



Scientific Excellence
Excellence scientifique •

Library's
ONLY
COPY

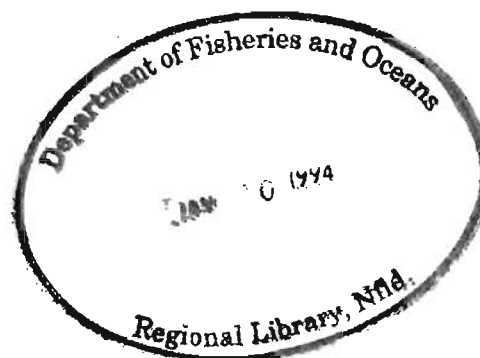


Conservation • Benefits for Canadians
Les ressources • Bénéfices aux Canadiens

Timing of the gametogenic development and spawning period of the giant scallop *Placopecten magellanicus* (Gmelin) in the southern Gulf of St. Lawrence.

L.-A. Davidson, M. Lanteigne and M. Niles

Science Branch
Department of Fisheries and Oceans
Gulf Fisheries Centre
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6



1993

Canadian Technical Report of
Fisheries and Aquatic Sciences 1935



Fisheries
and Oceans

Pêches
et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Technical Report of
Fisheries and Aquatic Sciences 1935

1993

**Timing of the gametogenic development and spawning period of
the giant scallop *Placopecten magellanicus* (Gmelin)
in the southern Gulf of St. Lawrence.**

by

L.-A. Davidson, M. Lanteigne and M. Niles

Science Branch
Department of Fisheries and Oceans
Gulf Fisheries Centre
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

*Imprimé sur du
papier recyclé*



*Printed on
recycled paper*

© Minister of Supply and Services Canada 1993
Cat. No. Fs 97-6/1935E ISSN 0706-6457

Correct citation for this publication:

L.-A. Davidson, M. Lanteigne and M. Niles. 1993. Timing of the gametogenic development and spawning period of the giant scallop *Placopecten magellanicus* (Gmelin) in the southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 1935: 14 p.

Contents

List of Tables	iv
List of Figures	iv
Abstract	v
Résumé	v
Introduction	1
Materials and Methods	2
Results	3
Discussion	3
Acknowledgements	6
References	6

List of Tables

TABLE 1.	Dates (weeks) when the spawning period began and the estimated length of the spawning period for the giant scallop (<i>Placopecten magellanicus</i>) from each sampling site in the southern Gulf of St. Lawrence, in 1984 and 1985	8
----------	---	---

List of Figures

FIGURE 1.	Sampling site locations in the southern Gulf of St. Lawrence 1) Baie des Chaleurs 2) northern Northumberland Strait 3) central Northumberland Strait 4) southern Northumberland Strait	9
FIGURE 2.	Reproductive cycle of <i>Placopecten magellanicus</i> from Baie des Chaleurs in 1984, illustrated as a percentage of males and females in each development stage. .	10
FIGURE 3.	Reproductive cycle of <i>Placopecten magellanicus</i> from Baie des Chaleurs in 1985 illustrated as a percentage of males and females in each development stage. .	11
FIGURE 4.	Reproductive cycle of <i>Placopecten magellanicus</i> from northern Northumberland Strait in 1985, illustrated as a percentage of males and females in each development stage.	12
FIGURE 5.	Reproductive cycle of <i>Placopecten magellanicus</i> from central Northumberland Strait in 1984, illustrated as a percentage of males and females in each development stage.	13
FIGURE 6.	Reproductive cycle of <i>Placopecten magellanicus</i> from southern Northumberland Strait in 1985, illustrated as a percentage of males and females in each development stage.	14

Abstract

L.-A. Davidson, M. Lanteigne and M. Niles 1993. Timing of the gametogenic development and spawning period of the giant scallop *Placopecten magellanicus* (Gmelin) in the southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 1935: 14 p.

The gametogenic development and spawning period (reproductive cycle) of *Placopecten magellanicus* was investigated in 1984 and 1985 at four sites in the southern Gulf of St. Lawrence. The gametogenic cycle was studied by histological examination of gonadal tissue and by calculating the gonosomatic index (GSI). Results showed that the gametogenic development of males and females was synchronized within each site. The exact spawning period varied among sampling sites and between years. The spawning period of Northumberland Strait scallops occurred two weeks to a month earlier than the spawning period of Baie des Chaleurs scallops and scallops from various other region previously studied. These results may be particularly interesting for scallop aquaculturists who collect scallop spat from wild populations. Calculating the GSI is an inexpensive technique that an aquaculturist can use to aid in predicting the optimal time for spat collection.

Key words: Giant Scallop, *Placopecten magellanicus*, spawning, gametogenic development, gonosomatic index.

Résumé

L.-A. Davidson, M. Lanteigne and M. Niles 1993. Timing of the gametogenic development and spawning period of the giant scallop *Placopecten magellanicus* (Gmelin) in the southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. 1935: 14 p.

Le cycle du développement des gamètes et la saison de ponte (cycle de reproduction) chez *Placopecten magellanicus* ont été étudiés en 1984 et 1985 dans quatre sites du sud du golfe du Saint-Laurent. Le cycle du développement des gamètes a été étudié par l'examen histologique des gonades et en calculant les indices gonosomatiques (IGS). Les résultats démontrent que le développement des gamètes mâles et femelles est synchrone à l'intérieur de chaque site. La période exacte de la ponte varie d'un site d'échantillonnage à l'autre et d'une année à l'autre. La période de ponte des pétoncles dans le détroit de Northumberland a eu lieu deux semaines à un mois plus tôt que la période de ponte des pétoncles de la Baie des Chaleurs et les pétoncles de plusieurs autres régions qui ont été étudiés dans le passé. Ces résultats sont particulièrement intéressants pour les aquiculteurs de pétoncle qui font la collecte du naissain à partir des populations naturelles. Le calcul du IGS est une méthode peu coûteuse qui peut aider l'aquiculteur à prédire la date optimale pour effectuer la collecte des naissains.

