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# Overview of yield per trap and shell height at sexual maturity for waved whelks, *Buccinum undatum*, caught on the east coast of New Brunswick - 1992.

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## ABSTRACT

Lanteigne, M. and L.A. Davidson, 1992. Overview of the yield per trap and shell height at sexual maturity for waved whelk, *Buccinum undatum*, caught on the eastern coast of New Brunswick - 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1896: 23 p.

Commercial fishing trials for the waved whelk (*Buccinum undatum*) were conducted on the east coast of New Brunswick during the month of July 1992. These trials were monitored closely by observers on board fishing vessels and by sampling the catches.

The fishing trials showed poor catches. The low yields per trap estimated from the data collected during the sea sampling do not justify the creation of a directed fishery at this time.

Analysis on preserved whelk samples was conducted to determine the size at sexual maturity. The gonosomatic indices and the penis length/shell height ratios for the males suggested that male sexual maturity is reached at sizes ranging from 50mm to 60mm. Determination of the size at sexual maturity for the females was not possible as sampling was conducted after the spawning period, when the ovaries are empty, and it was impossible to distinguish between immature and mature females using the gonosomatic indices.

The results of monitoring the experimental whelk fishery are discussed to highlight the important elements when structuring and implementing a management plan for whelk populations in the southern Gulf of St. Lawrence.

Key words: Waved whelk; *Buccinum undatum*; fishery; catches; size at sexual maturity.

## RÉSUMÉ

Lanteigne, M. and L.A. Davidson, 1992. Overview of the yield per trap and shell height at sexual maturity for waved whelk, *Buccinum undatum*, caught on the eastern coast of New Brunswick - 1992. Can. Tech. Rep. Fish. Aquat. Sci. 1896: 23 p.

Des essais d'exploitations commerciales du buccin commun du nord (*Buccinum undatum*) ont été conduits sur la côte est du Nouveau-Brunswick, au cours du mois de juillet 1992. Ces essais ont été suivis de près par des observateurs en mer et par la mise en place d'un programme d'échantillonnage des captures.

Les essais de pêche ont présenté des captures médiocres. Les faibles rendements par casier, calculés à partir des données récoltées lors de l'échantillonnage en mer, ne sont présentement pas adéquats pour justifier la mise en place d'une pêcherie commerciale dirigée vers cette espèce.

Des analyses ont été conduites sur des échantillons de buccins afin de déterminer leur taille à maturité sexuelle. Chez les mâles, les indices gonosomatiques et les ratios longueur du pénis/hauteur de coquille permettent de suggérer une taille à maturité sexuelle variant entre 50mm et 60mm. Cependant, les résultats n'ont pas permis de déterminer la taille à maturité sexuelle des femelles. Puisque l'échantillonnage a été conduit après la période de ponte, lorsque les ovaires sont vides, il était impossible de discerner entre les femelles immatures et matures en utilisant les indices gonosomatiques.

Les résultats du suivi des essais de pêche sont discutés afin de mettre en lumière des éléments importants à considérer lors de l'ébauche et de la mise en place d'un plan de gestion pour les populations de buccins dans le sud du golfe du Saint-Laurent.

Mots-clés: Buccin commun du nord; *Buccinum undatum*; pêcherie; captures; taille à maturité sexuelle.

## INTRODUCTION

The waved whelk, *Buccinum undatum* in the Gulf of St. Lawrence is fished mainly along the coastal regions of Québec. Gendron (1991) reviewed the historical landings for all coastal areas in that province and showed that, in comparison, the quantity and landed value of the Québec whelk fisheries are presently low. The landings fluctuated between 150 t and 650 t in 1975 to 1990 (except in 1987 when 1300 t was landed). The current fishing activities are sporadic and only provide a supplementary income to the participating fishermen.

The interest to develop a whelk fishery in the Gulf of St. Lawrence has always existed despite the numerous problems identified in the Québec fisheries. Many coastal fishermen in the Atlantic provinces (New Brunswick, Newfoundland, Prince Edward Island and Nova Scotia) have requested that a whelk fishery be developed and organized. Following these requests a program to develop the whelk fisheries on the east coast of New Brunswick was presented in 1992. Due to the lack of quantitative information on the N.B. whelk populations and attempting to insure adequate resource management, a provisional management plan was established which stipulated a minimum capture size of 75 mm. This restrictive management plan was developed based on results presented by Gendron (1991) who studied northern whelk populations in the Gulf of St. Lawrence.

There is little information available on the exploitable biomass and the population dynamics of the whelk found along the coast of N.B. It was deemed prudent to collect data on the biology and the fishery of this species to not only verify the effectiveness of the provisional management plan but eventually improve upon it. Data collection was possible through a project to monitor the fishery and sample the commercial catches. The objectives of the project were:

1) to determine the size when the whelk reaches sexual maturity to insure the imposed minimum catch size of 75 mm (shell height) protects the broodstock.

2) obtain a general overview of the commercial catch and yield.

This report presents the results of the monitoring project and the implications of a resource management strategy.

## MATERIAL AND METHODS

### SEA SAMPLING

Observers accompanied the commercial whelk fishermen to collect information on the fishing effort and the catches (see the field data sheet in Appendix I). Whelks were fished during July 1992 using whelk traps of various dimensions. The traps were baited with cod, mackerel, dogfish, striped bass, hake or smelt. Comparative analysis on the different types of traps and bait was not done.

The sea sampling procedures consisted of retaining the content of a randomly selected trap. For each selected trap, whelk (*Buccinum undatum*) and neptunea species (*Neptunea spp.*) were identified and their shell heights (*SH*) were measured (Figure 1). The silky whelk (*B. tenue*) and the stimpson's whelk (*Colus stimpsoni*) have been introduced in the Gulf of St. Lawrence yet they were not identified in the catches. No differentiation was made between the two species of neptunea, unfinished whelk (*Neptunea despecta tornata*) and ten-ridged whelk (*Neptunea decemcostata*). Both neptuneas were discarded at sea after they were measured. The position, bottom type, water depth and information on accidental catches were also recorded.

Each day the observers selected a sample of whelks from the catch and froze it for laboratory analysis. The observers tried to select a sample consisting of 10 individuals from each size class: 1-9 mm, 10-19 mm, 20-29 mm, 30-39 mm, 40-49 mm, 50-59 mm, 60-69 mm, 70-79 mm, 80-89 mm, 90-99 mm and > 100 mm. The whelks were frozen (-10 C) prior to the laboratory analysis.

## LABORATORY ANALYSIS

The analysis methods were similar to those used by Martel *et al.* (1986b) and Gendron (1991, 1992). Following a thawing period, the shell height (*SH*, Figure 1) and the total wet weight (*WW*) of the whelks were taken. The shells were then broken using a bench vice and tissues were removed. The weight of the wet body tissue (*BT*) and the sex was determined for each whelk. To facilitate the dissection, the body tissue was fixed in (5%) formalin for a minimum of seven days. Following the fixation period, the males penis length (*PL*) was measured and the organs of the males and the females were separated and weighed as follows (Figure 1):

| Females | Males |
|---|---|
| - Digestive gland weight (*DGW*) | - Digestive gland weight (*DGW*) |
| - Ovary weight (*OW*) | - Testis weight (*TW*) |
| - Pallial oviduct weight (*POW*) | - Seminal vesicle weight (*SVW*) |
| - Eviscerated weight ($EW_F$) (flesh weight less the digestive gland, ovary and pallial oviduct) | - Eviscerated weight ($EW_M$) (flesh weight less the digestive gland and testis) |

All linear measurements and weights were taken to the nearest mm and 0.01 g, respectively.

For each female, two types of gonosomatic indices (%) were calculated ($GSI_{oviduct}$, $GSI_{ovary}$) following the method of Martel *et al.* (1986b):

$$GSI_{oviduct} = \left( \frac{OW + POW}{EW_F} \right) \times 100$$

$$GSI_{ovary} = \left( \frac{OW}{EW_F} \right) \times 100$$

Based on Martel *et al.* (1986b) observations, females showing $GSI_{ovary}$ greater than or equal to 6% could be considered as sexually mature.

