SC-CAMLR-VI/BG/12 Rev.1

RESULTS OF FISH STOCK ASSESSMENT SURVEY, SOUTH GEORGIA REGION, NOVEMBER - DECEMBER 1986

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Abstract

Biomasses and length compositions of eight stocks from South Georgia are described based on results of a stratified random bottom trawl survey. A total of 124 tows was undertaken between 29 November and 17 December 1986 by the R.V. Professor Siedlecki using a Polish B-454 otter trawl. Biomass was estimated based on stratified swept-area calculations. Estimates of biomass of Notothenia rossii and Patagonotothen brevicauda guentheri were an order of magnitude lower than observed by Kock in 1985. Abundance of Dissostichus eleginoides and Pseudochanichthys georgianus appeared lower in 1986/87 than 1984/85, although not by an order of magnitude. Abundances of Notothenia gibberifrons and Chaenocephalus aceratus as estimated by this study and Kock were roughly equal. Abundance estimates of Chamsocephalus gunnari were larger in 1986/87 than 1984/85, probably due to good recruitment of 1983/84 and 1984/85 year classes. Coefficients of variation ranged from 67.9% (Notothenia squamifrons) to 12.6% (C. aceratus).

Résumé

Les biomasses et les compositions en longueurs de huit stocks de la Géorgie du Sud sont décrites à partir des résultats obtenus au cours d'une prospection stratifiée au chalut de fond effectuée au hasard. Entre le 29 novembre et le 17 décembre, le navire de recherche Professeur Siedlecki a effectué un total de 124 traits au moyen d'un chalut à panneaux polonais B-454. La biomasse a été estimée à partir de calculs portant sur une aire balayée stratifiée. Les estimations de la biomasse de Notothenia rossii et de Patagonotothen brevicauda guentheri étaient nettement inférieures à celles observées par Kock en 1985. L'abondance de Dissostichus eleginoides et de Pseudochaenichthys georgianus est apparue moindre en 1986/87 qu'en 1984/85, pas à un degré important cependant. En ce qui concerne l'abondance de Notothenia gibberifrons et de Chaenocephalus aceratus, cette étude et celle entreprise par Kock ont abouti à des estimations sensiblement égales. Les estimations d'abondance de Champsocephalus gunnari étaient plus élevées en 1986/87 qu'en 1984/85, probablement à cause d'un bon recrutement des classes d'âge 1983/84 et 1984/85. Les coefficients de variation allaient de 67,9% (Notothenia squamifrons) à 12,5% (C. aceratus).

Resumen

Se describen las composiciones por biomasas y por tallas de ocho reservas de Georgia del Sur, en base a los resultados de una prospección de arrastre de fondo aleatoria estratificada. El buque de investigación Professor Siedlecki emprendió un total de 124 remolques entre el 29 de noviembre y el 17 de diciembre de 1986 usando un arrastre con puertas polaco B-454. La biomasa fue estimada en base a cálculos estratificados de área barrida. Las estimaciones de la biomasa de Notothenia rossii y Patagonotothen brevicauda guentheri fueron menores en un orden de magnitud que las observadas por Kock en 1985. La abundancia de Dissostichus eleginoides y Pseudochaenichthys georgianus parecieron ser menores en 1986/87 que aquellas de 1984/85, aunque no en un orden de magnitud. Las abundancias de Notothenia gibberifrons y Chaenocephalus aceratus, tanto las estimadas en este estudio, como aquellas estimadas por Kock resultaron aproximadamente iguales. Las estimaciones de la abundancia de Champsocephalus gunnari fueron mayores en 1986/87 que aquellas de 1984/85, probablemente debido a un buen restablecimiento de las clases-año de 1983/84 y 1984/85. El rango de los coeficientes de variación fue de 67.9% (Notothenia squamifrons) a 12.6% (C. aceratus).

Резюме

Биомасса и состав по длине для восьми запасов в районе Южной Георгии даются на основе результатов послойных выборочных съемок с помощью донного трала. Всего в период с 29 ноября по 17 декабря 1986 г. НИС "Профессор Сидлецки" было произведено 124 траления польским оттертралом "B-454". Биомасса оценивалась на основе расчетов по послойно протраленным площадям. Оценки биомассы Notothenia rossii и Patagonotothen brevicauda guentheri были на порядок ниже, чем таковые по наблюдениям Кока в 1985 г. Численность Dissostichus eleginoides и Pseudochaenichthys georgianus оказалась меньше в 1986/87 г., чем в 1984/85 г., хотя и не на порядок. Оценки численности Notothenia gibberifrons и Chaenocephalus aceratus, полученные в данной работе и Коком, были приблизительно одинаковы. Оценки численности Champsocephalus gunnari были выше для 1986/87 г., чем для 1984/85 г., - возможно, в связи с успешным пополнением запаса годовыми классами 1983/84 и 1984/85 г.г. Коэффициент вариативности колебался от 67,9% (Notothenia squamifrons) до 12,6% (C. aceratus).

RESULTS OF FISH STOCK ASSESSMENT SURVEY, SOUTH GEORGIA REGION, 24 NOVEMBER - 17 DECEMBER 1986

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INTRODUCTION

The decline of groundfish stocks since the late 1970's in the South Georgia region has been documented for several years (e.g., Kock et al. 1985). Of the major finfish resources, the decline in abundance of Notothenia rossii has been the most pronounced; by 1985, Kock (1985a) estimated stock size of N. rossii to be less than 10% of its original unexploited level. Declines in abundance of other species were estimated to be substantial between 1975/76 and 1980/81 (Kock et al. 1985).

Regulation of the South Georgia groundfish fisheries was established in 1984 when the Commission for the Conservation of Antarctic Marine Living Resources adopted measures to rebuild stocks of N. rossii. Those measures included prohibition of commercial fishing within 12 miles of the island of South Georgia, implementation of a 12 mm minimum mesh size in fisheries directed toward N. rossii and Dissostichus eleginoides and implementation of a minimum mesh size of 80 mm in fisheries direction toward Notothenia gibberifrons, Notothenia kempi, Notothenia squamifrons, and Champsocephalus gunnari. The mesh measures were to become effective September 1985. In 1985, the Commission also recommended minimization of by-catch of N. rossii in other fisheries.

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1 Colleagues Dr Jozef Sosinski, Sea Fisheries Institute, Gdynia, Poland and Dr Krzysztof Skora, Marine Field Laboratory at Hel, Institute of Oceanography, Gdansk University Poland have not had the opportunity to review the content of this draft, but should be affiliated as authors because of their substantial past and future involvement and contribution.

The objective of this paper is to evaluate the current status of groundfish stocks, based on comparisons of estimates of stock biomass and length composition from research vessel surveys in 1984/85 (Kock 1985a, Kock 1985b) and 1986/87.

METHODS

Sampling was based on a stratified random survey design, in which stations were allocated to 100 m depth strata (stratum 1: 50–150 m, stratum 2: 151–250 m, stratum 3: 251–500 m) roughly in proportion to the area within each stratum (Everson 1984). Within each stratum, stations were randomly assigned. (The design of Kock (1985a,b) is most similar, and consequently will serve as the basis for most of the comparisons here.)

Thirty minute tows were made by the R.V. Profesor Siedlecki using a Polish B-454 otter trawl equipped with 80 mm mesh and a 20 mm liner. Distance between wing nets averaged 20.6 m, and headrope height was approximately 4 m. (Zaucha pers. comm.). Distance over bottom was recorded to the nearest tenth of a nautical mile (0.18532 km).

A total of 124 tows were accomplished between 29 November and 17 December 1986. Of 111 tows performed along the South Georgia coast, 95 were considered standard (e.g., relatively little or no gear damage) (Figure 1). In the Shag Rocks region, 13 tows were made without a liner, of which 11 were considered standard. Sampling density was 1 successful tow/384 km^2 along the South Georgia region and 1 tow/482 km^2 in the Shag Rocks region. Of the 58 possible division/depth combinations described by Everson (1984), 11 were unsampled, (9.8% of the total area between 50-500 m). Total trawlable biomass was estimated based on stratified swept-area calculations (SURVAN program, Kramer MS).

RESULTS

Notothenia rossii

Notothenia rossii occurred in 28 out of 95 hauls (26%) near South Georgia, primarily along the southeast and northern portions of the island (Figure 2). Eleven tows consisted of only one specimen, and 22 of the 28 hauls contained three individuals or less. A single relatively large haul (457.6 kg) northeast of Cumberland fjords (stratum 2) accounted for over 65% of the total biomass caught. Catch per tow (kg) and total biomass (mt) was lowest in stratum 1 (Table 1).

In light of the relatively large proportion of zero catches and the similarity to a log-normal distribution of the non-zero catches, biomass was estimated based on the delta distribution (Pennington, 1983) and normal distribution (Table 2), to develop more precise estimators.

From the survey data, N. rossii biomass was estimated to be 4 500 mt (from the normal distribution) and 2 400 mt (from the delta distribution). These values are 35% and 19%, respectively, of the 1984/85 estimates. Specimens ranged in length from 27-68 cm, with a mean length of 47.1 cm, and few fish below 40 cm (Figure 3).

Notothenia gibberifrons

Notothenia gibberifrons occurred at 97% of the South Georgia stations and 73% of the Shag Rock stations. Largest catches were obtained north and southeast of South Georgia (Figure 4), with the single largest catch (204.8 kg) contributing 9% of total catch.

