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Perspective note

Recent trends in the fishery for Antarctic krill

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Abstract

The fishery for Antarctic krill has been stable for a decade with approximately 100 000 tonnes being caught each year. There is continuing commercial interest in products derived from krill. An examination of patent databases indicates that the development of products for human consumption has been overtaken by the development of aquaculture, pharmaceutical and medical products. The development of products for aquaculture is most likely to be the factor that will drive growth in the krill fishing industry. Management of the Antarctic krill fishery has proceeded in advance of expansion and precautionary catch limits for Antarctic krill currently total 4.89 million tonnes ~50 times the existing harvesting level.

Keywords: Antarctic krill; Fishery

1. Developments

The biology of krill has recently been reviewed (Everson, 2000b; Mangel and Nicol, 2000) and the history of the fishery for Antarctic krill and its management is now well documented (Everson, 2000b; Nicol and Endo, 1999) but there have been developments in the krill fishery, which indicate that the anticipated increase in this fishery may be about to occur.

The fishery for Antarctic krill has been stable for the last 9 years with the catch in 2001/2002 being 98 414 tonnes (Convention on the Conservation of Antarctic Marine Living Resources, CCAMLR, 2001). The fishery currently operates in the South Atlantic with a winter fishery around South Georgia, moving south in spring and summer to the waters of the Antarctic Peninsula. Lately, because of reduced winter sea ice, the winter fishery has remained in the waters around the Peninsula and the South Shetlands (CCAMLR, 2001). Vessels from Japan, the Republic of Korea, Poland, Ukraine and the USA fished for krill in 2001/2002 and the krill catch has been dominated by Japan since 1993 following the demise of the USSR which was the main fishing nation in the 1970s and 1980s. A US company has operated a 4000 tonne krill trawler in Antarctic waters since 2001 producing products for human and animal feed (Dezula, 2002; Griffin, 2002a; Griffin, 2002b). Eventually two vessels will be operated by this company, to produce animal feed, human-grade meat and meal for aquaculture. The impetus for this venture is humanitarian rather than economic, aiming to provide low cost protein for human consumption with funding from the Family Federation for World Peace. This may open new markets for krill products but it may also affect fisheries for krill, which have purely economic aspirations.

Manufactured products from krill are becoming widely available (Nicol et al., 2000b). Krill hydrolysates have been developed as additives for aquaculture feed but they also have potential in the livestock and pet food markets (Nicol et al., 2000b). Krill oils are likely to be an expanding market in the nutriceutical, cosmetic and pharmaceutical fields which will result in high-value products (Hamovitch, 2001).

A large number (376) of patents relating to krill have been registered (information from US Patent and Trademark Office: http://www.patft.uspto.gov, European Patent Office: http://www.european-patent-office.org/online/, Japanese Patent office: http://www.jpo.go.jp/). Most of the patents relating to krill have been filed by companies or individuals from Japan, which has the longest history in the krill fishery (Table 1). The proportion of total patents filed by Japanese companies has decreased since the 1990s. Since 1988, 64.7% of the patents lodged have been from Japanese companies

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Table 1
Number of krill patents lodged by year and country of origin

