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# Age, Maturity and Other Biological Parameters of Two Morid Species *Lepidion eques* (Günther, 1887) and *Antimora rostrata* Günther, 1878, in Icelandic Waters.

by

Jutta V. Magnússon.
Marine Research Institute
Reykjavík, Iceland

**Abstract**

This paper presents biological parameters on two species of the morid family, *Lepidion eques* and *Antimora rostrata* collected in Icelandic waters by the Marine Research Institute, Iceland. Although both species are common in the waters off the south and west coasts of Iceland their habitat differs in depth and temperature. *Lepidion eques* is mostly observed in depths 500 - 900 m in temperatures between 5° and 6° C, while *Antimora rostrata* is mainly recorded in depths below 1300 m in temperatures of around 4°C.

The mean length of *Lepidion eques* increased with increasing depth. Males and females are very similar in size. Observations on ripening and newly spent fish lead to the assumption that the main spawning season in Icelandic waters, is well under way in February and seems to be over in May-June. The 50% maturity point was reached at a length of 30,8 cm for males and at 29,5 cm for females. An age-length key is given .

Females of *Antimora rostrata* were much larger in size than males. Larger fish especially females were more numerous in depths > 1500 m. Small fish were observed in shallower depths than adults. Spawning fish was not observed but observations on other maturity stages indicate that in Icelandic waters, spawning takes place in winter. The 50% maturity was reached at a length of 40-43 cm. Presumably, *Antimora rostrata* is a slow growing species. The age range was given from 3 years (15 cm) to 23 years (54 cm). Males are much smaller than females at a given age.

**Keywords**: *Lepidion eques, Antimora rostrata,* biological parameters, Iceland.

## Introduction

The two species of the morid family, North Atlantic codling *Lepidion eques* (Günther,1887) and blue antimora *Antimora rostrata* Günther,1878, have been observed for a long time in the bottom trawl catches during research cruises carried out by the Marine Research Institute (MRI), Iceland. They are common in the waters off the south and west coasts of Iceland but absent off the north and east coasts. However, their habitat is different. Blue antimora is living deeper than the North Atlantic codling with very little overlapping in depth and temperature.

The known geographical distribution of *Lepidion eques* reaches from the Bay of Biscay, south and west of Ireland, west of Scotland to the Faroes along the Iceland-Faroe Ridge, south and south-west of Iceland to east and west Greenland, from northern Labrador along the continental slope to the south-eastern Grand Bank (Templeman, 1970).

The geographical distribution of *Antimora rostrata* seems to be similar to that of *Lepidion eques* but it reaches further to the south along the east coast of North-America.

Several authors have reported on the depth distribution and size of both species from various areas. The depth distribution for North Atlantic codling has been reported from 127 m to over 2000 m depth, e.g. Sæmundsson (1949), Kotthaus and Krefft (1967), Templeman (1970), Gordon (1979a), Mauchline and Gordon (1980), Gordon and Duncan (1985a), Carrason et al. (1997). But the primary depth range for North Atlantic codling, e.g. in the Rockall Trough is 750-1000 m (Mauchline &Gordon, 1984). The reported depth range for blue antimora is greater and different from *Lepidion eques.* Thus, blue antimora has been observed in various areas, in depths of 229 - 2930 m, by Iwamoto (1975), Parsons (1976), Small (1981), Mauchline and Gordon (1984), Gordon and Duncan (1985a and 1985b), Snelgrave and Haedrich (1985), Vázquez (1991), and Hareide (1992), but most authors report the greatest abundance in 1300 or 1500 m to 2200 or 2500 m depth.

Information on size, sex composition, maturity and spawning is much scantier for the two species. Reports on one or more of these parameters for *Lepidion eques* have been given, by Templeman (1970), Gordon (1979a and 1979b), Mauchline and Gordon (1980) and Gordon & Duncan (1985a). Similarly for *Antimora rostrata*, reports include those by Iwamoto (1975), Parsons (1976), Wenner & Musick (1977), Small (1981), Gordon & Duncan (1985a), Vázquez (1991), Pohle et al. (1992) and Hareide (1992). Very little has been published on weight of *Lepidion eques* (Gordon and Duncan, 1985a) and of *Antimora rostrata* (Wenner & Musick, 1977, and Pohle et al., 1992). The only information on age of *Lepidion eques* was given by Gordon and Duncan (1985a) and for *Antimora rostrata,* by Gauldie et al. (1991).

Although already known in Icelandic waters since the turn of the century (Sæmundsson, 1926, Jónsson, 1992), both species were considered as rare until trawling extended into deeper waters and at least the North Atlantic codling incidentally turned out to be quite abundant. Neither the North Atlantic codling nor the blue antimora have ever been target species during the research cruises but have been recorded as bycatch. Reports on these species from Icelandic waters were mainly as rare fish in *Annales Biologiques* until 1976 when *Lepidion eques* was removed from the list of rare species (Jónsson et al., 1978). *Antimora rostrata* was not listed as rare species since 1993 (Jónsson et al.,1994). Sæmundsson (1926) reported on the first findings of adult *Lepidion eques* in Icelandic waters as well as on pelagic fry of the

species. Information on the distribution and occurrence were reported by Sæmundsson (1926) on *Lepidion eques* and Jónsson (1992) on both species, by Magnússon & Magnússon (1995) on *Lepidion eques*, and by Magnússon et al. (1998) on both species from the Reykjanes Ridge. Kotthaus and Krefft (1967) reported on *Lepidion eques* off south-east Iceland and Haedrich and Krefft (1978) on both species in the Irminger Sea.

In late years, the interest in deep water species especially on those which could be of a potential commercial interest has been steadily growing in Iceland. The latest example in this respect is the exploiting of the greater silver smelt (*Argentina silus*). Material gathered on non-target species had more or less been stored away. However, with the contribution of the three-years' EC-FAIR project CT 95-655, commenced in 1995, a thorough inventory of Icelandic survey data on non-target deep water fish species was carried out. This paper presents the gathered information on *Lepidion eques* and on *Antimora rostrata,* in the time period 1976 to 1997. Looking at the results present it should be borne in mind that sometimes they refer to little and sporadical recordings. However, the literature on the biology of these species in general and especially, on the species in Icelandic waters is very limited. Therefore, it was considered proper to come forward with the information available as a contribution to the limited knowledge on these two species in Icelandic waters especially on the depth distribution and abundance of *Antimora rostrata.*

## Material and methods

The material used in this paper was collected during several surveys carried out in Icelandic waters, over many years. Neither blue antimora nor North Atlantic codling were ever target species in the surveys and the data were thus collected as bycatch.

All catches were taken with standard two-panel bottom trawls. The codend was lined with fine-meshed nets (36-40 mm mesh size) in almost all surveys.

The data on *Antimora rostrata* derive to a great extent from recent years, in particular from a single survey carried out in the Reykjanes Ridge area, in June-July 1997 (KA1-97). One of the reason for the scarcity of material on blue antimora is that during most surveys the trawling depth was very seldom exceeding 1100 m mostly due to the restricted warp length and power of the vessels. Observations from earlier years were mainly recorded as counted specimens besides some length measurements.

Data on *Lepidion eques* have, on the other hand, been collected on surveys over a longer period of time. A considerable part of the material on length, sex, maturity and age derives from the 1980ties.

In later years, individual weighing was carried out on fresh samples for both species on board, in grammes (Marel M 2000 scales).

The length measurements are recorded as total length and all measurements are to the nearest cm.

The four-stage maturity method - Stage I, immature; Stage II, maturing; Stage III, spawning; Stage IV, newly spent (Sivertsen,1937)- commonly applied by the MRI for commercially important species, e.g., cod (*Gadus morhua* L.), was used for both species . For the maturity of North Atlantic codling, data were pooled and arranged by month.

Otoliths were used for the age estimation of both species. The same technique was applied as for routine age determination of cod and several other species. The otoliths

were embedded in black polyester resin and a thin section (0,9-1,0 mm) cut out of the centre of the otolith with a high-speed diamond saw. The sections were mounted on microscope glass slides with colourless resin and covered with a thin cover glass.
The age reading was carried out using transmitted illumination with a compound microscope, type Wilde M 8. For the age estimation of *Antimora rostrata,* the criteria of Gauldie et al. (1991) was applied, i.e. counting the edge of the central opaque zone as one. Most of the otoliths from North Atlantic codling and all otoliths of blue antimora were read and re-read by trained readers of the MRI.
The bottom temperature was measured with XBT, CTD, reversed thermometers and in late years with SCANMAR temperature sensor mounted on the headline of the trawl or the trawl doors.
Usually, the depth of the hauls was recorded immediately after shooting and at the end of the haul but sometimes also during the haul. The mean of the these records was used as depth of the haul.