Total biomass near South Georgia was estimated at approximately 13 500 mt, over half of which was estimated to occur between 151-250 m, and about one third occurring between 251-500 m (Table 1). Mean lengths of 17.9, 21.3 and 32.0 were observed in strata 1-3, respectively, with an overall mean length of 22.3 cm. Depending on the age-length schedule used,

modes at 8, 16 and 20 cm (Figure 5) would correspond to age groups 1-3, respectively; a mode expected near 26 cm (age 4) is not evident; and the peak at 38 cm would correspond to age 8 fish (1978/79 year class) (Boronin and Frolkina 1976, Shust and Pinskaya 1978, as tabulated in Kock et al. 1985). If alternate age-length schedules are used (e.g., Skora 1980, in Kock et al. 1985), the 21-23 cm values would probably represent age 3-5 fish, with relatively few age 6-8 year olds (25-29 cm). The peak at 37-38 cm would then correspond to age 12 fish, the 1974/75 year class. Biomass at Shag Rocks was relatively low (400 mt), primarily found between 50-150 m. Mean length in stratum 1 was estimated at 34.0 cm and 33.6 cm overall (age 9 under schedule of Skora, 1980; age 6 otherwise), and probably reflects the larger mesh size used there (Figure 6).

Notothenia squamifrons

Notothenia squamifrons occurred at relatively few South Georgia stations (31%) but contributed to some of the largest hauls in the survey (5 226 kg and 2 355 kg/30 min. tow, division 65) (Figure 7). Catch per tow was highest between 251-500 m (on the west/southwest coast) and between 200-250 m (on the northeast coast). The two largest hauls contributed 98% of the total biomass caught of this species. The species also occurred at Shag Rocks, but at much lower densities (Tables 1,2).

Biomass estimates based on a delta distribution were an order of magnitude lower than those based on a normal distribtion, 9 000 vs. 40 000 mt, respectively (Table 2); and the former estimate appears more realistic, as distribution of haul values is described by the delta distribution much more accurately than the normal. Specimen lengths range from 10 to 49 cm (Figure 8), with overall mean length of 35.0 cm and modes at 14 cm, 29 cm and 40-42 cm. Patterns at Shag Rocks were less regular (Figure 9), based on only the 45 specimens caught in that region.

Patagonotothen brevicauda guentheri

This species occurred only in the Shag Rocks region (division 89, Everson 1984) in the two shallowest strata (Table 1). All observed lengths fell between 9 -22 cm, except for a single specimen at 27 cm. Modes were observed at 13 and 17 cm in both strata; however, the 13 cm mode was more pronounced at shallower stations (between 50-150 m) (Figure 10). Biomass estimates appear unrealistically low, below recent reported catch levels and an order of magnitude lower than previous survey estimates (Kock, 1985b) (Table 2).

Dissostichus eleginoides

Catches of Dissostichus eleginoides were largest at stations between 251-500 m in South Georgia and between 151-250 m at Shag Rocks (Table 1, Figure 11). The species occurred at 37% of the stations from South Georgia at catch rates between 0.1-86.0 kg/tow. At Shag Rocks, the species was ubiquitous, occurring at ten out of eleven of the stations, at catch rates between 1.0-32.0 kg/tow.

Total biomass was estimated at 2 600 mt, with about one third of the biomass contributed by the Shag Rocks region (Table 2). Mean lengths of 16.6, 32.4 and 48.8 cm were observed from South Georgia strata 1-3, with an overall mean of 44.7 cm (Figure 12). At Shag Rocks, overall mean length was estimated at 38.3 cm (Figure 13). Length frequency distributions from both areas showed modes around 16-17 cm, 27 cm, 37-38 cm, 44-47 cm and 52-53 cm, with only a few individuals greater than 55 cm.

Champsocephalus gunnari

Champsocephalus gunnari was ubiquitous throughout the survey region, occurring at all stations at South Georgia and nine out of eleven stations st Shag Rocks (Figure 14). Catch per tow ranged from 0.2-879.5 kg/30 min tow. Most biomass was concentrated between 151-250 m (Table 1).

Biomass estimates of 61 000 mt in 1986/87 are comparable to below median levels observed between 1978-80 from virtual population analysis. The overall coefficient of variation of the biomass estimate (17.6%) is below the average for survey indices for Northwest Atlantic demersal species (NEFC, MS). Mean fish length by stratum increased with depth from 22.4 to 26.5 and 27.5 cm in strata 1-3 (South Georgia), respectively, averaging 25.2 cm overall (Figure 15). Modes at 14, 22 and 26 cm correspond to fish aged 1, 2 and 3. The shift in the length frequency distribution to a mode at 24 cm on Shag Rocks (Figure 16) may reflect differential distribution of the year class by size, and more likely, the use of unlined 80 mm mesh in that area.

Pseudochaenichthys georgianus

Highest catch rates of Pseudochaenichthys georgianus were obtained from stations on the eastern side of South Georgia, at depths greater than 151 m (Figure 17, Table 1). The species occurred at 79% of the South Georgia stations at catch rates between 0.1-58.0 kg/tow.

Total biomass was estimated at 5 200 mt, slightly over half of which was concentrated between 151-250 m. Overall mean length was 37.2 cm, with a strong mode at 33-34 cm, probably representing age 3 fish (Figure 18). The upper mode(s) (48-51 cm) probably include fish aged 6-7 or 8 (depending on published curve used) (Kock et al. 1985).

Chaenocephalus aceratus

Chaenocephalus aceratus was most abundant in the eastern and southeastern shelf of South Georgia (Figure 19), primarily at depths between 151-250 m (Table 1). The species was observed at 84% of the South Georgia stations; maximum catch in a single haul was 162.4 kg.

Total biomass was estimated at 11 700 mt. Observed lengths ranged between 13-76 cm, with an overall mean length of 34.2 cm (Figure 20). In contrast to most patterns of increasing fish size with depth, mean length in this case decreased with depth, from 49.8 to 34.8 and 32.3 cm in strata 1-3, respectively. A combined series of three adjacent stations north of Clerke Rocks between 250-500 m produced 19% of the total number of individuals estimated caught, with a strong mode at 25 cm. Seventy-one fish were measured from stations in stratum 1, representing almost the entire catch from the stratum; 89% of those fish were 40 cm or above. Successive modes in the length frequency distribution of 15, 25, 34, 42 and 50 cm correspond to published mean lengths at ages 1, 2, 3, 5 and likely 6 (Kock et al 1985); an expected mode corresponding to age 4 fish between 36-40 cm was not present. Length at 50% maturity has been estimated at around 46-47 cm (approximately age 6) and 95% maturity between 52-57 cm approximately age 7 (Kock et al. 1985). Consequently, it appears that about 10% of the population is between 50-95% mature (e.g. 46-51 cm) and only 12% of the current population is fully sexually mature (e.g. $\geq$52 cm).

DISCUSSION

Even though biomass estimates of N. rossii by Kock (1984a) and this study have relatively large associated variances, it is far more likely that the stock has continued to decline in recent years rather than stabilizing or rebuilding. The two largest single hauls in this study were both only 10% of the two largest hauls observed in 1984/85. The mean length (47.1 cm) was almost 3 cm smaller than observed in 1984/85 (49.9 cm), and was close to the length at 50% maturity for females (Kock 1986a); the mode has also shifted downward from 50 to 44 cm. (It remains to be investigated if length at sexual maturity has continued to decrease since 1984/85 (Kock 1985a)).

Biomass estimate for N. gibberifrons of 15 800 mt in 1984/85 and 14 000 mt in 1986/87 are not significantly different given the variability of the estimates. Based on length frequency distributions from South Georgia, recruitment appeared to be declining in recent cohorts in the

25-29 cm length range : the peak at 38 cm is consistent with the large 1974/75 year class identified in previous virtual population analyses, when consistent age/length schedules are used. Relatively large numbers of pre-recruits (<25 cm) may provide some opportunity to improve the status of this stock in the near future.

The extremely low biomass estimate for P. b. guentheri likely reflects the use of bottom trawl to sample a semi-pelagically distributed species. In that case, the difference in headrope height between this survey (approximately 4 m.) and the Federal Republic of Germany survey (6 m.) may also contribute to the lower estimate. Modes in the length frequency observed in this study are consistent with those observed by Kock (1985b), if interpreted using a growth curve developed by Soviet investigaotrs (Anon. 1984). In that case, modes observed in 1984/85 at 10 and 15 cm in January/February would correspond to fish ages 2 and 3 (1982/83 and 1981/82 year classes) (Figure 21). Modes observed here (November) at 13 and 17 would correspond to fish ages 3 and 4 (1983/84 and 1982/83 year classes), while the shoulder at 19 cm would correspond to fish age 5 (1981/82 year class). In that context, the low proportion of individuals greater than 16 cm observed by Naumov et al. (1983) in February 1978/79 may reflect low abundance of fish above age 3, or poor recruitment in year classes before 1976/77. This would be consistent with reports of no commercial catches of P. b. guentheri before 1978/79.

The estimated biomass of Dissostichus eleginoides is about 70% lower than in 1984/85 (Kock 1985b). Length frequency distributions contain few individuals over 55 cm, in contrast to 1984/85, when a significant proportion of fish were between 55-70 cm. Currently, nearly all of the population is likely to be sexually immature (Kock et al., 1985).

The 1987 estimate of C. gunnari biomass is three to four times that found by the 1985 Federal Republic of Germany survey (Kock 1985b, Table 2). Biomass estimates for this species are conservative : a) additional fish were observed using hydroacoustic gear at heights above the headrope during trawling and b) additional individuals on Shag Rocks may have been present but not retained by the mesh. The increase appears to be due to the

relatively strong presence of age 2 fish. Part of this cohort is already vulnerable to the fishery, based on length frequency results from 80 mm mesh used on Shag Rocks. The 1985/86 year class looks relatively small, however.

Biomass estimates of Ps. georgianus have dropped by about a third since 1984/85 (Kock 1985b). Length frequency distributions indicate a relatively strong 1983/84 year class that would be expected to reach length of 50% maturity by the end of 1987/88 or the beginning of 1988/89.

