Species of Flabellifera (Crustacea; Isopoda) and their distribution in Icelandic waters

Anika Karen Guðlaugsdóttir

Species of Flabellifera (Crustacea; Isopoda) and their distribution in Icelandic waters

Anika Karen Guðlaugsdóttir

12 eininga ritgerð sem er hluti af
Baccalaureus Scientiarum gráðu í líffræði

Leiðbeinandi
Jörundur Svavarsson

Líf- og umhverfisvísindadeild
Verkfræði- og náttúruvísindasvið
Háskóli Íslands
Reykjavík, maí 2010

Species of Flabellifera (Crustacea; Isopoda) and their distribution in Icelandic waters
12 eininga ritgerð sem er hluti af *Baccalaureus Scientiarum* gráðu í líffræði

Líf- og umhverfisvísindadeild
Verkfræði- og náttúruvísindasvið
Háskóli Íslands
Askja, Sturlugötu 7
107 Reykjavík

Sími: 525 4000

Skráningarupplýsingar:
Anika Karen Guðlaugsdóttir, 2010, Species of Flabellifera (Crustacea; Isopoda) and their distribution in Icelandic waters, BS ritgerð, Líf- og umhverfisvísindadeild, Háskóli Íslands, XX bls.

ISBN XX

Prentun: XX
Reykjavík, maí 2010

Abstract

The Flabellifera (Crustacea; Isopoda) holds over 3000 described species and is the second largest isopod suborder, containing 18 families. Flabelliferans occur both in marine environment as well as in fresh water habitats, at all depths and latitudes of the world ocean. The Iceland-Faeroe Ridge is a part of the Greenland-Scotland Ridge and separates the Nordic Seas and the North Atlantic. The Greenland-Iceland-Faeroe (GIF) Ridge is relatively shallow and separates depths of more than 2000 meters on both sides and is a natural boundary between relatively warm Northeast Atlantic water and cold subarctic water masses. Iceland is located centrally on the GIF Ridge and the regions around Iceland hold a diversity of water masses, ranging in both temperature and saline concentration.

The distribution of isopods (Crustacea, order Isopoda; suborder Flabellifera Sars 1882; families Aegidae Leach, 1815 and Cirolanidae Dana, 1852) were examined in Icelandic waters, based on analysis of 427 specimens collected between 1991-2004 on the GIF Ridge at 95 stations. The distributional pattern of the Flabelliferans in Icelandic waters was investigated and species assigned to water masses. Both families were species poor in the area, in total occurring with only 7 species in 4 genera. Species were found at temperatures ranging from 2.70-7.84°C and at depths from 140-2369 meters. Most species were restricted to warmer water.

Efnisyfirlit

Figures

Tables

1 Introduction

The isopoda are a diverse group of crustaceans, with more than 10,300 species found in all kinds of habitats (Wilson 2008). They are frequently found in marine littoral and in waters around the world. Isopods occur at all water depths and at all latitudes of the world ocean. In contrast to other animal groups, they do not exhibit reduction in species from tropical latitudes to the Poles. The composition of the fauna undergoes considerable change from low to high latitudes and from lesser to greater depths (Kussakin 1973).

The Flabellifera is a suborder of isopods crustaceans and are found world wide in mareine environment and in fresh water. Flabellifera is the second largest isopod suborder, containing 18 families (Kensley 1989). Two of these families, which will be discussed here, Aegidae and Cirolonidae, are known associates of fish. They attach and feed on their host, but rarely form permanent association with them. Instead they de-attach after their feed and are therefore considered micropredators, rather than parasites.

The Aegidae is a large family holding species of *Aega, Aegapheles, Aegiochus, Rocinela* and *Syscenus* and are usually found at depths from less than 100 meters to approximately 1200 meters. Distribution of individual species ranges from cold-high latitudes to the tropics. Only species of *Rocinela* have their distribution limited to either the Northern or the Southern Hemisphere and most of them are largely restricted to a region (Bruce 2009). For other species of Aegidae, distribution of species may depend on the influence of other environmental factors. It may be attributed to the stability of the ecosystem which, in the historical sence of the evolution of the earth, may account for the existence of a large number og species in the tropical regions. In more limited areas variation and richness of the species may depend on the charecteristics of the bottom, food availability, patterns of tides and sea level, community composition, prey-predator relationships, interactions among species, reproduction strageties etc. (Boschi 2000). Extreme condition for life in the cold water and in the absence of light are associated with rich radiation of biodiversity in the deep sea, fewer, rather than greater number of species are usually expected compared to more benign conditions. Isolation and relatively recent evolutionary age of the Norwegian Sea causes the polar waters of the deep-water environment in this area to be unusually low in species richness (Gage 2000).

***Table 1**: Typical properties of the main water masses exchanged across the Greenland–Scotland Ridge*

Name	Temperature range	Salinity
Modified North Atlantic Water (MNAW)	7.0–8.5°C	35.10–35.30
Irminger Water (IW)	4–5°C	34.9–35.00
Labrador Sea Water (LSW)	3–4°C	34.90–34.95
Icelandic Sea Overflow Water)ISOW)	2–3°C	34.85–35.00
Modified East Icelandic Water (MEIW)	1–3°C	34.70–34.90
Norwigian Sea Deep Water (NSDW)	< -0.5°C	< 34.90
Norwegian Sea Arctic Intermediate Water (NSAIW)	-0.5–0.5°C	34.85–34.90
Arctic/Polar Water (A/PW)	0–2°C	34.30–34.90
Costal Water (CW)	5–12°C	<34.50

The Greenland-Iceland-Faeroe Ridge (GIF) is a shallow ridge extending across the North Atlantic in an east-west direction. The saddle depth of the Ridge is 830-860 meters and it separates basins that are > 4000 meter deep. Little data has been published on the diversity of the benthic fauna, except for recently, e.g. where Svavarsson et al. 2010 investigated the distribution and diversity of desmosomatid and nannoniscid isopods (Crustacea) on the Greenland-Iceland-Faeroe Ridge. It has not been clear what shapes the distribution at the ridge but temperature is known to be most important factor. It has been shown that there is a considerable difference in species composition between the cold areas north og the ridge and the warm areas south of the ridge. The water masses and its properties (temperature and salinity) has been linked to the distributional patterns as well as the nature and thickness of the sediment cover, that changes dramatically with increasing depth (Svavarsson et al. 1990; Svavarsson et al. 2010).

The water masses in this observation are dominated by the Modified East Atlantic Water (MNAW; 7.0–8.5°C, salinity 35.10–35.30), Labrador Sea Water (LSW; 3–4°C, salinity 34.90–34.95), Iceland Sea Overflow Water (ISOW; 2–3°C, salinity 34.85–35.00); Modified East Icelandic Water (MEIW; 1–3°C, salinity 34.70–34.90), Norwegian Sea Deep Water (NSDW; < -0.5°C, salinity <-34.40), Norwegian Sea Arctic Intermediate Water (NSAIW; -0.5 to 0.5°C, salinity 34.85–34.90), Arctic/Polar Water (A/PW; 0–2°C, salinity 34.30–34.90) and Coastal Water (CW; 5–12°C, salinity <34.50) all differing in salinity (total range 34.30–35.45) and temperature (total range -0.55 to 7.84°C). The water masses and their properties (salinity and temperature ranges) are listed in table 1. It represents the properties of water shortly before crossing the Greenland-Scotland Ridge and are based on long-term observations (Hansen and Østerhus 2000).

The BIOICE project (Benthic Invertebrates in Icelandic waters) was designed to investigate the faunal composition and species distrubution in the northernmost part of the North Atlantic and the Nordic seas. Here I evaluate the distribution of the Flabelliferans in Icelandic waters.

