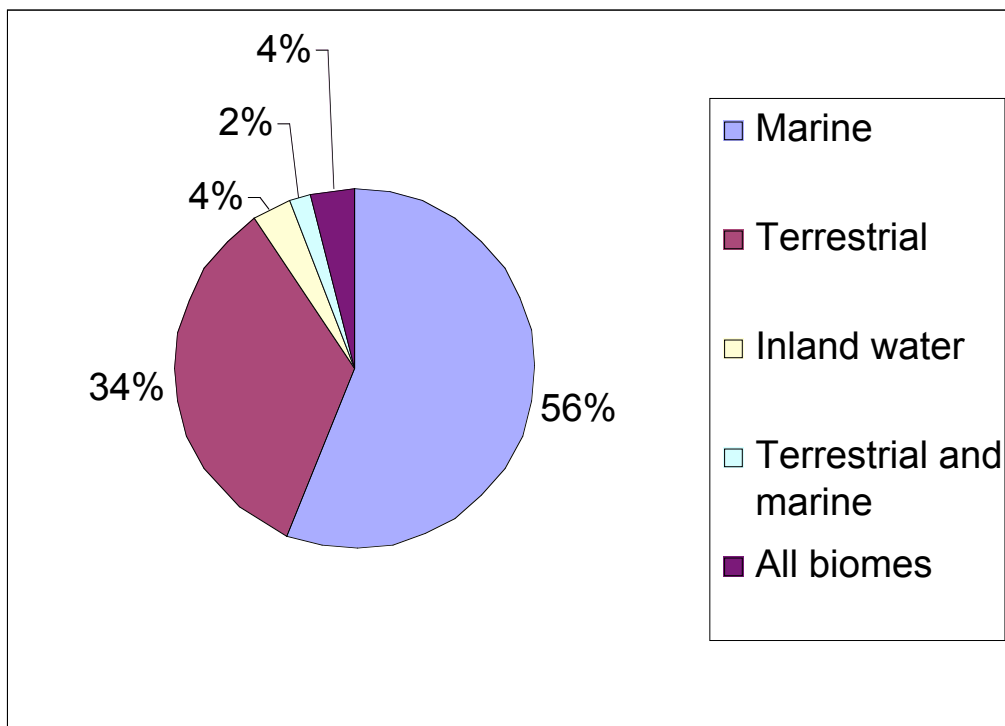


Figure 1: Breakdown of records for each biome. 56% of the records in the Antarctic Biological Prospecting Database relate to organisms collected from the marine environment, while 34% relate to terrestrial ecosystems and only 4% to inland water

ecosystems. In addition, 4% of the records rely on samples collected from all of the above biomes. These records consist mainly of culture collections. 2% relate to both the marine and terrestrial environments, and include organisms that have been collected from both, such as certain bacteria that can exist in a number of different environments.

3. Types of source organisms and their uses

A majority of the marine records in the database are based on various products derived from krill. As seen in figure 2, the rest consist mainly of sponges, bacteria, fish and algae.

