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OBSERVATIONS ON WHELK POPULATIONS (*BUCCINUM UNDATUM* L., MOLLUSCA; GASTROPODA) IN BREIÐIFJÖRÐUR, WESTERN ICELAND

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ABSTRACT

The common whelk *Buccinum undatum* L. is abundant in shallow waters around Iceland. Catch experiments were done with baited traps at 12 stations in Breiðifjörður, W-Iceland. Catches of up to 4.3 $kg \cdot trap^{-1} \cdot day^{-1}$ were taken and numbers up to 178 $snails \cdot trap^{-1} \cdot day^{-1}$. The smallest snails caught had shell height of about 20 mm and the modal sizes were of 40 to 80 mm. Only few snails larger than 90 mm were caught. Size at 50% sexual maturity differed between sites and varied between 45 and 75 mm shell height. Age determinations indicate that the animals grow relatively fast during the first 5-6 years after which the growth is slow. The oldest snails were at the age of 13 years.

INTRODUCTION

The whelk *Buccinum undatum* L. is a common species in the North Atlantic and in the Arctic sea. It is found from Spitzbergen in the north to Spain in the south on the European side and to the border between Canada and USA on the American coast (Golikov 1968). Although whelk is most abundant in the shallow sublittoral zone it has been recorded from the littoral zone and down to a depth of more than 200 m (BIOICE unpublished). It occurs on both soft and hard substratum (Jalbert *et al.* 1989). The whelk has internal copulation and the females glue the egg masses to the substratum, preferably on hard substratum (Martel *et al.* 1986). Larval stages develop inside the egg capsules before hatching and the snails start their benthic life without planktonic larva. Tagging experiments have shown that the movement of the whelk is very limited (Govanlock 1926, Hancock 1963). Exchange between closely situated populations is therefore probably limited which could explain the fact that growth, size and age at sexual maturity can differ significantly from one populations to another (Gendron 1992).

The whelk has for a long time been exploided in Europe, mostly in the British Isles, Holland and Belgium (Hancock 1967). In the eighties however the largest catches were

taken in France (Santerelli *et al.* 1986). According to FAO statistics the three countries with the highest whelk catches in 1993 were Ireland, England (including Wales) and France with 2,562, 1,898 and 996 tonns respectively (FAO fisheries statistics 1995). Whelks are also taken in eastern Canada where the catches reached 1,300 tonns in the 1987 (Gendron 1991).

In Iceland whelk has been found in all parts of the country (Óskarsson 1962). In ancient times whelk was subject to local fishing and used as bait in hand line fishing for cod (Kristjánsson 1980). Recently interest has developed for catching whelk for food. Very limited knowledge is available on the biology of whelk in Iceland. The present paper describes the results of a survey we made on whelk in West Iceland in 1993.

MATERIAL AND METHODS

Sampling: Whelks were sampled with baited traps at 12 localities in the bay Breiðifjörður, Western Iceland (fig. 1) in May and September 1993. All stations are in sheltered sites except one, Lágmúli 40 m which is at an exposed site in the outer part of the bay. The depth at the sampling sites varied from 8 to 40 m. Four types of baited traps were used in the survey, three were made of a net with 2 cm mesh size fitted on a wire frame, pyramidal, conical and cylindrical in shape. The fourth type was made of perforated plastic pipes (holes 1 cm in diameter), 20 cm in diameter and 90 cm in length with plastic funnels fitted at the openings. All traps were about 30 l in volume. The traps were tied to a string, 6 to 10 together with an interval of 10 m. Fresh herring was used as bait and the traps were taken up after 24 hours on the bottom.

Measurements: In the field the total weight to the nearest 0.1 g of the individual whelks was determined and the height of the shell measured with a vernier caliber to the nearest 0.1 mm. The shell was then cracked with pliers and removed. The total weight of the soft tissue was determined and for the males the length of the penis was measured to the nearest 0.1 mm. Thereafter the animals were fixed in 10 % formalin in sea water. In the laboratory the animals were washed in sea water and the following parts were weighted after dissecting the animals: for the females the gonads and the capsular gland, and for the males the testis. At the onset of sexual maturity the penis length increases rapidly and its length becomes more than half the height of the shell. Male whelks with penis length of more than half the height of the shell have been classified as mature and those with a shorter penis as immature (Hancock 1962, Köie 1969).