Does the topography of the GIF Ridge (e.g depth, sediment) shape the distribution of Flabelliferans?

Do the properties of the water masses (salinity and temperature) shape their species distribution?

2 Materials and methods

2.1 Study area

The study area comprises the northernmost part of the North Atlantic and the south-western part of the Nordic Seas. In the north-east Atlantic, a southward flow of cold water from the Norwegian Sea is constrained by a topographic ridge that extends from east Greenland to Scotland. The ridge forms a continous barrier below 840 meters and it seperates the relatively warm Northeast Atlantic water and the cold sub-arctic water masses. The Denmark Strait lies between Greenland and Iceland. The sill depth is about 620 meters and the opening is fairly wide. The westernmost Atlantic water inflow to the Nordic seas flows northwards through the Denmark Strait and is commonly termed the North Icelandic Irminger Current. The Iceland-Faeroe Ridge lies between Iceland and the Faeroe Islands. The minimum crest depth is about 300-500 meters, deepening from Iceland to the Faeroe Islands and through the Iceland-Faeroe gap the North Atlantic current flows. After crossing the Iceland-Faeroe Ridge, the Atlantic water meets colder and less saline waters in the Iceland-Faeroe Front, north of Iceland. A part of this Atlantic water that flows through the gap is absorbed into the Icelandic Sea, providing heat and salt to these areas.

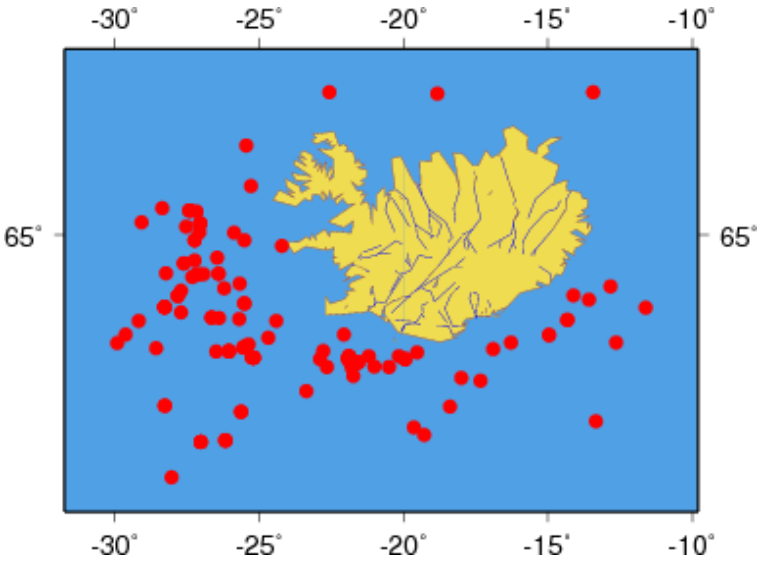

Figure 1. *A map showing the location of all stations that were used in this study*

The area north of the Greenland-Scotland Ridge is sometimes called the Arctic Mediterranean and it contains the Arctic Ocean and the Nordic Seas. The shallow Barrents Sea and the the deep Norwegian, Icelandic and the Greenland Sea which make up the Nordic Seas. The shallower parts of the Ridge hold warm waters while the deepest basins contain mostly colder water, flowing from the north (Hansen and Østerhus 2000). In the deep ocean, some of the strongest persistent bottom currents occur where deep-water flow is funnelled through narrow topographic passages (Mason 2004). At each station, except for stations taken on cruise with the RV *Magnus Heinason*, temperature and salinity were measured. Based on these data, stations were assigned to the water masses (Table 1 and table 2).

2.2 Sampling and analysing

Samples were taken during the BIOICE project from 1991 to 2004. In total 1,411 samples were collected with various instruments during the BIOICE cruises on the research vessels *Bjarni Sæmundsson, Håkon Mosby* and *Magnus Heinason*. The present study is based on 95 samples taked with a modified Rothlisberg-Pearcy epibenthic sledge with 0.5 mm mesh in the cod end. The samples were decanted through a series of sieves, the smallest mesh size being 0.5 mm. The specimens were then preserved in 10% buffered formalin and later transferred to 80% ethanol. Samples were sorted at the BIOICE facilities in Sandgerði where all specimens were sorted to family. Shipek grab samples were taken at some of the same station as the RP sled samples. These were analysed for sediment composition. The sediments were defined by the percentage of grain size (percentage of sand, muddy sand, sandy mud and gravel). Maps were generated using GMT3 Map Generator and species were indentified according to Sars 1899.

3 Results

In total, 427 specimens of the family Flabellifera were collected on the 95 stations analysed here and were assigned to 4 genera and 7 species. The most common species was *Aega ventrosa* comprising 244 specimens collected at 37 stations (i.e. 38.9% of the stations; see table 5 in appendix 3). *Cirolana borealis* was the second most frequent species occurring at 22 stations (23.2% of the stations) with the total number of 37 specimens. *Aega psora* was the third most frequent species occurring at 20 stations (21% of the stations) with 35 individuals. *Aega arctica* was the fourth most frequent occurring at 15 stations (15.8% of the stations) with 52 individuals. *Rocinela danmonienstis* was the fifth most frequent species occurring at 13 stations (13.7% of the stations) with 27 individuals. *Eurydice pulchra* and *Eurydice affinis* had the lowest individual count and found at only 7 and 5 stations, respectively. All species had a wide depth range (>1000) except for *Eurydice* species which were more restrict to shallower water (209-778 m respectively).

***Table 2**: List of Flabellifera species occurring in the area, including information about the number of stations, number of specimens, minimum and maximum depth (m), minimum and maximum temperature (°C) area where they were found and the type of water mass they occurred in.*

Species	No.of stations	No. of indivi-duals	Min. depth (m)	Max. depth (m)	Area	Min. tem. (°C)	Max. temp (°C)	Warer masses (s)*
Aega arctica	15	52	780	1678	SW, S, SV	2.70	6.50	CW, ISOW, IW, MNAW, LSW
Aega psora	20	35	165	1067	N, SW, S, SE	2.70	7.08	ISOW, A/PW, MNAW, IW
Aega ventrosa	37	244	192	1563	SW, S, NE, SE	-0.55	7.48	NSAIW, LSW, MNAW, IW
Cirolana borealis	22	37	172	1744	SW, S, SE	3.12	7.13	MNAW, IW, LSW
Rocinela danmoniensis	13	27	140	2369	NW, SW, S, SE	3.06	7.84	MNAW, LSW
Eurydice pulchra	5	7	242	612	S	6.14	7.06	MNAW
Euridice affinis	7	25	209	305	SW	6.05	7.12	MNAW

*Water masses are detailed in table 1

3.1 *Aega arctica* (Lütken, 1859)

Of 427 isopods collected 52 individuals were *Aega arctica or 12.2%. Aega arctica* was the fourth most frequent specie occurring at 15 stations of the 95 analysed stations (i.e 15.8% of the stations).

3.1.1 Remarks

This species is easily distinguished from other *Aega* by the slender form of the antennae, the comparatively large size of the metasome, and the shape of its telson (Sars 1899).