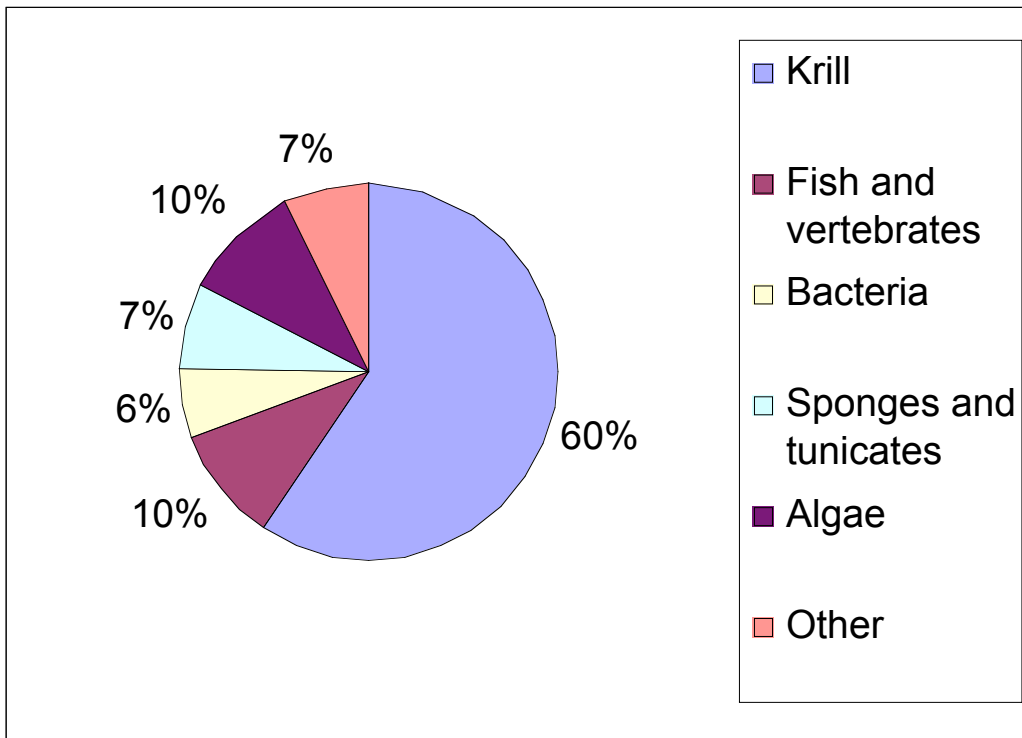


Figure 2: Source organisms for marine bioprospecting in Antarctica. Krill make up 60% of the marine records, while fish and other vertebrates come in second at 10%. Of those records, the majority relate to fish, with one record relating to the King Penguin. The rest of the records include marine algae (10%), sponges and tunicates (7%), and bacteria (6%). The records marked as “other” generally relate to culture collections or, in one case, the use of myriad unspecified marine organisms.

As can be seen in figure 3, the biggest users of Antarctic marine genetic resources are the food and beverage industries and the pharmaceutical/medical technology industries. Industrial applications, molecular biology and biotechnology, and the cosmetics and personal care industries are other major users of marine genetic resources from Antarctica.

