

## **Blue whiting — a key species in the mid-water ecosystems of the north-eastern Atlantic**

Mikko Heino and Olav Rune Godø

*Abstract.* Blue whiting (*Micromesistius poutassou*) is a mesopelagic gadoid that is widely distributed in northeastern Atlantic from the Canary Island to Spitsbergen. It is abundant and commercially exploited in the Norwegian Seas, off Iceland, Faeroe Islands, Hebrides and Ireland, and in the Bay of Biscay. Blue whiting is a highly migratory species. During the spawning season (March-April), blue whiting concentrates to dense aggregations on the well-known spawning locations along the shelf edge west of Ireland and Hebrides and in the Rockall area. Other spawning areas also exist, but stock structure, distribution and migration of this abundant species are insufficiently known. The oceanic distribution of blue whiting westward, towards the mid-Atlantic Ridge (MAR), has not been thoroughly investigated. Scattered observations show that the species occurs along the MAR from the Azores in the south to the Reykjanes Ridge in the north. The possibility that blue whiting is a key species in the mi-water community of the MAR should not be dismissed. Where present, blue whiting is often highly abundant, and plays an important role in the pelagic ecosystems, both as a consumer of zooplankton and small mesopelagics, and as a prey for larger fish and cetaceans. Is there a 'stock' of blue whiting over the MAR? If yes, is this stock separate from the stock(s) in the northeastern Atlantic? Institute of Marine Research in Bergen has proposed a component project of MAR-ECO that combines routine monitoring information with observations from the MAR-ECO surveys to evaluate the significance of blue whiting in the pelagic ecosystem of the MAR. We present the available background information, along with hypotheses being tested. We also describe some of the methodological and technological challenges.

*Keywords:* Blue whiting, distribution and migration, stock structure, ecology

Mikko Heino, Institute of Marine Research, P.O. Box 1870 Nordnes, N-5817 Bergen, Norway & International Institute for Applied Systems Analysis, Laxenburg, Austria [tel: +47 55236962, fax: +47 55238687, e-mail: mikko@imr.no]. Olav Rune Godø, Institute of Marine Research, P.O. Box 1870 Nordnes, N-5817 Bergen, Norway [tel: +47 55238675, fax: +47 55238687, e-mail: olavrune@imr.no]

## 1. Introduction

Blue whiting is a widely distributed (Fig. 1) and abundant gadoid species of high commercial value. The main oceanic distribution is considered to represent a single stock and is managed accordingly (ICES 2002). Population genetic studies have, however, indicated that partially separated stocks exist in the Mediterranean and in the eastern Barents Sea (Mork and Giæver 1995, Giæver and Mork 1995, Giæver and Stien 1998). Local spawning occurs in many areas, e.g. along the coasts of Iceland, in the Norwegian Sea and in some fjords along the Norwegian coast (Zilanov 1968a, Coombs and Pipe 1981, Bjørke 1983, Schöne 1984, Monstad 1990, Giæver and Mork 1995), but the most important spawning area is the region to the west of the British Isles. It is possible that the blue whiting south and north of this spawning area are partially separated because of the drift patterns of the larvae (e.g. Skogen *et al.* 1999), although in a population as large as blue whiting even a small amount of mixing will prevent genetic differentiation.

Blue whiting normally start spawning at age 2-4 and at a size of 19-24 cm. Spawners of age 1 have become increasingly frequent in recent years (ICES 2002).

Large-scale exploitation of the spawning stock started in the late 1970s, and the stock sustained catches between 0.5 and 1.0 mill. tonnes in most years. In 2001 the total catch exceeded 1.7 mill tonnes, representing a large expansion of the international fishery on both mature and immature fish. The major fishing areas are the spawning grounds west of Ireland and Scotland, the Norwegian Sea and the Bay of Biscay (Anon. 1999, ICES 2002).

There are several unresolved questions related to the biology and population dynamics of blue whiting, despite its importance. What is the geographic extension of the total stock spawning west of the British Isles? The three major spawning locations, Porcupine Bank, St. Kilda and Rockall – do they recruit fish to different nursery areas? Earlier major coordinated research efforts have given much information about fish distributed along the continental shelves of Europe and in the Norwegian Sea (Porteiro *et al.* 1996, Reid 2001).