Males were considered sexually mature if their penis length (*PL*)/shell height (*SH*) ratios were larger than 0.5 (Santarelli-Chaurand, 1985). In addition, a gonosomatic index (%) was calculated for each male ($GSI_{male}$) following the method of Martel *et al.* (1986b):

$$GSI_{male} = \left( \frac{VSW}{EW_M} \right) \times 100$$

Shell height and weight data collected in the laboratory were used to calculate allometric equations that allow the conversion any whelk shell height (*SH*) into its corresponding total wet weight (*WW*):

$$WW = a\,(SH^b)$$

The linear form of the allometric equation is obtained by a logarithmic transformation:

$$\ln(WW) = \ln(a) + [b \times \ln(SH)]$$

where *a* and *b* are the intercept and the slope of the regression, respectively.

The female and male whelk sea sampling data were combined and used to calculate an allometric equation and to estimate whelk catches (kg) in traps.

## RESULTS

### CATCH AND YIELD PER TRAP

Between July 13 and July 27, 1992, seven fishing trips were carried out along the New Brunswick coast (Figure 2). The fishing activities were carried out on rocky bottoms, at depths varying from 11 to 18 fathoms (20m to 33m).

During these fishing trips, observers sampled 74 traps and measured 4190 whelks (*B. undatum*). A summary of sea sampling results is presented in Table I. The number of whelk per trap varied from 0 to 128, for traps in water for 2 to 5 days. The by-catch was composed of rock crabs (*Cancer irroratus*), toad crabs (*Hyas araneus* and *Hyas coartatus*), and sea urchins (*Strongylocentrotus dröebachiensis*). Lobsters (*Homarus americanus*) and snow crabs (*Chionocetes opilo*) were not captured (Table I).

The size frequency distribution of the whelk sampled (grouped by 5mm size class) is presented in Figure 3. Whelks which were greater or equal to the minimum size imposed for this developmental fishery (≥75mm) represented 42.1% of the captured whelks (Table II). Although the whelks were fished from two distinct areas (see Figure 2), landings were not compared.

Results of the calculated allometric relationship between SH and WW are presented in Figure 4. The yield per traps (Table II) was calculated from the allometric regressions without considering a minimum size and with different scenarios of minimum sizes (Figure 5).

The allometric relationships between SH and EW as well as WW and EW are presented in Appendix II as information only. This information was not employed to interpret the results. The relationships could be used to calculate the whelk meat yields for commercial processing.

### SEXUAL MATURITY

Laboratory analyses were preformed on 205 female whelks with shell heights between 36mm and 108mm (mean = 66.7mm, $s$ = 16.81) and 61 male whelks with shell height between 34mm and 75mm (mean = 59mm, $s$ = 8.95). The selected sampling of the commercial catch (amount pre-determined for each age class) revealed a sexual ratio of 3.4 females for every male. This ratio must not be interpreted to be representative of the whelk population. Female whelk reach greater sizes than the males therefore selective sampling causes a bias representation of the number of females in the greater size class.

Villemure et Lamoureux (1975) observed similar sex ratios in commercial catches in Québec. Thus, 70% of the captured whelks with a shell height of >80mm were females.

Results of the calculated gonosomatic indices of females ($GSI_{oviduct}$ and $GSI_{ovary}$) expressed as a function of shell height (SH) are presented in Figures 6 and 7. These figures do not display a relationship between the indices and SH. Many females had a visible ovary but were empty and impossible to dissect. This explains the lower value of the $GSI_{ovary}$ compared to $GSI_{oviduct}$. It must be noted that the $GSI_{ovary}$ values are distributed on either side of the 6% value for the size range of the sampled whelks. According to Martel *et al.* (1986b), indices greater than 6% indicate sexual maturity in females.

Results of the calculated PL/SH ratio and the gonosomatic indices for males ($GSI_{male}$) are presented in Figures 8 and 9 respectively. Interpretation of the PL/SH ratio supports the suggestion that changes are beginning to take place at shell height in the interval between 50mm to 60mm. At those sizes, the male whelks begin to have PL/SH ratios greater that 50%, which is indicative of sexual maturity (Santarelli-Chaurand, 1985). The calculation of $GSI_{male}$ values shows an increase when the whelks attain a size of 50mm to 60mm which corroborates the PL/SH ratio observation. However, many individuals of shell greater than 50mm have a low $GSI_{male}$ value. These low values may indicate that the testicles contained few or no spermatozoa.

## DISCUSSION

### COMMERCIAL CATCHES

The size frequency distribution of the commercial whelk catches is unimodal with a mean size of 68.4mm ($s$=10.7, n=4190) which is less than the imposed minimum catch size (75mm). This distribution has similar characteristics as the distribution observed in the commercial catches in the Magdalen Islands region (Gendron, 1991).

Imposing the minimum catch size of 75mm has forced more than 50% of the trapped whelk to be rejected (Table II). When a minimum size of 75mm is respected, the average yield was 1.0kg/trap (live weight) and 2.4kg/trap if the minimum size is not enforced. Even if the minimum size is not enforced, the yield is inferior to that obtained in the commercial fishery along the Québec coast (Gendron, 1991). The results from monitoring the developed whelk fishery in northern Northumberland Strait in 1974 (Léger, 1974) and on the north-east coast of New Brunswick in 1979 and 1980 (Gauvin, 1979; Turmel and Lauric, 1980) also support the conclusion that the yields are low. Based on monitoring done in 1975 and 1978 (Savoir, 1976; Mallet, 1978) promising yields were obtained in Chaleur Bay. Unfortunately, data on the size of the whelk caught were not recorded during that study. It is difficult to estimate actual yields if a minimum size is to be considered.

The whelk is a carnivorous/necrophagous mollusc that relies on its ability to sense liberated substances in the water as prey or food (chemotaxis). This is an important factor when orienting and searching for its food (Himmelman, 1988). The catch rate of the baited traps will therefore be influenced by water current. A swift current can increase the dilution of attractant or reduce the whelk travelling speed. The choice of the fishing site and the fishing period may be important factors when explaining the yield variation observed in the commercial catches on the coast of Québec (see Gendron, 1991) and in this study.

The peculiar life cycle of the whelk may explain some of the observations in the commercial catches and laboratory analysis. According to Martel *et al.* (1968a, b), the spawning period of the whelk population in northern Gulf of St. Lawrence occurs from the end of May to August (Figure 10). This period is marked

by a decrease in whelk feeding activity. Thus, the percentage of whelk having food in their stomach is at a maximum during the winter and fall, decreasing in May to reach low levels which are maintained until October (Martel *et al.*, 1986a). These seasonal changes in feeding activity are related to reproductive cycle and may explain the low catch rate observed in July during sea sampling along the New Brunswick coast. Decreases in catch per unit effort were observed in the summer by Villemure and Lamoureux (1975) in the Gulf of St. Lawrence estuary. Considering the lack of seasonal sampling of the catches and corresponding information on the changes in the digestive glands of the whelk population along the coast of New Brunswick, two hypotheses are presented:

- the low catch rate may be the result of fishing during a time period when whelk are not easily captured due to reduced feeding activity, or,

- the biomass of the whelk populations in the explored area is limited and it is not possible to increase the catch.

More work is necessary to verify these hypotheses.

## SEXUAL MATURITY

According to Martel *et al.* (1986b), female whelks reach a greater shell height than males before becoming sexually mature. Also, the size at sexual maturity for the two sexes varies greatly between the northern and southern populations of the Gulf of St. Lawrence (Martel *et al.*, 1986b; Gendron, 1992). Martel *et al.* (1986b) indicated that female sexual maturity on the northern coast of Québec is reached at a shell height of 70-80mm, while those on the coast of Gaspé have shell height of 60-65mm.

A markedly higher index, which usually indicates sexual maturity, was not identified when analyzing the gonosomatic indices of females in relation to their shell height (Figures 6 and 7). Sampling was probably conducted after the reproduction period which occurs from May to the beginning of July (Martel *et al.*, 1986b). The gonosomatic indices drop to their lowest level after spawning and explains the absence of the fluctuations of indices in relationship to the shell heights. These results were confirmed by the presence of females in the samples with empty ovaries which made dissection impossible.