Mots clés: Pétoncle giant, *Placopecten magellanicus*, ponte, gamétogénèse, indice gonosomatique.

Introduction

The giant scallop (*Placopecten magellanicus*, Gmelin, 1791) is found from the north shore of the Gulf of St. Lawrence to Cape Hatteras, North Carolina (Posgay 1957). This species is commercially fished throughout its range and the different scallop stocks are regulated by various management strategies. These strategies are aimed at controlling the fishing effort and hence, protecting the resource. They include setting the length of the fishing season, defining gear type and imposing a minimum number of adductor meats per kilogram (meat count). Effective management strategies require a knowledge of the different populations' reproductive cycles (Hennick 1970).

There is growing interest in giant scallop aquaculture and presently there are commercial and experimental scallop aquaculture sites along the coast of all four provinces in Atlantic Canada,. One of the prerequisites to successful scallop aquaculture is securing a readily available supply of spat (Naidu and Cahill 1986). To insure successful spat collection, the aquaculturist must know the reproductive cycle of the scallop in the area selected for spat collection. The reproductive cycle can be divided in a period of gametogenic development and a spawning period. The cycle can be studied by periodic examination of the reproductive organ or gonad of the animal. Of the various methods of assessing the stage of development of the scallop gonads, two methods were employed in this study: I) histology and II) gonosomatic index.

Histological preparation of the gonadal tissue provides a direct means of examining and assessing development of the gonads. Although the gametogenic development is a continual process, most investigators have ascribed development stages to certain cytological features of gonadal tissue (Barber and Blake 1991).

The gonad weight depends on the size of the animal and the stage of the gonad development. The most common means of accounting for the effects of the differential body size on gonad size have been to express gonad weight as a percentage of body weight (DeVlaming *et al.* 1982). Unlike many other shellfish, the gonad of the giant scallop is separate from the rest of the visceral mass (Beninger and LePennec 1991), therefore it is easily removed and weighed. A practice widely used is to calculate the ratio of the weight of the gonad to the total body weight and multiply the result by 100 to convert it to a percentage. This ratio expressed as a percentage is termed the gonosomatic index (GSI) (Grant and Tyler 1983).

Barber and Blake (1991) summarized the reports of various authors who have studied the spawning periods of *P. magellanicus* from Georges Bank, the coast of Newfoundland, Nova Scotia, Maine, Massachusetts, New Jersey and North Carolina. A fall spawning period was reported for all these giant scallop populations. An additional spring spawning period was reported for giant scallop populations on the west coast of Newfoundland (Naidu 1970), on Georges Banks (DiBacco 1993) and a population extending from New Jersey to North Carolina (DuPaul *et al.* 1989). Jamieson (1979) reported a late summer spawning season for scallops found in the Northumberland Strait. In this paper, the timing of the gametogenic development and the spawning period of various populations of giant scallop in the southern Gulf of St. Lawrence are reported.

Materials and Methods

Giant scallops were collected from May to November in 1984 and 1985 using a commercial Digby dredge. The sampling sites are shown in Figure 1 and the sampling dates are included in Figures 2 to 6 for each study area. It was not possible to sample regularly due to logistic problems (samples were taken whenever possible). In 1984, samples were taken from Baie des Chaleurs and northern Northumberland Strait. In 1985, additional samples were collected from Baie des Chaleurs, central and southern Northumberland Strait.

Each sample consisted of 30 scallops in 1984 and 60 scallops in 1985 (~ 50% males and females). The overall mean size of scallops was 95.4 ± 12.6 mm shell height (n= 1871; range: 46 to 140mm). The shell height is the distance from umbo to distal margin of the scallop. The gonad of each scallop was removed and placed in Bouin's fixative for at least 48 hrs and then stored in 70 % alcohol until it was processed. To process the gonad for histology, a tissue sample near the tip of each gonad was removed, dehydrated, cleared and embedded in paraplast (Humason 1972). The tissues were then sectioned 8 μ m thick and stained with Haematoxylin-Eosin or Masson's Trichome. Each gonad section was examined under a microscope and its development stage classified according to the gonad development stages described by Davidson and Worms (1989). For each sampling site, the gonad development cycle was illustrated as percentage of male and female scallops in each of the development stages. Stacked histograms were used to show the percentages and the number of males and females in each samples was recorded above the respective histogram bar (Figs. 2 to 6).

In 1985, prior to the removal and fixation of the gonad, the shell height, total weight, shell weight and gonad weight were recorded for each scallop. The shell weight was subtracted from the total weight to obtain the total body weight. The gonosomatic index (GSI) was calculated by dividing the gonad weight

by the body weight (DeVlaming *et al.* 1982, Beninger 1987) and multiplied by 100 to express it as a percentage. The mean GSI values and the corresponding standard deviations of the samples are plotted as a line graph along with the histogram bars of the histological observations (Figs. 3, 4 and 6).

The starting date and duration of the spawning periods were estimated subjectively by interpreting the histograms of the percentage of males and females in each development stage (Table 1). Due to the erratic sampling at most sites, the spawning periods may have been estimated to be slightly greater than they actually were.

Results

The reproductive cycle of male and female giant scallops (*P. magellanicus*) collected in 1984 and 1985 from Baie des Chaleurs, northern, central and southern Northumberland Strait are illustrated in Figures 2 to 6. The numbers above the histogram bars indicate sample size for each sex. Within each study site the gametogenic development of males and females appear to be synchronized. The beginning or the length of the spawning period varied among study sites and between years (Table 1). However the spawning periods of the three populations within the Northumberland Strait were very similar. The spawning period of scallops in the Northumberland Strait populations occurred two weeks to a month earlier than in Baie des Chaleurs (Table 1).

The GSI values calculated for samples collected in 1985, corresponded well with results from histological observations (Figs. 3, 4 and 6). The GSI increased gradually prior to the spawning period and decreased steadily during the spawning period.