## Results

### *Lepidion eques*

DISTRIBUTION AND ABUNDANCE
The North Atlantic codling is very common in Icelandic waters and quite abundant in the slope area off the west, south-west and south coasts. It has also been observed off south-east Iceland (Iceland-Faroe Ridge) and off East Greenland (Fig. 1). The depth in which the species has been observed ranged from less than 200 metres to over 1400 metres but it is most abundant in 500 to 900 metres when considering the number of individuals per nautical mile towed (Fig.2).
Records with 500 to over 1000 specimens per station are not uncommon within the optimal depth range. However, in the catch composition North Atlantic codling rarely exceeded 10 % of the total catch in weight but was mostly within the range of 0,4 to 3 %.

SIZE COMPOSITION
The overall size distribution showed a wide range, from 8 to 49 cm, the bulk being between 25 and 35 cm (Fig.3). There are only minor differences in size between sexes as reflected in the mean length of 28,96 cm for males and 28,85 cm for females (Fig.4).
Small fish (16 cm and smaller) was quite frequently recorded, almost over the entire area of distribution of North Atlantic codling in the Icelandic slope region. The average depth of the hauls where small fish was recorded was 658 m while the average depth of all stations with North Atlantic codling was 760 m.

LENGTH IN RELATION TO DEPTH
There was a relationship between the size of North Atlantic codling and depth. The length data pooled together resulted in a wide length range in each depth category but the overall mean length increased with increasing depth. Thus, the mean length for the depth category <500 m was 20,99 cm while it was 33,24 cm in depths over 1200 m (Fig.5). Males were more numerous in the catches, the overall sex ratio being 1:0,89. But the sex ratio and the size distribution by depth was similar for both sexes.

However, the increase in mean length by depth was somewhat more pronounced for males than for females (Fig.6).

WEIGHT IN RELATION TO LENGTH

Data on the length-weight relationship of 584 North Atlantic codling in the length range of 11 to 41 cm were pooled for 1988-1997. Like in the length distribution the length-weight relationship of the sexes was very similar. Sexual differences occurred only for specimens of about 33 cm and over (Fig.7).

RELATION TO TEMPERATURE

The bottom temperature in which North Atlantic codling was recorded in Icelandic waters ranged from 2,0°C to 7,9°C, with an average of 5,5°C. Differences related to depth and to the area off south-west to south-east Iceland could be observed (Table 1). Both in areas west and east of 20°W, the temperature decreased with increasing depth but the temperatures east of 20°W were lower. The regional average temperature was 5,39°C west of 20° W and 4,12°C east of that longitude. Looking at the average length it increased in both regions with increasing depth.

MATURITY

Information on maturity of North Atlantic codling was available for six months (February, March, May, June, July and October), pooled together from several years (Fig.8). Immature fish dominated in all months. Stages II and IV, i.e. maturing and newly spent, were also represented in all months but were by far most numerous in February and March. Spawning specimens (stage III) were rare in the catches but they were also observed in the last mentioned two months. Newly spent specimens have been observed in all months which might indicate some spawning year round as commonly observed for deep water fish species. Assumingly, the main spawning is already well under way in February but seems to be over in May-June.

Maturity by depth is shown in Table 2. Immature fish of both sexes was distributed over a broad depth range as well as females of stage II. Males of stage II were mainly distributed in depths 800 to 900 m. The few spawning specimens were mainly observed in 600 to 900 m depth, i.e. in the depth of greatest abundance.

The 50% maturity point was reached at a length of 30,8 cm for males and at 29,5 cm for females, respectively. This corresponds to an age of approximately 8 to 9 years.

AGE

Otolith samples from several cruises and years mainly from 1982 were used for the age determination of North Atlantic codling. About one third of the otoliths were considered unreadable. The remaining 296 otoliths were pooled together in one age/length key (Table 3). There was no noteworthy difference in age/length between males and females. The growth rate seems to be about two to three centimetres up to the age of 9 years decreasing gradually with age after that. The age composition is presented in Fig.9.

***Antimora rostrata***

DISTRIBUTION AND ABUNDANCE

Blue antimora was observed from East Greenland to the Iceland-Faroe Ridge (Fig.10). The species is quite common in Icelandic waters. It might, however, be more abundant

in the slope area than indicated in Figure 10 because hauls deeper than 1200 metres were not carried out by the MRI until recently. Also, the species appeared to be more numerous in the deepest hauls in the Reykjanes Ridge area than in the continental slope area. Blue antimora was observed in depths from 800 metres to over 1700 metres which was the deepest haul made in our surveys. It was most abundant in depths over 1300 metres (Fig.11).
In the catch composition blue antimora exceeded rarely 3 % of the total catch but it was mostly within the range of 0,4 to 3 % in weight in depths greater than 1200 m. However, it should be noted that during one joint Russian/Icelandic research cruise, off south Iceland, in September 1984 (not recorded in the Icelandic inventory), at two stations, *Antimora rostrata* was recorded as 13,3 % and 15,2 % respectively (50 kg) of the total catch. Both stations were taken in 1400 m depth.

SIZE COMPOSITION

The overall length distribution ranged from 10 to 65 cm. The main peak was at 36 to 38 cm (Fig. 12). Contrary to North Atlantic codling, there was a considerable sexual difference in the overall mean length (fig. 13), the males being much smaller (32,80 cm) than the females (43,50 cm).
Small fish (20 cm and smaller) was equally distributed in all the sampled areas in Icelandic waters. However, the average depth of all hauls containing small blue antimora was 1289 m compared with the average depth of 1405 m for all hauls where the species was recorded.

LENGTH IN RELATION TO DEPTH

For studying the relation length to depth, the material at hand was divided into two depth strata, i.e. less than 1500 metres and over 1500 metres. The main differences in the length distribution of these two depth strata were that the smallest specimens, in particular males, were more represented in the depth strata <1500 m and the larger sizes, i.e. mainly females, were more numerous in depths over 1500 m (Fig. 14). This is also reflected in the mean length by sexes in both strata. Thus, the mean length of males were 31,54 cm and of females 42,88 cm in depths less than 1500 m, while it was 34,04 cm for males and 43,91 cm for females in depths over 1500 m.

WEIGHT IN RELATION TO LENGTH

Information on weight in relation to length were obtained from cruises in 1993 and in 1997, for a total of 391 specimens, in a length range of 15 to 65 cm. Although there were great sexual differences in the overall average length and average weight (males 32,51 cm and 259 g and females 43,36 cm and 755 g), they occurred mainly for specimens larger than about 50 cm (Fig.15).

RELATION TO TEMPERATURE

Observations on the bottom temperature in which blue antimora was observed in Icelandic waters derived mainly from FAIR-Areas 04 and 05, in the months May to July and October. The overall temperature range was 3,4°C to 5,2°C with one exception in the NW area of Iceland where a temperature of -O,7°C was recorded. Variations according to depth were small yet there was a regional difference in the average temperature. In FAIR -Area O4, i.e. the area west of the Reykjanes Ridge, the average bottom temperature was 3,73°C but in FAIR-Area 05 (east of the Reykjanes Ridge and off south Iceland), it was 4,25°C.

MATURITY

Information on maturity stages of blue antimora was available from cruises in March 1993, June-July 1997 and October 1997. Most of the observations on maturity stages are from June/July (Fig. 16). The mean length for the different maturity stages of blue antimora was as follows:

| mat.stage | I | | II | | IV | |
|---|---|---|---|---|---|---|
| | no | Ml(cm) | no | Ml(cm) | no | Ml(cm) |
| males | 116 | 32,00 | 8 | 44,13 | 4 | 46,00 |
| females | 70 | 35,20 | 79 | 50,76 | 21 | 50,67 |

Immature fish (stage I) was most numerous in June-July but was also present in the other months. Spawning specimens (stage III) were not observed in any of the four months. Newly spent specimens (stage IV) were observed in March and July but not in October while maturing fish (stage II) were well represented in July and particularly, in October. Most of the maturing and of the newly spent specimens were observed in depths over 1400 metres.

The 50% maturity point was reached at a length of 40-43 cm for males and 41-43 cm for females, respectively.