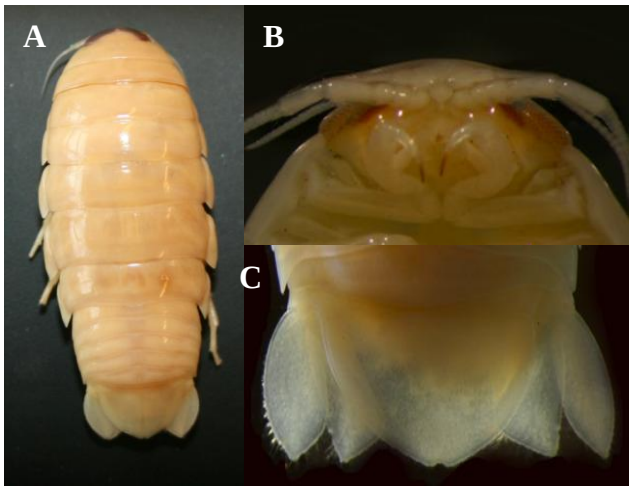

Fig 2: A) Dorsal view of *Aega arctica*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

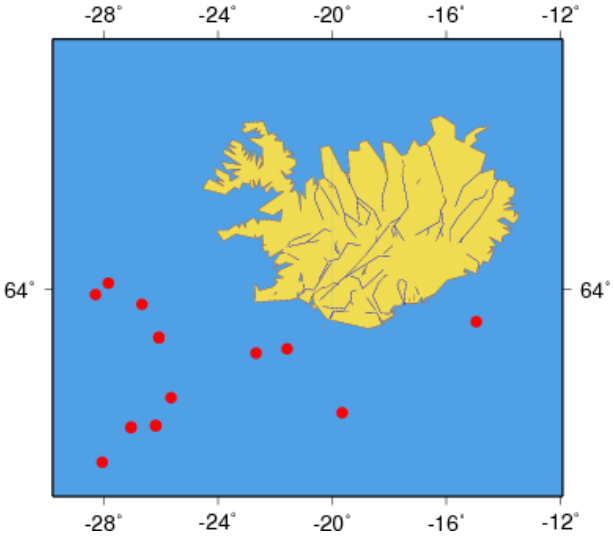

Fig 3: Distribution of *Aega arctica* in the samling area.

3.1.2 Disrtibutional patterns

Aega arctica occurred in waters southwest and southeast of Iceland and was collected in deep waters, 780–1678 meters, respectively. It was found in water ranging in temperature from 2.70–6.50°C and occurred in water masses MNAW, LSW, CW, ISOW and IW (see Table 2 for properties). It was not found to enter the cold waters north of the ridge which might indicate either that the topography of the ridge, with the sill depth of about 620 meters, could hinder it from entering the colder water or that the specie is restricted to warmer water masses which are not found in the northern side of the ridge. (Fig 3; table 1; table 3 in appendix 1).

3.2 *Aega psora* (Linneaus, 1758)

Of 427 isopods collected 35 individuals were *Aega psora or 8.2%. Aega psora* was the third most frequent specie occurring at 20 stations of the 95 analysed stations (i.e 21% of the stations).

3.2.1 Remarks

This species is easily distinguished from other Aega by the rather broad, oval body, the distinctly separated eyes, and by the form of the terminal segment of the metasome, and the deep emargination occurring on the inner plate of the uropoda, outside the tip (Sars 1899).

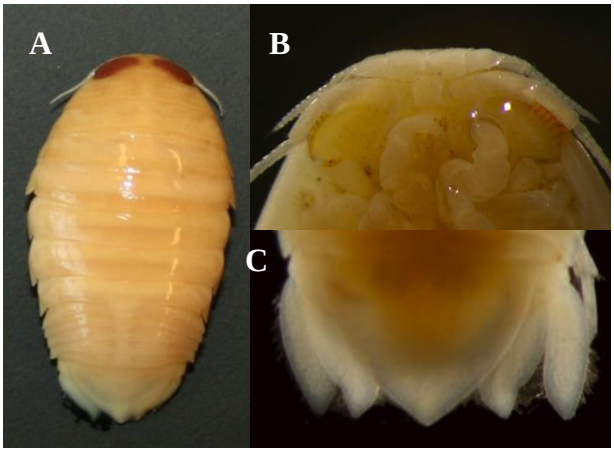

Fig 4: A) Dorsal view of *psora*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

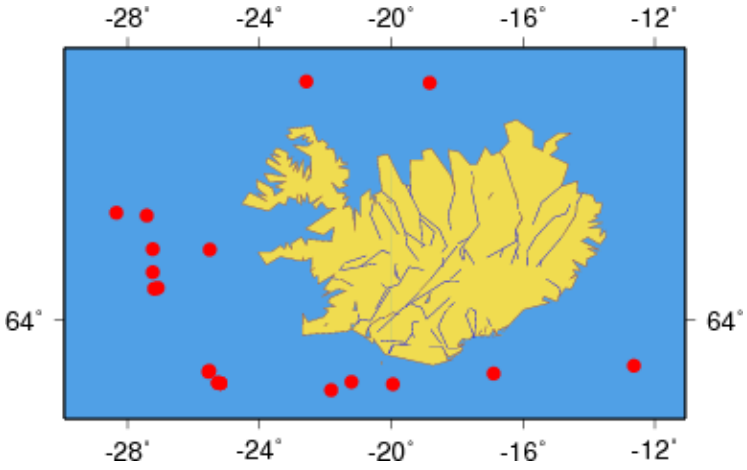

Fig 5: Distribution of *Aega psora* in the samling area

3.2.2 Distributional patterns

Aega psora was found at a variety of depths, ranging from 165 meters down to 1067 meters but manly found at a shallower depths, most commonly at 400–600 meters. It was found at temperatures from 2.70–7.08°C (Table 4 in appendix 2) and occurred in water masses ISOW, A/PW, MNAW and IW. The IW and MNAW are both considerably warm compared to A/PW and ISOW which are colder. The topography of the ridge does not seem to be an obstacle for the specie, being found in the south, southwest, southeast and southeast. It is also found in water masses differing in properties which indicates that the species is not restricted to a certain water mass. A notable exception is that it did not occur in the oceans northeast of Iceland where the East Iceland Current (EIC) brings flows which is colder and less saline (Hansen and Østerhus 2000).

3.3 *Aega ventrosa* (M. Sars, 1859)

Of 427 specimens 244 individuals collected belonged to the species of *Aega ventrosa* or 57% . She was collected at 37 stations of the 95 analysed stations (38.9% of the stations) and therefore being the most frequent species of Flabellifera.

3.3.1 Remarks

Aega ventrosa is similar to *Aega arctica* in structure. What differs is the size of the antennae, and the body is comparatively broader The eyes are also much narrower and the terminal segment of the metasome is also of different shape (Sars 1899).