Discussion

The results in the present study confirmed the statement by Barber and Blake (1991) that, within a population, the male and female scallops tend to develop and spawn synchronously. Site-specific variations in scallop reproductive cycles have been observed in several other studies (Barber and Blake 1991, and references therein). The timing of the reproductive cycle may be regulated physiologically by an interaction between site specific endogenous and exogenous factors. Variations between populations may be an adaptive response to geographic differences in temperature and food availability (Sasthy 1979, Barber *et al.* 1988).

The different events of the reproductive cycle include growth of the gametes (Stage I, II, and III), ripening of the gametes (Stage IV), spawning (Stage V₁ and V₂) and a resting period (Stage VI, latent)

(Davidson and Worms 1989). The spawning period provides a convenient tool for comparing the reproductive cycle among populations and years. The major spawning period for the scallops on the coast of Newfoundland, Nova Scotia, Maine, Massachusetts, New Jersey, and Georges Bank occurred from August to September or October (Barber and Blake 1991). A few authors have reported some spawning in the spring or early summer in addition to the major fall spawn (Naidu 1970, Barber *et al.* 1988, DuPaul *et al.* 1989). In 1984 and 1985, the spawning period for scallops found in the Northumberland Strait occurred sometime between the end of July and the beginning of September while scallops from Baie des Chaleurs spawned from mid or the end of August to mid September. In 1978, Jamieson (1979) noted that scallops from the Northumberland Strait had spawned sometime prior to September. The spawning period of Northumberland Strait scallops occurred two weeks to a month earlier than the spawning period of Baie des Chaleurs scallops and scallops from various other regions previously studied.

Naidu (1970) suggested that the duration of the spawning period is a reflection of the strength of the stimulus that induces spawning: when gonads are ripe, any favourable external stimulus may cause scallops to spawn. Since the timing and duration of the spawning period vary from site to site and from year to year, Barber and Blake (1991) suggested that one or more environmental factors may stimulate the spawning process. The parameters which trigger spawning include temperature, salinity, lunar phase, light, dissolved oxygen, pH, presence of gametes of the opposite sex, mechanical shock and various chemicals (Barber and Blake 1991). A fluctuation in water temperature, either an increase or a decrease, appears to be the most frequently implicated factor in the initiation of spawning (Naidu 1970, Barber and Blake 1991).

Beninger (1987) reported that GSI clearly reflected the information given by the histological staging technique, with one exception. The histological examination of gonads indicated winter maturity in 33% of the male scallops from Chamcook Bay, N.B., and the GSI data did not confirm this phenomenon. In the present study the GSI values corresponded well with the histological observations. In Baie des Chaleurs (Fig. 3), and in northern Northumberland Strait (Fig. 4) the peak GSI is reached at the same time the greatest percentage of ripe gonads are histologically observed. The peak GSI in the southern Northumberland Strait is not readily distinguished. On July 5 most of the gonads were developing and filling; on July 30 more than half of the scallops were spawning and the rest were ripe. Perhaps, if a sample had been taken between July 5 and July 30, mostly ripe gonad along with a peak GSI would have been observed. Parsons *et al.* (1992) studied the reproductive cycle of the giant scallop in Passamaquoddy Bay by monitoring the GSI values from 1985 to 1990 but only examined gonads histologically in 1985 from April to November. Weekly samples were collected during the time period when the scallops were actively developing sexual products. As a result, Parsons *et al.* (1992) were able to compile the histological data

to present a detailed picture of the scallop gonad activity in 1985.

Parsons *et al.* (1992) have shown that the GSI values by size class of scallops, sampled in July when gonads were ripe, increased from 2.5% at 30 mm size class up to 14% at 70 mm after which the larger scallops (≥ 80 mm) attained a plateau and the GSI was independent of size. In this study the size range of the scallop shell height was 46 to 140 mm with an average size of 95.4 ± 12.6 mm. Therefore, in this study, the data obtained from the scallops with a shell height less than 80 mm reduced the GSI values of the sample.

Robinson *et al.* (1981) have found that the adductor meat weight for a given shell size decreases significantly over the duration of a spawning period. DuPaul *et al.* (1989) reported that managers sensitive to this phenomenon have allowed a seasonal increase in adductor meat counts during the spawning season. The seasonal occurrence of spawning is the same within each site. However the precise timing may fluctuate. Scallop fisheries managers who allow a higher meat count during the spawning period only need to know the general spawning time period to implement their management strategies.

Knowing the precise scallop spawning period each year is important information for the scallop aquaculturist. Since most of the scallop spat used in the giant scallop aquaculture industry is collected from the wild, aquaculturists need to know when to deploy their artificial spat collectors. To be successful, the aquaculturist should start collecting spat about five weeks after the spawning period because giant scallops are planktonic for the first five weeks of their lives (Culliney 1974). The substrate of the artificial spat collector must be relatively clean (Naidu and Cahill 1986). Therefore, knowledge of the spawning period is essential to avoid undesirable fouling on collectors that could result if they were deployed in the water too early. Determining the spawning period by means of histological preparation of gonadal tissue for microscopic examination is costly and time consuming. The GSI values can be calculated relatively quickly and inexpensively. According to Grant and Tyler (1983), determining the reproduction cycle using the GSI is satisfactory for species with a strong seasonality of reproduction. The giant scallop satisfies this criterion and it has also been shown that GSI reflects the information given by the histological examination (Beninger 1987). Therefore, calculating the GSI is a simple and effective means, particularly for scallop aquaculturists, to assess the reproduction cycle of scallops in their area. It is recommended that a weekly regime of sampling scallops ≥ 80 mm be performed during gamete development and spawning in order to monitor the GSI values with accuracy.

Acknowledgements

We are sincerely grateful to Dr. J. Worms, with whom the project was initiated, as well as to Dr S. Reeb, students in the Université de Moncton course BI-6283, (Séminaire en lecture dirigée), Dr T.W. Sephton, G. Chouinard and H. A. Kerr for having reviewed this paper.

