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Biological prospecting in the Antarctic region: a conservative overview of current research

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Introduction

Much recent attention has been given to the topic of biological prospecting in Antarctica, exemplified by papers at ATCM XXXII (WP1, WP18, WP26, IP70, IP91), and set out in detail for the previous period by ATCM XXXII WP26.

At ATCM XXXI, SCAR was requested to prepare a paper for ATCM XXXII on the following tasks:

- “1. review the most recent published research that may involve biological prospecting in the Antarctic Treaty region and provide an assessment of these efforts from discovery to development to commercialization to product use, based on fundamental scientific principles.
2. provide a survey of ongoing biological prospecting research being undertaken within the SCAR community”.

At ATCM XXXII, SCAR reported (IP65) that complexities arise when trying to distinguish work explicitly undertaken with bioprospecting in mind from work that might later be utilized for a bioprospecting objective. SCAR also noted a low response to a survey to ascertain information regarding activities that might be considered bioprospecting from its member nations. SCAR agreed to provide a paper for ATCM XXXIII.

Significant considerations

In addressing the questions posed, it was immediately obvious (as noted in ATCM XXXII IP65), that assessments of bioprospecting research face several difficulties due to the nature of the enterprise, the scientific methods used for bioprospecting, and the paucity of reporting of such activities in a way that easily discerns a bioprospecting objective. These are set out in the current section as significant qualifiers for and background to this paper and its conclusions. It is for these reasons that the subtitle of this paper is ‘*a conservative overview*’.

As noted in previous Treaty documents, consensus about the definition of bioprospecting has not been reached. SCAR, in its census of members who might be undertaking such research, provided two common definitions (see Appendix 1). However, SCAR recognizes that other definitions might be adopted, or that it might include the gamut of work from systematic search to trials and further application (ATCM XXXII IP 70). As a consequence, differences in how ‘bioprospecting’ is defined will influence what is reported as bioprospecting research. In addition the definition of the term will also influence whether a project, report or publication is included in a database or other collection on bioprospecting. SCAR points out that agreement on fundamental working definitions will be essential for this discussion to be carried forward in a meaningful and deliberative manner.

It should also be recognized that the initial step in any bioprospecting activity is often not necessarily described as such. That is, the outcomes of systematic searches for organisms are often published as systematic literature without indication that prospecting activities are involved and they may well not be - initially. Early steps in bioprospecting require identification of organisms, but this may or may not be the original reason for an organismal survey. Distinguishing whether or not this is the case can be straightforward, but on occasion the same research group may be involved in routine systematic work and in bioprospecting at the same time. Moreover, research undertaken for purely descriptive taxonomic, systematic, or ecological purposes, and which is typically available publically may be subsequently used for bioprospecting. In many cases it is not possible to predict the final disposition of the information gathered.

Among the organisms that have been the focus of bioprospecting research in the Antarctic, some are distributed outside the region, sometimes widely so. As a consequence, bioprospecting research involving an Antarctic organism may well have been conducted using material collected elsewhere. The kelp *Durvillaea antarctica* is an excellent example (see Dhargalkar & Verlecar 2009; ATCM XXXII WP1; see also Hollibaugh et al. 2002).

Because of the broad definition of bioprospecting, identifying research concerned with Antarctic bioprospecting is essentially an open-ended endeavour. Which published work, reports, or patented products should be included in a survey may well be a subjective choice. For example, in a search of the ISI Web of Science™ database of published (mostly Anglophone) research (1970-2010) using the term ‘*Candida antarctica*’ (identified previously as an Antarctic organism that has been the subject of bioprospecting research – see ATCM XXXII WP1), 1954 published references were found. However, much of this research might be considered to be outside of the scope of bioprospecting research for the Treaty area because it is concerned with downstream utilization of products from the organism (mostly *Candida antarctica* lipase; e.g. Capello et al. 2005; Akoh et al. 2007; Secundo et al. 2007; Fjerbaek et al. 2009). Thus, assessing the extent to which bioprospecting research is being undertaken on this organism depends on how bioprospecting is defined and how that definition might later be interpreted.