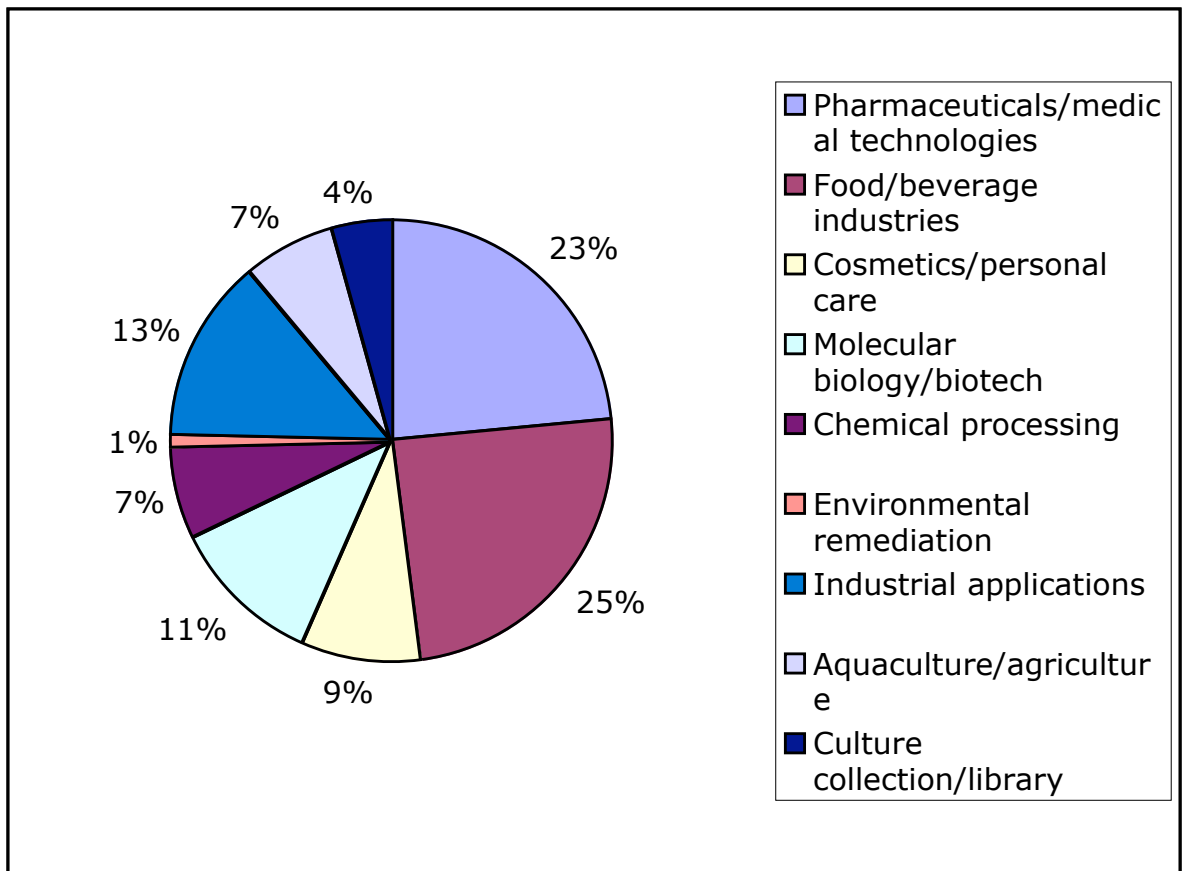


Figure 3: Types of uses of marine genetic resources. The biggest user of marine genetic resources in Antarctica is the food and beverage industry (25%), followed by the pharmaceutical/medical technology industries (23%), industrial applications (13%), molecular biology and biotechnology (11%), cosmetics and personal care (9%), chemical processing (7%), aquaculture and agriculture (7%), culture collection or library (4%) and environmental remediation (1%).

4. Countries undertaking research and bioprospecting in regards to Antarctic genetic resources

Research organizations and companies from a number of countries have undertaken research for commercial purposes in the Antarctic marine environment. These countries include Japan, USA, Spain, United Kingdom, Korea, Canada, Sweden, China, Chile, New Zealand, France, Belgium and Poland. The greatest number of marine records in the

Antarctic Bioprospecting Database originate from Japan, owing mainly to krill-related work. Companies from United States and Spain have the next greatest number of records.