It is difficult to explain why the $GSI_{ovary}$ values of a large number of small whelks (40-60mm) were greater than 6% (Figure 8) which, according to Martel *et al.* (1986b), indicates that a female is sexually mature. This seems to indicate that the females may be sexually mature when they reach a shell height of 40mm. Based on studies conducted in Québec (Martel *et al.* 1986a; Gendron, 1992), it is highly unlikely that female whelk reach sexual maturity at such small sizes. Since ovary dissection was only possible for a few females, it is difficult to assume that these observations are representative of the whelk population in general. According to Gendron (1991), 50% of the females in the Magdalen Islands region reach sexual maturity at a shell height of 60mm, which is smaller than whelks from northern Gulf of St. Lawrence (76-80mm). Unfortunately, the size at sexual maturity cannot be determined clearly from the data collected on the east coast of New Brunswick. Additional studies are necessary to monitor the temporal change of the reproductive organs and study the complete reproductive cycle through the spawning period.

Graphic representation of penis length (PL, Figure 8) and gonosomatic indices of males ($GSI_{male}$, Figure 9), as a function of shell height, shows the increase in indices which is related to acquiring sexual maturity. Thus, the males reach sexual maturity at a shell height varying between 50mm to 60mm. These results are similar to those obtained by Gendron (1992) for the Magdalen Islands where 50% of the males were sexually mature at a shell height of 49mm.

A large number of male and female whelk of various sizes have shown a null (=0) gonosomatic index. A complete reabsorption of gonad and penis atrophy were reported by Gendron (1992) for whelk populations of the Gulf of St. Lawrence. According to Køie (1969); and Fretter and Graham (1962), a parasitic trematode may have caused the castrations and can affect the secondary sex characteristics. Unfortunately, sample analysis in this study did not include tissue examination to detect parasites and it is difficult to associate the null indices to parasitic castration. However, this parasite was observed by Hamel (1989) in the northern Gulf of St. Lawrence and farther south (S. McGladdery, Parasitologist, Fisheries and Oceans, pers. obs.).

## CONCLUSION

On the whole, the commercial catches of whelk on the east coast of New Brunswick gave low yields per trap compared to those along the Québec coast. The results are similar to those obtained in studies and monitoring programs conducted on the New Brunswick coast during 1974 to 1980.

Keeping in mind the peculiar reproductive cycle of the whelk, which reduces its feeding activities during the summer, the use of baited traps to capture the whelk has proven to be a method with a seasonally variable efficiency. This seasonal efficiency of the trap casts doubt over all results of the biological sample analysis. Thus, it is reasonable to believe that the whelks which enter the traps in search of food are only those which have reached a particular physiological state of their reproductive cycle. It is therefore difficult to draw conclusions for the whelk population as a whole, based solely on the results of the present study.

Other sampling methods to study the whelk populations do exist. Among these methods, scuba diving is the most effective. However this method is limited by the depth at which the divers can work (10-15 meters). Dredging, another method, requires less effort and allows the sampling to be conducted at greater depths. Since the whelk population along the coast of New Brunswick is found at depths greater than 20 meters, dredging is the preferred sampling method. Future biological studies on whelk could take advantage of the scallop fisheries which are practiced in areas where whelk can be found. If scallop fishermen would participate, sampling could be simplified and a greater fishing area could be covered.

The whelk biology is different from that of other commercially exploited bivalve molluscs in the Gulf of St. Lawrence. Contrary to bivalve molluscs, which liberate their reproductive products (oocytes and spermatozoa) in the marine environment where fertilization occurs, the whelk use internal fertilization by copulation. The eggs are deposited on a solid substrate and hatch without going through a planktonic stage. The potential dispersion of young whelks is therefore limited when compared to species which have a planktonic larvae stage. This feature, along with a slow growth rate and a greater shell height at sexual maturity, renders the whelk population vulnerable to over-fishing. Without a management plan adapted to the specifics of the whelk population, it is easy to remove the broodstock before they have had a chance to reproduce. Additionally, in an un-managed fishery, there exists a risk of reducing population densities to levels which would no longer permit the two sexes to meet and copulate.

Based on the study conducted in 1992, it is not possible to define a size at sexual maturity for female whelks. Not knowing the size at sexual maturity for females compromises any attempt to reduce the minimum catch size to improve the fishing yields. Additional work will be necessary to determine the size at which females reach sexual maturity in order to insure that the selected minimum catch size does not jeopardize the whelk population broodstock.

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Table I. Summary of the information collected by sea observers during the sampling conducted on board commercial whelk fishing vessels.

| Species | Number caught | Minimum and maximum size | Ratio female/ male |
|---|---|---|---|
| *Buccinum undatum*<br>Waved whelk | 4190 | 34 mm - 99 mm | 3.4/1.0 * |
| *Neptunea spp.*<br>Neptune | 6 | 52 mm - 76 mm | ** |
| *Cancer irroratus*<br>Rock crab | 26 | 65 mm - 124 mm | 0.1/1.0 |
| *Hyas spp.*<br>Toad crab | 194 | 42 mm - 110 mm | 0.2/1.0 |
| *Strongylocentrotus dröebachiensis*<br>Sea urchin | 388 | (measurements not taken) | ** |
| *Chionocetes opilio*<br>Snow crab | 0 | | |
| *Homarus americanus*<br>Lobster | 0 | | |

* The female/male ratio was calculated from data collected during the laboratory analyses of the sea samples.

** Sex identification was not conducted.

Table II. Catches and yields (kg whelk/trap) calculated from the data collected during the sampling of the whelk commercial fleet on the eastern coast of New Brunswick, 1992. Different scenarios of minimum catch size are presented. The shell heights (SH) were transformed in wet weights (WW) using the allometric equation: $WW = 0.000687\ (SH^{2.599})$.

| | Different scenarios of minimum catch size | | | |
|---|---|---|---|---|
| | None | 70mm | 75mm | 80mm |
| Percentage of the catch (in number) consisting of whelks under the minimum catch size | 0% | 39.2% | 57.9% | 74.0% |
| Average yield (kg/trap) (standard deviation) | 2.4 (1.71) | 1.5 (1.32) | 1.0 (1.03) | 0.6 (0.68) |
| Minimum yield (kg/trap) | 0 | 0 | 0 | 0 |
| Maximum yield (kg/trap) | 5.3 | 4.5 | 3.6 | 2.1 |
| Average reject (% in weight) | 0% | 38.6% | 56.6% | 73.8% |