Published research

An assessment using the ISI Web of Science™ as the primary source suggested that published bioprospecting research on Antarctic organisms is substantial. Even if all work on *Candida antarctica* is discounted (recalling that at least 1954 works listed by ISI Web of Science™ name this species), a conservative estimate suggests that more than 300 papers have been published in this field since 1970 (the majority since the 1990s). The estimate is conservative because some work is not readily identifiable as bioprospecting research because the motivation for the work is often not provided. Thus some purely descriptive work in systematic or chemical ecology may well have been part of a bioprospecting project or may have been motivated by a search for natural products. In this case, the published work will not have been identified as bioprospecting.

Of the published bioprospecting research undertaken to date (listed as in point 9 above and largely excluding work on *C. antarctica*), 27 of the 31 of the SCAR full member countries have had researchers, working at addresses within the country, co-author one or more published research papers in the field.

The full scope of bioprospecting activities, from systematic surveys to screening, to product testing are represented in the published research available from the ISI Web of Science™.

However, because grey literature and commercial research that may not be published are not represented in the ISI Web of Science™ database, nor in many others, the scope of work undertaken is likely to be much greater than indicated here. Indeed, work not considered in the present assessment will also include many non-Anglophone sources, as well as book chapters, and work published in non-ISI listed journals. Other search engines, such as SCOPUS™ or Google Scholar™, list additional works, though searches such as using the terms ‘bioprospect* AND Antarct*’ are constrained by the fact that bioprospecting research is typically not reported as such or the word is not used in the title or the publication *per se*.

Therefore, considering the readily accessible, available published research, it can be concluded that bioprospecting research across the full range of activities is taking place on Antarctic organisms. Efforts in this area of research can be considered substantial (a partial bibliography is available from SCAR).

SCAR member survey

Of the 31 SCAR full member countries that were sent the questionnaire (Appendix 1), 25 responded (an 80% return rate).

Of these 25 members, 13 indicated that bioprospecting research, as defined in the questionnaire, is being undertaken presently or has been undertaken in the past five years within the country’s National Antarctic Programme. Anywhere between one and eight projects (mean of 2) were listed by these countries.

Of the 25 members that responded, 18 were of the view that research currently being undertaken could later be used for bioprospecting (listing between 1 and 16 projects).

Considering the respondents that listed publications or patents arising from activities that could be considered bioprospecting, 179 individual entries were made (with an average of nine per member, varying between 2 and 48 citations).

The publications and/or patents listed typically were concerned with the description of the species involved, their associated products, or the biological activities of these products, with far fewer listings concerning product development and trials.

It is clear from this survey that a substantial proportion of SCAR members are involved in research in the Antarctic region that could be considered bioprospecting.

Conclusions

Identifying the published and unpublished outcomes of bioprospecting research will inevitably involve some degree of subjectivity owing to the complexities of the field, how bioprospecting is defined, and how the outcomes are eventually reported (acknowledging that some will go unreported).

Various databases, including the ISI Web of ScienceTM, SCOPUSTM, Google ScholarTM, the Bioprospector database (<http://www.bioprospector.org/bioprospector/antarctica/home.action>), and various patent databases (e.g. the United States Patent and Trademark Office <http://patft.uspto.gov/> and Goggle Patent betaTM <http://www.google.com/patents>), differ in their coverage of both published and unpublished work on Antarctic bioprospecting owing to variations in their mandates, definitions, decisions on what warrants inclusion, and update frequency. The same is true of the present assessment. Such variation is typical of all databases and no listing can therefore be considered complete or even comprehensive.

Given the above caveats, it is nonetheless clear, both from a conservative assessment of the current published literature and from the survey of SCAR members, that bioprospecting research in the Antarctic region and/or involving Antarctic organisms is extensive and widespread.

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