Although estimates of biomass of C. aceratus have been relatively constant over time (10 013 mt, 1982/83 (Slosarczyk et al. 1984); 11 542 mt, 1984/85 (Kock 1985b); 11 742 mt 1986/87), the age structure of the population appears to have changed markedly, even since 1984/85. When length frequencies 30 cm or greater are considered, in 1984/85 about half the fish were at or above length of 95% maturity and a quarter of fish were below length of 50% maturity (Kock 1985b). By 1986/87, the situation was reversed : half the fish were below length of 50% maturity and about a quarter were at or above length of 95% maturity. Thus, although biomass estimates appear stable, the fraction of the biomass that is sexually mature seems to be decreasing, with the attendant increasing risk of recruitment overfishing.

ACKNOWLEDGEMENTS

We are especially grateful for the long hours by the participating scientists from the Sea Fisheries Institute and the deck crew of the R.V. Profesor Siedlecki during this cruise; as well as volunteer assistance by personnel from the British Antarctic Survey, Smithsonian Institute, Southeast Fisheries Center, University of Hawaii and Moss Landing Marine Laboratory.

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Table 1 Estimates of mean trawlable biomass and coefficients of variation by depth strata, November–December 1986/87.

	Stratum							
	50 - 150 m.		151 - 250 m.		251 - 500 m.		Combined	
	Minimum biomass (mt)	Coef. var. (%)	Minimum biomass (mt)	Coef. var. (%)	Minimum biomass (mt)	Coef. var. (%)	Minimum biomass (mt)	Coef. var. (%)
N. rossii								
South Georgia	131	38.7	3636	83.9	761	95.1	4528	69.2
N. gibberifrons								
Shag Rocks	349	54.4	51	46.5	-	-	400	47.9
South Georgia	1920	47.7	7567	15.8	4057	33.0	13544	14.9
N. squamifrons								
Shag Rocks	-	-	22	64.0	15	99.8	37	55.6
South Georgia	3	99.6	59	52.1	39930	76.3	39991	76.2
P. b. guentheri								
Shag Rocks	119	94.6	224	48.4	-	-	343	45.5
D. eleginoides								
Shag Rocks	202	40.7	433	57.1	335	99.8	969	43.7
South Georgia	5	85.7	50	36.4	1546	35.2	1601	34.0
C. gunnari								
Shag Rocks	5551	87.4	4992	60.8	-	-	10543	54.3
South Georgia	10224	62.7	32634	18.5	7556	29.5	50414	18.0
Ps. georgianus								
South Georgia	483	44.4	3253	20.2	1503	25.1	5240	15.0
Ch. aceratus								
South Georgia	551	40.2	7659	16.2	3533	21.7	11743	12.6
Number of hauls								
Shag Rocks	3		6		2		11	
South Georgia	19		47		29		95	

Table 2 Comparisons of estimates of mean trawlable biomass, standard deviation and coefficient of variation based on normal and delta distributions, November-December 1986/87, and relative to estimates by Kock (1985), January-February 1984/85.

	Shag Rocks			South Georgia			Combined		
	Minimum biomass (mt)	Std. dev.	Coef. var. (%)	Minimum biomass (mt)	Std. dev.	Coef. var. (%)	Minimum biomass (mt)	Std. dev.	Coef. var. (%)
N. rossii	-	-	-	4528	3134	69.2	4528	3134	69.2
Delta	-	-	-	2384	994	41.7	2384	994	41.7
Kock (1985)							12781	12768	99.9
N. gibberifrons	400	191	47.9	13544	2018	14.9	13944	2027	14.5
Kock (1985)							15762	4476	28.4
N. squamifrons	37	21	55.6	39991	30468	76.2	40028	30468	76.1
Delta	39	23	59.0	8997	6133	68.2	9036	6132	67.9
P. b. guentheri	343	156	45.5	-	-	-	343	156	45.5
Kock (1985)							7256	3417	47.1
D. eleginoides	969	423	43.7	1601	545	34.0	2570	690	26.8
Kock (1985)							8159	6242	76.5
C. gunnari	10543	5723	54.3	50414	9073	18.0	60957	10727	17.6
Kock (1985)							15821	16042	101.4
Ps. georgianus	-	-	-	5240	787	15.0	5240	787	15.0
Kock (1985)							8134	2684	33.0
Ch. aceratus	-	-	-	11743	1478	12.6	11743	1478	12.6
Kock (1985)							11542	4686	40.6

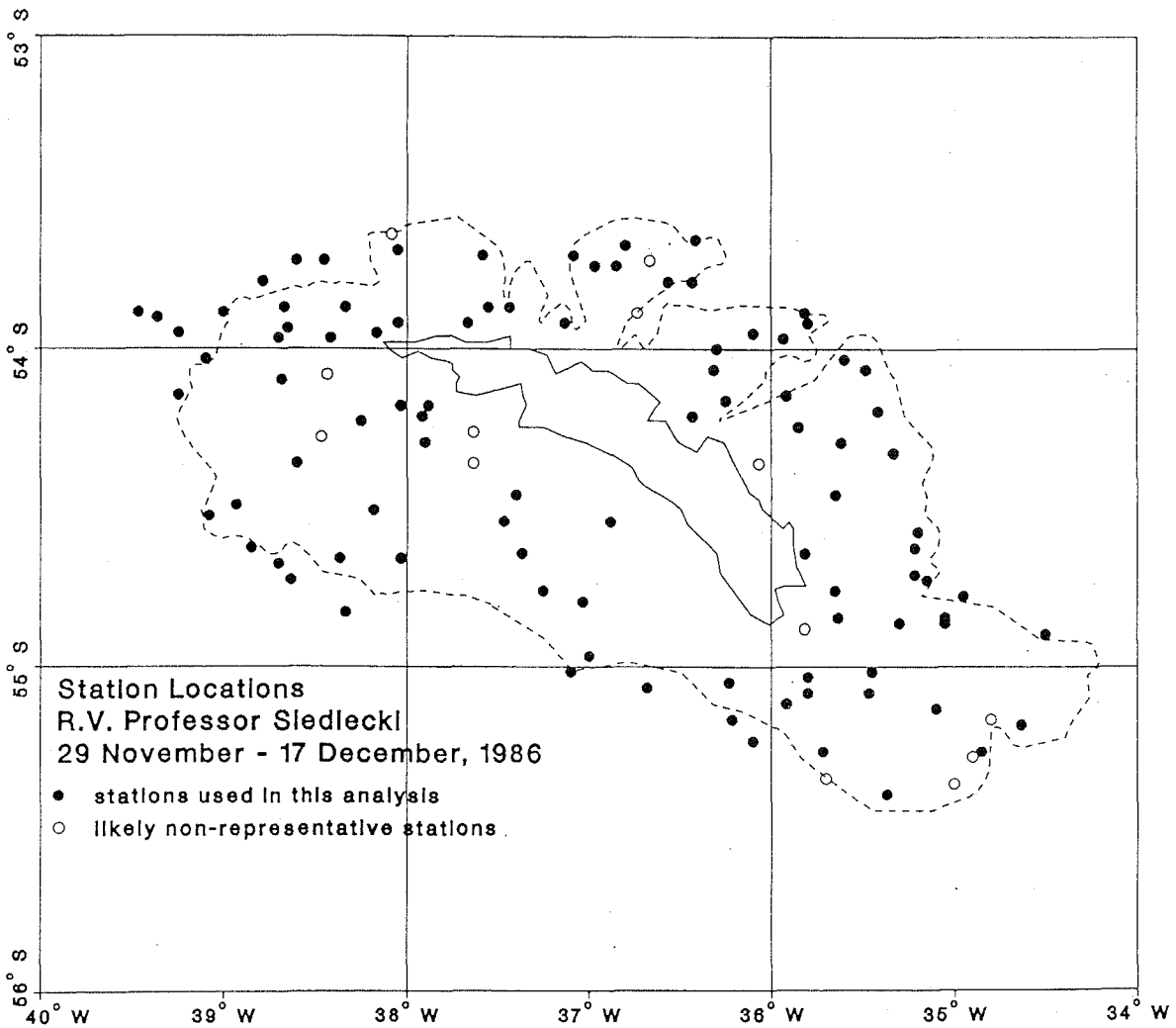


Figure 1. Station locations, South Georgia, R.V. Profesor Siedlecki, 29 November - 17 December 1986.