The age of the whelk was determined by counting concentric rings in the operculum after staining them with methylene blue for better discrimination of growth zones (Santerelli and Gros 1985, Gendron 1992). A Von Bertalanffy growth curve is fitted to

the data

$$H_t = H_\infty [1-e^{-k(t-t_0)}],$$

where H_t is shell height at age t, H_∞ the asymptotic maximum shell height and k is the growth constant.

RESULTS

Catches

Whelk was the dominant species in the traps, accounting for more than 90 % of the catch. Other species caught included spider crabs (*Hyas araneus*), hermit crabs (*Eupagurus bernhardus*), the conch *Neptunea despecta*, short spined sea scorpion (*Myoxocephalus scorpius*) and juvenile cod (*Gadus morhua*). The catch at each locality varied from 17 to 416 whelks and the mean catch varied between 3 and 52 per trap, with weight varying between 60 and 860 g average catch per trap (table). Catches of up to 4.3 kg per trap per 24h were taken with numbers up to 178 snails per trap per 24h. On the average the largest catches were taken at "Sviðnur" at 18 m depth i.e. 863 g per trap per 24 h. When comparing pairs of localities close to each other, but differing in depth, bigger catches were always taken at greater depth. This was statistically significant in two cases at "Staður" 18 vs 10 m depth and at "Sviðnur" at 18 vs 8 m (Student's t-test $p<0.05$, see table 1).

Size frequency

No animals smaller than 16 mm were caught in the traps and very few were smaller than 35 mm. The largest animal was 104 mm in shell height. The size distribution in the catches varied from locality to locality (fig. 2). The distribution of shell height was either unimodal (e.g. "Staður",18 m and "Sviðnur" 18 m) or as was most often the case, multimodal, with modes in the interval from 40 to 80 mm shell height. The mean size of the whelks in the catches varied from 50 mm to 63 mm (table 1).

No significant difference was found in the height-weight relationship between localities. The relationship between the two parameters is shown in figure 3 for all stations together. A highly significant relationship was observed between the two parameters.

Sexual maturity

There is a marked seasonal variation in the size of gonads in the whelk (Martel *et al.* 1986). In the present study the size of the gonads were found to be very variable. The use of the gonads to determine sexual maturity proved to be impossible from these samples as the time of spawning is not known and it is impossible e.g. to tell whether an animal with small gonads is immature or just spent.

In general the length of the penis of the male whelks increased slowly with increase in shell height while the whelks were small (fig. 4). Then there was a rapid increase in the length of the penis and its length became more than half the shell height. This was true for all station except the most exposed one, Lágmúli at 40 m. At Lágmúli the penis length only reached about 1/3 the shell height after the rapid growth and would therefore be considered immature by the criteria adopted. Non of the animals at Lágmúli had developed gonads which indicates that these males were actually immature. The inflexion point i.e. the shell height at which 50% of the males (in 5 mm height intervals) have passed this fast growth period, and hence are sexually mature, varies from locality to locality. The range was from 45-50 mm penis length at sexual maturity at Staður 18 m to over 75 mm at Miðjanes 10 m (table 1).

Age and growth

The annual growth zones of the operculum of whelk are often hard to distingish. A number of secondary zones make determination of actual age difficault. Figure 5 shows the relationship between shell height and age of animals selected because of relatively clear growth rings. Growth was relatively fast until the age of 5 years when the average shell height was about 55 mm. After 5 years the growth slowed down and the average shell height of 10 year old whelks was about 65 mm. The oldest snail examined was at the age of 13 years.