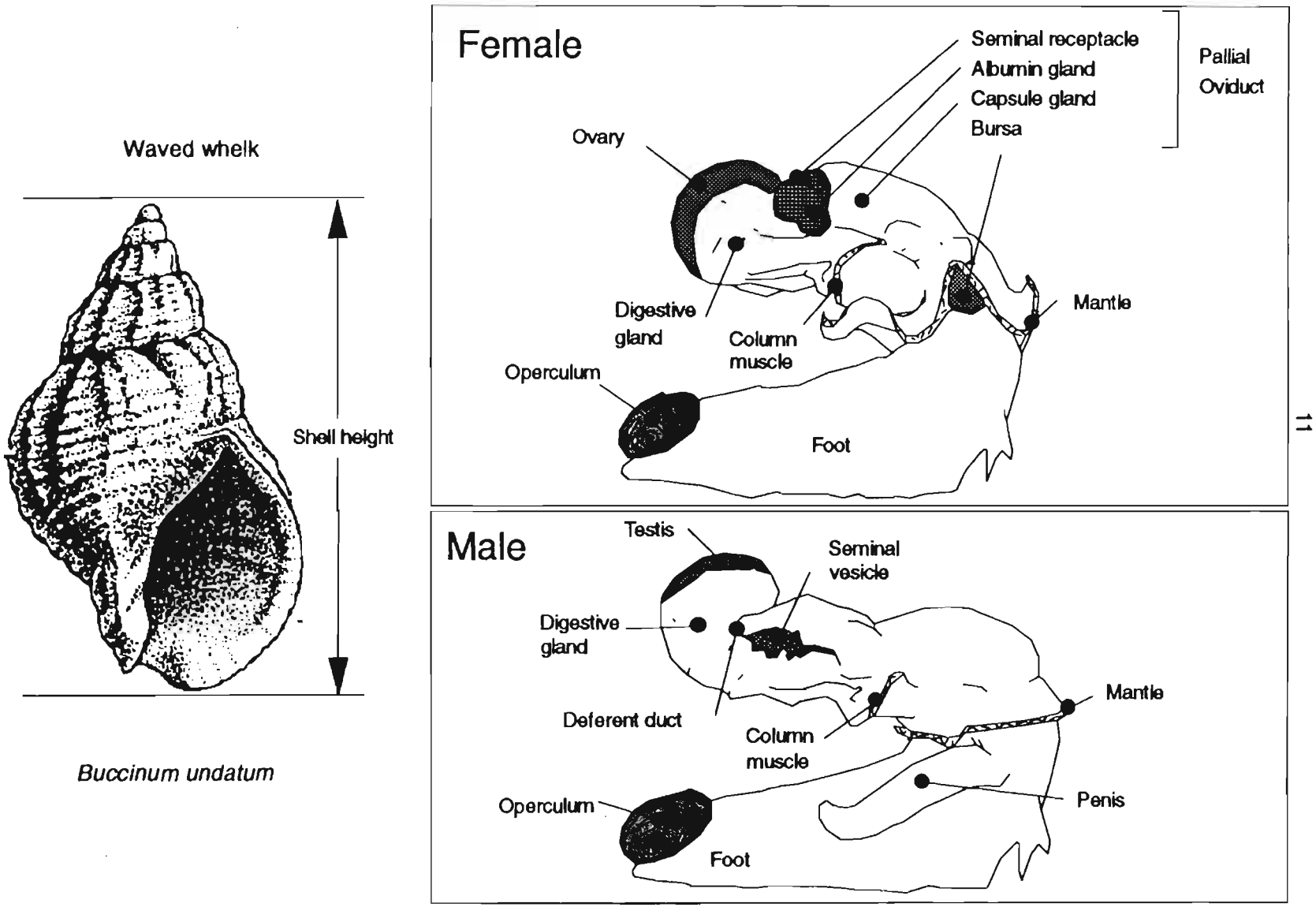


Figure 1. Definition of the term "shell height" used in the text and of the general anatomy of female and male waved whelks (from Martel *et al.*, 1986b).

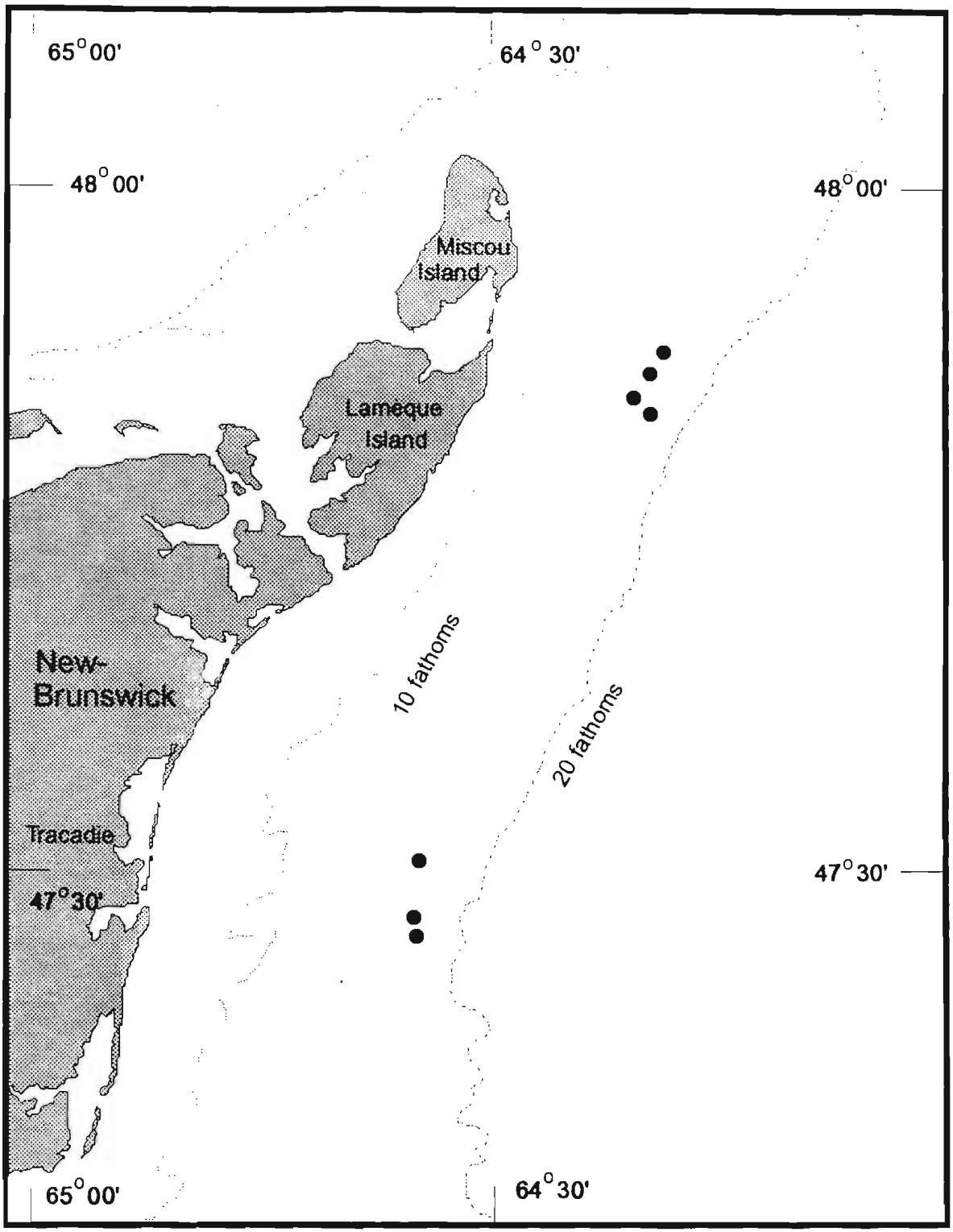


Figure 2. Position of the seven whelk fishing trips that were sampled during the month of July, 1992.