References

- BARBER, B.J. and N.J. BLAKE. 1991. Reproductive physiology In: Shumway, S.E. (ed.), *Scallops: biology, ecology and aquaculture*, Elsevier, New York, pp. 377-428.
- BARBER, B.J., R. GETCHELL, S. SHUMWAY and D. SCHICK. 1988. Reduced fecundity in a deep water population of the giant scallop *Placopecten magellanicus* in the Gulf of Maine, USA. *Mar. Ecol. Prog. Ser.* 42:207-212.
- BENINGER, P.G. 1987. A qualitative study of the reproductive cycle of the giant scallop, *Placopecten magellanicus* in the Bay of Fundy (New Brunswick, Canada). *Can. J. Zool.* 65:495-498.
- BENINGER, P.G. and M. LE PENNEC. 1991. Functional anatomy of scallops In: Shumway, S.E. (ed.), *Scallops: biology, ecology and aquaculture*, Elsevier, New York, pp. 133-223.
- CULLINEY, J.L. 1974. Larval development of the giant scallop *Placopecten magellanicus* (Gmelin). *Biol. Bull. (Wood Hole, MA)* 147:321-332.
- DAVIDSON, L.A. and J. WORMS. 1989. Stages of gonad development in the sea scallop, *Placopecten magellanicus* (Gmelin) based on both macroscopic and microscopic observation of the gametogenic cycle. *Can. Tech. Rep. Fish. Aquat. Sci. No.* 1686:v + 20 p.
- DEVLAMING, V., G. GROSSMAN and F. CHAPMAN. 1982. On the use of the gonosomatic index. *Comp. Biochem. Physiol.* 74A:31-39.
- DIBACCO, C. 1993. Reproductive cycle of the giant sea scallop, *Placopecten magellanicus* (Gmelin), on Northeastern Georges Bank. M.Sc. Thesis, Dalhousie University. 78p.
- DUPAUL, W.D., J.E. KIRKLEY and A.C. SCHMITZER. 1989. Evidence of a semiannual reproductive cycle for the sea scallop, *Placopecten magellanicus* (Gmelin), in the Mid-Atlantic region. *J. Shellfish Res.* 8:173-178.
- GRANT, A. and P.A. TYLER. 1983. The analysis of data in studies of invertebrate reproduction. I. Introduction and statistical analysis of gonad indices and maturity indices. *Int. J. Invert. Reprod.* 6:259-269.
- HENNICK, D.P. 1970. Reproductive cycle, size at maturity, and sexual composition of commercially harvested weathervane scallops (*Platinopecten caurinus*) in Alaska. *J. Fish. Res. Bd. Canada* 27: 2112-2119.
- HUMASON, G.L. 1972. Animal tissue techniques. W.H. Freeman and Company, San Francisco, 3rd edition. 641 p.

- JAMIESON, G. S. 1979. Status and assessment of Northumberland Strait scallop stocks. Fish. Mar. Serv. Tech. Rep. 904: 12 p.
- NAIDU, K.S. 1970. Reproduction and breeding cycle of the giant scallop *Placopecten magellanicus* (Gmelin) in Port au Port Bay, Newfoundland. Can. J. Zool. 48:1003-1012.
- NAIDU, K.S. and F.M. CAHILL. 1986. Culturing giant scallops in Newfoundland waters. Can. Man. Rep. Fish. Aquat. Sci. 1876: 23 p.
- PARSONS, G.J., S.M.C. ROBINSON, R.A. CHANDLER, L.A. DAVIDSON, M. LANTEIGNE, and M. DADSWELL. 1992. Intra-annual and long-term patterns in the reproductive cycle of giant scallops *Placopecten magellanicus* (Bivalvia:Pectinidae) from Passamaquoddy Bay, New Brunswick, Canada. Mar. Ecol. Prog. Ser. 80:203-214.
- POSGAY, J.A. 1957. The range of the sea scallop. Nautilus 71:55-57.
- ROBINSON, W.E., W.E. WEHLING, M.P. MORSE, and G.C. MCLEOD. 1981. Seasonal changes in soft-body component indices and energy reserves in the Atlantic deep-sea scallop, *Placopecten magellanicus*. Fish. Bull. 79:449-458.
- SASTRY, A.N. 1979. Pelecypoda (excluding Ostreidae) In: Giese, A.C. and S. Pearse (eds.), Reproduction of marine invertebrates. Vol. V, Molluscs: pelecypods and lesser classes. Academic Press, New York, pp. 113-292.

TABLE 1. Dates (weeks) when the spawning period began and the estimated length of the spawning period for the giant scallop (*Placopecten magellanicus*) from each sampling site in the southern Gulf of St. Lawrence, in 1984 and 1985.

SAMPLING SITE	YEAR	DATE OF START OF SPAWNING PERIOD	DURATION OF SPAWNING PERIOD
BAIE DES CHALEURS	1984	END OF AUGUST	—
	1985	MID AUGUST	4 WEEKS
NORTHUMBERLAND STRAIT			
NORTHERN	1985	FIRST WEEK OF AUGUST	6 WEEKS
CENTRAL	1984	END OF JULY	4 WEEKS
SOUTHERN	1985	END OF JULY	6 WEEKS