DISSCUSSION

Although the traps used could catch up to 4.3 kg after 24 h immersion the average catch was always well below 1 kg. This does not necessarily mean that the survey area is unproductive in terms of whelk. The sampling stations were chosen without any prior knowledge of the area. Later experimental fishing in the area has given much higher catches (Gunnarsson and Einarsson, unpublished results).

The fact that only very few whelks less than 35 mm in shell height, which corresponds to about 17 mm shell width, were caught by the traps, indicates that smaller snails are not attracted by the traps to the same degree as the larger ones. Jalbert *et al.* (1989) have shown that the smallest whelks prefer different habitat than larger ones, possibly because of difference in dietary preference (Nielsen 1975). In addition small

whelks that are found in the lower littoral zone are usually found in rock crevises and under stones (Gunnarsson personal observations), probably escaping predation. The cryptic habit might prevent the small snails from exposing themself by moving over a large distance to seek food in the traps.

Hancock and Simpson (1962) and Köie (1969) have shown that the penis length increases rapidly at the onset of sexual maturity and its length becomes more than half the height of the shell. This rapid increase in penis size coincides with the development of reproductive tissue in the males (Hancock and Simpson 1962, Gendron 1992). In France Santerelli and Gros (1986) found size at sexual maturity of 55 mm for both males and females using gonado-somatic indices. In Britain a similar size at sexual maturity is given by Hancock and Simpson (1962). In Breiðifjörður the increase in the size of the penis happened at a shell height that differs from one locality to another. The size at 50 % sexual maturity varies from 45 to 80 mm between localities. In the Gulf of St. Lawrence in Canada Gendron (1992) has equally shown that there is a variation in the size at sexual maturity between populations ranging from 49 to 81 mm.

It has been proposed to use size at sexual maturity for regulating the fisheries, and to set the minimum catchable size of the snails at a size that secures that some reproductive animals are left in the population (Gendron 1992). As the size at sexual maturity in Breiðifjörður differs from one locality to another the minimum catchable size have to vary between fishing areas even between areas that are close together. Using a compromis of an average size for larger areas, one would risk that some of the local populations would be driven to extinction.

The growth of whelks in Breiðifjörður was relatively rapid to the age of 5, after which it slowed down and the size at 10 years was on the average 65 mm. The largest individual caught in the survey was 104 mm in shell height and was 13 years of age according to the number of growth zones in the operculum. In France the size of the whelks is similar to that found in Iceland (Santerelli and Gros 1985). The average height of the whelk at 5 years in France was 57.1 mm but the growth after the age of 5 seemed to be faster as whelks at the age of 9 have reached 78.7 mm in France compared to about 65 mm in Iceland.

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Table 1. Population parameters measured for whelk in Breiðafjörður.

Locality	n	Mean numbers				Shell height at 50% maturity (mm)
		Catch pr. trap weight (g)	number pr.trap	Shell height (mm)	Shell weight (g)	
1 Staður 10 m	43	165	6.1	61.3	26.9	70-75
2 Staður 18 m	268	578	51.8	49.5	12.8	45-50
3 Sviðnur 8 m	83	220	9.2	60.8	25.1	55-60
4 Sviðnur 18 m	277	863	34.6	61.2	24.9	65-70
5 Mulanes 8 m	62	169	7.5	61.5	21.8	60-65
6 Mulanes 18 m	119	400	14.9	62.8	26.9	70-75
7 Hnallar 18 m	144	207	13.1	49.9	15.4	55-60
8 Flikrusker 18 m	22	65	3.7	50.5	17.6	60-65
9 Hrappsey 10 m	98	290	14.7	53.2	18.8	55-60
10 Miðjanesvík 10 m	63	223	9	58.5	25.2	75-80
11 Sandsker 20 m	40	74	4	52.8	18.5	70-75
12 Lágmúli 40 m	178	364	22.3	49.6	11.9	55-60