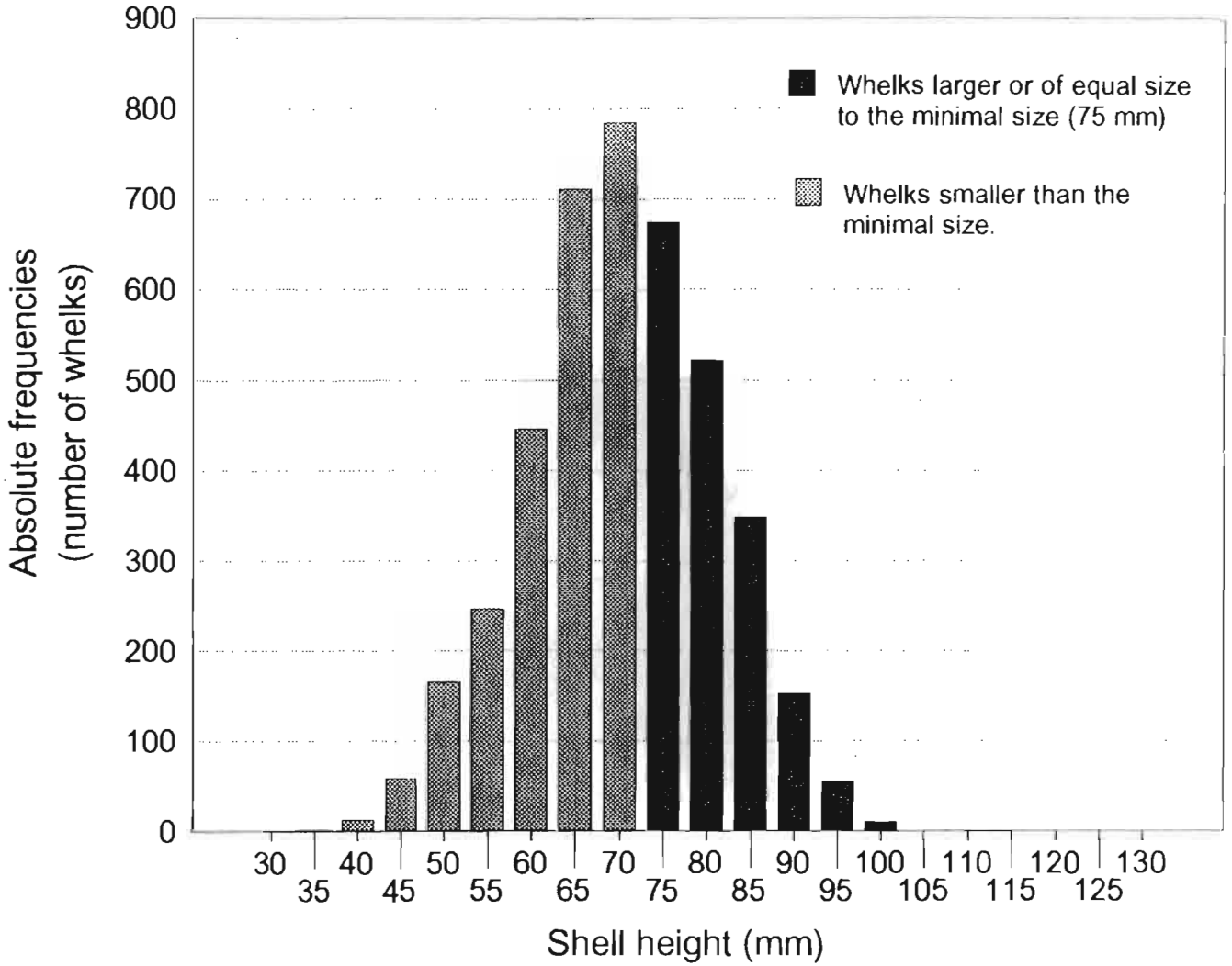


Figure 3. Size frequency (5 mm size classes) of the commercial catches of whelks (*Buccinum undatum*) collected during sampling expeditions (females and males combined).

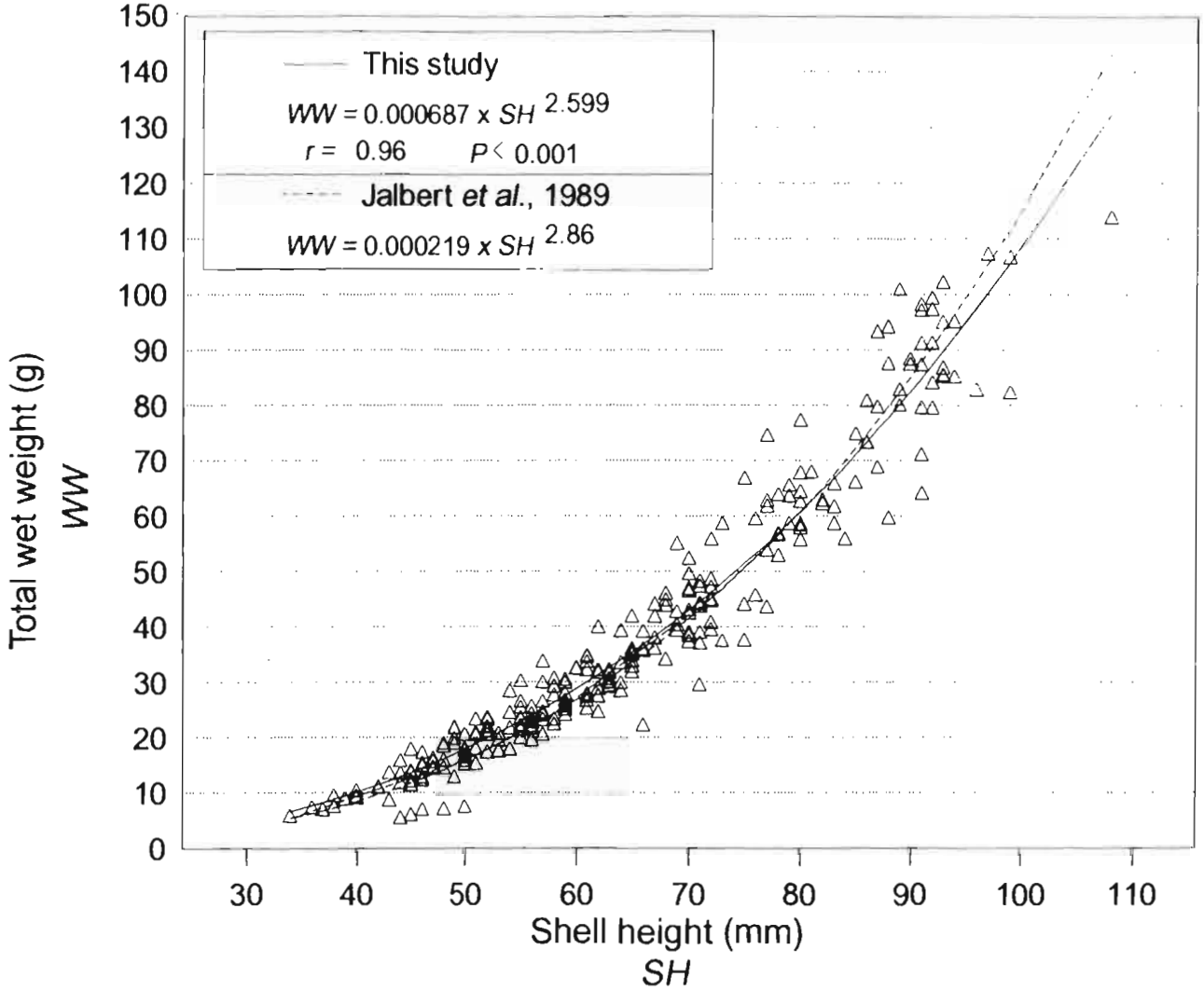


Figure 4. Allometric relationship between the shell height and the total wet weight for all the whelks (*Buccinum undatum*) analysed in the laboratory. The allometric relationship calculated by Jalbert *et al.* (1989) is also presented.