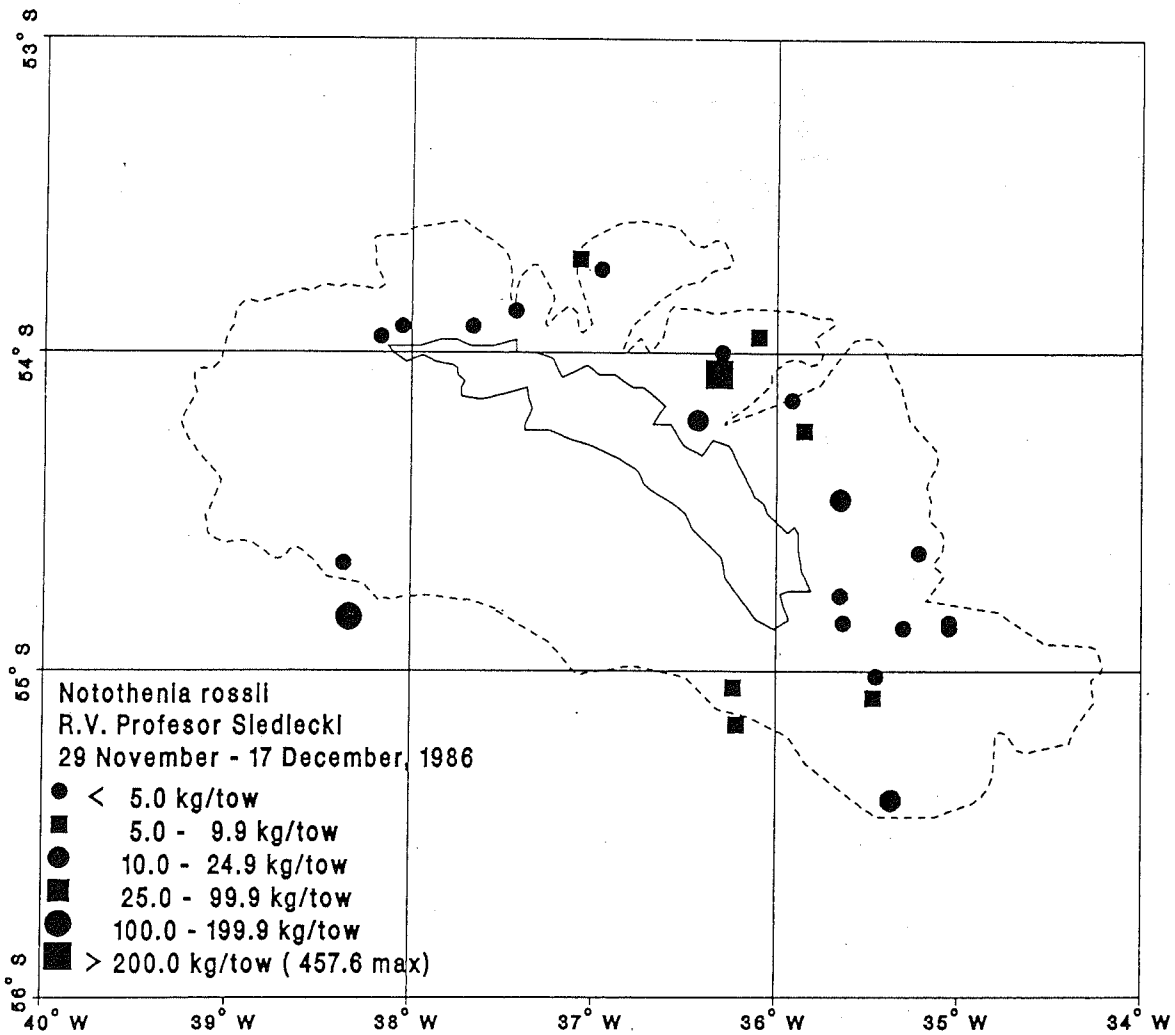


Figure 2. Distribution of catch per tow, Notothenia rossii, South Georgia.

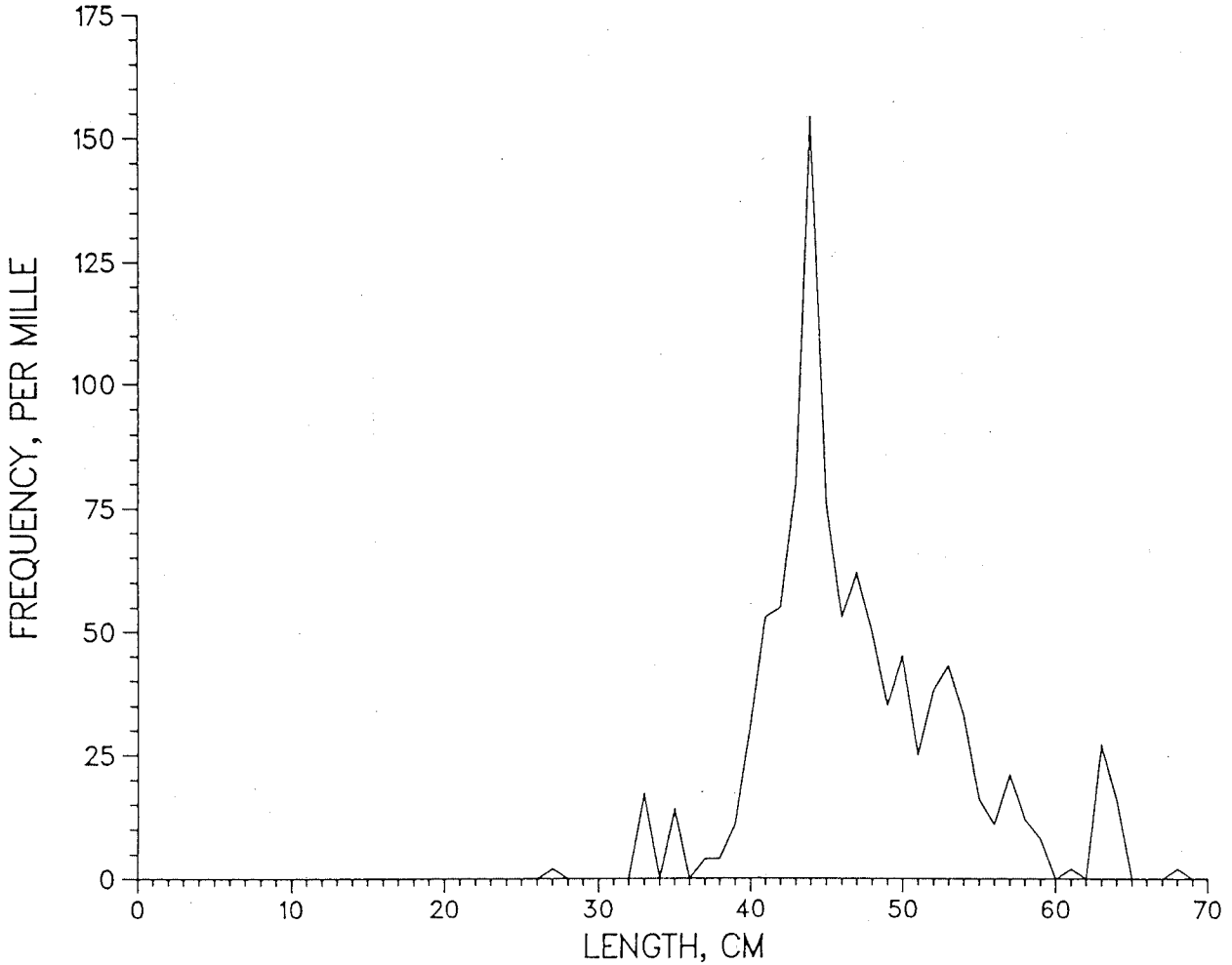


Figure 3. Length frequency distribution, N. rossii, South Georgia.