MAR-ECO is a Census of Marine Life pilot project focusing on the ecosystems associated with the Mid-Atlantic Ridge from Iceland to the Azores. This project is considered an important possibility to supplement earlier studies that could, by collecting new data as well assembling existing data from various sources, fill important gaps in knowledge of biology and dynamics of blue whiting. In particular, MAR-ECO is an opportunity to increase our knowledge on life history and dynamics of blue whiting along the Mid-Atlantic Ridge and on how these fish are coupled (genetically and dynamically) to the continuous distribution in the Northeast Atlantic.

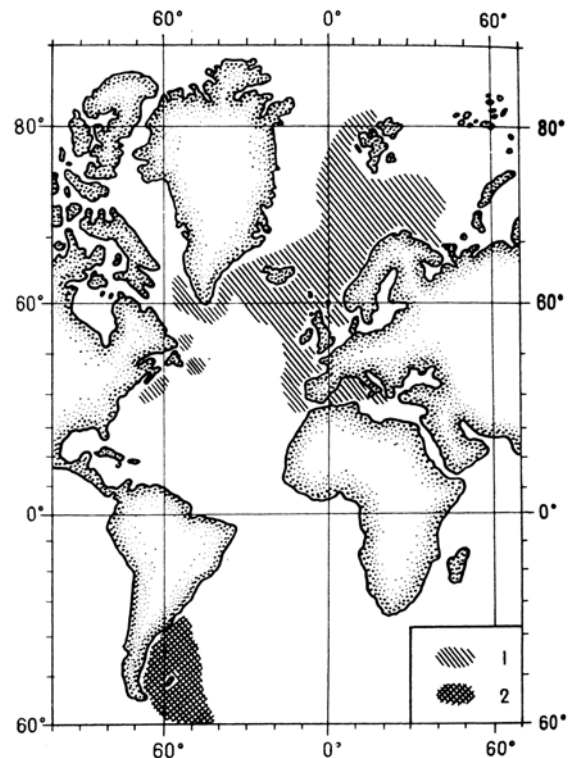


Figure 1. Distribution of blue whiting (single hatching) and southern blue whiting (*M. australis*; double hatching) according to Zilanov (1968b).

## 2. Distribution of blue whiting with special reference to the Mid-Atlantic Ridge

The distribution of blue whiting is traditionally supposed to cover the North-east Atlantic, extending to the Barents Sea in the east and the Greenland Sea in the north, with smaller areas of occurrence around southern Greenland and along the coast of northeast Northern America. A separate population exists in the Mediterranean. Early distribution maps were published by Schmidt (1909), Tåning (1958), Raitt (1966) and Zilanov (1968b). Later research effort has only refined our picture on the distribution of blue whiting in the North-east Atlantic but left the main picture unchanged (Bailey 1982, Whitehead *et al.* 1986, Cohen *et al.* 1990). The spatial extent of the main spawning areas west of the British Isles is well known owing to the surveys by the former Soviet Union (e.g., Gerber and Demenin 1993) and Norway (e.g., Monstad 1990) and the Continuous Plankton Recorder data (Coombs and Pipe 1981). Commercial catch data (Anon. 1999) show the distribution of blue whiting at later ages.

The Mid-Atlantic Ridge is traditionally included in the distribution of blue whiting only on the Reykjanes Ridge south of Iceland; this area may also support a separate spawning stock (Bailey 1982, see below). Below we summarize the knowledge of occurrence of blue whiting in different parts of the Mid-Atlantic Ridge.

FishBase. Search in the FishBase (as of 8.8.2002; [www.fishbase.org](http://www.fishbase.org)) resulted in five records from or near the Mid-Atlantic Ridge: two records from the Reykjanes Ridge and three around the Azores. The records near the Azores are from the R/V Anton Dohrn expedition to the Sargasso Sea in 1979.

Fisheries surveys in Icelandic waters. Spawning or larval blue whiting are recorded regularly in Icelandic waters, although there is huge annual variability (Magnusson *et al.* 1965, Sveinbjörnsson 1982, Schöne 1982, 1984). No special attention has been given to the Reykjanes Ridge, although the distribution seems to extend further offshore along the ridge than elsewhere (e.g., Magnusson *et al.* 1965, Sveinbjörnsson 2002).