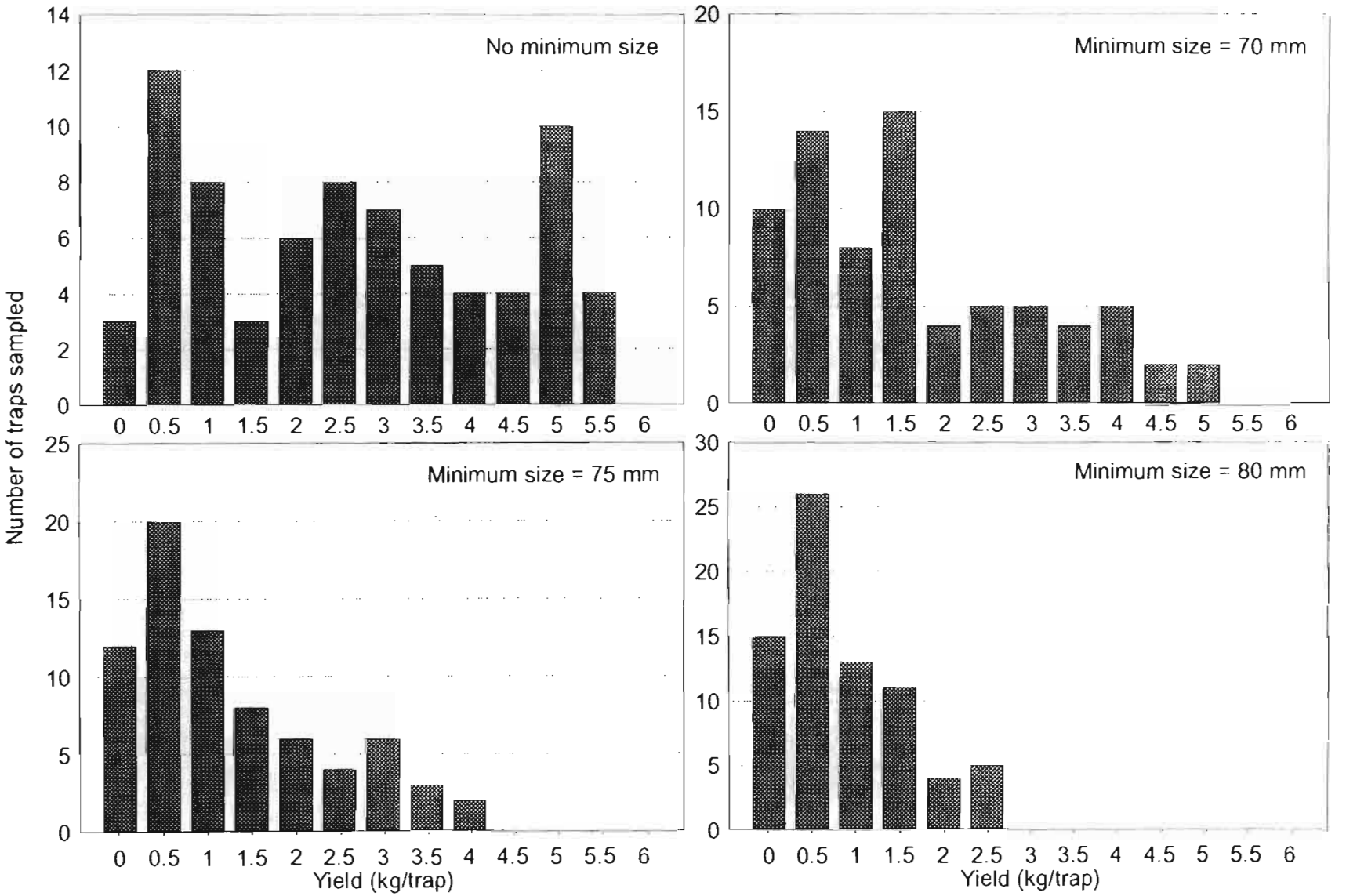


Figure 5. Yield per trap calculated from the data collected during the sampling of commercial catch of whelks on board fishing vessels. Different scenarios of minimal size at capture are presented.

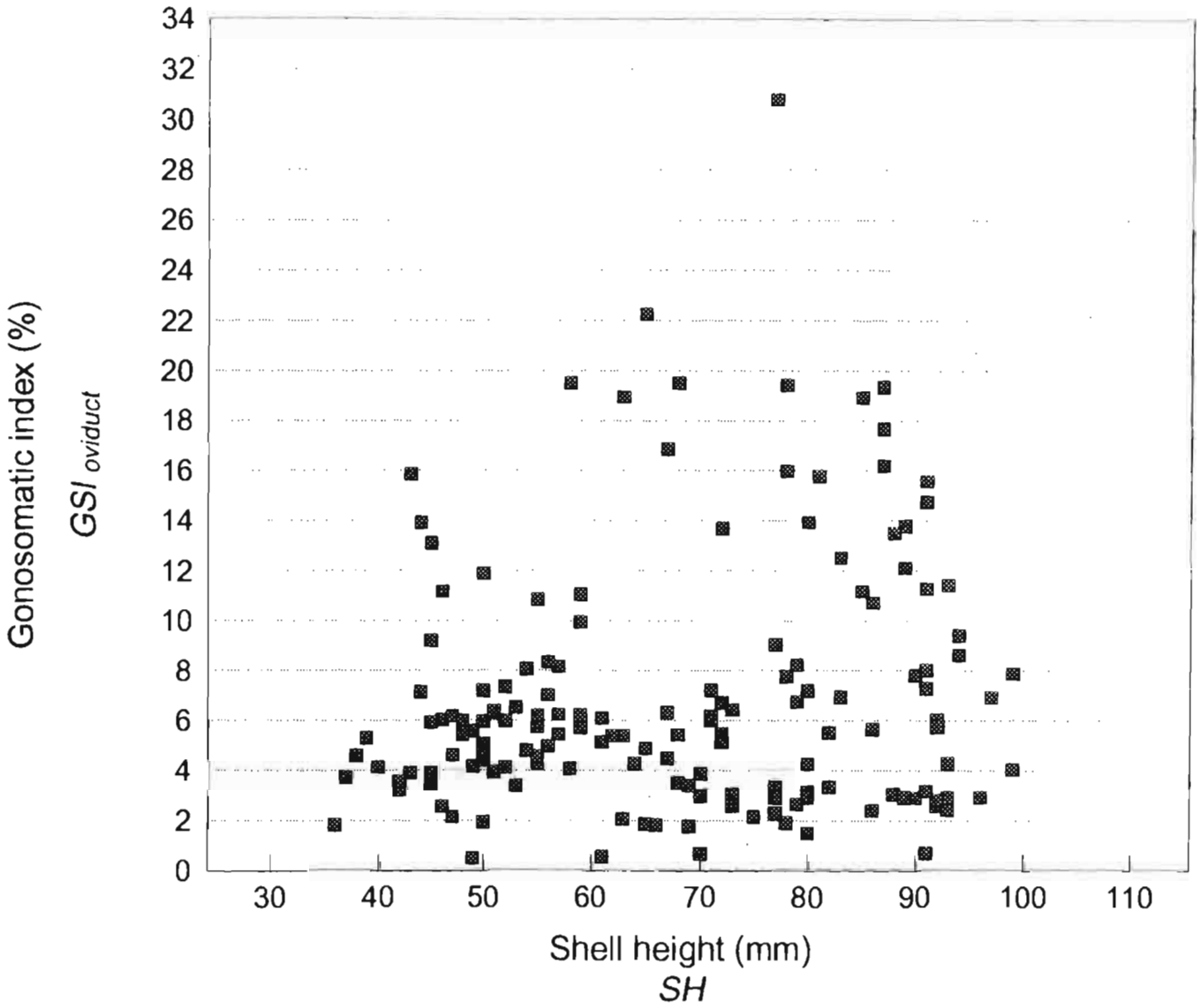


Figure 6. First gonosomatic indices calculated for all the female whelks. The indices are obtained by calculating the ratio (%) of the pallial oviduct weight over the eviscerated weight (see text).