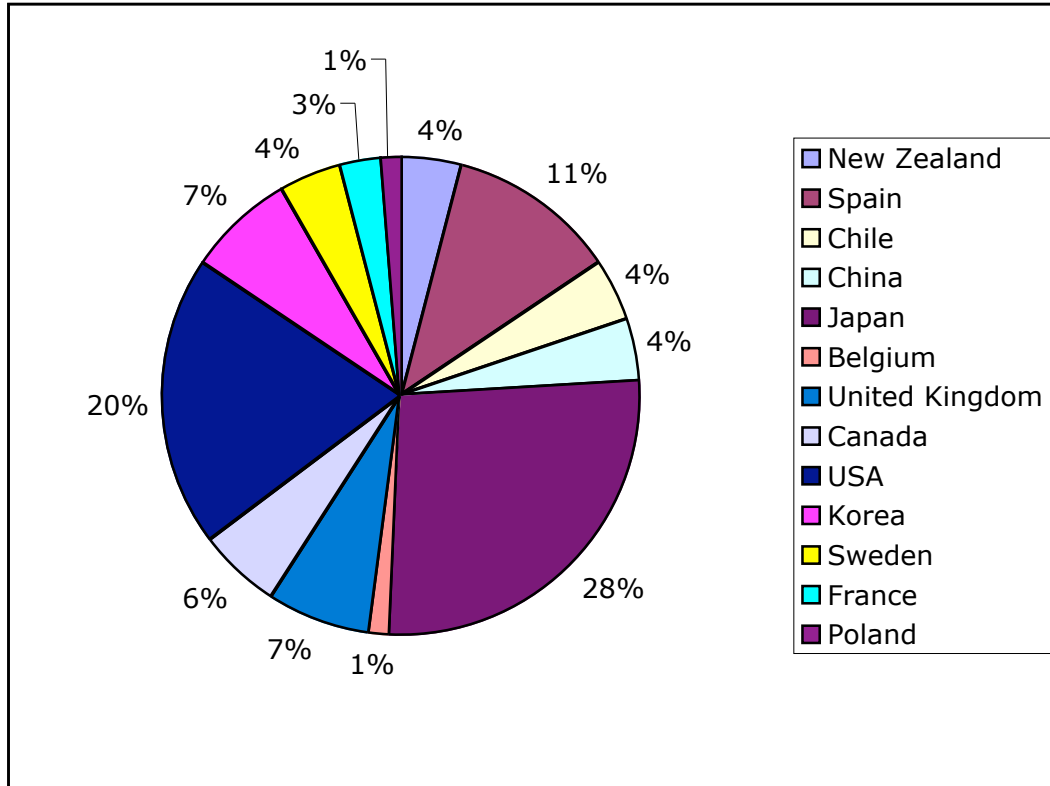


Figure 4: Number of marine records per country. The proportion of records by country in the Antarctic Biological Prospecting Database is as follows: Japan (28%), USA (20%), Spain (11%), United Kingdom (7%), Korea (7%), Canada (6%), Sweden (4%), China (4%), Chile (4%), New Zealand (4%), France (3%), Belgium (1%) and Poland (1%).

5. Some examples of marine biological prospecting in Antarctica

The Antarctic krill, *Euphausia superba*, has been the source organism of the largest number of patents and commercial applications of all marine species. The patented applications of krill range from commercial purposes including laundry detergents and other cleaning agents, food processing, food products, chemical processing, molecular biology, enzymes, aquaculture, pharmaceuticals, nutraceuticals, dietary supplements and skin care products. Many of these patents have been filed by Japanese companies such as Nippon Suisan Kaisha Ltd, but also by companies in Spain, Chile, United Kingdom, Sweden, Canada, USA, Poland and Korea. Krill-derived enzymes and extracts have been proposed for the treatment or prevention of acne, infections, inflammations, diabetes,

immune reactions and certain cancers, as well as for the removal of dental plaque. Another common use of krill is as food for aquaculture, pets and even humans, for example as flavouring in soya sauce. Because krill are rich in Omega-3 fatty acids, krill oils have shown to be beneficial as dietary supplements for humans. Companies such as Canada's Neptune Technologies & Bioresources, Source Naturals (USA) and Norway's Aker BioMarine market a range of vitamins and nutraceuticals derived from krill and krill by-products. Examples of nutritional supplements include NKO Neptune Krill Oil (US\$ 21.50 for 30 softgels) and Superba™ krill oil (to be launched in March 2008). The use of krill oil in food and nutritional products will likely increase in the future, given a recent ruling by a U.S. panel that Neptune Krill Oil is safe as an ingredient in food, paving the way for its wider commercialisation in the USA. Neptune signed research deals in 2007 with Swiss food group Nestle and with the Yoplait dairy unit of U.S. food maker General Mills Inc. over use of krill in foods.