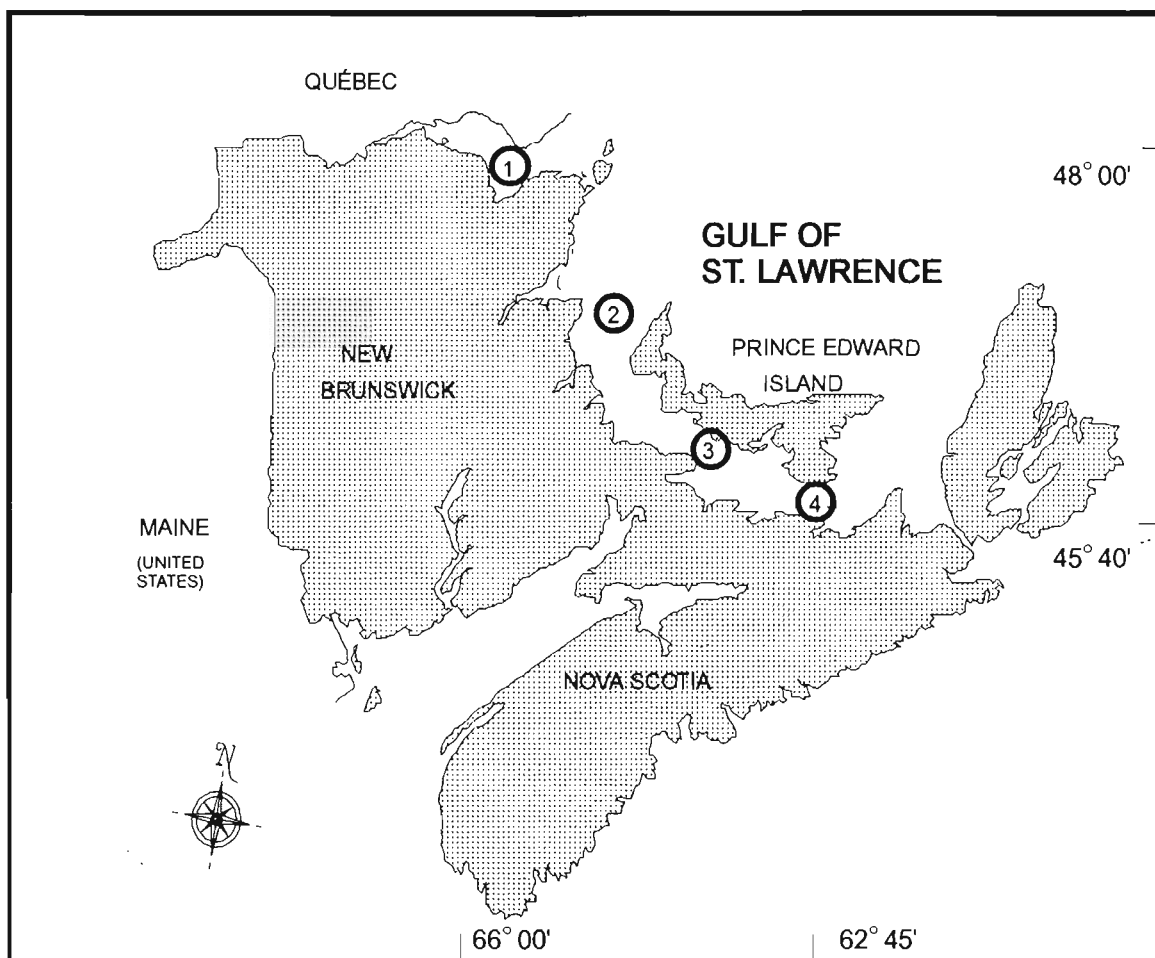
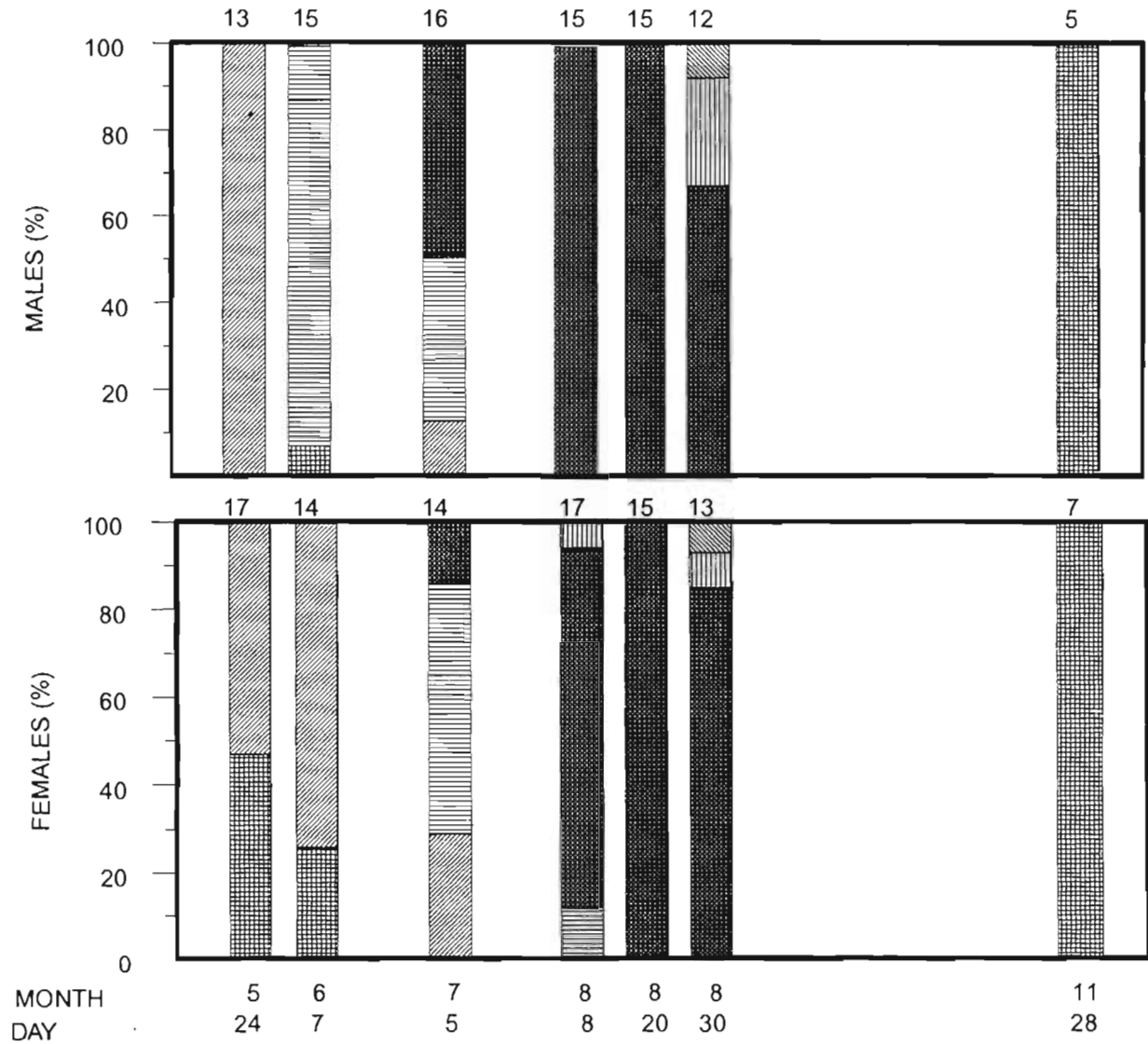