AGE

The otoliths of blue antimora were extremely difficult to interpret. Out of 84 otoliths the readers considered about 50 % absolutely unreadable but full agreement was reached on about 20% of the sample. Nevertheless, this exercise indicates that blue antimora is a relatively slow growing species. The estimated age ranged from 3 years (15 cm) to 23 years (54 cm). Ages 8 to 13 years corresponded to the 30-40 cm length range for the sexes combined. It is obvious that males are much smaller than females at a given age. Thus, for the age of 10 and 11, the difference amounted to 3 to 4 centimetres.

## Discussion

### *Lepidion eques*

The depth distribution of *Lepidion eques* in Icelandic waters, i.e. primarily 500 to 900 metres seems to be somewhat shallower than e.g. in the Rockall Trough from where it is reported to be primarily 750 m to 1000 m depth (Mauchline & Gordon, 1984). The shallower depth distribution of North Atlantic codling in Icelandic waters is probably temperature related. Ellett (1978), reported (in Gordon &Duncan, 1985a) that the temperature on the Hebridean Terrace was 9.5 to 5.5 °C in 500 to 1200 m depth. In Icelandic waters, North Atlantic codling was mainly observed from 6,45 to 4,52°C, in a similar depth range (400 to 1200 m). These differences are even still more pronounced for the area south-east of Iceland where the temperature in the corresponding depths was markedly lower because of the influx of the cold overflow water, also reported by Kotthaus & Krefft (1967). Templeman (1970) reported temperatures of 5.2 and 9.4°C for the area south and south-west of Iceland.

Looking at the distribution chart of *Lepidion eques* one might conclude that the species is not very common on the Reykjanes Ridge. This must not necessarily be the case. North Atlantic codling was obtained as far south as just north of the 57°N

latitude. At the farther part of the ridge, the bottom topography is characterised by an array of underwater mountains and peaks not accessible for bottom trawling. As a matter of fact the whole area is most difficult and actually not suitable for trawling at all. Therefore, most of the hauls taken in this area had to be carried out in much deeper water, i.e. beyond the main habitat of *Lepidion eques*. In times to come additional information will most likely be obtained about abundance of fish species already recorded in this area as well as on deep water species which have escaped our knowledge until now because of the above described difficulties in catching them.

Little is known on early life stages of North Atlantic codling in Icelandic waters. To our knowledge, eggs have not been reported. During the annual O-group surveys, a 79 mm specimen analysed as *Moridae* sp. was recorded at 60°41'N 34°08'W (Magnússon & Sveinbjörnsson, 1991). Specimens smaller than 8 cm have not been caught in bottom trawls,. Considering that pelagic fry of 50-60 mm in size was taken off South Iceland, in 30 m depth over more than 2000 m depth (Sæmundsson,1926), it seems likely that the smallest fish is living pelagically as also suggested by Gordon and Duncan (1985a) and that specimens smaller than 8 cm have not yet reached bottom.

The length distribution of North Atlantic codling at Iceland is similar to that reported from the Rockall Trough (Gordon&Duncan,1985a) but the smallest length groups seem to be more abundant at Iceland than in the area west of Scotland. The smallest fish at Iceland was 8 cm total length, while it was 8 cm standard length off Scotland. Since the smallest length group was observed in somewhat shallower water (Magnússon & Magnússon, 1995) it was not surprising that the mean length of North Atlantic codling increased with increasing depth which was also observed by Mauchline & Gordon, (1980). Sexual differences in the size distribution of the North Atlantic codling were not recorded in the Icelandic material. This was also observed off the west coast of Scotland (Gordon, 1979). Sexual differences in the length-weight relationship were only observed for larger specimens, for both *Lepidion eques* as well as for *Antimora rostrata.*

Spawning females and in particular males were very rare in the trawl catches, a known phenomena for several other deep water species such as the grenadiers (*Macrouridae*) and greater silver smelt (*Argentina silus*). A seasonal reproduction cycle has been reported by Gordon (1979a,1979b) and Krefft (quoted by Templeman, 1970) suggesting spawning in April to May. Our material also indicates a seasonal reproduction cycle but with the spawning already well under way in February and March. There were also indications that some spawning is taking place beyond the main spawning season perhaps year round although the main spawning season seems to be mostly over in May. Considering the maturity stages in general it is striking that not only the spawning fish was rare in the trawl catches but also the relatively low number of males of stage II which indicates that males are even less catchable than females when approaching spawning condition.

Very little has been published about the age of *Lepidion eques*. To our knowledge, Gordon & Duncan (1985a) are the only ones presenting a more detailed overview on this subject. Our exercise on age reading of *Lepidion eques* (Table 3) does not fit very well with that of Gordon & Duncan (1985a, Fig.5). Assuming that the length measurements are given as standard length, the differences in their age estimation of 5 groups are rather great. Also, it is rather unlikely that fish of 10 to 20 cm SL belong to group 0, rather to group I or even to I and II. The discrepancy between the age reading

here presented and that of Gordon & Duncan would be less expressed if their age O to IV could be grouped I to V, even VI.

***Antimora rostrata***

Apparently, no attempts have yet been made to determine the age of *Antimora rostrata* except for the study that Gauldie et al. (1991) have carried out on the structure of the otoliths of this species. They state that the otoliths of *Antimora rostrata* have a very complex shape. However, they pointed out that outside the central opaque zone "there were many narrow closely spaced opaque zones.."(page 17), and that the edge of the central opaque zone counted as 1. As already mentioned before, the age determination on the Icelandic material of *Antimora rostrata* was very difficult. In spite of that it was considered worthwhile to present the results of our exercise.

In spite of the lack of spawning specimens of *Antimora rostrata* in the catches, the occurrence of the other maturity stages might give an indication of a spawning period. In our data, the maturity stages II (ripening) and IV (newly spent) by months might indicate that spawning in Icelandic waters (Reykjanes Ridge and the continental slope west of Iceland) takes place in winter. Especially the advanced ripening specimens in stage II observed in October support this assumption. Information on maturity of blue antimora in the literature is rather scarce. Gordon and Duncan (1985a) did not observe any maturing females in the catches from the Rockall Trough between January and October. Iwamoto (1975) did not have any information on the reproductive phase of the life history of *Antimora rostrata* but he suggested that the species might have a distinct though prolonged spawning season. Wenner and Musick (1977) mentioned only two maturing females in their samples. The lack of maturing specimens has led to theories about migration in connection with feeding and spawning. The observations on the Icelandic material on *Antimora rostrata* do not lead to assumptions on migrations although definite spawning grounds have not yet been located.

The depth in which blue antimora was observed in Icelandic waters ranged from 821 m to 1713 m. The latter one was the depth limit for bottom trawl catches during Icelandic cruises. Compared to other authors reporting from different regions (Mauchline and Gordon 1984, Gordon and Duncan 1985a and 1985b, Gordon 1996) one can expect that blue antimora occurs in greater depths than hitherto reported from Iceland. On the other hand, new records on *Antimora rostrata* from depths shallower than 821 m are rather unlikely because information from depths above 800 m are much more extensive in the Icelandic material. However, Haedrich and Krefft (1978) reported the species in the Denmark Strait in a depth as low as 493 m. Also other authors reported on the species in depths above 500 m. (Iwamoto 1975, Parsons 1976, Snelgrove and Haedrich, 1985).

In Icelandic waters, the species was most abundant in depths greater than 1300 m, i.e. according to our available information on depth distribution. The reports on maximum abundance appears to be different according to region (Wenner and Musick 1977, Gordon and Duncan 1985a and 1985 b, Snelgrove and Haedrich 1985).

Juvenile blue antimora, i.e. fish 20 cm and smaller, have been recorded in the entire Icelandic distribution area of the species but in an average depth of 1289 m which is shallower than observed for adult blue antimora, i.e. 1405 m. A similar observation was also mentioned by Gordon and Duncan (1985a). Lengths larger than 60 cm have also been mentioned by other authors, e.g. Small (1981) and Hareide (1992). The great difference in the overall mean length of males and females of blue antimora has

been reported on by several authors, e.g. Iwamoto (1975), Wenner and Musick (1977), Small (1981), Gordon and Duncan (1985a) and Pohle et al., (1992). Several authors mentioned that males occurred at shallower zones than females, e.g. Wenner and Musick (1977), Gordon and Duncan (1985a). Iwamoto (1975) suggests a sex segregation of the species at larger sizes. Small (1981) reports a segregation by sex and size within depths and Novikov (1970) observed the domination of females in trawl catches as an attribute to segregation of the sexes according to depth. The latter could not be confirmed by our material since males were abundant in both depth strata (<1500 m and >1500 m) although females were much more abundant in the lower depth zone. However, females outnumbered males in the larger size groups in both depth zones. Both sexes showed an increase in the mean length per depth as also observed by e.g. Wenner and Musick (1977).