Sponges and other marine invertebrates have commonly been used as source organisms for bioprospecting, particularly for pharmaceuticals. The Antarctic sponge *Kirkpatrickia variolosa* is the source of a potential cancer drug, Variolin, which has been patented and is now being tested in-vivo by the Spanish pharmaceutical company PharmaMar. The University of South Florida has shown that extracts from the tunicate *Synoicum adareanum* show selective toxicity against several different cancer cell lines, and may be useful in the treatment of cancers, particularly malignant melanomas, colon cancer, and renal cancer cell lines. The potential drug, Palmerolide A, is in preliminary experiments with laboratory mice at the United States National Cancer Institute. These experiments have shown that Palmerolide A maintains its test tube melanoma-killing properties in living tissue. Full testing on a mouse melanoma model should begin soon, but development of a human treatment using the compound will take years. If successful, these new cancer medications might generate similar annual sales to other successful cancer drugs such as Avastin (\$2.7 billion per year) or Herceptin (\$1.3 billion per year). However, it must be kept in mind that much of the experimental medicines do not lead to commercial drugs.

Marine bacteria collected from seawater, sea ice and abyssal ooze have also lent themselves to commercial applications. For example, the bacterium *Pseudoalteromonas haloplanktis* collected from Antarctic seawater has yielded enzymes that are able to function at extremely low temperatures, and can be useful as novel tools for biotechnology. The psychrophilic bacteria HK-47, collected from the oceans surrounding Antarctica, has yielded a new, heat sensitive form of the enzyme alkaline phosphatase. This phosphatase is useful as a research tool, particularly for radioactive end-labeling of nucleic acids. There is demand globally for these types of enzymes, and the international enzyme market is valued at a minimum of \$50 billion a year, with growth occurring at between 3% and 5% in each of the past several years.

Fish (Cold Ocean Teleost Fish) from the Southern Ocean have been a source of patented anti-freeze proteins. The fish anti-freeze proteins are used for the control of cold-induced damage in medical, food, and cosmetic products, and are marketed by the American/Canadian company A/F Protein Inc. as "antifreeze protein type I", "antifreeze

protein type III”, and “antifreeze glycoprotein”. Some proposed and actual applications include improving the survival of biological materials, for example in transplant surgery, improving aquaculture production in cooler climates, and lengthening the shelf life of frozen foods.

The cosmetics and personal care industries have used Antarctic marine algae and other organisms in their products. The French cosmetics giant Clarins uses the algae *Durvillea antarctica* in its Extra Firming Day Cream, which it markets for the treatment of mature skin. Algae from the Antarctic are claimed to provide resistance to pollution, central heating and other hazards. Launched in 1996, this product quickly became a top seller with a 1.7 fl.oz. (50ml) jar costing US\$ 75. In addition, Mycosporine amino acids found in a myriad of Antarctic marine organisms are thought to have potential as sunscreen agents.

The annex provides a summary of all the marine records in the Antarctic Biological Prospecting Database.

Annex

Summary of marine records in the Antarctic Biological Prospecting Database

Record No.	<i>Activity/product</i>	Research sector	Source organism	Country
2	Isolation of varolin from an Antarctic sponge	Pharmaceuticals	The marine sponge <i>Kirkpatrickia varialosa</i>	New Zealand, Spain
13	Krill-derived cold adapted trypsin-like activity enzyme	Industrial and commercial uses including laundry detergents, food processing, drugs and skin care products (Chemical processing, Medical technologies, Molecular biology/biotech)	Antarctic krill (<i>Euphausia superba</i>)	Chile
14	Alkaline low-temperature protease	Molecular biology/biotech	Bacteria in abyssal ooze	China
15	Hot-formed products from the liquid and dense fractions of Antarctic krill	Molecular biology/biotech	Antarctic krill (<i>Euphausia superba</i>)	Spain