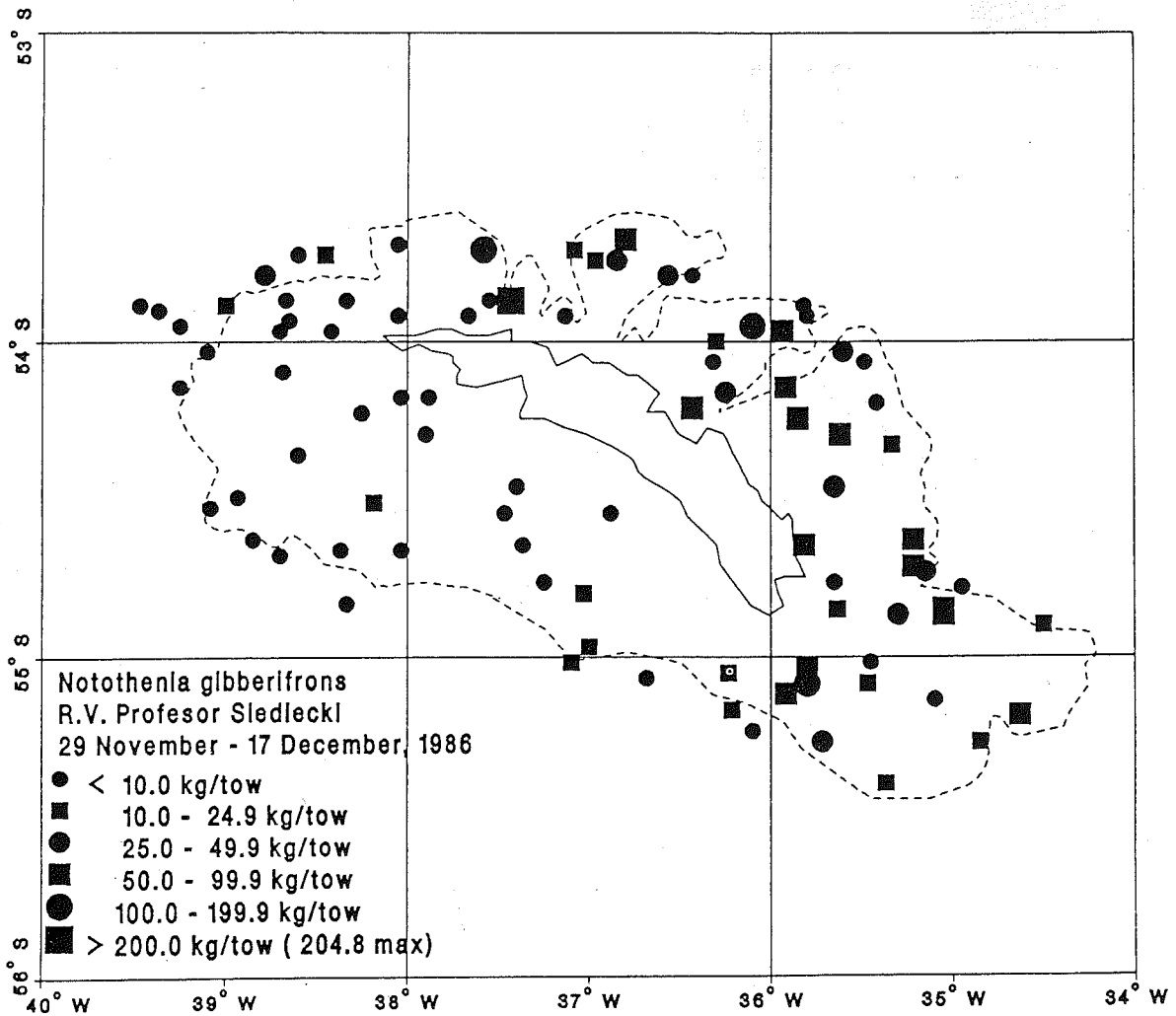
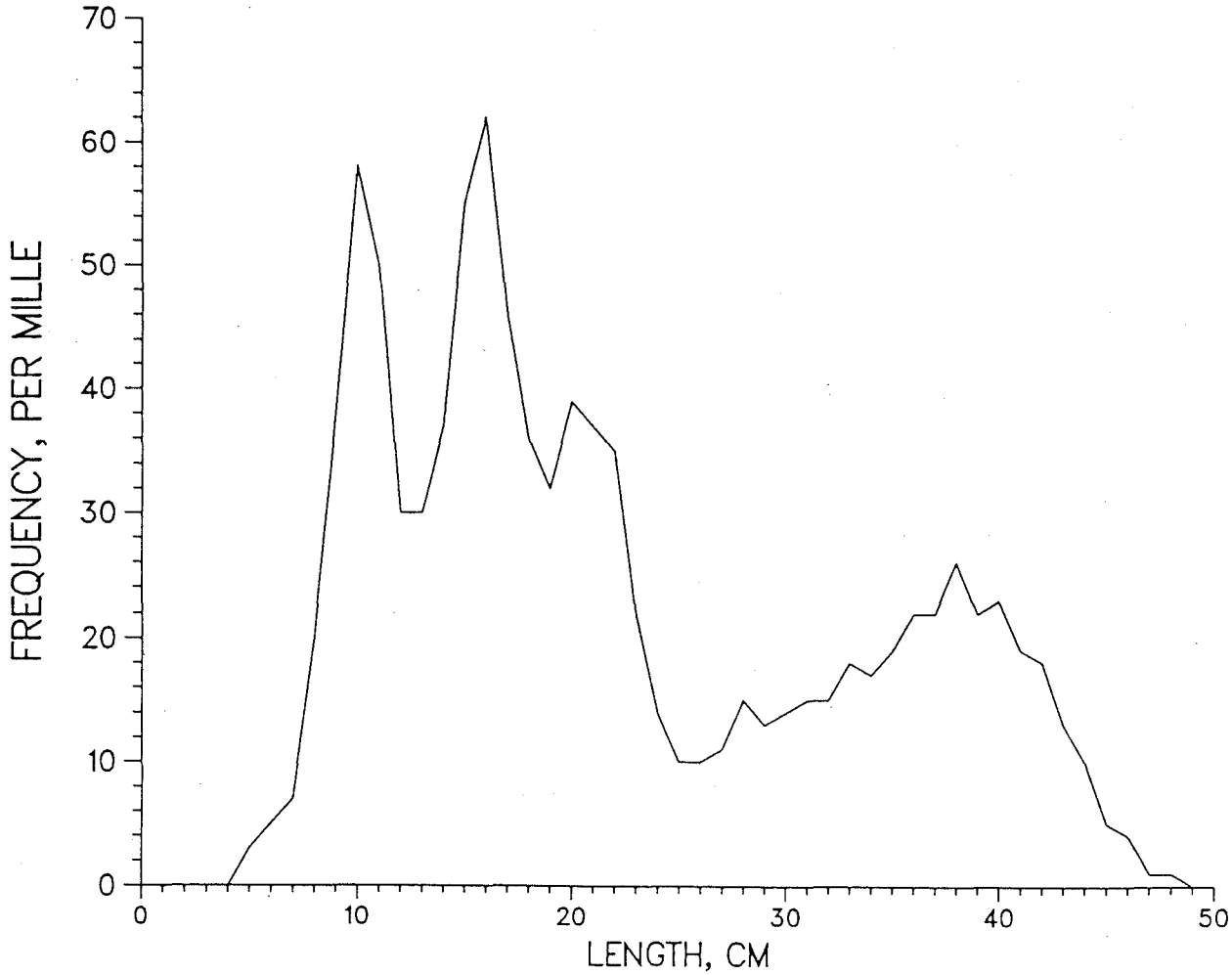


Figure 4. Distribution of catch per tow, Notothenia gibberifrons, South Georgia.



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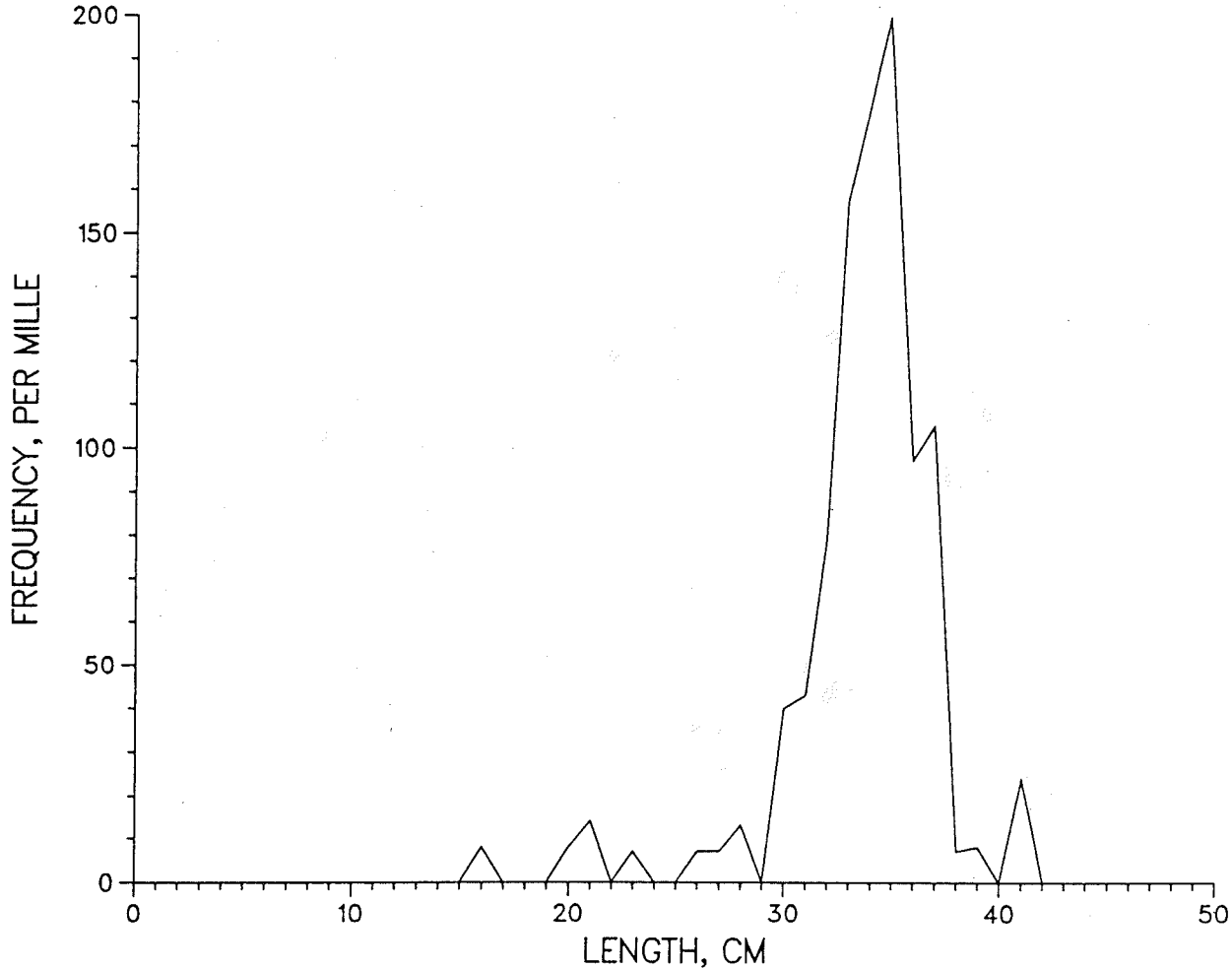