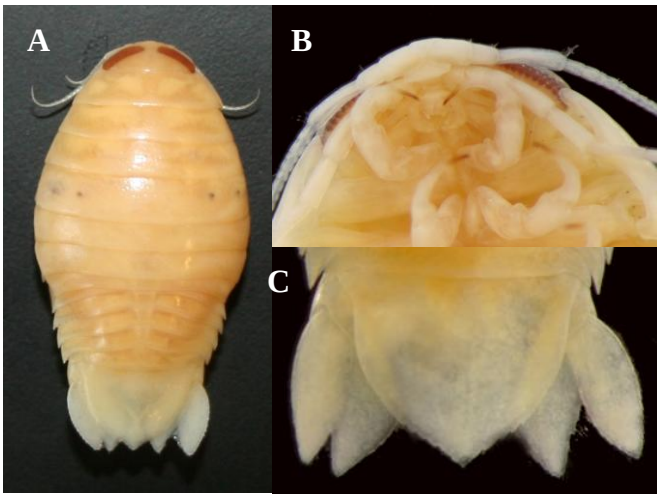

Fig 6: A) Dorsal view of *Aega ventrosa*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

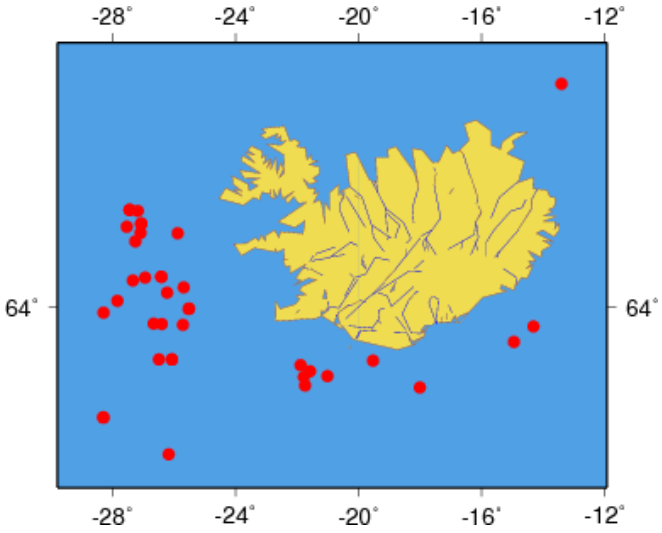

Fig 7: Distribution of *Aega ventrosa* in the samling area.

3.3.2 Distributional patterns

Aega ventrosa was collected at depths from 188–1553 meters and was randomly distibuted down the waterpole and found at temperatures ranging from (-)0.55–7.48°C (Table 5 in appendix 3). Of all of the species, *Aega ventrosa* was the most frequent and found varying the most in temperature ranges and types of water masses, occurring in NSAIW, LSW, MNAW and IW (Table 2). It was usually found at the southern side of the ridge and less frequent at the northern side (Fig. 4). The topography of the ridge does not seem to hinder the species from entering the northern part. It is more likely that it is restricted to a specific water mass or masses and their properties.

3.4 *Cirolana borealis* (Lilljeborg, 1851)

Of 427 specimen collected 37 were *Cirolana borealis* or 8.7% and was the second most frequent species occurring at 22 stations of the 95 analysed stations (23.2 % of the stations).

3.4.1 Remarks

Body is oblong oval and broadest in the middle. The coxal plates are large and are perfectly smooth. The mesosome is considerably narrower than the metasome, with a terminal segment longer than preceding ones combined (Sars 1889).

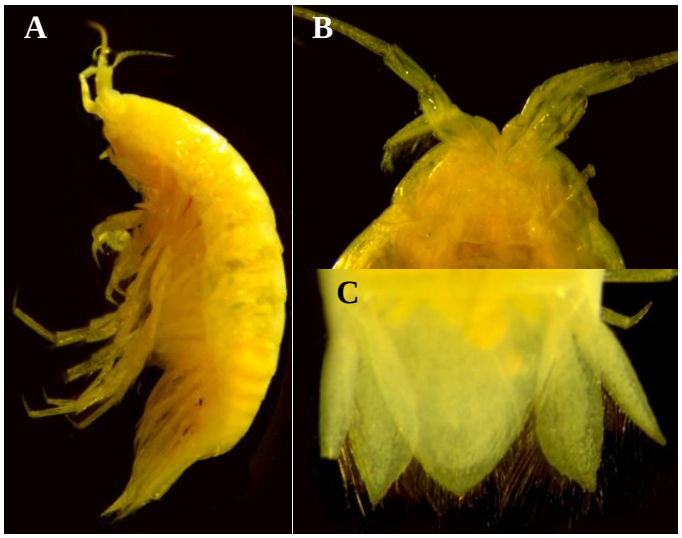

Fig 8: A) Lateral view of *Cirolana borealis*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

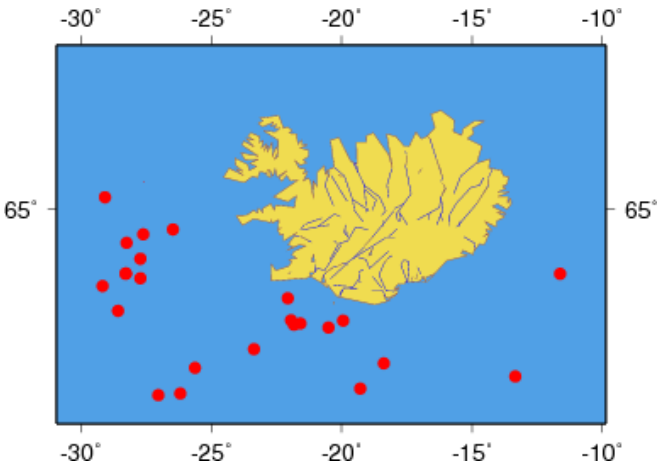

Fig 9: Distribution of *Cirolana borealis* in the samling

3.4.2 Distributional patterns

Cirolana borealis was collected at depths from 172-1840 meters, but most commonly found at more depths (1200–1400 meters). It was found at temperatures ranging from 3.12–7.13°C (Table 7 in appendix 5) and occurred in water masses MNAW, IW and LSW which are all considerably warm (3.0–8.5°C). It was the second most frequent species and occurred in oceans south of Iceland. It is not found in colder waters at the northern side of the ridge, which might indicate that the species is restricted to a certain water mass or masses of higher temperatures.

3.5 *Rocinela danmoniensis* (Leach, 1815)

Of 427 specimens collected, 27 were *Rocinela danmoniensis* or 6.3%. *Rocinela danmonienstis* was the fifth most frequent species occurring at 13 stations of the 95 analysed stations (13.7% of the stations).

3.5.1 Remarks

It bears a strong resemblance to *Aega*, but may be distinguished by the more compressed, and less compact body, the large angular eyes and the evenly rounded terminal segment of the metasome (Sars 1899).

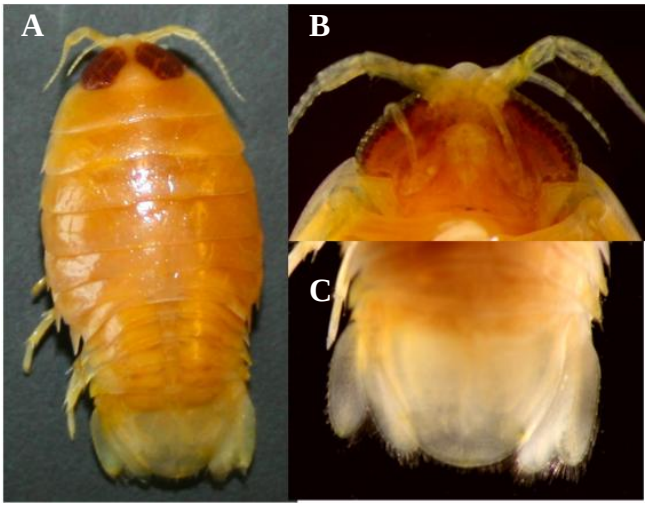

Fig 10: A) Dorsal view of *Rocinela danmoniensis*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

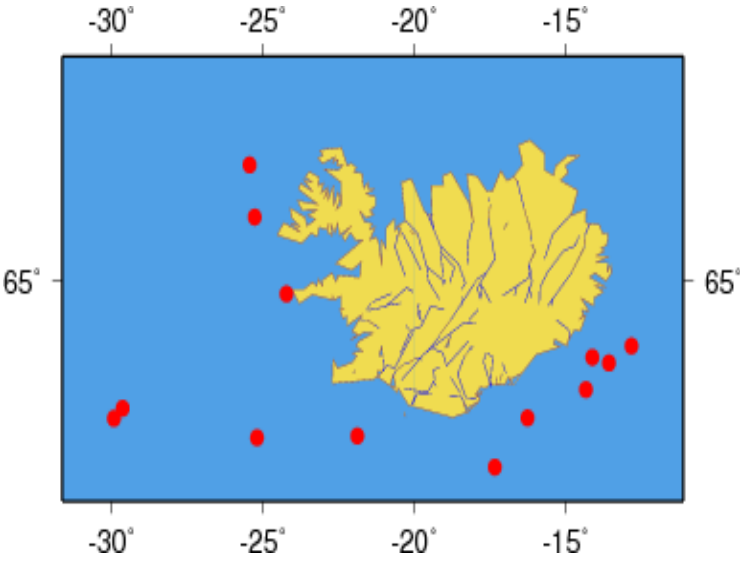

Fig 11: Distribution of *Rocinela danmoniensis* in the samling area.