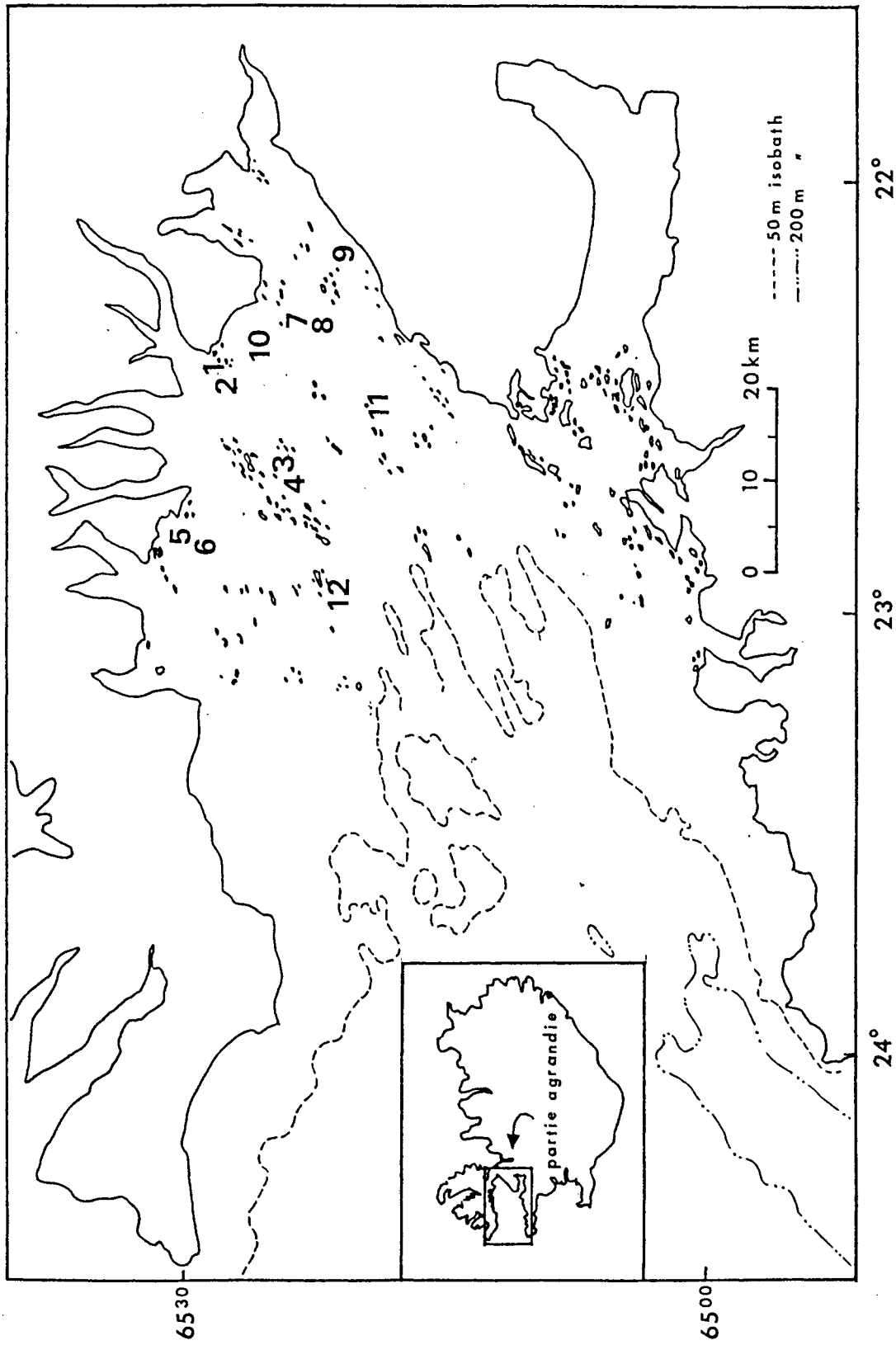

Figure 1. Sampling localities in Breiðifjörður Western Iceland, The numbers refer to sampling localities as listed in table 1.