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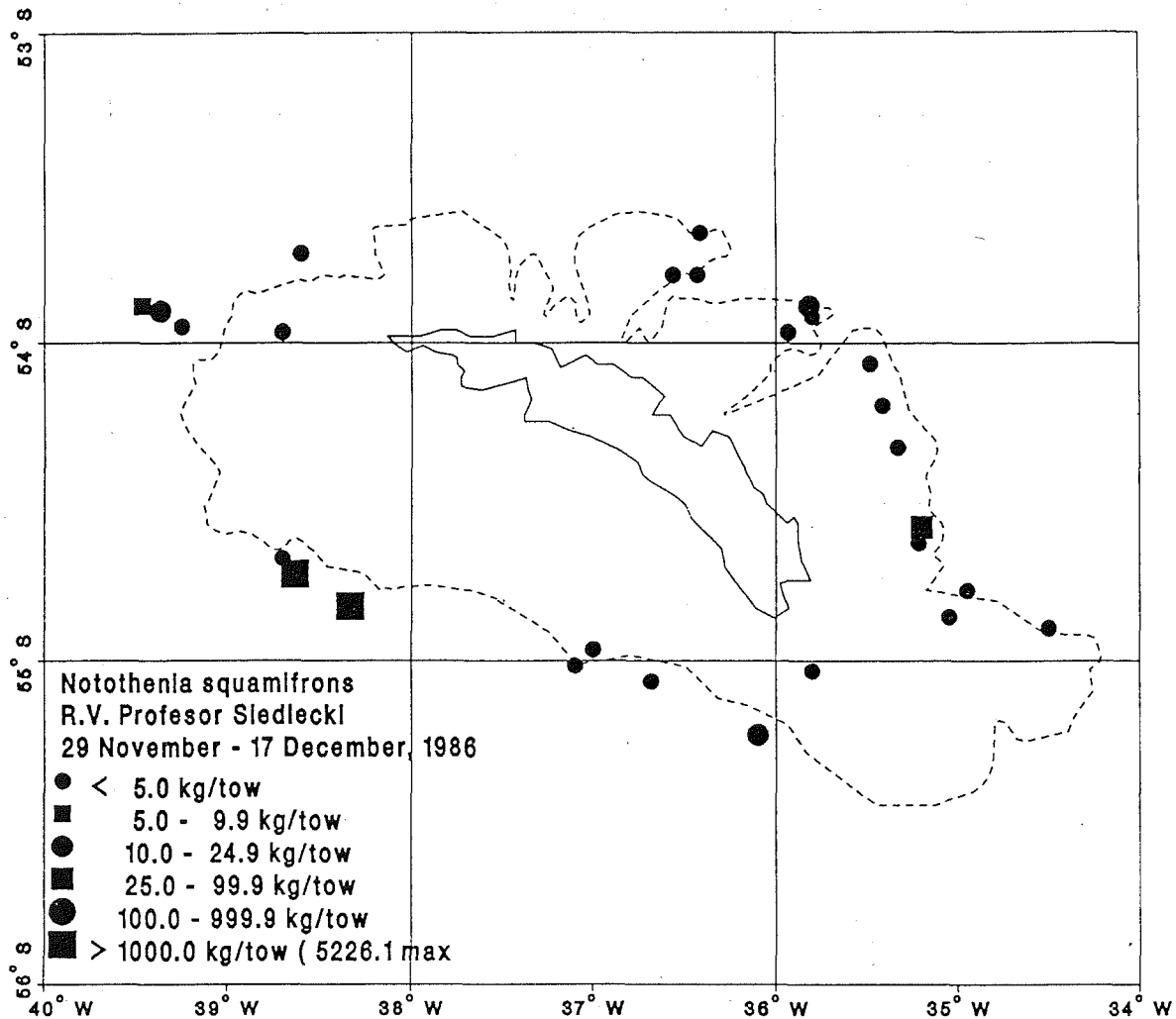

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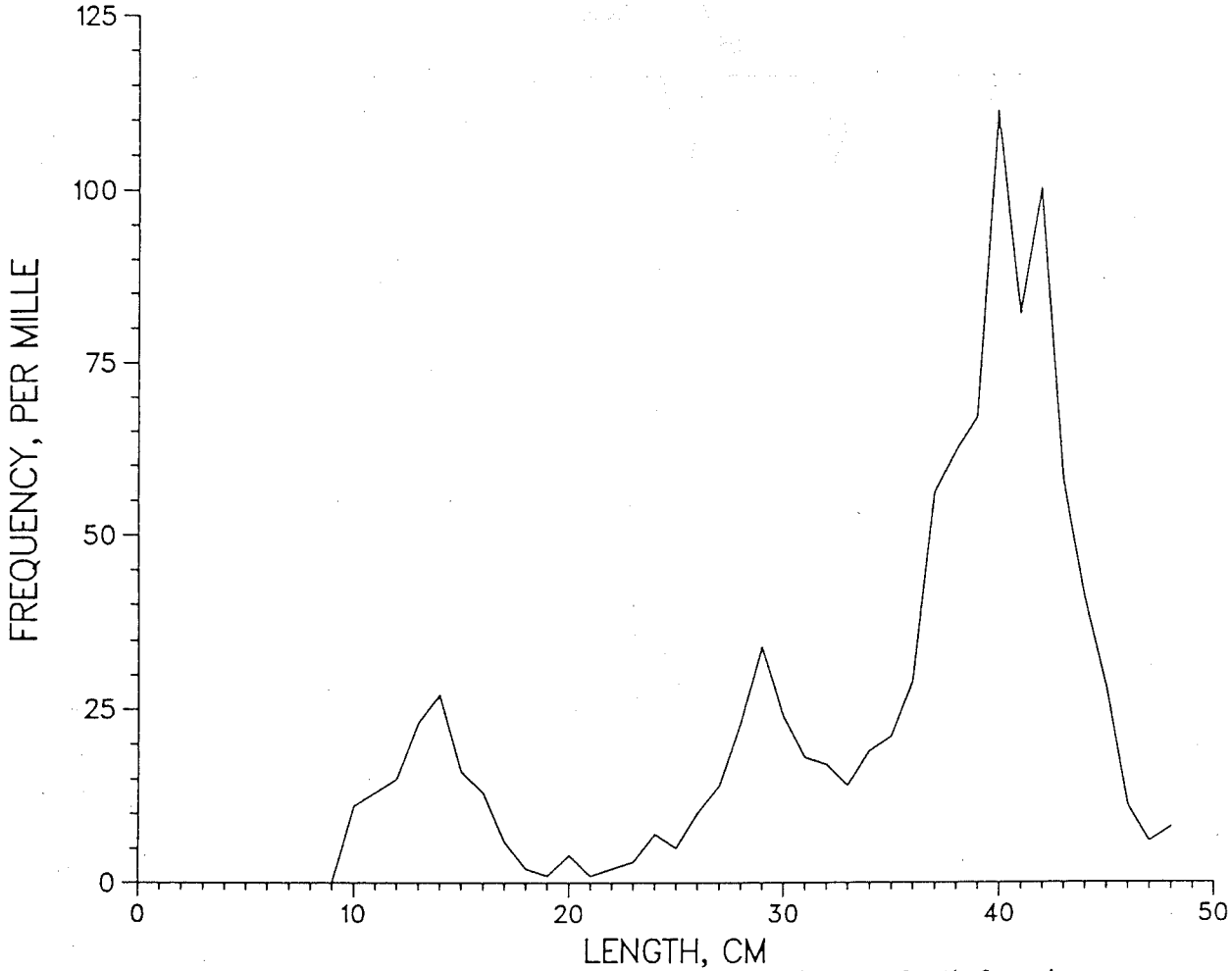

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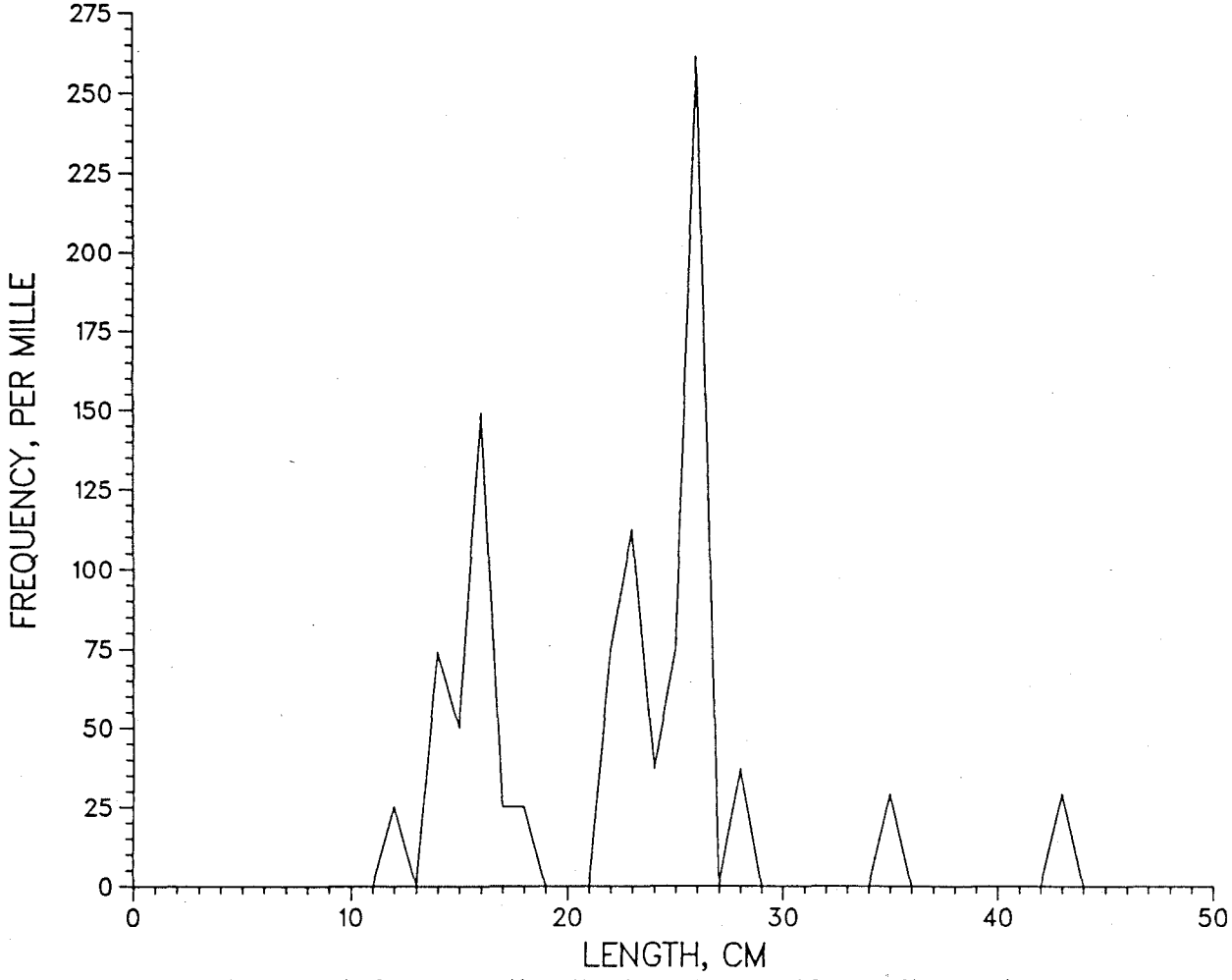