The range of bottom temperature presented in this paper does not correspond with any of the range given by other authors. Iwamoto (1975) mentions preference of 1,5-4,5°C. Trunov (1992) reports the lower range of -1,5°C on the Antarctic continental slope. Haedrich and Krefft (1978) recorded blue antimora in the Denmark Strait and the Irminger Sea, in 1,3-3,4°C, at depths over 2000 m and in 0,1-3,0°C at depths 493-1519 m. Our temperature range will most probably change with more information on deeper hauls.

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**Table 1.** *Lepidion eques.* Av. temperature (t°C) by depth category. Area: SW to SE Iceland.

| west of 20°W | | | | east of 20°W | | | |
|---|---|---|---|---|---|---|---|
| depth(m) | t° | no.meas. | av.length(cm) | depth(m) | t° | no.meas. | av.length(cm) |
| 200-400 | 7,35 | 9 | 23,78 | 200-400 | 6,50 | 13 | 24,46 |
| 401-600 | 6,45 | 112 | 21,35 | 401-600 | 3,27 | 6 | 26,50 |
| 601-800 | 5,91 | 395 | 27,73 | 601-800 | 2,77 | 9 | 27,55 |
| 801-1000 | 5,04 | 253 | 30,18 | >800 | 3,50 | 46 | 28,22 |
| 1001-1200 | 4,52 | 29 | 30,48 | | | | |
| >1200 | 4,09 | 20 | 33,45 | | | | |
| total obs. | 95 | 818 | | total obs. | 13 | 74 | |
| average | 5,39 | | 28,43 | average | 4,12 | | 25,80 |

**Table 2.** *Lepidion eques.* Maturity stage by depth category.

**A) males**

| | mat. stage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | I | | II | | III | | IV | |
| m | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) |
| <500 | 3 | 27,00 | 3 | 27,00 | – | – | – | – | – | – |
| 501-600 | 20 | 23,45 | 19 | 22,84 | 1 | 35,00 | – | – | – | – |
| 601-700 | 67 | 29,87 | 46 | 28,02 | 9 | 36,78 | – | – | 12 | 31,75 |
| 701-800 | 74 | 28,68 | 51 | 26,69 | 4 | 34,00 | – | – | 19 | 32,89 |
| 801-900 | 95 | 31,27 | 43 | 28,44 | 23 | 32,65 | 1 | 37,00 | 28 | 34,46 |
| 901-1000 | 39 | 31,23 | 26 | 29,65 | 6 | 35,00 | – | – | 7 | 33,86 |
| 1001-1100 | 15 | 29,53 | 14 | 29,14 | 1 | 35,00 | – | – | – | – |
| 1101-1200 | 9 | 35,90 | 1 | 33,00 | – | – | – | – | 8 | 36,13 |
| >1200 | 5 | 37,60 | 3 | 37,67 | 2 | 36,50 | – | – | – | – |

**B) females**

| | mat.stage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | I | | II | | III | | IV | |
| m | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) | no. | ml(cm) |
| <500 | 3 | 24,67 | 2 | 23,00 | 1 | 28,00 | | | | |
| 501-600 | 110 | 26,89 | 53 | 23,50 | 54 | 29,90 | – | – | 3 | 32,67 |
| 601-700 | 71 | 29,46 | 41 | 27,41 | 19 | 32,84 | 3 | 33,67 | 8 | 30,38 |
| 701-800 | 73 | 29,66 | 49 | 27,18 | 16 | 35,56 | 1 | 30,00 | 7 | 33,43 |
| 801-900 | 91 | 30,52 | 43 | 28,47 | 29 | 32,10 | 3 | 33,00 | 16 | 32,69 |
| 901-1000 | 30 | 31,40 | 15 | 29,40 | 6 | 33,83 | – | – | 9 | 33,11 |
| 1001-1100 | 8 | 30,63 | 6 | 29,83 | – | – | – | – | 2 | 33,00 |
| 1101-1200 | 14 | 29,64 | 7 | 27,29 | 6 | 31,83 | 1 | 33,00 | – | – |
| >1200 | 5 | 36,20 | 2 | 33,50 | 3 | 38,00 | – | – | – | – |

**Table 3.** *Lepidion eques.* Age- length key for sexes combined.

| Length | Age(years) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (cm) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | total |
| 11 | 1 | | | | | | | | | | | | 1 |
| 12 | 2 | | | | | | | | | | | | 2 |
| 15 | | 2 | | | | | | | | | | | 2 |
| 16 | 1 | 2 | | | | | | | | | | | 3 |
| 17 | | 3 | | | | | | | | | | | 3 |
| 18 | | 3 | 2 | | | | | | | | | | 5 |
| 19 | | 3 | 7 | | | | | | | | | | 10 |
| 20 | | | 2 | 1 | | | | | | | | | 3 |
| 21 | | | 1 | 6 | | | | | | | | | 7 |
| 22 | | | 1 | 17 | 3 | | | | | | | | 21 |
| 23 | | | | 3 | 12 | | | | | | | | 15 |
| 24 | | | | 1 | 20 | 1 | | | | | | | 22 |
| 25 | | | | | 9 | 9 | | | | | | | 18 |
| 26 | | | | | 5 | 6 | 1 | | | | | | 12 |
| 27 | | | | | | 15 | 8 | | | | | | 23 |
| 28 | | | | | | 9 | 12 | 1 | | | | | 22 |
| 29 | | | | | | 4 | 26 | 3 | 1 | | | | 35 |
| 30 | | | | | | | 12 | 10 | | 1 | | | 23 |
| 31 | | | | | | | 7 | 7 | 7 | | | | 21 |
| 32 | | | | | | | 2 | 16 | 4 | 2 | | 1 | 25 |
| 33 | | | | | | | 1 | 6 | 4 | 2 | | | 13 |
| 34 | | | | | | | | 1 | 2 | 2 | | | 5 |
| 35 | | | | | | | | | | 4 | 1 | | 5 |
| total | 4 | 13 | 13 | 28 | 50 | 44 | 69 | 44 | 18 | 11 | 1 | 1 | 296 |
| $L_m$ | 12,75 | 17,23 | 19,38 | 21,89 | 23,54 | 26,77 | 29,07 | 31,27 | 31,89 | 33,45 | 35,00 | 32,00 | 26,74 |

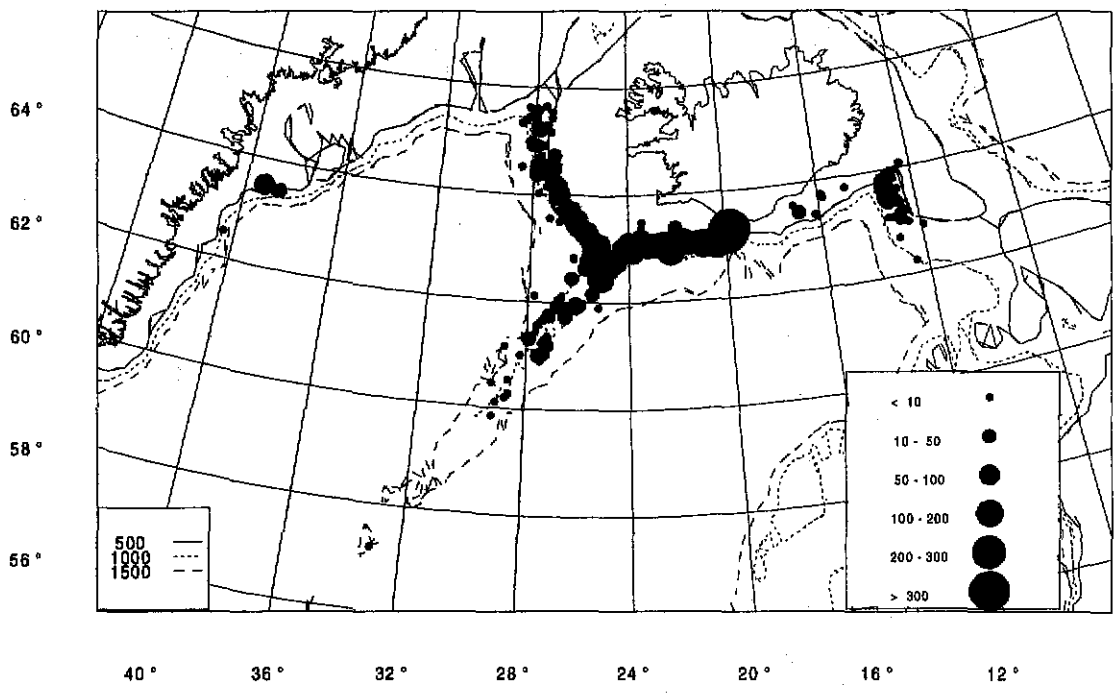


**Figure 1.** *Lepidion eques.* Distribution and relative abundance in Icelandic waters. based on research vessel catches in number per haul (each haul approximately 3.8-4.0 nautical miles).