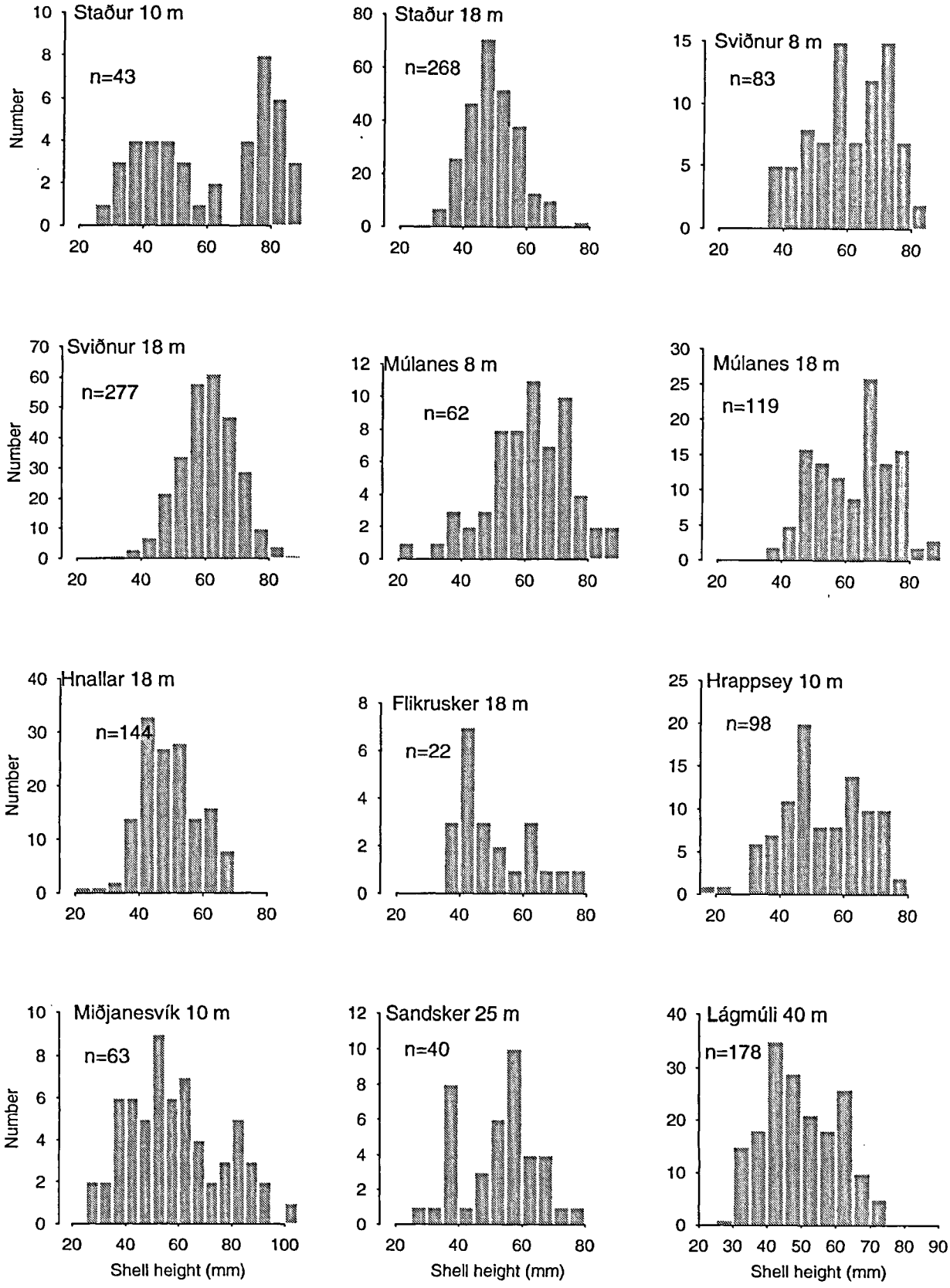

Figure 2. Size distribution of whelk in the 12 sampling localities in Breiðifjörður.