FIGURE 1. Sampling site locations in the southern Gulf of St. Lawrence. 1) Baie des Chaleurs, 2) northern Northumberland Strait, 3) central Northumberland Strait, 4) southern Northumberland Strait.



LEGEND

GONAD DEVELOPMENT STAGES



FIGURE 2. Reproductive cycle of *Placopecten magellanicus* from Baie des Chaleurs in 1984, illustrated as a percentage of males and females in each development stage (data collected from histological observations). Numbers above histogram bars indicate sample size.

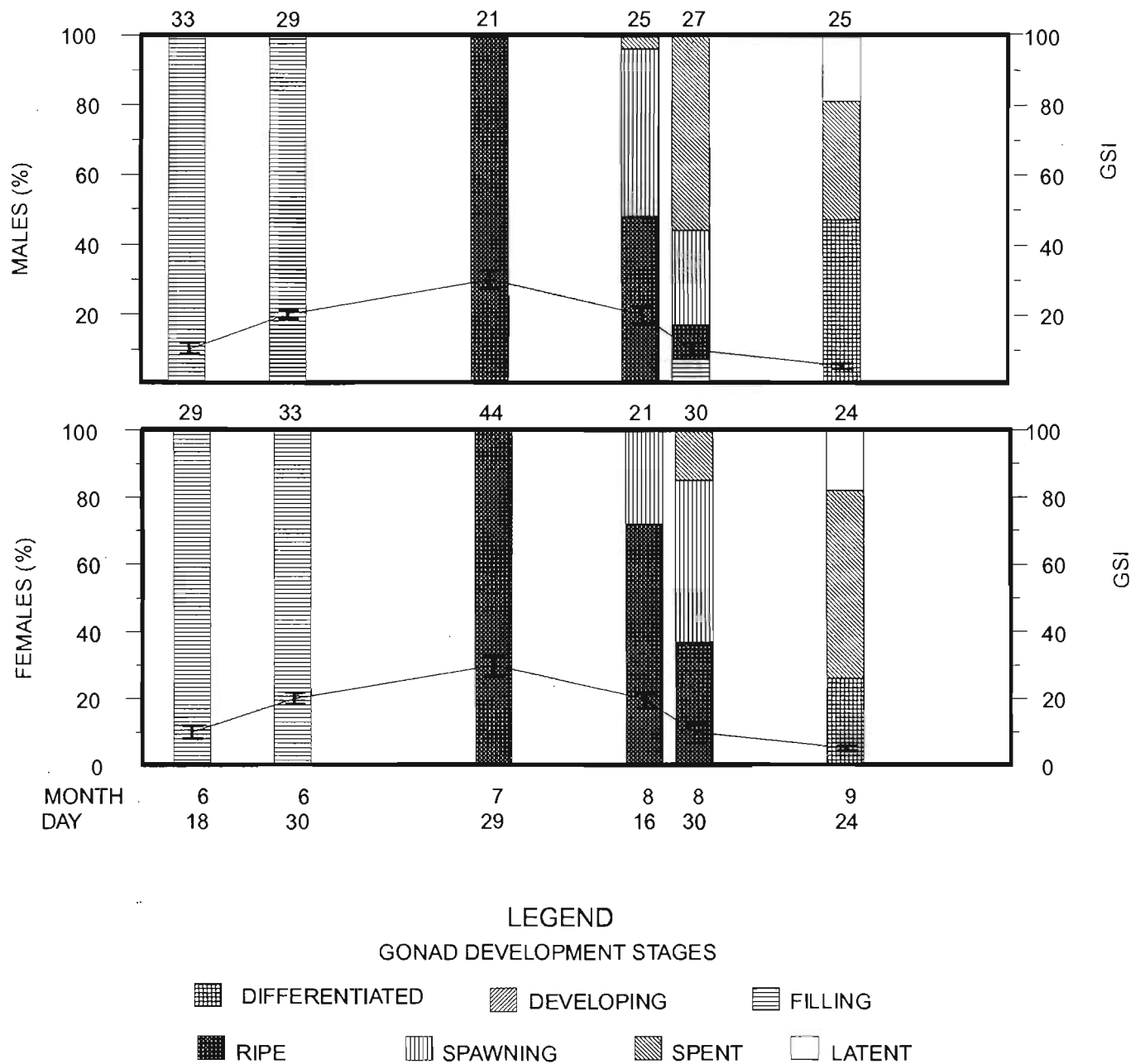


FIGURE 3. Reproductive cycle of *Placopecten magellanicus* from Baie des Chaleurs in 1985, illustrated as a percentage of males and females in each development stage (data collected from histological observations). The gonosomatic (GSI) values are also presented (line graphic). Numbers above histogram bars indicate sample size.