Continuous Plankton Recorder data. Summary of the Continuous Plankton Recorder (CPR) data from 1958-1977 shows the occurrence of larval blue whiting in two locations on the Reykjanes Ridge (Coombs and Pipe 1979). However, sampling effort is not very intensive around the Mid-Atlantic Ridge. No summary of possible blue whiting observations after 1977 or south of 41°N is available. Analysis of the new samples and samples around the Azores has been initiated in cooperation with the Sir Alister Hardy Foundation for Ocean Science.

Russian surveys along the Mid-Atlantic Ridge. Russian survey data from 1974-1987 has been summarized by Gerber (1993). Blue whiting is reported from the Reykjanes Ridge (Fig. 2), although it is infrequent in the southern parts of the ridge (<60°N). However, blue whiting is quite

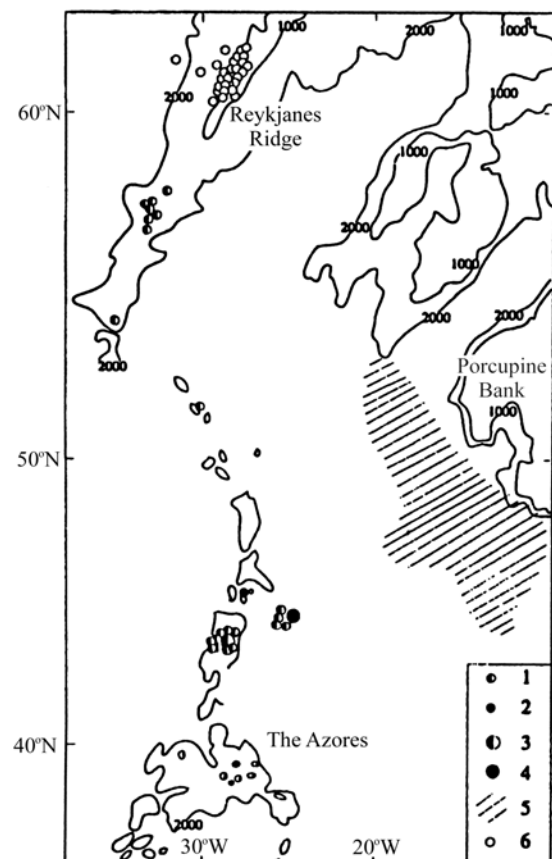


Figure 2. Occurrence of blue whiting on the Mid-Atlantic Ridge according to Russian data (Gerber 1993). Symbols 1-4 indicate increasing abundance of blue whiting in trawl catches. Hatching indicates distribution of larvae and open circles sites with immature fish.

frequent in trawl hauls (25/221, 12%) near seamounts north of the Azores, 43-44°N and 25-28°W. Based on morphological differences and the presence of mature females, Gerber (1993) suggests that blue whiting in this area comprises a stock separate from the main stock spawning west of the British Isles. No actual observations on spawning exist, but the sampling during the likely spawning season has been very limited.

Miscellaneous. In the Azores, blue whiting are occasionally caught in local bottom longline fishery (Santos *et al.* 1997). However, a non-negligible proportion of blue whiting is recorded in the diet of swordfish (*Xiphias gladius*) in Azorean waters (Clarke *et al.* 1995), suggesting that the species is not uncommon in the Azores.

Morocco is usually indicated as the southern limit of species' range (Zilanov 1968b, Whitehead *et al.* 1986, Cohen *et al.* 1990), although this limit seem not very well established. In the coast of Morocco, the range extends west towards the waters near the Canary Islands (database of Institute of Marine Research, Bergen).

### 3. Ecology of blue whiting in the north-eastern Atlantic

Blue whiting is one of the most abundant fishes in midwater ecosystems in the north-eastern Atlantic. It lives mostly in the depths of 100m-600m, although it may also visit surface waters during its diurnal vertical migrations. In deep water, acoustic observations on blue whiting have been made down to the depth of 890m (Monstad *et al.* 2001), and its range may extend beyond the depth of 1000m.

High abundance of blue whiting suggests that it might be an important species in the pelagic ecosystem of the Atlantic. First, blue whiting is potentially an important grazer of zooplankton and fish larvae. Second, blue whiting may be important food items for fish and cetaceans. However, being a mesopelagic species, it occupies somewhat deeper water than other commercially important pelagic species do. In shallower areas, such as the Barents Sea, the species may live close to the bottom, allowing for the possibility of strong ecological interactions with commercially important demersal fish.