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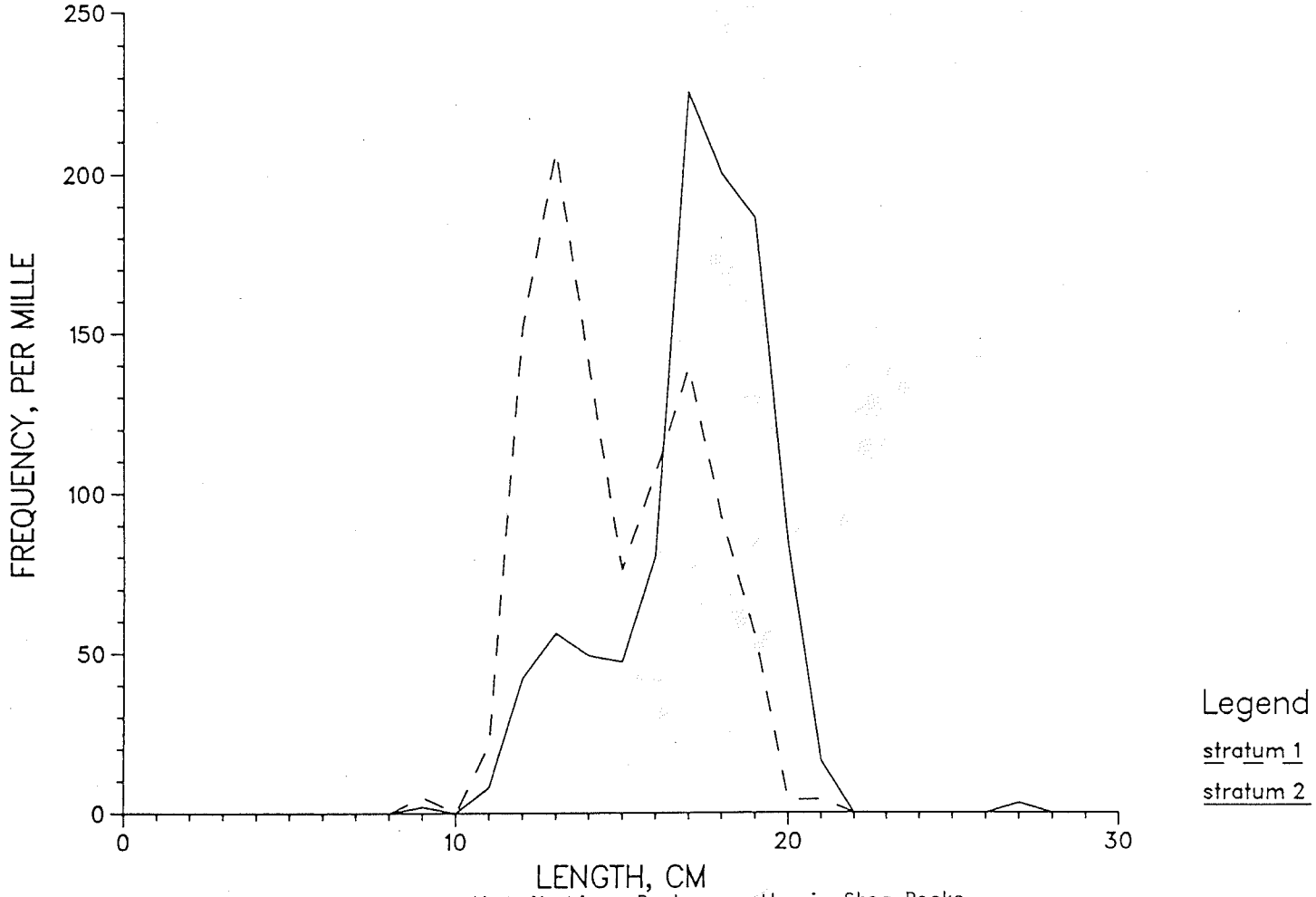
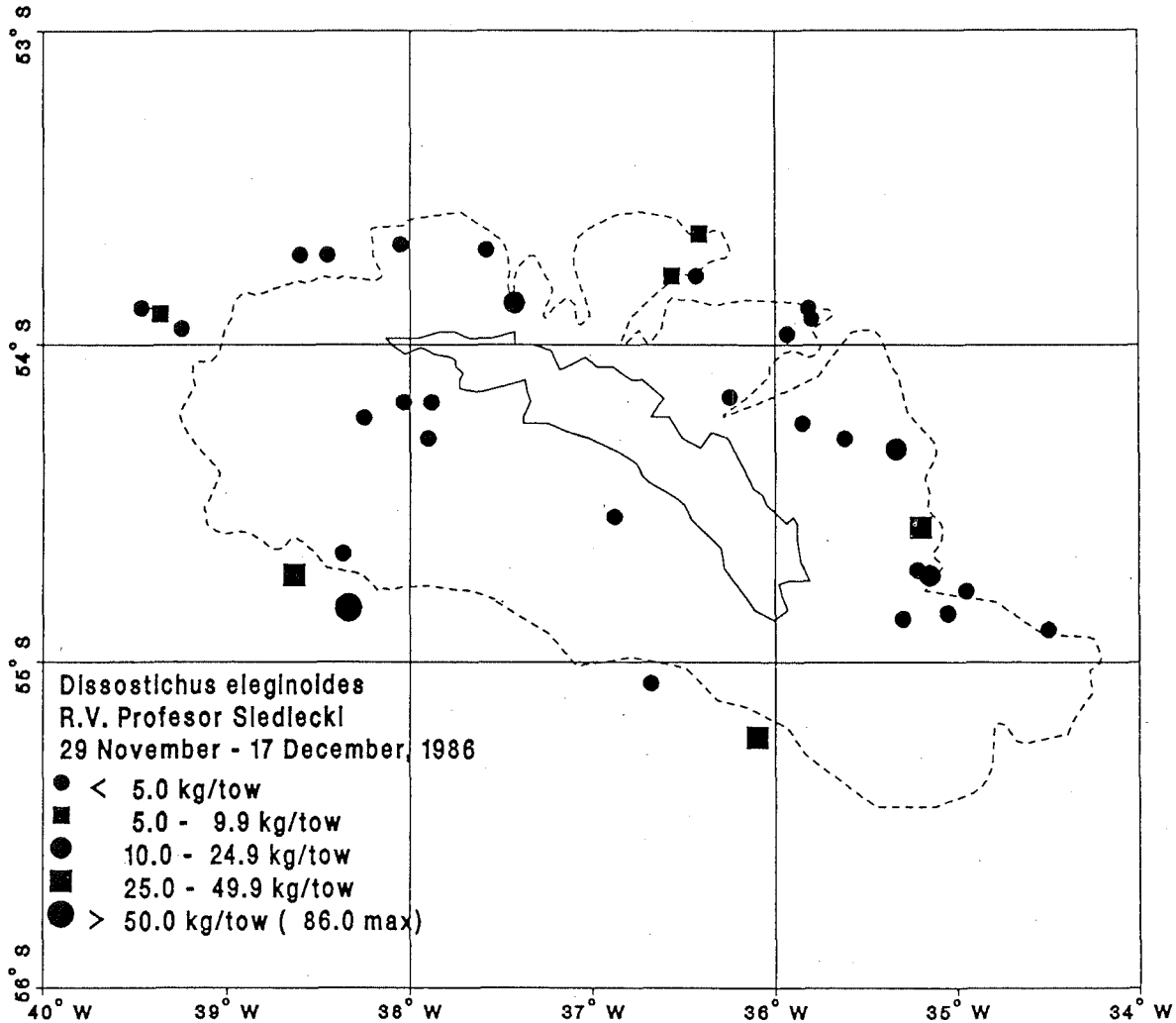


Figure 10. Length frequency distribution, P. b. guentheri, Shag Rocks.