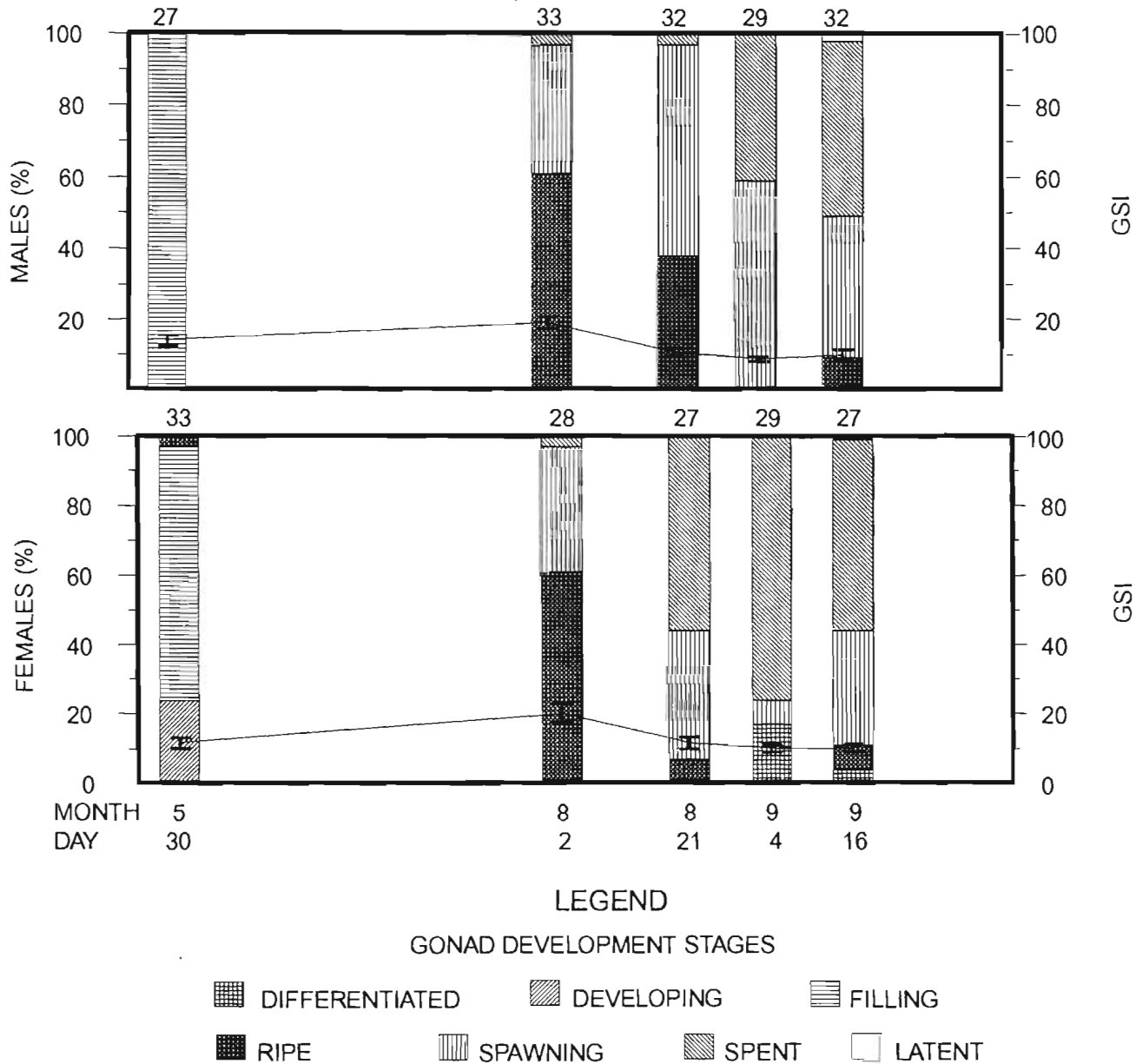


FIGURE 4. Reproductive cycle of *Placopecten magellanicus* from northern Northumberland Strait in 1985, illustrated as a percentage of males and females in each development stage (data collected from histological observations). The gonosomatic index (GSI) values are also presented (line graphic). Numbers above histogram bars indicate sample size.