3.5.2 Distributional patterns

Rocinela danmoniensis was collected at depths from 140–2369 meters but usually found at depths from 100–200 meters. It was found at temperatures ranging from 3.06–7.84°C (table 6 in appendix 4) and occurred in water masses MNAW and LSW which are considerably warm (table 2). It is not found in cold water masses The species is found distributed from the northwest of Iceland to southeast (fig 11).

3.6 *Eurydice pulchra,* (Leach, 1815)

Of 427 specimens collected 7 were *Eurydice pulchra* or 1.64%. *Eurydice pulchra* occurred at 5 stations of the 95 analysed stations (5.26% of the stations).

3.6.1 Remarks

Body more or less semi cylindrical in shape, the eyes are lateral and of normal size. Colour darker than *Eurydice affinis*, with numerous black chromatophores extending laterally and ventrally to the pleon.

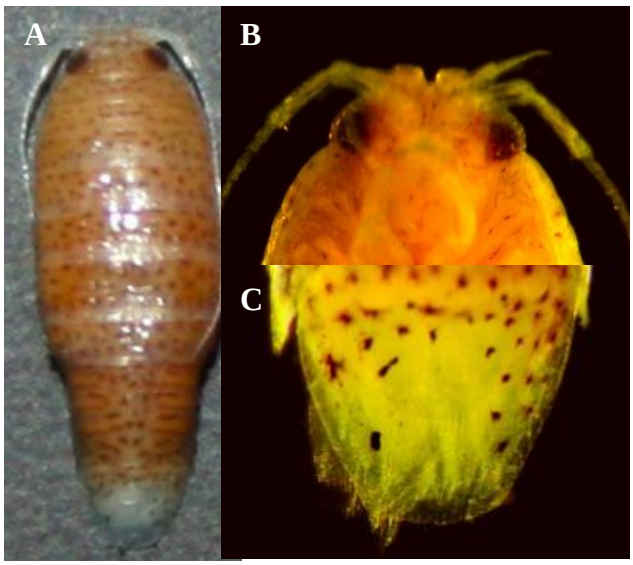

Fig 12: A) Dorsal view of *Eurydice pulchra*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

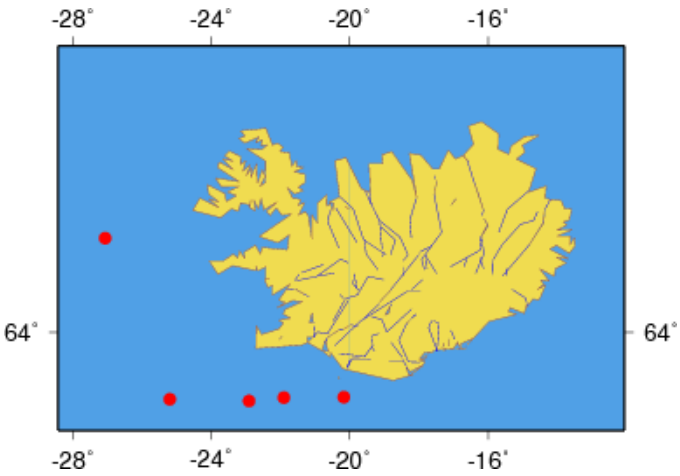

Fig 13: Distribution of *Eurydice pulchra* in the samling area.

3.6.2 Distributional patterns

Eurydice pulchra was collected at depths from 242–612 meters and at temperature ranging from 6.14–7.06°C (table 8 in appendix 6). it was only found in one type of water mass, MNAW, which is relatively warm. It is found south and southwest in the oceans of Iceland and is not found to enter the oceans at the northern side. The topography therefor does not seem to shape the species distribution, but rather the water mass and its properties.

3.7 *Eurydice affinis,* (Dollfus, 1888)

Of 427 specimens collected 25 were *Eurydice affinis* or 5.9%. *Eurydice affinis* occurred at 7 stations of the 95 analysed stations (7.36% of the stations)

3.7.1 Remarks

Body more or less semicylindrical in shape, the eyes are lateral and of normal size. The colour is pale, with black chromatophores restricted to dorsal body surface. The abdomen is yellowish.

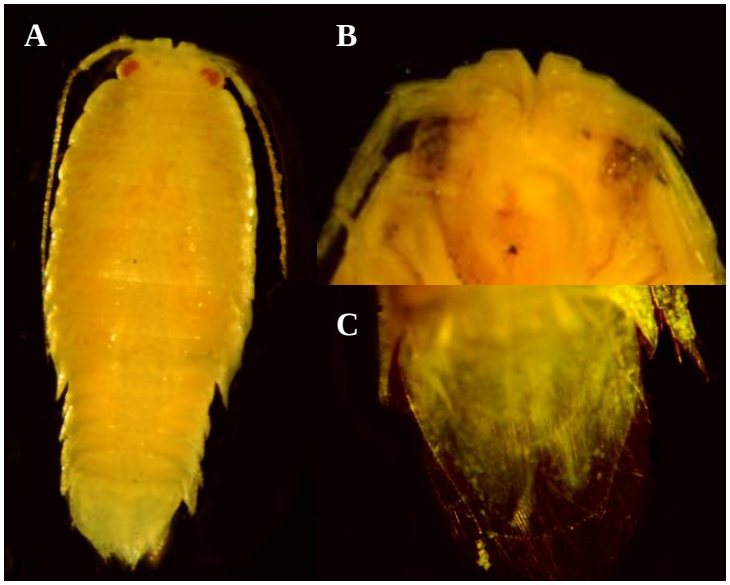

Fig 14: A) Dorsal view of *Eurydice affinis*. B) ventral view of its mouthparts. C) Dorsal wiew of the telson

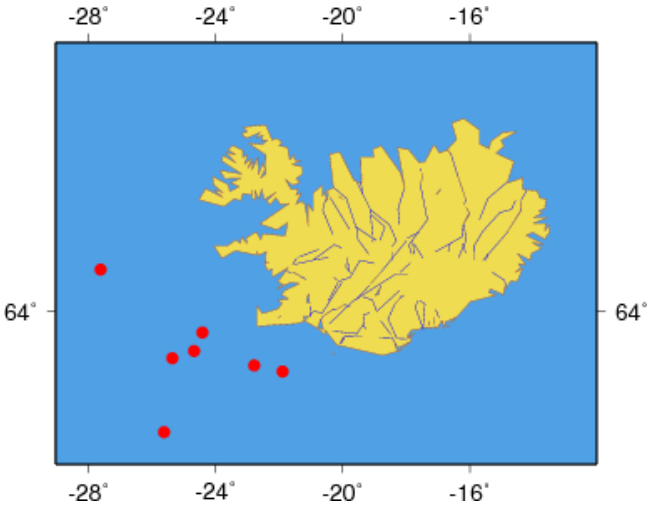

Fig 15: Distribution of *Eurydice affinis* in the samling area.