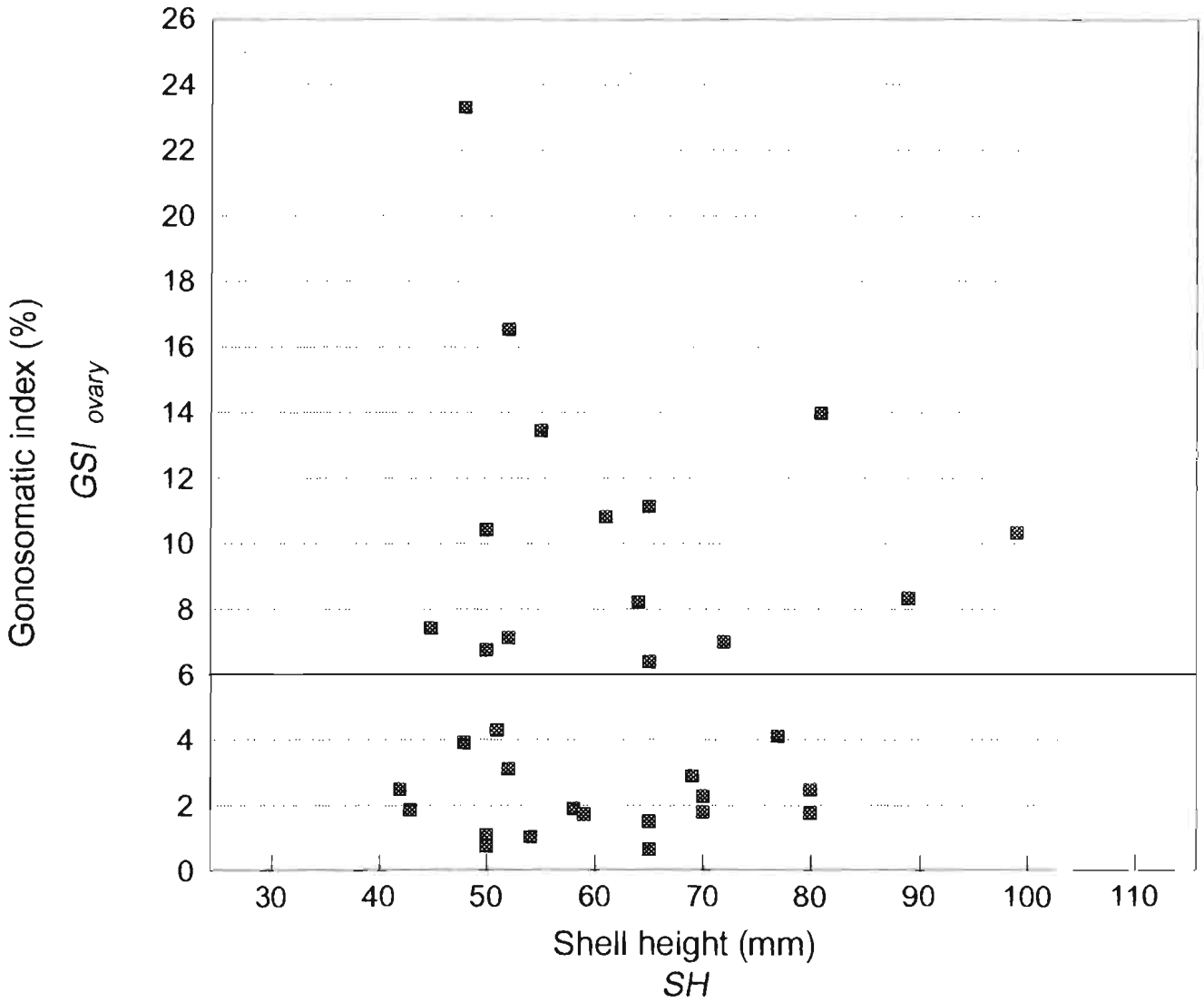




Figure 7. Second gonosomatic indices calculated for all the female whelks. The indices are obtained by calculating the ratio (%) of the ovary weight over the eviscerated weight (see text). The 6% level indicating sexual maturity is shown by a horizontal continuous line.

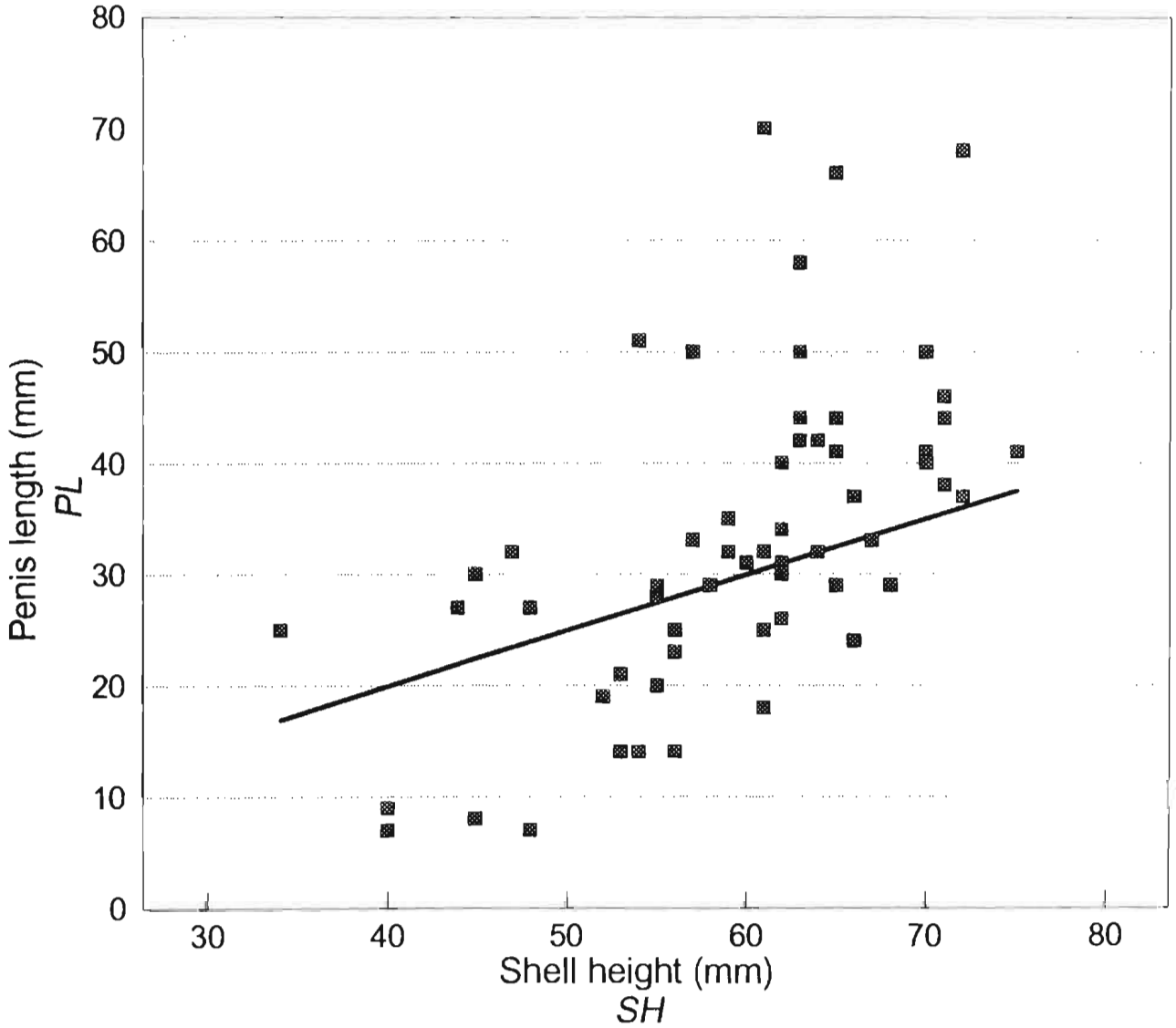


Figure 8. Penis length in relation with the shell height of whelks. The continuous line represents the ratio *PL* / *SH* = 0.5. Whelks with ratios above 0.5 are considered sexually mature.