16	Food product containing autolysis product of krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
17	Freezing of Antarctic krill for subsequent use	Chemical processing	Antarctic krill (<i>Euphausia superba</i>)	Spain
24	Krill-derived cold adapted trypsin-like activity enzyme	Variety of industrial contexts, including laundry detergents, food processing, drugs and skin care products. (Chemical processing, Cosmetics/personal care, Industrial applications, Medical technologies, Food/Beverage industries)	Antarctic krill (<i>Euphausia superba</i>)	Chile
25	Cold-active beta-galactosidase	Environmental/remediation, Food/Beverage industries	Marine bacterium (<i>Pseudoalteromonas haloplanktis</i>)	Belgium
26	Treatment and prevention of immune rejection reactions	Medical technologies	Antarctic krill (<i>Euphausia superba</i>)	United Kingdom
27	Harvesting, digestion and dehydrating of krill hydrolysates	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Canada
28	Isolation of an antifreeze protein	Food/Beverage industries, Industrial applications	Antarctic eelpout (<i>Rhigophila dearborni</i>)	Japan
29	Use of a krill-derived enzyme for treatment of infections	Medical technologies (pharmaceuticals)	Antarctic krill (<i>Euphausia superba</i>)	United Kingdom
30	Use of krill-derived enzyme for treatment of acne	Cosmetics/personal care, Medical technologies	Antarctic krill (<i>Euphausia superba</i>)	United Kingdom
31	Use of krill and fish enzymes for treatment of infections	Cosmetics/personal care, Medical technologies	Antarctic krill (<i>Euphausia superba</i>)	United Kingdom
32	A cold adapted trypsin-like activity enzyme from krill	Variety of industrial contexts and commercial purposes including laundry detergents, food	Antarctic krill (<i>Euphausia superba</i>)	Chile

		processing, drugs and skin care products. Includes Chemical processing, Cosmetics/personal care, Food/Beverage industries, Industrial applications		
33	Interaction of thermal hysteresis proteins with cells and cell membranes for protection and preservation of mammalian cells	Molecular biology/biotech, medical tech	Antarctic and arctic fish	USA
37	Anti-freezing applications	Industrial applications	Antarctic Microalgae <i>Porosira</i> Genus	Korea
40	Anti-freezing applications	Chemical processing	Antarctic Microalgae <i>Porosira</i> Genus	Korea
42	Alkaline low-temperature protease	Molecular biology/biotech	Bacteria in abyssal ooze	China
44	Food product containing autolysis product of krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
52	Food supplement based on krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Spain
53	Use of krill enzymes to remove dental plaque	Cosmetics/personal care, Medical technologies	Antarctic krill (<i>Euphausia superba</i>)	Sweden
54	Carcinogenesis promotion inhibitor containing a krill extract	Medical technologies, Molecular biology/biotech, Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	Japan
55	Antifreeze polypeptide or antifreeze glycopeptide from the fluid or serum of Artic and Antarctic fish	Industrial applications, Molecular biology/biotech	Artic and Antarctic fish	USA
56	Heat sensitive alkaline phosphatase from marine bacteria	Chemical processing	Psychrophilic oceanic bacteria HK-47	USA/Japan
57	Protein food with improved storage characteristics from krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
58	Extra firming day	Cosmetics/personal	Marine algae <i>Durvillea</i>	France

	cream containing Antarctic algae	care	<i>antarctica</i>	
60	Cytotoxin Compound (Palmerolide A) from tunicates	Pharmaceuticals	Tunicate <i>Synoicum adareanum</i>	USA
62	Antifreeze Lipoprotein from bacterium	Food/Beverage industries, Industrial applications	Bacterium (<i>Moraxella</i> sp)	Japan
64	Sunscreen agents from marine organisms	Cosmetics/personal care	Mycosporine amino acids found in a myriad of Antarctic marine organisms	USA
65	Laminarinase from krill to produce glucose and various oligosaccharides	Industrial applications, Molecular biology/biotech	Antarctic krill (<i>Euphausia superba</i>)	Japan
66	Non-immunogenic enzymatic pharmaceutical agents from krill for treatment of various diseases	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	Sweden
67	Tripeptide from krill	Industrial applications, Molecular biology/biotech	Antarctic krill (<i>Euphausia superba</i>)	Japan
68	Reduction of fluorine from Antarctic krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Korea
69	Feed for pisciculture from krill	Aquaculture	Antarctic krill (<i>Euphausia superba</i>)	Japan
71	Eicosapentaenoic acid or its ester from krill	Food/Beverage industries, Industrial applications, Molecular biology/biotech	Antarctic krill (<i>Euphausia superba</i>)	Japan
72	Protein food from krill with improved storage characteristics	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
73	Antifreeze proteins from cold ocean teleost fish	Cosmetics/personal care, Food/Beverage industries, Pharmaceuticals	Cold Ocean Teleost Fish including Antarctic notothenioids	Canada, USA
74	Antifreeze gene promoter in aquaculture	Aquaculture	Cold Ocean Teleost Fish including Antarctic notothenioids	Canada, USA
75	Collection of microbes, bacteria	Culture collection/Library	Culture collection	USA