3.7.2 Distributional patterns

Eurydice affinis was collected at depths from 209–778 meters and at temperature 6.05–7.12°C (table 9 in appendix 6). It is found in oceans southwest of Iceland in one type of water mass, MNAW. The water mass is relatively warm and the species is not found in colder areas, north of the Ridge. Since it is found at depths shallower than the sill depth (620 meters) it can be concluded that the topography does not shape its distribution, rather it is the water mass and its properties (i.e temperature).

4 Discussion

Isopods have been considered highly diverse in the deep sea for a long time. However, waters of the northernmost part of the Atlantic Ocean have been considered low in diversity. Changes in temperature and climate have been shown to shape ecological communities of benthos. Other factors, such as the young age of the area, changes in the general circulation and in the deep-water formation have contributed to the low diversity. The shallow fauna of cold and temperate waters may be regarded as geologically recent and the deep-sea fauna to be the youngest. Comparative-anatomic data indicate that the suborder Flabellifera is the most primitive. Analysis of vertical distributions of all isopods in the world ocean suggests that primitive isopods are principally confined to tropical shelves (Kussakin 1973).

The water masses found within the Nordic Seas are formed from a mixture og Atlantic and Polar water, while Arctic water is an intermediate stage between the two. Surface waters are modified locally by costal runoff or atmospheric cooling. The temperature and salinity of the intermediate water are function of the proportion og Atlantic water that went into its formation and the length of time it has spent in the Nordic Seas. Deep water is formed by cooling and deep convection (Read 1992). The GIF Ridge was formed 57–16 million years ago and the youngest part being at the spreading axis through Iceland (Bott 1983). It holds a diversity of water masses, ranging in both temperature and saline consentration. The northern part holds colder water and the south part holds warmer water. The water masses have been assigned to several kinds of masses that differ in their physical properties.

Species of *Eurydice pulchas* snd *Eurydice affinis* occurred only in shallower waters (248-612 meters) southwest of Iceland and only in MNAW water which is relatively warm and high in saline consentration (7.0–8.5°C, salinity 35.10–35.30). They showed the least abundance, and found only at 5 and 7 stations. As for the other species, relative abundance was also considerably low, except for *Aega ventrosa*, which also had the widest temperature range, being found at the coldest temperature observed here (-0.55°C) as well as the highest (7.48°C). *Aega arctica* was restricted to deeper waters (780-1678 meters) and *Eurydice affinis* and *Eurydice pulchra* were only found at lower depths. For the other species, they were not restricted to a certain depth range, occurring from approximately 200-2000 meters.

As has been mentioned earlier, many factors can shape distribution and the composition of species. Most isopod species around Iceland are restricted to water masses of a certain temperature and salinity. Recent studies have shown that temperature is a shaping factor of both species composition and diversity, where certain species are restricted to either cold water or warm water (e.g. Brix and Svavarsson 2010). Other species of Crustaceans (e.g Cumacea, Tanaidacea) have their distribution limited to a certain depth or type of sediment, rather than a water mass of a special property (Stransky and Svavarsson 2009).

The above analysis of the distribution of the Flabellifera species in Icelandic waters leads to the conclusion that the water mass and its properties shapes the pattern. All species

occurred in several water masses, except for *Eurydice affinis* and *Eurydice pulchra.* which seemed to be restricted to a single water mass (table 2). Species may be adapted to a narrow range of temperatures and all species were restricted to warm water masses in oceans south and southwest of Iceland, except for *Aega ventrosa* which occurred at both sides of the ridge and at a temperature ranging from -0.55°C to 7.48. For the other species, the distribution was shaped by water masses with higher temperature. Extensive information of distribution of the benthic invertebrates at the GIF Ridge indicates that many species have their distributional limits in the vicinity of the ridge. (e.g. Svavarsson 1993b; Svavarsson 2009). Changes in temperature and climate might lead further research on distributional patterns and potential changes.

.

5 References

Bakhrebah, O. A (2006) Description of the isopoda *Aega psora* (Linnaeus, 1758) infesting the red sea parrotfish "*Scarus ferrugineus"* in Jeddah, Saudi Arabia. Egyptian Journal of Aquatic Research 32: 450-456

Boschi, E. E. (2000) Species of decapod crustaceans and their distribution in the american marine zoogeographic provinces. Contributión INIDEP n°1152.

Bott, MHP (1983) Deep structure and geodynamics of the Greenland–Scotland Ridge: an introductory review. In: Bott MHP, Saxov Talwani M, Thiede J (eds) Structure and development of the Greenland–Scotland Ridge new methods and concepts. Springer, US, pp 3–10

Brix, S. and Svavarsson, J (2010) Distribution and diversity of desmosomatid and nannoniscid isopods (Crustacea) on the Greenland-Iceland-Faeroe Ridge. Polar Biol. 33: 515-530

Bruce, N.L. (1983) Aegidae (Isopoda: Crustacea) from Australia with descriptions of three new species. Journal of Natural History 17: 757-758

Bruce, N.L. The marine fauna of New Zealand: Isopoda, Aegidae (Crustacea) / by Niel L. Bruce –Wellington: NIWA (National Institude of Water and Atmospheric Reasearch Ltd), 2009 (NIWA Biodiversity Memoir, ISSN 1174-0043; 122)

Brusca, RC., Coelho, VR., and Taiti, S. (2001) Guide to the Coastal Marine Isopods of California. Tree of life project.

Gage, J.D. (2000) Deep-sea benthic community and environmental impact assessment at the Atlantic Frontier. Continental Shelf Research 21 (2001) 957–986

Grassle, J.F and Maciolek, N.J (1992) Deep-sea species richness: Regional and local diversity estimates from quantitative bottom samples. The Americal naturalist vol. 139, No. 2 313-341

Hansen, B. and Østerhus, S. (2000) North Atlantic-Nordic Seas exchanges. Prog Oceanogr 45:109–208

Kensley, B. and Schotte, M. (1989) Guide to the Marine Isopod Crustaceans of the Caribbean.

Kussakin, O.G (1973) Peculiarities of the Geographical and Vertical Distribution of Marine Isopods and the Problem of Deep-Sea Fauna Origin. Marine Biology 33: 19-34

Malmberg, S.A. and Valdimarsson, H. (2003) Hydrographic conditions in Icelandic waters, 1990–1999. ICES Mar Sci Symposia 219:50–60

Masson, D.G., Wynn, R.B. and Bett, B.J. (2004)Sedimentary environment of the Faeroe-Shetland and Faroe Bank Channels, north-east Atlantic, and the use of bedforms as indicators of bottom current velocity in the deep ocean. Sedimentology 51: 1207-1241

Read, J. F. And Polland, R. T (1992) Water masses in the Region of the Iceland-Færoes Front. Journal of physical oceanography. 1365-1378

Sars. G.O (1899) Isopoda, an account of the Crustacea of Norway, Bergen Museum, Bergen 2: 1-270

Stransky, B and Svavarsson, J. (2010) Diversity and species composition of peracarids (Crustacea: Malacostraca) on the South Greenland shelf: spatial and temporal variation. Polar Biol. 33: 125-139

Svavarsson, J, Brattegard, T, Strömberg, J.O (1990) Distribution and diversity patterns of asellote isopods (Crustacea) in the deep Norwegian and Greenland Seas. Prog Oceanogr 24:297–310

Svavarsson, J, Gudmundsson, G, Brattegard, T (1993b) Feeding by asellote isopods (Crustacea) on foraminifers (Protozoa) in the deep sea. Deep Sea Res I 40:1225–1239

Svavarsson, J (1997) Diversity of isopods (crustacea): new data from the Arctic and Atlantic Oceans. Biodiversity and conservations 6, 1571-1579.