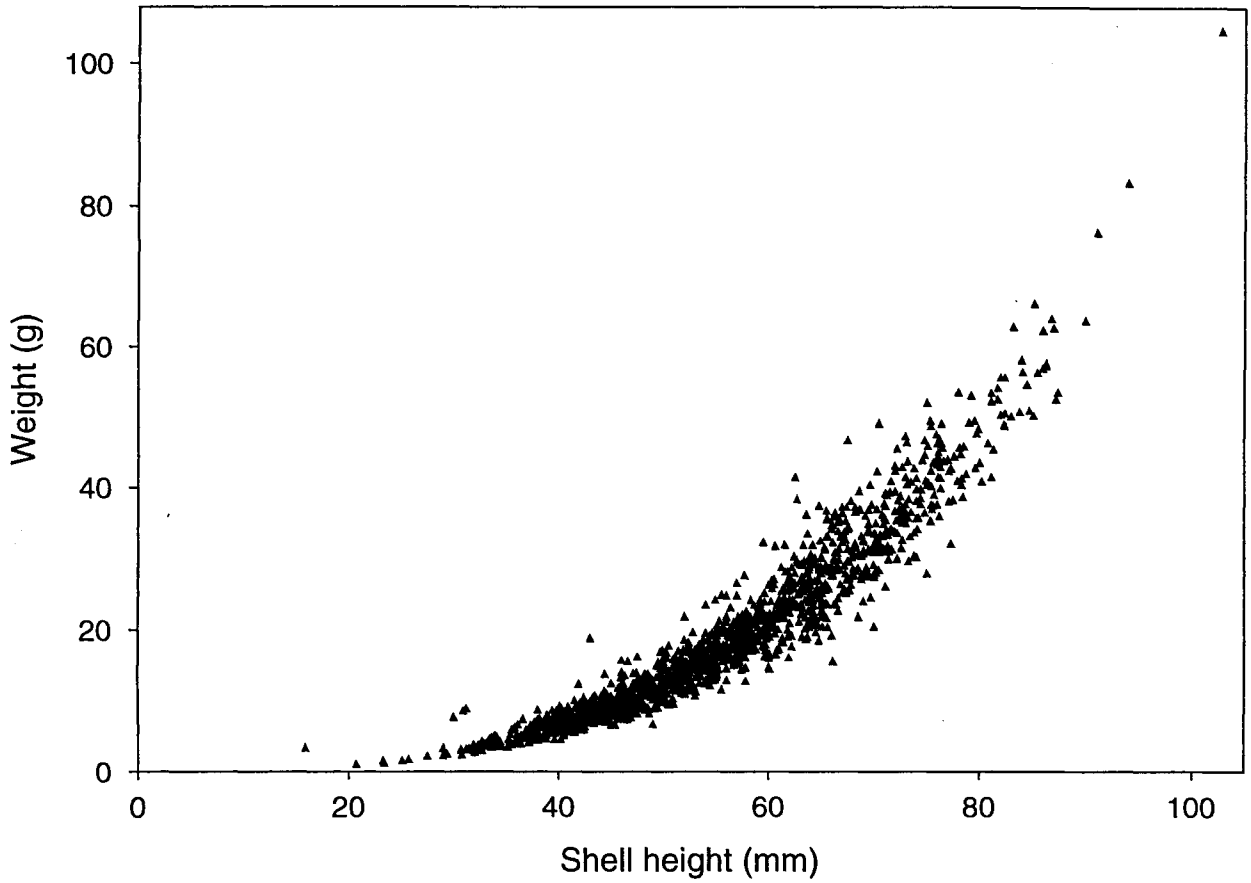

Figure 3. Shell height - weight relationship of whelk in Breiðifjörður. All samples.