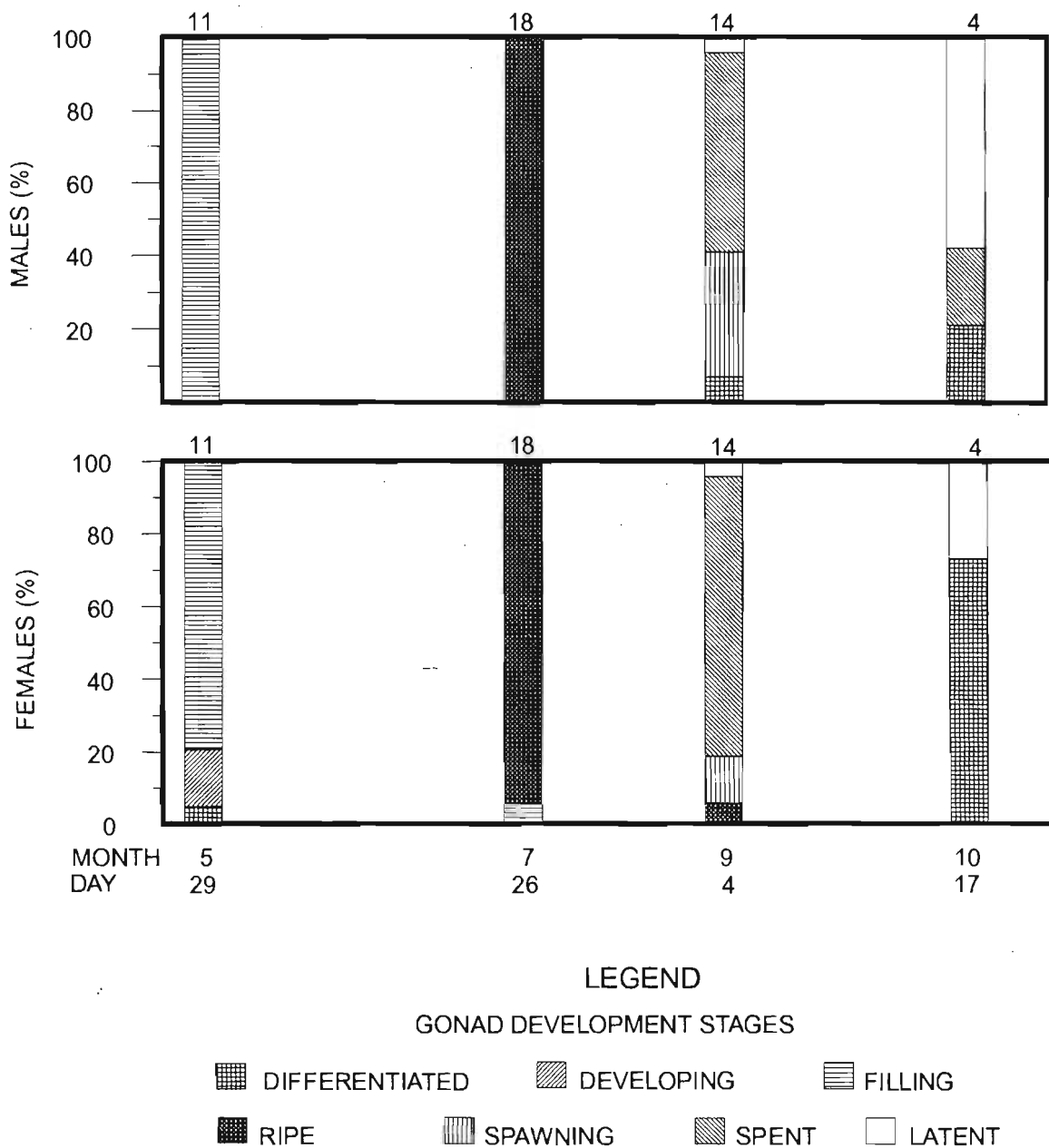


FIGURE 5. Reproductive cycle of *Placopecten magellanicus* from central Northumberland Strait in 1984, illustrated as a percentage of males and females in each development stage (data collected from histological observations). Numbers above histogram bars indicate sample size.

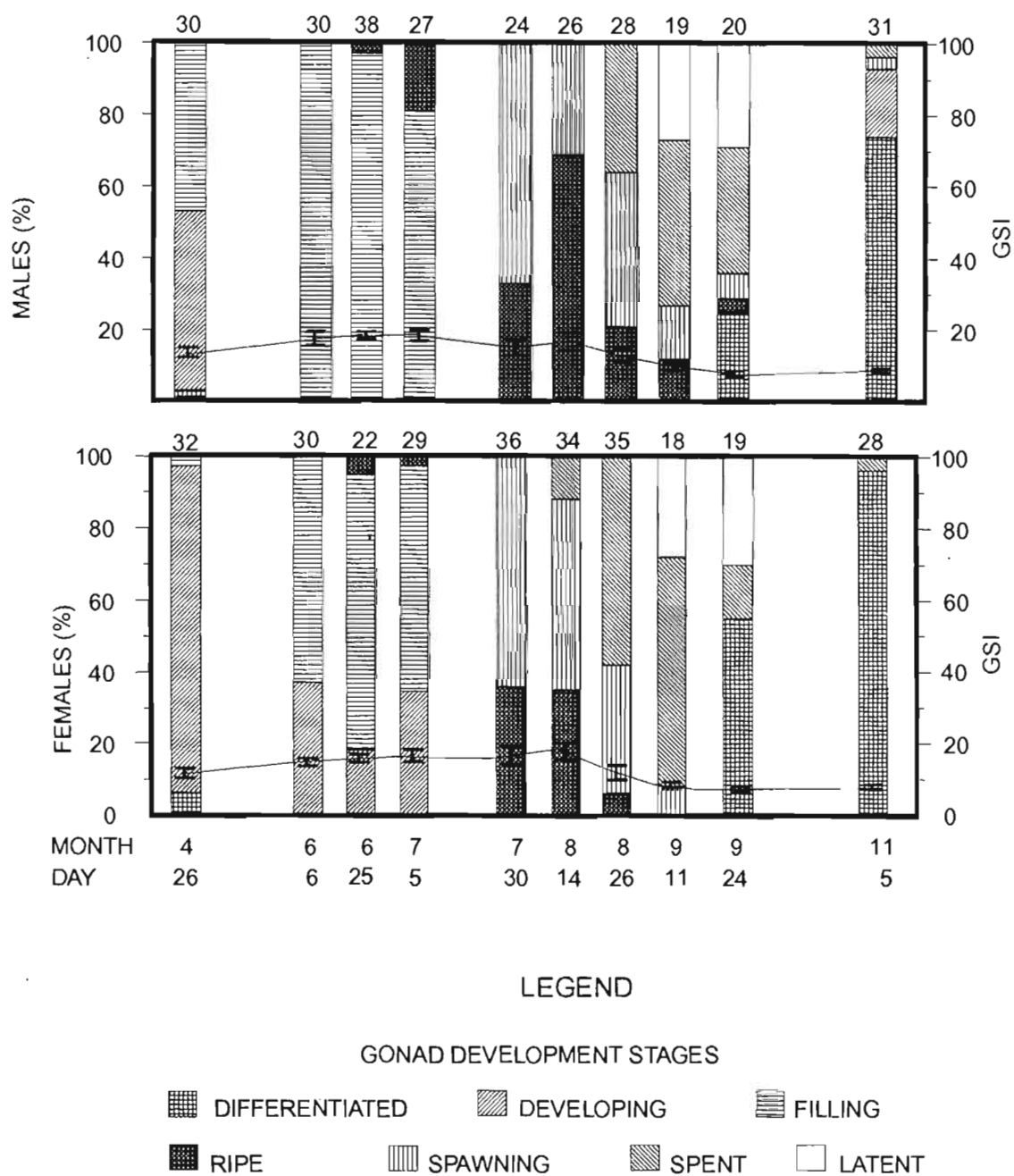


FIGURE 6. Reproductive cycle of *Placopecten magellanicus* from southern Northumberland Strait in 1985, illustrated as a percentage of males and females in each development stage (data collected from histological observations). the gonosomatic index (GSI) values are also presented (line graphic). Numbers above histogram bars indicate sample size.