	Japan	USA	Canada	Norway	Denmark	UK	Korea	Sweden	Australia	Netherlands	Uruguay	Russia	Germany	Poland	Switzerland
2002	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
2000	5	0	6	1	1	1	1	0	0	0	0	0	0	0	0
1999	2	2	3	0	2	2	0	0	0	0	0	0	0	0	0
1998	7	1	1	0	3	0	0	1	0	0	0	0	0	0	0
1997	5	0	1	1	0	0	0	1	1	1	0	0	0	0	0
1996	10	2	2	0	3	1	0	1	1	0	1	0	0	0	0
1995	8	1	1	0	0	0	0	4	0	0	0	1	0	0	0
1994	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	4	0	0	1	0	0	0	2	0	0	0	0	1	0	0
1992	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1991	9	0	0	0	0	0	2	0	0	0	0	0	0	0	0
1990	13	0	0	0	0	0	0	2	0	0	0	0	0	0	0
1989	12	0	0	0	0	0	0	2	0	0	0	0	0	3	0
1988	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	16	0	0	0	1	0	0	0	0	0	0	0	0	2	0
1986	19	0	0	0	1	0	0	0	0	0	0	0	0	3	0
1985	14	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1984	14	0	0	0	0	0	0	0	0	0	0	0	0	6	0
1983	25	1	0	0	0	0	0	0	0	0	0	0	0	0	1
1982	17	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1981	15	0	0	0	0	0	0	0	0	0	0	2	0	0	2
1980	14	1	0	0	0	0	0	0	0	0	0	2	0	0	0
1979	1	0	0	0	0	0	0	0	0	0	0	2	0	1	0
1978	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1977	14	0	0	0	0	0	0	0	0	0	0	2	0	0	0
1976	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Total	277	11	15	3	12	6	3	14	2	1	1	9	1	16	5
Percentage of total	73.7	2.9	4.0	0.8	3.2	1.6	0.8	3.7	0.5	0.3	0.3	2.4	0.3	4.3	1.3
Number 1988–2002	121.0	9.0	15.0	3.0	9.0	4.0	3.0	14.0	2.0	1.0	1.0	1.0	1.0	3.0	0.0
Percentage of 1988–2002	43.7	81.8	100.0	100.0	75.0	66.7	100.0	100.0	100.0	100.0	100.0	11.1	100.0	18.8	0.0

compared to 82.5% of the patents prior to 1988. Most patents relate to the use of krill for human consumption (29.3%) although only 33.6% of these have been filed since 1988 (Table 2). Next most numerous are patents that relate to the production of fish feed or bait (21.3%), and a further 4.8% deal with either hydrolysates or pigments which are used in aquaculture. Aquaculture-related patents show an increase in later years with 64.3% of these being registered since 1988. Medical uses, which require small quantities of high quality krill, constitute 17% of all patents but of these 87.5% have been filed in the period since 1988.

2. Management

Availability of krill from Northern Hemisphere sources is restricted and this will put pressure on Antarctic krill stocks. The West Coast Canadian krill fishery is capped at 500 tonnes (Everson, 2000a). Exploratory krill fisheries proposed off Alaska, California and the East Coast of Canada have resulted in prohibitions on krill fishing in each of these areas (Anonymous, 1997, 1998, 2000). Japanese coastal krill fisheries are probably near capacity at ~70 000 tonnes/year (Endo, 2000). It seems unlikely that new coastal krill fisheries will develop in the Northern Hemisphere because of opposition from existing fishing industries, fishery managers and conservation groups. Krill fisheries have been proposed to provide aquaculture feed and the prohibition of many fisheries on northern species of krill has meant that companies developing krill-based aquaculture feeds are restricted to using krill harvested off Japan or to Antarctic krill.

Catch limits for Antarctic krill are set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) using biomass estimates from acoustic surveys. New precautionary Catch Limits have been set for the South East Indian Ocean (CCAMLR Division 58.4.1) (Nicol et al., 2000) and for the South Atlantic (Division 48) (Trathan et al., 2001) (Table 3). The catch limit in the South Atlantic has risen from 1.5 million tonnes in 1991 to 4 million tonnes in 2000. This change reflects changes in acoustic methodology (Everson et al., 1990) rather than an increase in abundance.