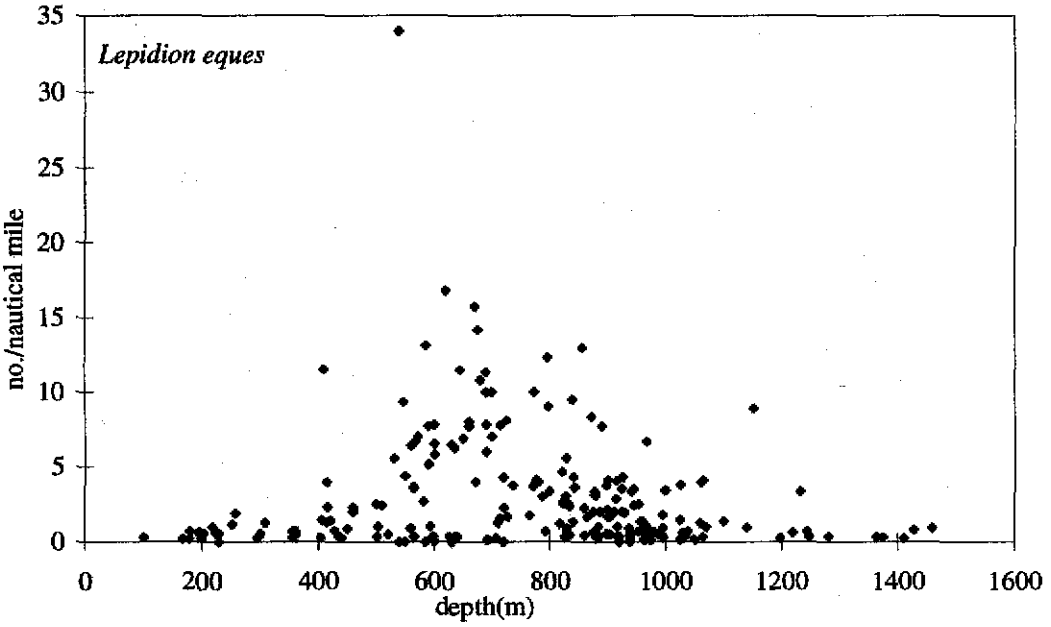


**Figure 2.** *Lepidion eques.* Catch in number/nautical mile by depth

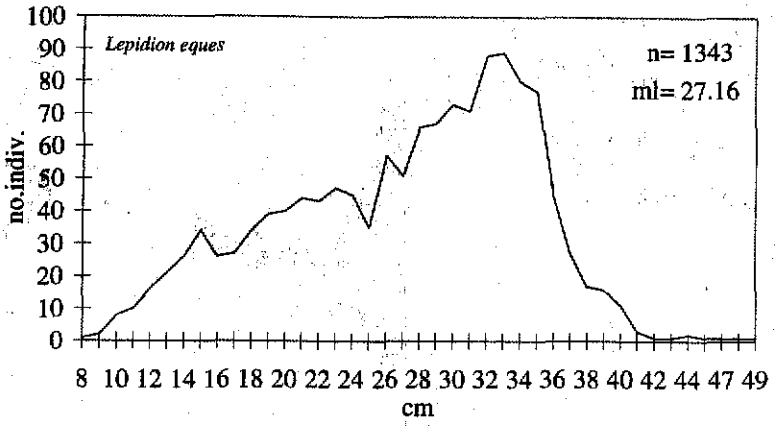


**Figure 3.** *Lepidion eques*. Overall length distribution

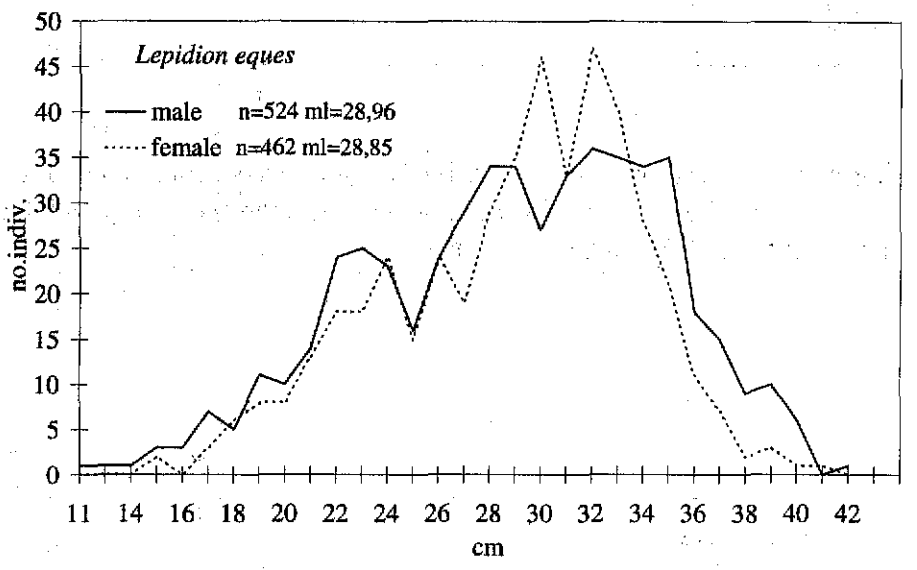


**Figure 4.** *Lepidion eques*. Length distribution by sex

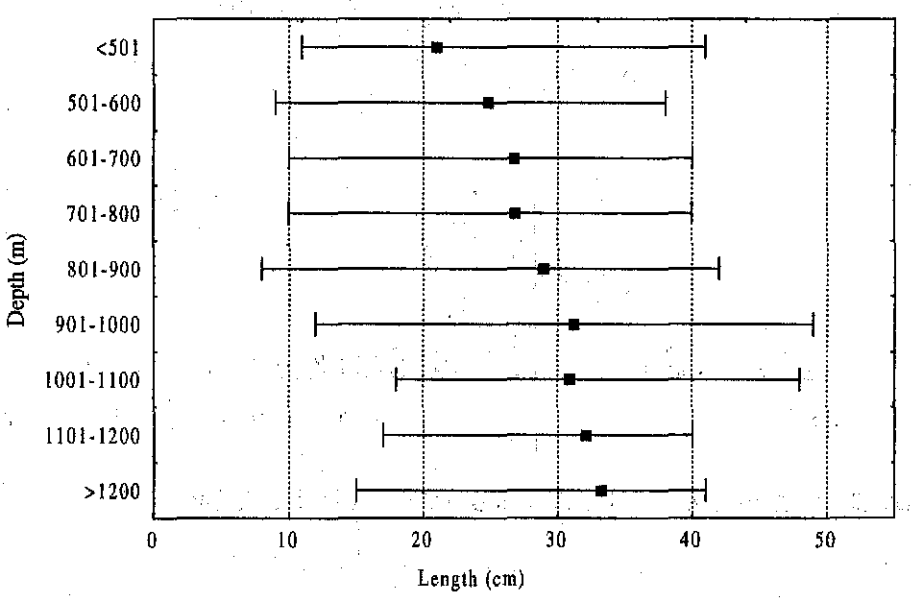


**Figure 5.** *Lepidion eques*. Mean length and length range by depth category. Based on bottom trawl catches.

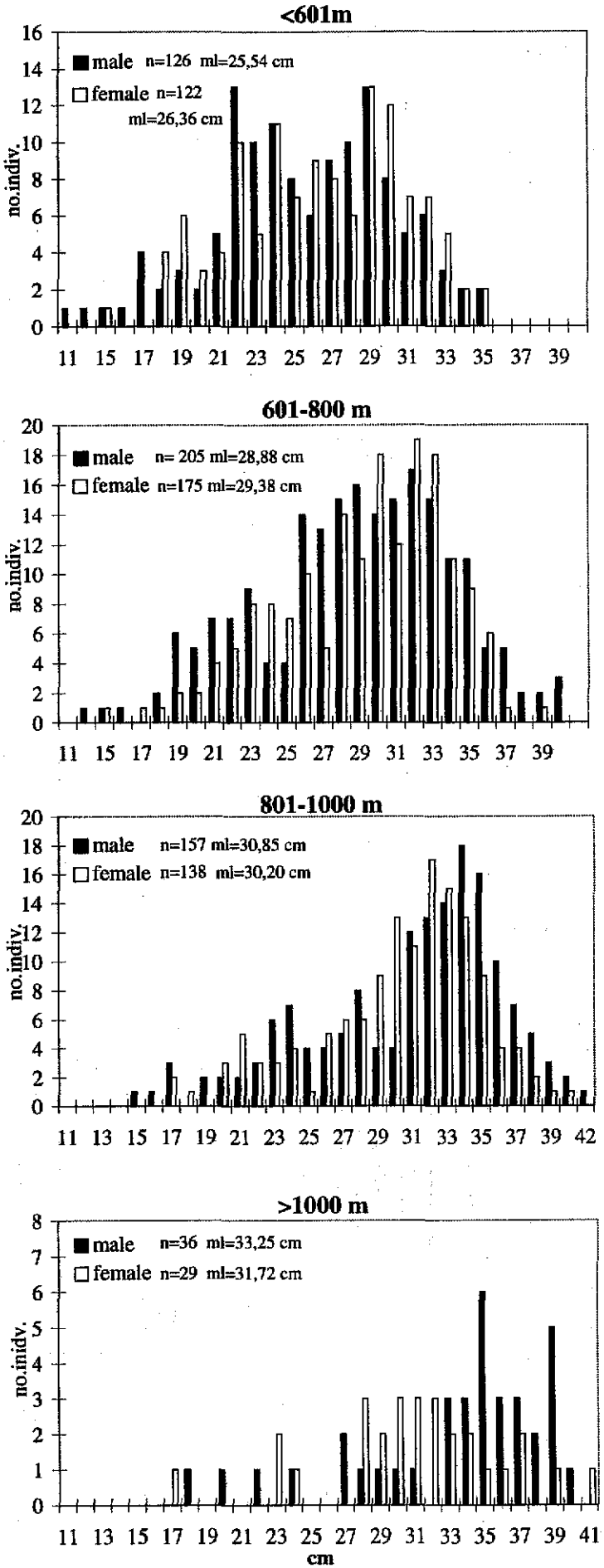