Wilson, G. D. F (2008) Global diversity of isopod crustaceans (Crustacea; isopoda) in freshwater. Freshwater animal diversity assessment. Hydrobiologia 595: 231-240

Appendix 1

Table 3. *Station data of cruiese B-13-92, B-9-93, B-13-94, B-8-97, B-11-02 and B-4-03 of Bjarni Sæmundarson showing sample location, bottom temperature, salinity and depth where Aega arctica was found*

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
B-13-92	984	05.07.92	63°14.61	26°49.97	4.88	34.96	1030
B-13-92	984	05.09.92	63°15.49´	26°31.42´	4.88	34.96	1030
B-13-92	1001	10.09.92	63°00.10´	22°33.57´	5.53	35.03	804
B-9-93	587	05.07.93	63°04.20´	21°15.25´	5.54	35.03	780
B-13-94	727	02.09.92	64°05.50´	27°15.66´	3.84	34.92	1123
B-13-94	729	03.09.92	63°55.30´	28°11.40´	3.71	34.91	1408
B-8-97	278	05.07.97	63°29.93´	14°11.70´	3.89	34.99	1165
B-11-02	517	03.09.02	62°02.40´	19°38.00´	2.70	34.99	1678
B-4-03	388	03.09.03	63°45.95´	26°49.60´	6.07	35.06	806
B-4-03	398	08.09.03	61°13.06´	28°12.08´	5.82	35.07	973
B-4-03	400	09.09.03	61°47.76´	27°57.20´	6.09	35.08	889
B-4-03	400	09.09.03	61°48.08´	27°34.17´	6.09	34.08	879
B-4-03	401	10.09.03	61°49.58´	26°05.80´	5.52	35.07	917
B-4-03	401	10.09.03	61°49.73´	26°11.80´	5.52	35.07	914
B-4-03	402	10.09.03	62°17.38´	25°53.52´	6.50	35.12	784

Appendix 2

Table 4. *Station data of cruiese HM-1-92, B-13-92, B-13-93, B-13-94, B-13-95, MH1-93, B-9-93 and B-8-96 of Bjarni Sæmundarson, Håkon Mosby and Magnus Heinason showing sample location, bottom* temperature, salinity and depth where *Aega psora* was found

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
HM-1-92	27	08.07.92	66°59.02	18°49.97	2.70	34.86	202
B-13-92	979	04.09.92	63°18.74´	25°31.42´	6.88	35.11	362
B-13-92	980	04.09.92	63°18.18´	25°33.57´	6.86	35.11	467
B-13-92	988	08.09.92	63°08.97´	25°15.25´	6.52	35.09	552
B-13-92	988	08.09.92	63°09.05´	25°15.66´	6.52	35.09	569
B-13-92	989	08.09.92	63°08.60´	25°11.40´	6.77	35.11	458
B-13-92	989	08.09.92	63°08.67´	25°11.70´	6.77	35.11	464
MH-1-93	15	08.05.93	63°23.00´	12°38.00´	NA	NA	497
B-9-93	559	01.07.93	63°02.90´	21°49.60´	5.94	35.03	840
B-9-93	564	02.07.93	63°09.93´	21°12.08´	7.08	35.11	280
B-9-93	568	03.07.93	63°07.90´	19°57.20´	4.80	35.00	1007
HM-1-93	46	16.07.93	67°00.10´	22°34.17´	5.41	34.99	205
B-13-94	737	07.09.94	64°25.40´	27°05.80´	6.00	35.05	494
B-13-94	738	07.09.94	64°24.80´	27°11.80´	6.05	35.05	597
B-13-95	723	26.08.95	63°16.66´	16°53.52´	6.74	35.12	597
B-8-96	463	22.08.96	64°37.52´	27°14.30´	6.35	35.06	555
B-8-96	465	23.08.96	64°55.40´	27°14.58´	6.14	35.06	364
B-8-96	470	24.08.96	65°21.22´	27°25.43´	6.24	35.05	578
B-8-96	473	24.08.96	65°23.27´	28°21.27´	4.78	34.98	1067
B-8-96	502	30.08.96	64°55.12´	25°31.00´	6.42	35.06	165

Appendix 3

Table 5. *Station data of cruiese HM-1-91, B-13-92, B-13-94, B-13-95, B-9-93, B-8-96, B-8-97 and B-4-03 of Bjarni Sæmundarson and Håkon Mosby showing sample location, bottom temperature, salinity and depth were Aega ventrosa was found*

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
HM-1-91	22	23.07.91	67°00.25´	13°25.44´	-0.55	NA	833
B-13-92	984	05.09.92	63°14.61´	26°03.43´	4.88	34.96	999
B-13-92	985	05.09.92	63°14.61´	26°29.14´	4.09	34.94	1209
B-9-93	557	30.06.93	63°09.90´	21°53.20´	7.06	35.11	346
B-9-93	560	01.07.93	62°59.20´	21°47.00´	4.57	34.98	934
B-9-93	561	02.07.93	62°51.60´	21°44.10´	4.00	34.97	1074
B-9-93	563	02.07.93	63°00.18´	21°00.54´	5.36	35.02	819
B-9-93	570	03.07.93	63°13.80´	19°31.70´	5.48	35.03	965
B-9-93	587	05.07.93	63°04.20´	21°34.90´	5.54	35.03	842
B-13-94	727	02.09.94	64°05.50´	27°49.70´	3.84	34.92	1121
B-13-94	729	03.09.94	63°55.30´	28°16.80´	3.71	34.91	1407
B-13-94	735	07.09.94	64°25.70´	26°24.20´	5.56	35.04	300
B-13-94	735	07.09.94	64°25.80´	26°24.20´	5.56	35.04	304
B-13-94	736	07.09.94	64°25.20´	26°55.40´	5.71	35.04	332
B-13-94	739	07.09.94	64°22.70´	27°19.10´	6.00	35.05	711
B-13-95	728	27.08.95	62°49.82´	18°00.42´	3.26	34.98	976
B-8-96	465	23.08.96	64°55.40´	27°14.58´	6.14	35.06	367
B-8-96	466	23.08.96	65°02.30´	27°04.10´	6.29	35.06	219
B-8-96	467	23.08.96	65°09.95´	27°02.80´	6.14	35.06	242
B-8-96	467	23.08.96	65°09.80´	27°03.70´	6.14	35.06	229
B-8-96	468	23.08.96	65°07.20	27°31.40´	6.24	35.06	464
B-8-96	469	23.08.96	65°20.40	27°10.00´	6.27	35.06	332
B-8-96	470	24.08.96	65°21.09´	27°25.50´	6.24	35.05	507