The diet of blue whiting consists mostly of crustaceans and, particularly in larger individuals, small fish (e.g. Bailey 1982). It has been speculated that blue whiting is an important competitor or predator for herring (*Clupea harengus*) in the Norwegian Sea (Zilanov 1968b). Blue whiting are known to be cannibalistic, although the importance and population dynamic consequences of cannibalism are unknown. Blue whiting are predated by a range of piscivores, and it has been identified as an important item in the diet of e.g. cod (*Gadus morhua*; Du Buit 1995), Greenland halibut (*Reinhardtius hippoglossoides*; Bjelland *et al.* 2000), swordfish (*X. gladius*; Clarke *et al.* 1995) and long-finned pilot whale (*Globicephala melas*; Desportes and Mouritsen 1993, Hoydal and Lastein 1993). Nevertheless, the role of blue whiting as predator or prey remains poorly quantified (see Bailey 1982 for discussion).

### 4. Research activity in connection with the MAR-ECO

Collating existing information. Plenty of ecological data on blue whiting have been collected during surveys that have been conducted by several research institutions. Often the results have only briefly been summarized in survey reports, which are not readily available outside respective institutes. Another body of data resides in the Continuous Plankton Recorder (CPR) recordings, which have not been comprehensively analysed with respect to blue whiting. Collating and linking the existing sources of information is a challenging task that is expected to improve our knowledge on temporal and spatial dynamics of blue whiting.

Collection of new data. The major effort will take place in summer (June – August) 2004 with the new Norwegian research vessel G.O. Sars. Norway has surveyed the spawning stock of blue whiting west of the British Isles annually, with few exceptions, in March-April since the mid 1970s. This time series and information from the more westerly coverage in some years

by Russian scientists will be used as a basis for the planning of the major 2004 survey on the Mid-Atlantic Ridge. Also, international efforts for redfish in the Irminger Sea on the Reykjanes part of the ridge may supply important data before 2004, particularly; the surveys carried out by Iceland on the Reykjanes Ridge may strengthen our basis. During the G.O. Sars 2004 survey the following activities on blue whiting are planned to take place:

- Surveying of distributional characteristics with acoustic methods. Coverage from 0 to 1500 m is obtained by using towed instrumentation and an autonomous vehicle. Such instrumentation will improve the vertical coverage and our ability to observe single fish acoustic characteristics.
- Sampling on age- and length structure as well as the maturity status to characterise the life history and dynamics of blue whiting along the Mid-Atlantic Ridge.
- Genetic sampling for studying genetic stock structure of blue whiting, including identifying possible genetically isolated stocks.
- Sampling on meristic characters. These are readily measured and allow comparisons to older studies.

Distributional characteristics through the year will be investigated with merchant vessels. Scientific acoustic instrument packages will be deployed on such vessels, yielding information on seasonal variation in the acoustic backscatters over the Mid-Atlantic Ridge. TS observation and acoustic density monitoring down to between 600 and 1000m depth will give some reference with respect to temporal variation in distribution and abundance of pelagic species.

## 5. Concluding remarks

Blue whiting occur in reasonable numbers in the Azores and near the seamounts north of the archipelago, as well as along the Reykjanes Ridge in the north. What is the importance of blue whiting along Mid-Atlantic ridge? It will be an important challenge to merge available information from all field activities (spawning stock surveys, Reykjanes Ridge surveys, merchant vessel data etc.) and earlier literature into an overall analysis of the importance of blue whiting in the oceanic pelagic ecosystem.

It is unclear why Continuous Plankton Recorder data does not reveal blue whiting's presence in the Azores area. The reason could be either that the samples have not been properly analysed for blue whiting larvae, or that the larvae are too rare at the sampling depth (10m) of the CPR. Interestingly, no observation of blue whiting larvae in the CPR data west of the Reykjanes Ridge were known to Bainbridge and Cooper (1973), although the species is known to occur in the CPR cruise lines.

Russian studies show scattered occurrence of immature as well as of mature blue whiting in this area (Gerber 1993). Are these fish spawning along the ridge, or do they represent the fringes of the distribution along the European continental shelf? Although the abundance of blue whiting in the ridge area probably is not very high, a better understanding of the western limit of the blue whiting distribution is important for a complete understanding of the dynamic of the stock in relation to sustainable management.

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