**Figure 6.** *Lepidion eques.* Length by depth category and sex.

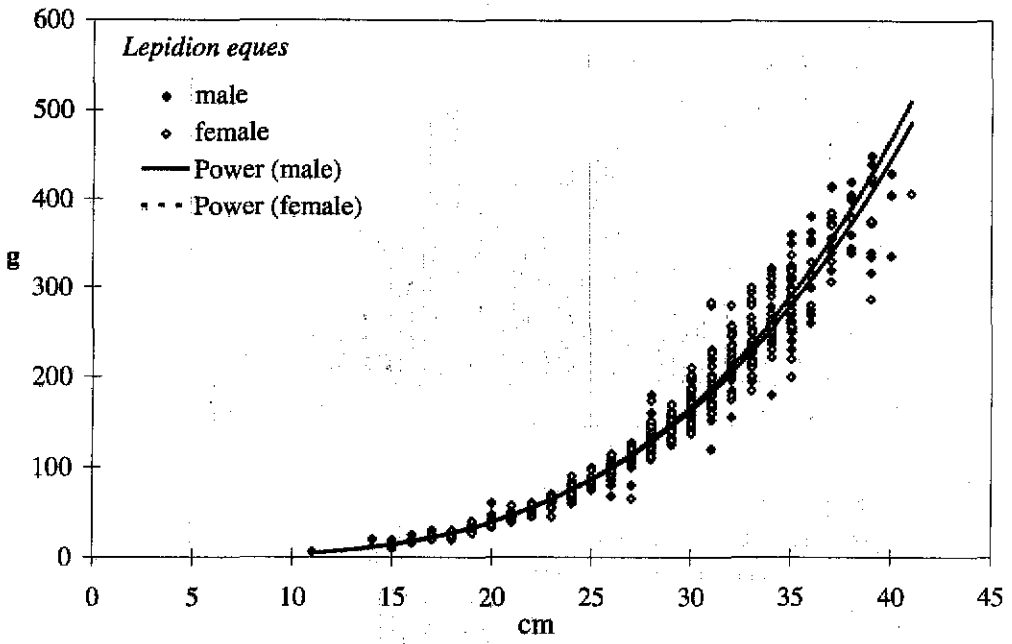


**Figure 7.** *Lepidion eques.* Length-weight relationship by sex.
Males: W=0,0011x $TL^{3,4975}$ $r^2$=0,9749. Females: W=0,0008x$TL^{3,5853}$ $r^2$= 0,9687.

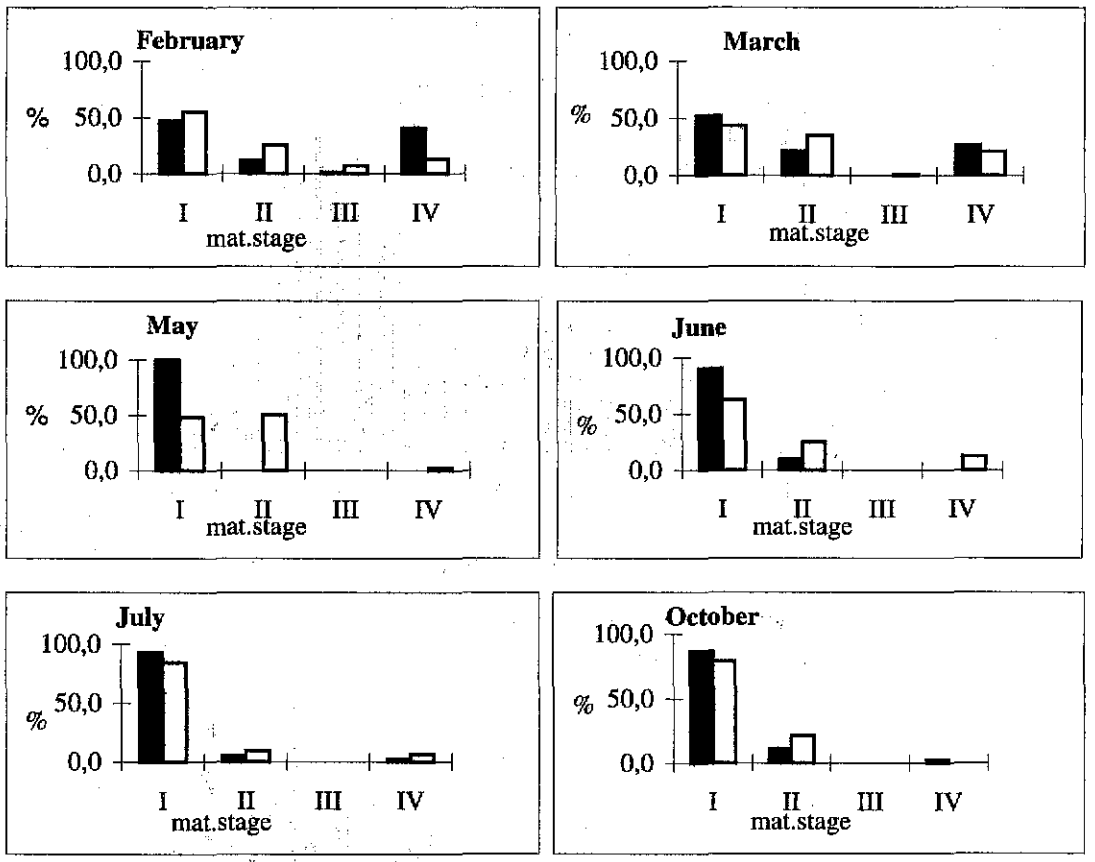


**Figure 8.** *Lepidion eques.* Maturity stages by sex and month. Solid bars, males; open bars, females.

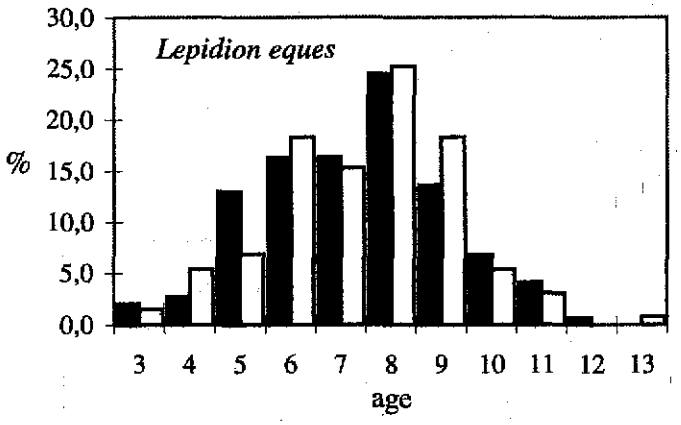


**Figure 9.** *Lepidion eques.* Age composition by sex, in pooled aged samples 1982-1997.Solid bars, males; open bars, females.