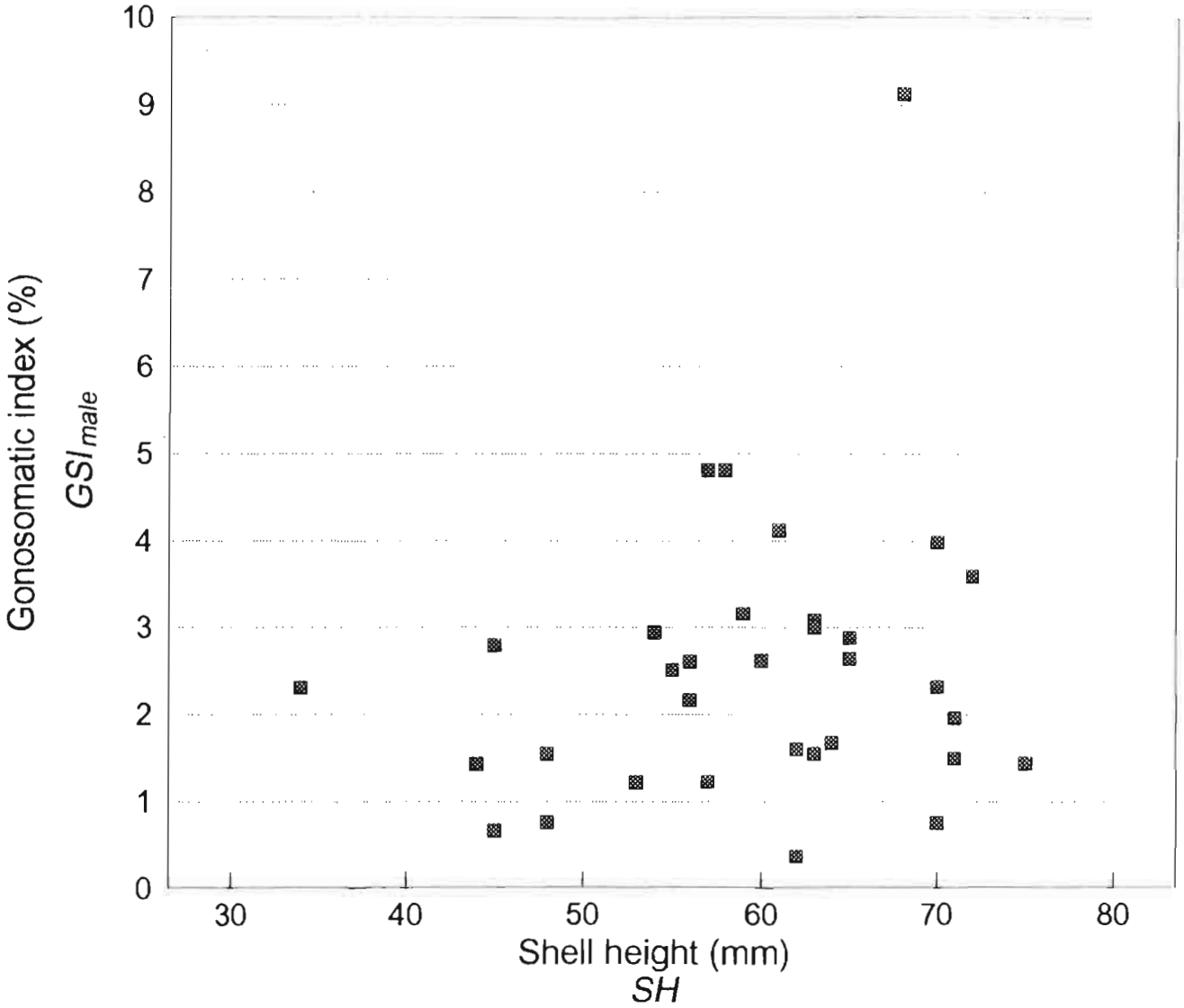


Figure 9. Gonosomatic indices for all male whelks sampled. The indices are obtained by calculating the ratio (%) of the seminal vesicle weight over the eviscerated weight.

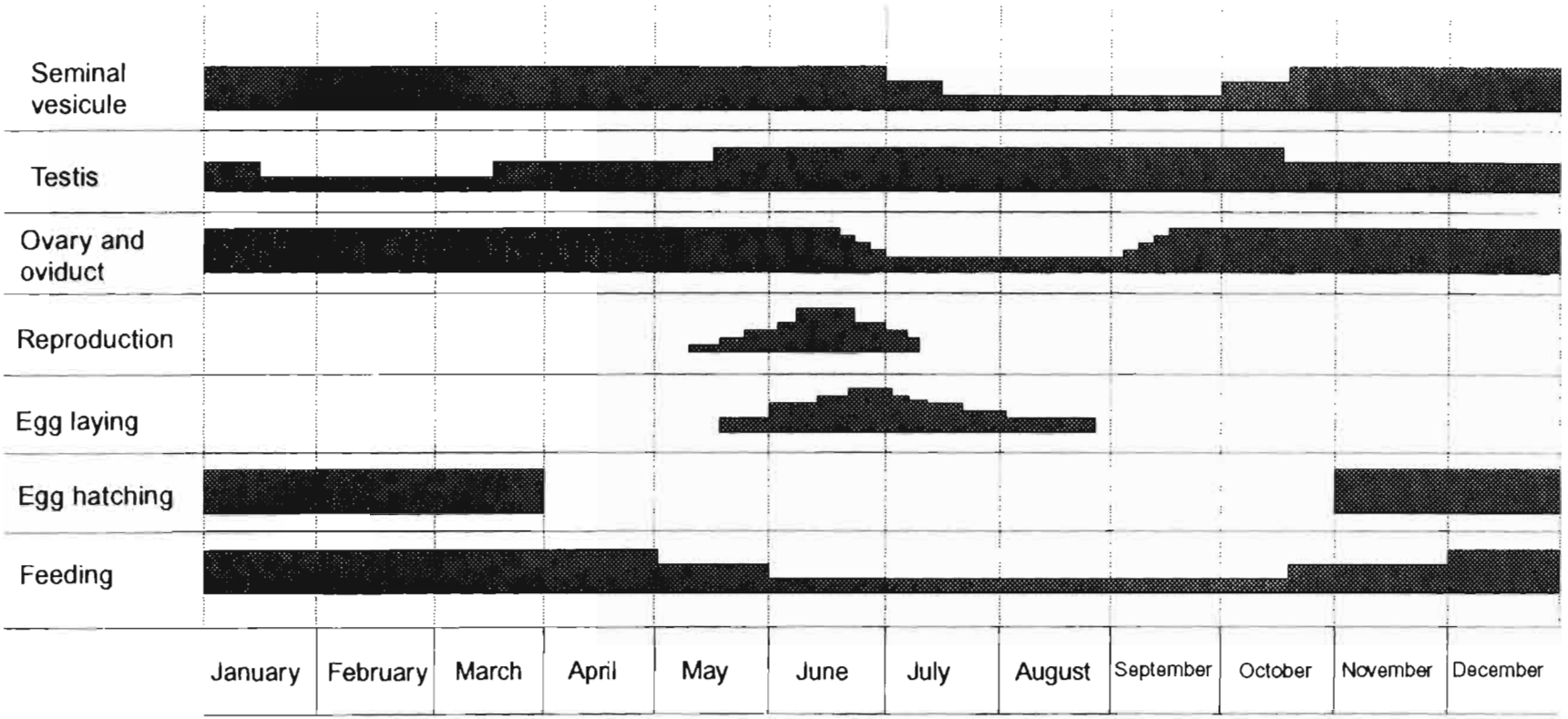


Figure 10. Summary of the physiologic developments and major activities characterising the life cycle of *Buccinum undatum* in the northern Gulf of St. Lawrence. An increase in the size of an organ or an activity is indicated by a thickening of the bar (figure adapted from Martel *et al.*, 1986b).

Appendix I. Data sheets used to record the information collected during the sampling of the commercial waved whelk (*Buccinum undatum*) fishery.

**FIELD DATA SHEET FOR OBSERVERS**
**CATCH DATA FOR WHELKS**



| Field data sheet #1 | Trap #: | Date: | Code-type of trap: |
|---|---|---|---|

| Latitude<br>Longitude | | Depth (fathoms) | | Name of fisherman: | Time | |
|---|---|---|---|---|---|---|

**Shell height of trapped whelks.**

| Edible (Waved) Whelk (Buccinum undatum) |
|---|
| |

| Ten-Ridged Whelk (Neptunea decemcostata) |
|---|
| |

| Bottom type | Rock | Gravel | Sand | Mud |
|---|---|---|---|---|

| Type of bait used | |
|---|---|

| Date trap was last visited | |
|---|---|

Appendix I. (continued).

FIELD DATA SHEET FOR OBSERVERS
CATCH DATA OF WHELKS



| Field data sheet #2 | Trap #: | Date: | Code-type of trap: |
|---|---|---|---|

| species/organisms (living and dead) | Few | Many | Number (if possible) |
|---|---|---|---|
| Sea-urchin | | | |
| Starfish | | | |
| Brittle star | | | |
| Sand dollar | | | |
| Sea cucumber (holothuries) | | | |
| Fish and other (specify) | | | |

| Rock crab | Carapace width and sex of rock crab trapped |
|---|---|
| | |

| Lobster | Carapace length and sex of lobster trapped |
|---|---|
| | |

| Toad Crab (Hyas sp.) | Carapace width and sex of toad crab trapped |
|---|---|
| | |

| Other species of crab trapped | Carapace width and sex of other species of crab trapped |
|---|---|
| | |

Problems encountered while fishing (ex:mechanical problem, etc.):
Comments:

Appendix II. Allometric relationships between the whelk shell height and the eviscerated weight (A) and between the total wet weight and the eviscerated weight (B).