Table 2
Categorisation of krill patents by type and year

	Human use, food	Human use, medical	Chitin	Fish feed/bait	Hydro-lysates	Enzyme use	Processing	Harvesting	Packaging	Pigment	Preservation	Meat product	Peeling	Total
2002	1	1	0	0	0	0	0	0	0	0	0	0	0	2
2001	2	0	1	1	1	0	0	0	0	0	0	0	0	5
2000	5	0	0	5	0	1	1	3	0	0	0	0	0	15
1999	0	2	1	2	1	2	0	1	0	1	1	0	0	11
1998	4	2	0	2	1	1	0	0	0	0	1	2	0	13
1997	3	3	0	3	0	1	0	0	0	0	0	0	0	10
1996	4	6	0	8	0	2	0	1	0	0	0	0	0	21
1995	1	5	1	4	0	2	0	1	0	0	0	1	0	15
1994	0	2	1	5	0	0	0	0	0	1	0	0	0	9
1993	0	1	1	4	0	1	0	0	0	1	0	0	0	8
1992	3	1	0	3	0	1	0	0	0	1	0	0	0	9
1991	1	3	1	2	0	3	0	0	0	0	1	0	0	11
1990	0	4	0	5	0	2	0	0	0	1	0	1	2	15
1989	5	1	1	5	0	2	0	0	0	1	0	2	0	17
1988	8	1	1	5	0	6	1	0	0	0	1	3	0	26
1987	6	0	2	5	0	0	1	0	0	1	1	1	2	19
1986	7	2	2	6	0	1	1	0	0	0	0	1	3	23
1985	2	1	0	5	0	0	0	0	2	4	0	0	1	15
1984	8	1	0	2	0	0	0	0	0	2	4	0	3	20
1983	18	2	0	0	0	0	0	0	0	1	1	3	2	27
1982	10	1	0	3	0	0	0	0	0	0	2	2	1	19
1981	9	0	1	2	0	0	2	0	0	0	1	2	2	19
1980	7	0	0	3	0	0	0	1	1	0	2	0	3	17
1979	0	0	0	0	0	0	1	0	0	0	0	1	2	4
1978	1	0	0	0	1	0	1	0	0	0	1	0	2	6
1977	4	0	0	0	0	0	6	0	0	0	0	0	6	16
1976	0	0	0	0	0	0	1	0	0	0	1	0	0	2
1934	1	0	0	0	0	0	0	0	0	0	1	0	0	2
Total	110	39	13	80	4	25	15	7	3	14	18	19	29	376
Percentage of total	29.3	10.4	3.5	21.3	1.1	6.6	4.0	1.9	0.8	3.7	4.8	5.1	7.7	
Total 1988–2002	37	32	8	54	3	24	2	6	0	6	4	9	2	187
Percentage since 1988	33.6	82.1	61.5	67.5	75.0	96.0	13.3	85.7	0.0	42.9	22.2	47.4	6.9	49.7

The circumpolar biomass of krill has been estimated to be between 60 and 155 million tonnes (Nicol et al., 2000a). There have been suggestions that krill biomass off the Antarctic Peninsula may have decreased linked to declines in the annual sea ice extent (Loeb et al., 1997). It is uncertain whether these observed changes are representative of wider-scale changes. Changes in the Antarctic physical environment (Zwally et al., 2002) are likely to have ecological effects but it is not yet possible to indicate whether there are associated trends in krill populations.

3. Conclusion

Fisheries for krill have shown great promise of expansion yet have failed to reach anticipated levels. The slow development of the krill fishery has allowed environmental considerations to be taken into account when developing management procedures. Environmental considerations have prevented the commencement or expansion of most Northern Hemisphere krill fisheries. Only in the Antarctic does there appear to be great scope for expansion of a krill fishery and

Table 3
Recent CCAMLR catch limits on Antarctic krill

CCAMLR statistical area	Area surveyed	Biomass estimate	Precautionary catch limit	Year surveyed	Reference
Area 48 (South Atlantic)	2.06 million km^2	44.3 million tonnes	Overall 4.0 million tonnes subdivided into: 0.832 million tonnes (48.4), 1.104 million tonnes (48.3), 1.056 million tonnes (48.2), 1.08 million tonnes (48.1)*	2000	CCAMLR, 2000; Trathan et al., 2001
Division 58.4.1 (South East Indian Ocean)	872 500 km^2	4.83 million tonnes	Overall limit 440 000 tonnes subdivided into: 0.277 million tonnes west of 115°E and 0.163 million tonnes east of 115°E	1996	CCAMLR, 2000; Nicol et al., 2000

* 48.1, Antarctic Peninsula; 48.2, South Orkneys; 48.3, South Georgia and 48.4, South Sandwich Islands (see Nicol and Endo, 1999 for map).

this potential has been anticipated by the imposition of precautionary catch regimes to ensure that ecological effects are minimised and that overcapitalisation in the industry is prevented. The focus of the krill fishing industry has shifted from products for human consumption to the development of a range of products with a particular focus on aquaculture. The growing demand for marine oils and for aquaculture feed will mean that the Antarctic krill fishery will not continue to stagnate.

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