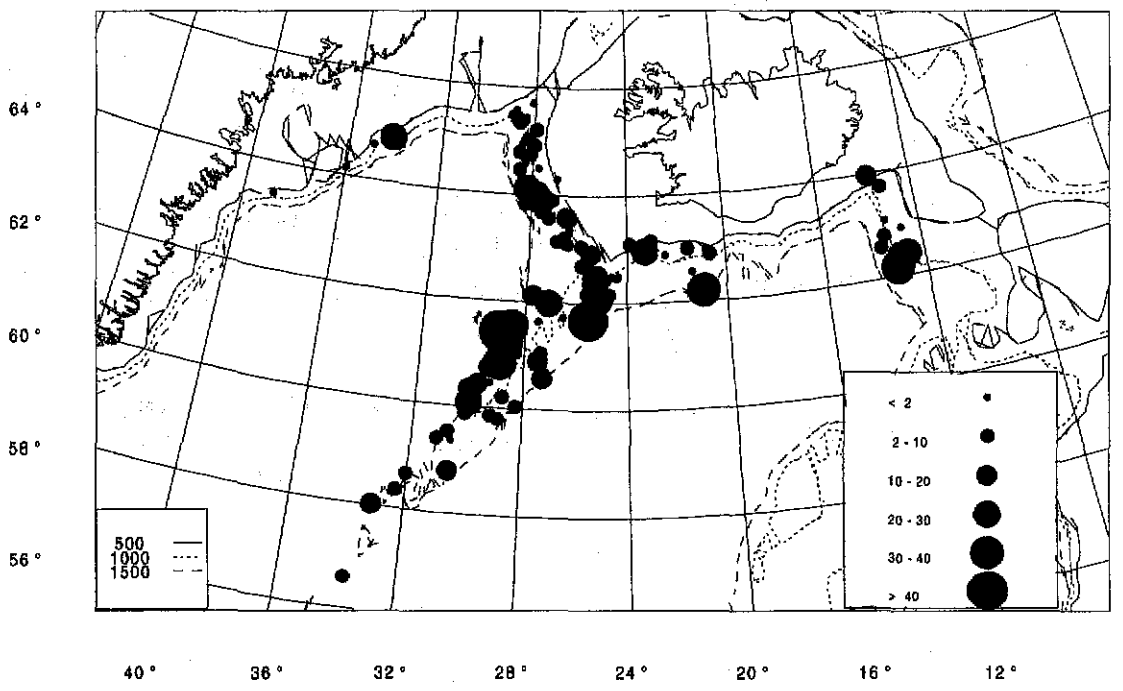


**Figure 10.** *Antimora rostrata.* Distribution and relative abundance in Icelandic waters. Based on research vessel catches in number per haul (each haul approximately 3.8-4.0 nautical miles)