***Table 5**: Continued*

B-8-96	470	24.08.96	65°21.22´	27°25.43´	6.24	35.05	513
B-8-96	500	30.08.96	65°01.96´	25°52.27´	6.34	35.06	163
B-8-97	278	05.07.97	63°29.93´	14°57.95´	3.89	34.99	1109
B-8-97	300	10.07.97	63°43.56´	14°19.84´	6.10	35.08	417
B-4-03	384	02.09.03	64°16.91´	25°40.42´	7.19	35.16	300
B-4-03	385	02.09.03	64°12.33´	26°12.65´	6.95	35.14	336
B-4-03	387	03.09.03	63°45.46´	26°23.10´	7.48	35.18	496
B-4-03	388	03.09.03	63°45.95´	26°39.16´	6.07	35.06	790
B-4-03	397	07.09.03	62°23.15´	28°16.91´	3.77	34.95	1558
B-4-03	397	07.09.03	62°22.98´	28°16.13´	3.77	34.95	1553
B-4-03	401	10.09.03	61°49.58´	26°09.97´	5.52	35.07	916
B-4-03	406	11.09.03	63°44.84´	25°41.95´	7.10	35.15	366
B-4-03	407	12.09.03	63°58.80´	25°30.48´	7.43	35.17	188
B-4-03	407	12.09.03	63°58.63´	25°30.69´	7.43	35.17	188

Appendix 4

Table 6. Station data of cruiese B-13-92, B-9-93, B-13-94, B-8-97, B-11-02 and B-4-03of *Bjarni Sæmundarson* showing sample location, bottom temperature, salinity and depth where *Rocinela danmoniensis* was found

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
B-13-92	989	08.09.92	63°08.67´	25°11.70´	6.77	35.11	464
B-9-93	557	30.06.93	63°09.90´	21°53.20´	7.06	35.11	348
HM-1-93	12	12.07.93	66°16.52´	25°26.51´	5.58	35.02	150
B-13-94	732	06.09.94	64°50.50´	24°13.00´	7.14	35.04	230
B-8-96	490	29.08.96	65°42.18´	25°16.75´	6.82	35.05	161
B-8-97	286	09.07.97	64°14.17´	12°49.29´	7.08	35.15	188
B-8-97	292	09.07.97	64°02.23´	13°34.29´	7.84	35.13	140
B-8-97	295	10.07.97	64°06.11´	14°07.27´	7.74	35.15	141
B-8-97	300	10.07.97	63°43.56´	14°19.84´	6.10	35.08	439
B-11-01	734	15.09.01	63°22.98´	16°16.15´	7.97	35.20	323
B-11-02	525	08.09.02	62°47.19´	17°.2037´	3.36	35.02	1662
B-4-03	391	05.09.03	63°30.14´	29°3819´	3.14	34.92	2242
B-4-03	392	05.09.03	63°22.49´	29°54.85´	3.06	34.92	2369

Appendix 5

Table 7 *Station data of cruiese MH-1-93, B-9-93, B-13-94, B-8-96, B-9-00, B-11-02, and B-4-03 of Bjarni Sæmundarson and Magnus Heinason showing sample location, bottom temperature, salinity and depth where Cirolana borealis was found*

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
MH-1-93	10	05.05.93	62°08.00´	13°20.00´	NA	NA	1305
MH-1-93	18	07.05.93	63°55.00´	11°37.00´	NA	NA	324
B-9-93	553	30.06.93	63°30.10´	22°03.70´	7.13	35.10	172
B-9-93	558	01.07.93	63°07.50´	21°56.32´	6.74	35.09	580
B-9-93	559	01.07.93	63°02.90´	21°49.60´	5.49	35.03	840
B-9-93	568	03.07.93	63°07.00´	19°56.60´	4.80	35.00	1095
B-9-93	587	05.07.93	63°04.20´	21°34.90´	5.54	35.03	780
B-13-94	724	31.08.94	64°26.10´	28°14.20´	3.72	34.92	1212
B-13-94	726	02.09.94	64°10.20´	27°43.10´	4.20	34.93	1042
B-13-94	728	02.09.94	63°50.50´	27°42.80´	3.80	34.92	1295
B-13-94	729	02.09.94	63°55.80´	28°16.30´	3.71	34.91	1408
B-13-94	729	02.09.94	63°55.30´	28°16.80´	3.71	34.91	1408
B-8-96	464	23.08.96	64°34.76´	27°36.60´	6.05	35.03	778
B-8-96	475	25.08.96	65°10.80´	29°04.29´	3.90	34.94	1454
B-9-00	437	25.07.00	62°37.11´	23°21.61´	3.61	34.99	1252
B-11-02	512	31.08.02	62°59.90´	20°30.30´	5.82	35.10	819
B-11-02	516	03.09.032	61°54.95´	19°17.02´	3.12	35.01	1605
B-11-02	520	04.09.032	62°22.20´	18°23.35´	3.77	35.03	1334
B-4-03	390	04.09.033	63°42.71´	29°10.36´	3.24	34.92	1840
B-4-03	393	06.09.033	63°17.46´	28°34.39´	3.70	34.95	1744
B-4-03	400	09.09.03	61°47.76´	27°01.58´	6.09	35.08	889
B-4-03	408	12.09.03	64°39.72´	26°27.94´	6.99	35.14	272

Appendix 6

Table 8. *Station data of cruiese B-9-93, B-13-93 and B-8-96 of Bjarni Sæmundarson showing sample location, bottom temperature, salinity and depth where Eurydice pulchra was found*

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
B-9-93	557	30.06.93	63°10.00´	21°53.80´	7.06	35.11	348
B-13-93	989	08.09.92	63°08.60´	25°11.40´	6.77	35.11	458
B-9-93	566	03.07.93	63°10.27´	20°09.54´	6.46	35.08	575
B-9-93	558	01.07.93	63°07.40´	22°53.90´	6.74	35.09	612
B-8-96	467	23.08.96	65°09.95´	27°02.80´	6.14	35.06	242

Table 9*. Station data of cruiese B-4-93, B-8-96, B-9-93, B-13-92 and B-13-93 of Bjarni Sæmundarson showing sample location, bottom temperature, salinity and depth where Eurydice affinis was found*

Cruise	Station	Date	Latitude N	Longitude W	Temperature bottom (°C)	Salinity bottom	Depth (m)
B-13-93	1004	10.09.92	63°15.02´	22°47.37´	7.12	35.13	266
B-8-96	464	23.08.96	64°34.76´	27°36.60´	6.05	35.03	778
B-4-03	402	10.09.03	62°17.37´	25°37.58´	6.50	35.12	768
B-9-93	557	30.06.93	63°09.90´	21°53.20´	7.06	35.11	348
B-13-92	977	04.09.92	63°27.10´	24°40.75´	6.92	35.11	295
B-13-92	978	04.09.92	63°21.07´	25°21.78´	6.65	35.10	305
B-13-92	975	04.09.92	63°42.72´	24°24.78´	6.98	35.11	209

Appendix 7

Table 10 *List of flabellifera species occurring in the area, including information about the number of stations, number of specimens, minimum and maximum depth (m), minimum and maximum temperature (°C) and water masses*

Species	**No. of stations**	**No. of indiv-iduals**	**Min. depth (m)**	**Max. depth (m)**	**Area**	**Min. temp. (°C)**	**Max. temp. (°C)**	**Warer masses (s)**
Aega arctica	15	52	780	1678	SW, S, SV	2.70	6.50	CW, ISOW, IW, MNAW, LSW
Aega psora	20	35	165	1067	N, SW, S, SE	2.70	7.08	ISOW, A/PW, MNAW, IW
Aega ventrosa	37	244	192	1563	SW, S, NE, SE	-0.55	7.48	NSAIW, LSW, MNAW, IW
Cirolana borealis	22	37	172	1744	SW, S, SE	3.12	7.13	MNAW, IW, LSW
Rocinela danmoniensis	13	27	140	2369	NW, SW, S, SE	3.06	7.84	MNAW, LSW
Eurydice pulchra	5	7	242	612	SW	6.14	7.06	MNAW
Euridice affinis	7	25	209	778	SW	6.05	7.12	MNAW