	and fungi			
76	Nutraceuticals and dietary supplements derived from Antarctic krill and Arctic fish	Food/Beverage industries, Nutraceuticals	Antarctic krill (<i>Euphausia superba</i>)	USA
77	Library of unique enzymes	Culture collection/Library	Culture collection	USA
79	Antarctic culture collection	Culture collection/Library	Culture collection	New Zealand
91	Pet food from krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
92	Proteinous raw food material	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Japan
93	Method for separating shells from the flesh of krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Poland
94	Enzyme composition from krill as cleaning agent	Industrial applications	Antarctic krill (<i>Euphausia superba</i>)	Sweden
95	Feed for pisciculture	Aquaculture	Antarctic krill (<i>Euphausia superba</i>)	Japan
96	Anti-inflammatory agent prepared from ground krill	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	Japan
97	Preparation of krill enzyme	Agricultural	Antarctic krill (<i>Euphausia superba</i>)	Japan
98	Composition for improving body colour or meat colour of cultured animal	Agricultural, Aquaculture	Antarctic krill (<i>Euphausia superba</i>)	Japan
99	A process for reducing the fluorine content of krill	Food/Beverage industries	Antarctic krill (<i>Euphausia superba</i>)	Korea
100	Anti-inflammatory formulations from krill	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	USA
130	Feed for raising chickens	Agricultural	Antarctic krill (<i>Euphausia superba</i>)	Japan
131	A method for permanently preserving all species genes and biological samples in the world	Culture collection/Library	Various organisms (culture collection)	China
132	Method for processing	Food/Beverage industries, Industrial	Antarctic krill (<i>Euphausia superba</i>)	Spain

	crustaceans	applications		
133	Method for obtaining hot-formed products from the liquid and dense fractions of krill	Food/Beverage industries, Industrial applications	Antarctic krill (<i>Euphausia superba</i>)	Spain
134	Antifreeze composition to improve the survival of biological materials	Medical technologies	Antarctic eel pout (<i>Rhigophila dearborni</i>), Cold Ocean Teleost Fish (<i>Nototheniidae</i>)	USA
136	Krill and/or marine extracts for prevention and/or treatment of cardiovascular diseases arthritis, skin cancer, diabetes, premenstrual syndrome and transdermal transport	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	Canada
137	Variolin derivatives and their use as anti-tumor agents	Pharmaceuticals	Marine sponge <i>Kirkpatrickia varialosa</i>	Spain
138	Compositions for the prevention, therapy and/or treatment of several disease states	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	USA
139	Peptides having antimicrobial properties for preservation of foodstuffs	Food/Beverage industries	King penguin <i>Aptenodytes patagonicus</i>	France
140	Removing dental plaque with krill enzymes	Pharmaceuticals	Antarctic krill (<i>Euphausia superba</i>)	UK
141	Variolin derivatives as anti-cancer agents	Pharmaceuticals	Marine sponge <i>Kirkpatrickia varialosa</i>	New Zealand, Spain
143	Derivatives of anti-tumor compound Variolin b	Pharmaceuticals	Marine sponge <i>Kirkpatrickia varialosa</i>	Spain