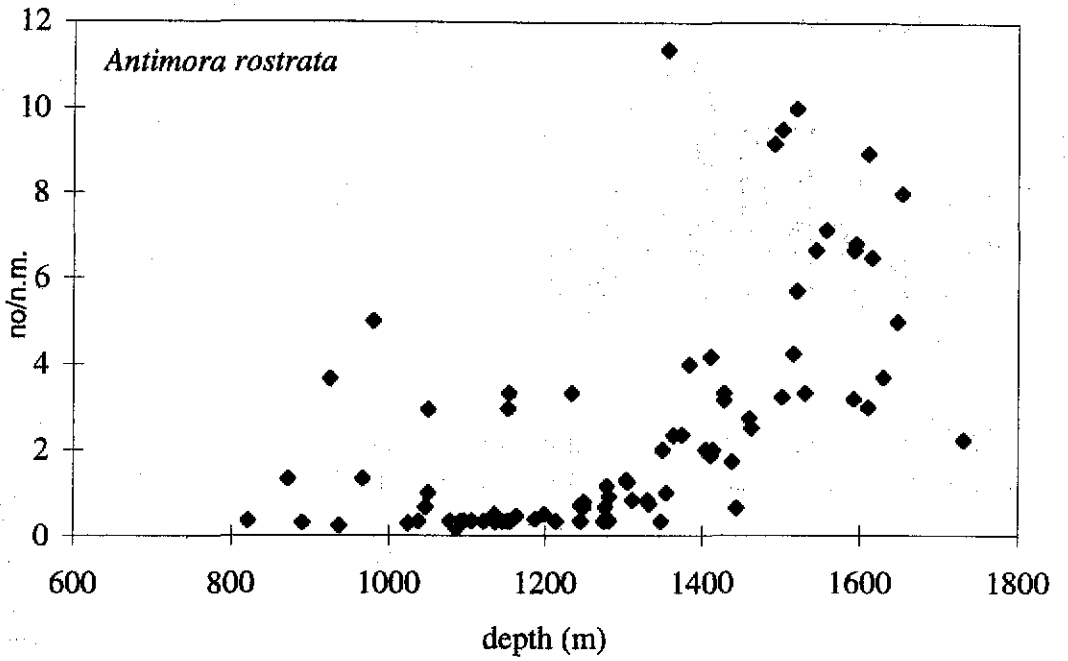


**Figure 11.** *Antimora rostrata.* Catch in number/nautical mile by depth.

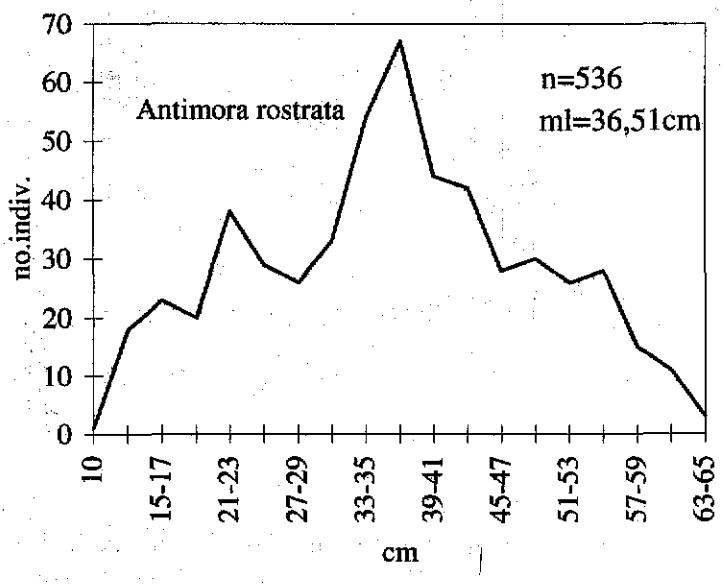


**Figure 12.** *Antimora rostrata.* Overal length distribution.

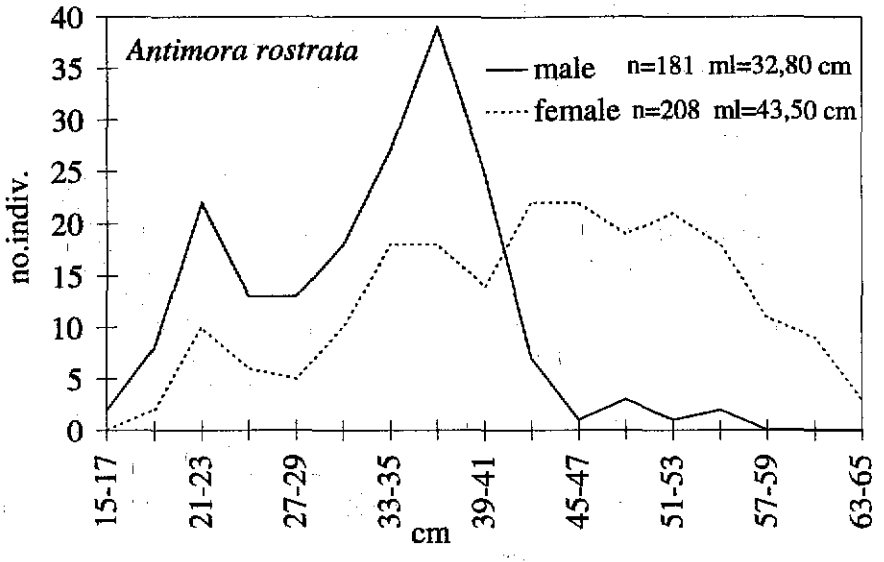


**Figure 13.** *Antimora rostrata.* Length distribution by sex.

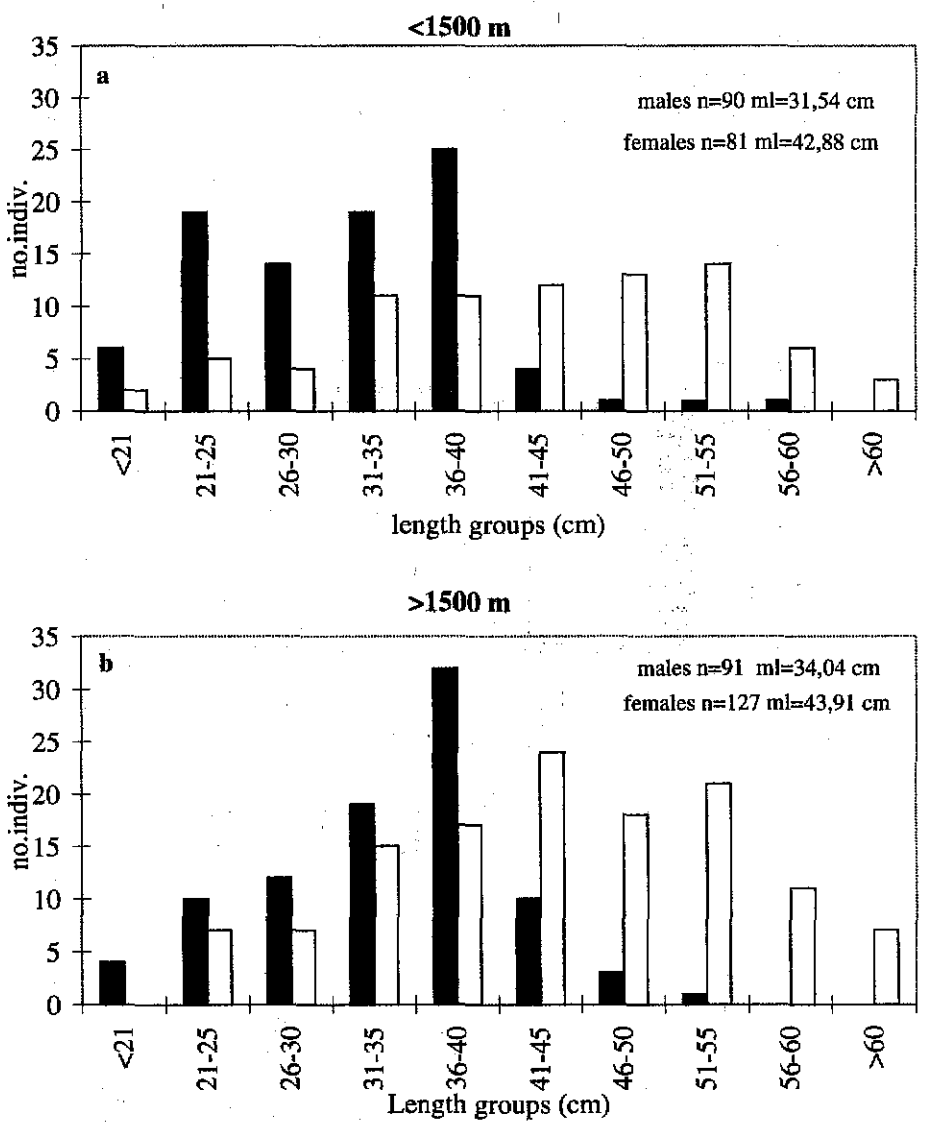


**Figure 14.** *Antimora rostrata.* Length distribution by depth category. Based on bottom trawl catches. Solid bars, males; open bars, females. a: <1500 m, b:>1500 m depths.

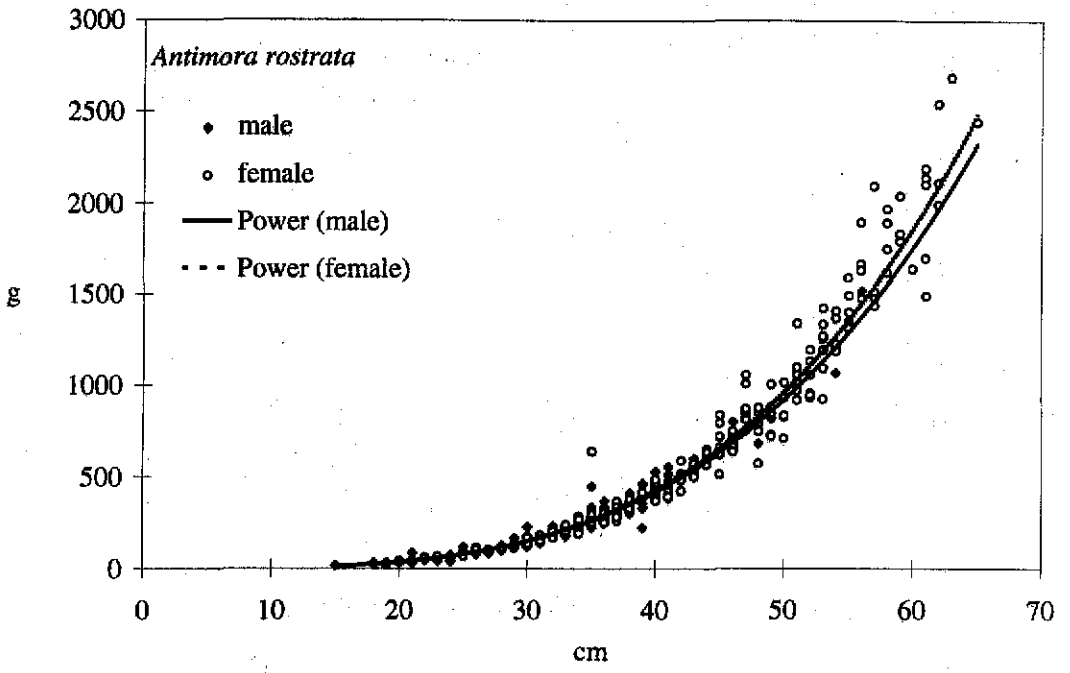


**Figure 15.** *Antimora rostrata.* Length-weight relationship by sex.
Males: $W=0{,}001 \times TL^{3{,}5187}$ $r^2= 0{,}9703$.
Females: $W=0{,}0007 \times TL^{3{,}6053}$ $r^2= 0{,}9829$.

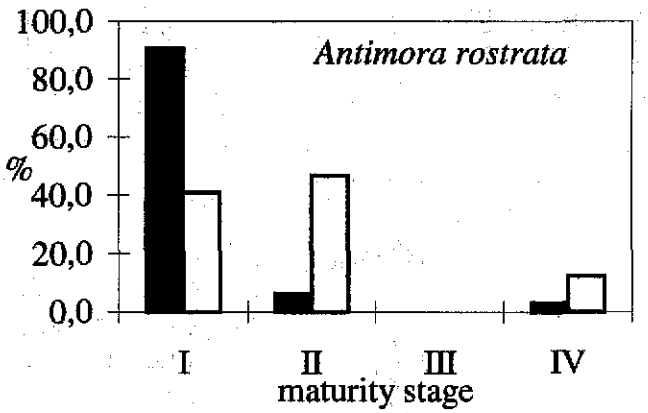


**Figure 16.** *Antimora rostrata.* Maturity stages by sex. Solid bars, males; open bars, females