

## Short note

# A Geographical Information System (GIS) Atlas of cephalopod distribution in the Southern Ocean

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### Introduction

The geographic distributions of many Antarctic cephalopod species are not well understood. Many may be influenced by physical factors such as water masses, ice extent or bathymetry. For example, there is an apparent association of mesoscale oceanographic features with some species (Rodhouse *et al.* 1996). Such associations suggest certain physical factors in the environment that may be predictors of foraging locations for cephalopods and/or their predators. Improving our understanding of such interrelations is important in developing a better scientific basis for conservation and sustainable management of commercial fisheries (Trathan *et al.* 1993).

### Material and methods

Data were obtained from published papers, published reports and unpublished data held at the British Antarctic Survey, UK. The species studied, from suborder Oegopsida, were: *Kondakovia longimana*, *Moroteuthis ingens*, *Moroteuthis knipovitchi*, *M. robsoni*, *Gonatus antarcticus*, *Histioteuthis atlantica*, *H. eltaninae*, *H. macrohista*, *H. miranda*, *Batoteuthis skolops*, *Psychroteuthis glacialis*, *Alluroteuthis antarcticus*, *Bathyteuthis abyssicola*, *Brachioteuthis ?picta*, *Martialia hyadesi*, *Todarodes filippovae*, *Chiroteuthis veranyi*, *Mastigoteuthis psychrophila*, *Galiteuthis glacialis*, *Mesonychoteuthis hamiltoni* and *Taonius sp* (cf *pavo*). The data utilized were from commercial and scientific fishing gear.

Data were compiled from the different sources including as much detail as possible. The minimum information required was species name and location (latitude and longitude).

After loading into *Arc/Info* (ESRI), a Geographical Information System, three maps were produced for each species: species distribution with bathymetry; species distribution with oceanic fronts, and species distribution with winter/summer sea-ice extent.

The bathymetry was taken from the GEBSCO Digital Atlas (Jones *et al.* 1994), oceanic fronts from Orsi *et al.* (1995) and sea-ice extent from Gloersen *et al.* (1992). The winter and summer sea-ice extent used are mean monthly Antarctic sea-ice concentrations from the Scanning Multichannel Microwave Radiometer average over 1978–87 (Gloersen *et al.* 1992).

### Results

A total of 2497 geographic positions of 21 species of squid (suborder Oegopsida) were obtained, combining data from 1886 (Challenger Expedition) to 1997. There are huge areas without any geographic positions that appear under-sampled. The best represented species were *G. glacialis* (625 geographic positions), *B. picta* (412), *T. filippovae* (293), *B. abyssicola* (250), *M. hamiltoni* (188), *M. hyadesi* (184) and *P. glacialis* (112).

The maps of the species distribution in relation to bathymetry, ocean fronts and sea-ice extent are on World Wide Web page:

<http://www.nerc-bas.ac.uk/public/mlsd/squid-atlas/>  
A detailed bibliography is also provided there.

### Discussion

GIS is a very useful tool in marine biology. It has been used in marine fisheries (Waluda & Pierce in press), fisheries assessment and management (Trathan *et al.* in press) and planning of artificial aquatic habitat developments (Gordon 1994). In this study we demonstrate the ability of GIS to handle large amount of data from different sources, particularly cephalopod species distribution.

One of the advantages of GIS is the capacity for adding new data to the system. The species distribution maps produced within the GIS can be updated as soon as more data are available and can be made available via Internet. The use of GIS and Internet technology combined will allow the scientific community to have easy access to the most recent information.

The compilation of data in the different maps allows certain important aspects of squid ecology, such as distribution, to be examined.

There are large areas with no data. Though research surveys may have covered some of these areas, a large number of reports were rejected because no gear was specified or because of the inability of the specified gear to catch squid. In various reports, the gear used was designed to sample other species (i.e. krill) and squid were merely a by-catch. Thus, it is possible that some catches taken by scientific nets were not representative of the population (Rodhouse *et al.* 1996). Despite this, most data were obtained with scientific nets as there are no squid fishery data from Antarctic waters. In the future new fisheries may improve available data (Gonzalez &

Rodhouse 1998).

Most species had geographic positions south of the Antarctic Polar Front (APF), in Antarctic waters. The only species that were not found in Antarctic waters were *H. atlantica*, *H. miranda* and *H. macrohista*; these were geographically distributed in subantarctic and subtropical waters.

The muscular families Ommastrephidae and Onychoteuthidae are mainly distributed in subantarctic and subtropical waters while the ammoniacal families Histioteuthidae and Cranchiidae are mainly found in Antarctic and subantarctic waters. This may indicate that morphological features, such as the presence or absence of ammoniacal tissues, affect the geographic distribution of squid species. Furthermore, in this case, these families seem to be complementary in their geographic distribution.

Geographic distribution of several species, south of the APF, within the summer ice extent, suggested that they are endemic to Antarctic waters: *K. longimana*, *A. antarcticus*, *M. knipovitchi* (Okutani & Clarke 1985), *M. hamiltoni*, *G. glacialis*, *B. picta*, *H. eltaninae*, *B. skolops*, *M. psychrophila*. *B. abyssicola* is also present in the winter and summer extent, but because it is cosmopolitan elsewhere in the world's ocean (Filippova 1972), it is probably also cosmopolitan in Antarctic waters.

The species with circumpolar distributions in the Antarctic are: *G. glacialis*, *M. hamiltoni*, *P. glacialis*, *A. antarcticus* (Rodhouse & Piatkowski 1995), *K. longimana* (Roper *et al.* 1985), *M. psychrophila* (Rodhouse 1990) and *M. knipovitchi* (Nemoto *et al.* 1988).

*Mesonychoteuthis hamiltoni* is also found north of the Subtropical Front (STF), although Clarke (1980) considered this front to be an oceanographic barrier to this species.

All species were present in oceanic waters, but some were also associated with coastal waters (*A. antarcticus* (Kubodera 1989), *H. eltaninae* (Voss *et al.* 1998) and *P. glacialis* (Rodhouse 1989)), groups of islands (*M. knipovitchi* (Rodhouse 1989)), continental shelves (*M. ingens*, *G. antarcticus* (Roper *et al.* 1985), *M. hyadesi* (Dunning 1988) and *H. atlantica* (Voss *et al.* 1998)), slopes of continental shelves (*G. glacialis*, *H. eltaninae*, *H. miranda* (Nesis (1994); *T. filippovae* (Rodhouse 1998), *P. glacialis* (Roper *et al.* 1985), submarine rises (*H. miranda* (Voss *et al.* 1998)) and seamounts (*H. miranda* (Nesis 1994)).

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