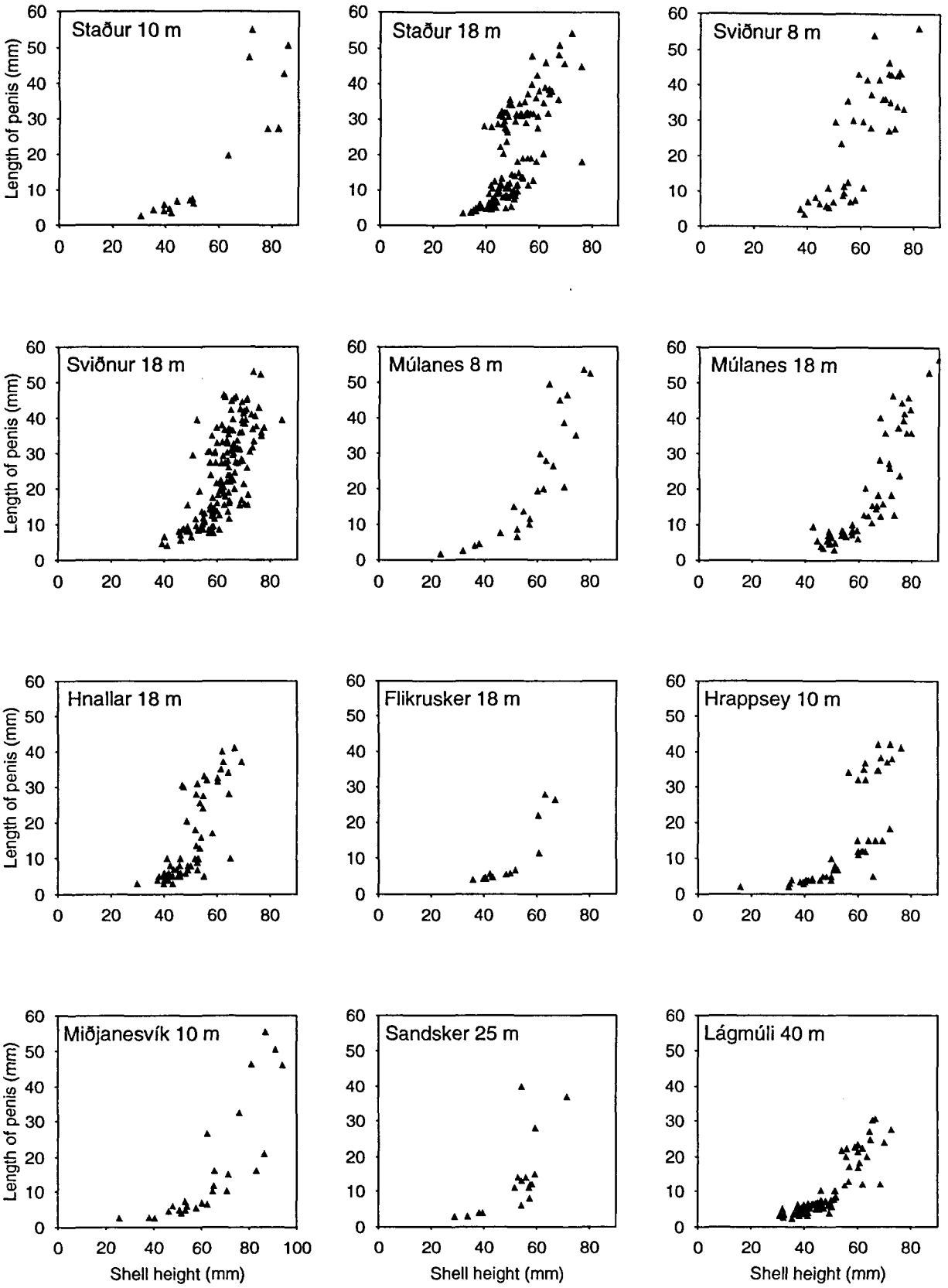

Figure 4. Size of penis in relation to shell height of whelk in the 12 sampling localities in Breiðafjörður.

Figure 5. Relationship between shell height and age of whelk at Hnallar 18 m in Breiðifjörður. A von Bertalanffy growth curve is fitted to the data.