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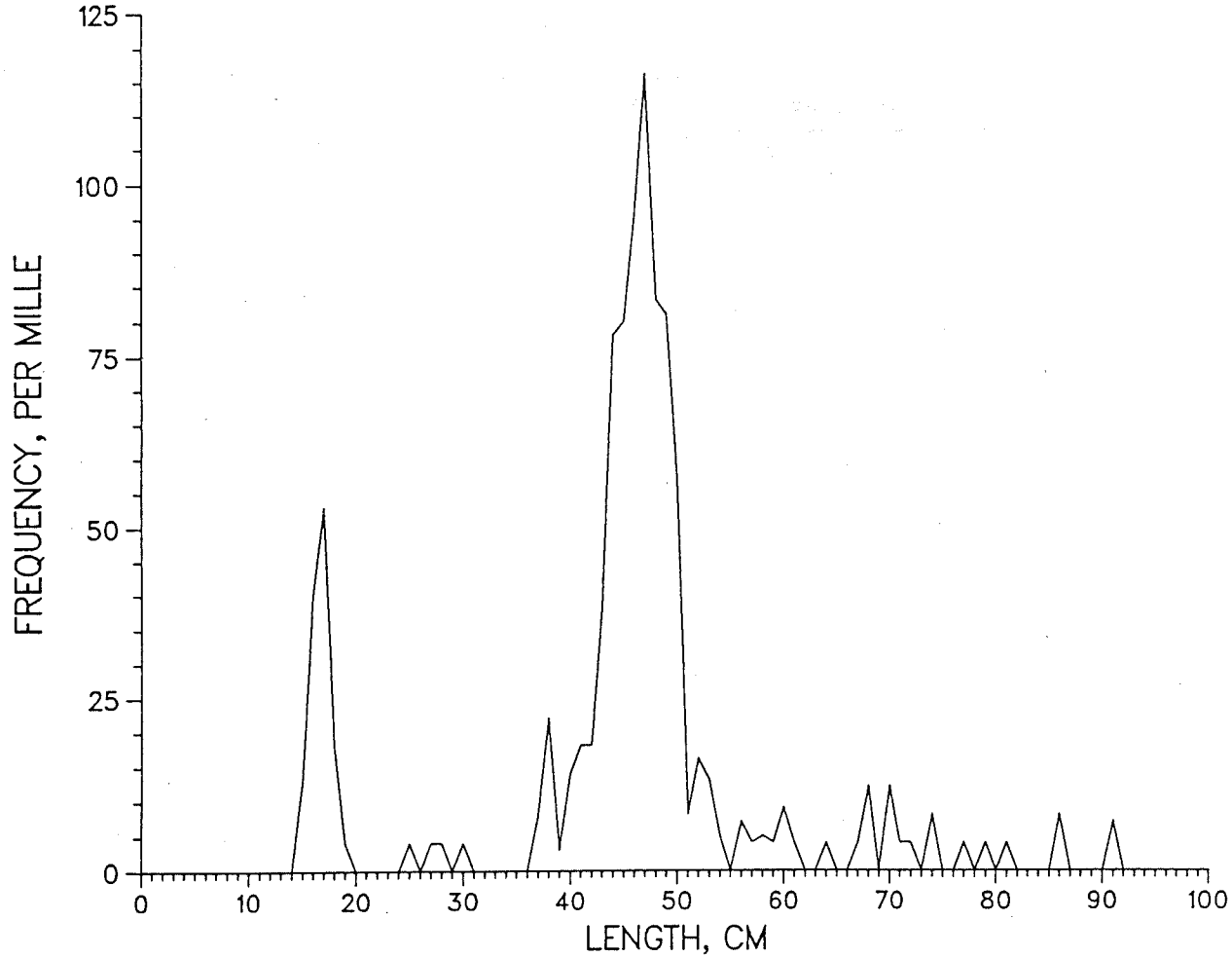

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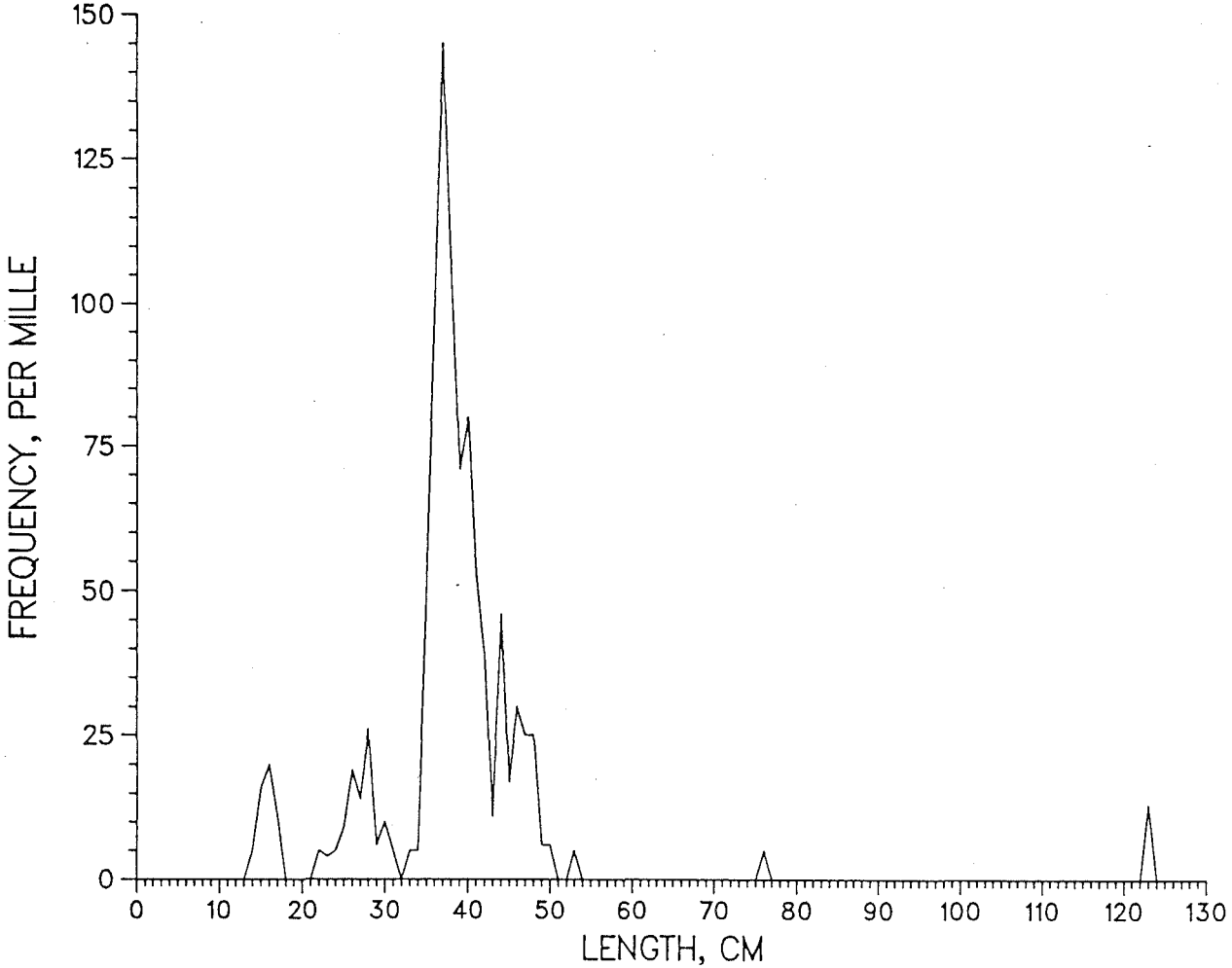

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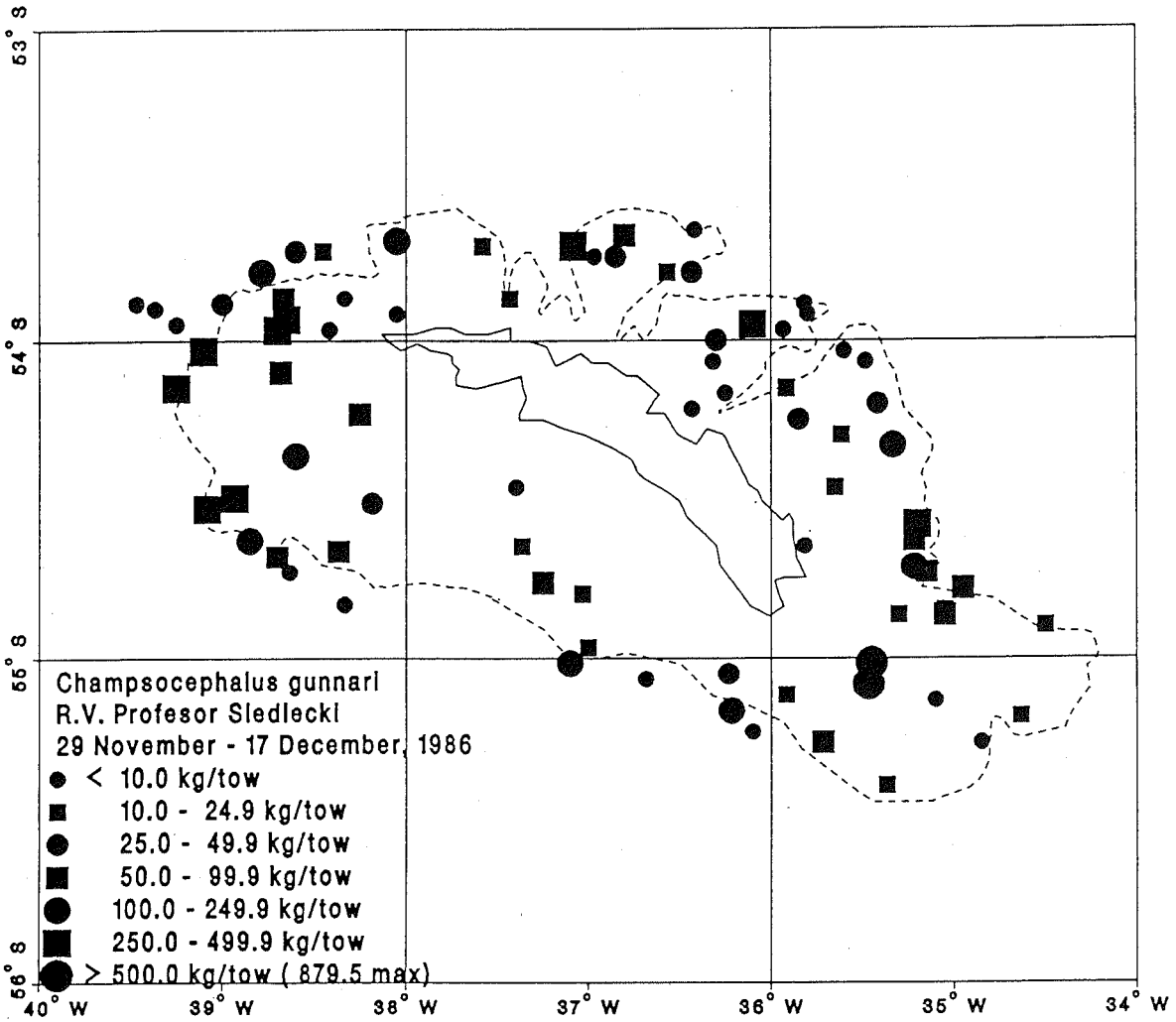

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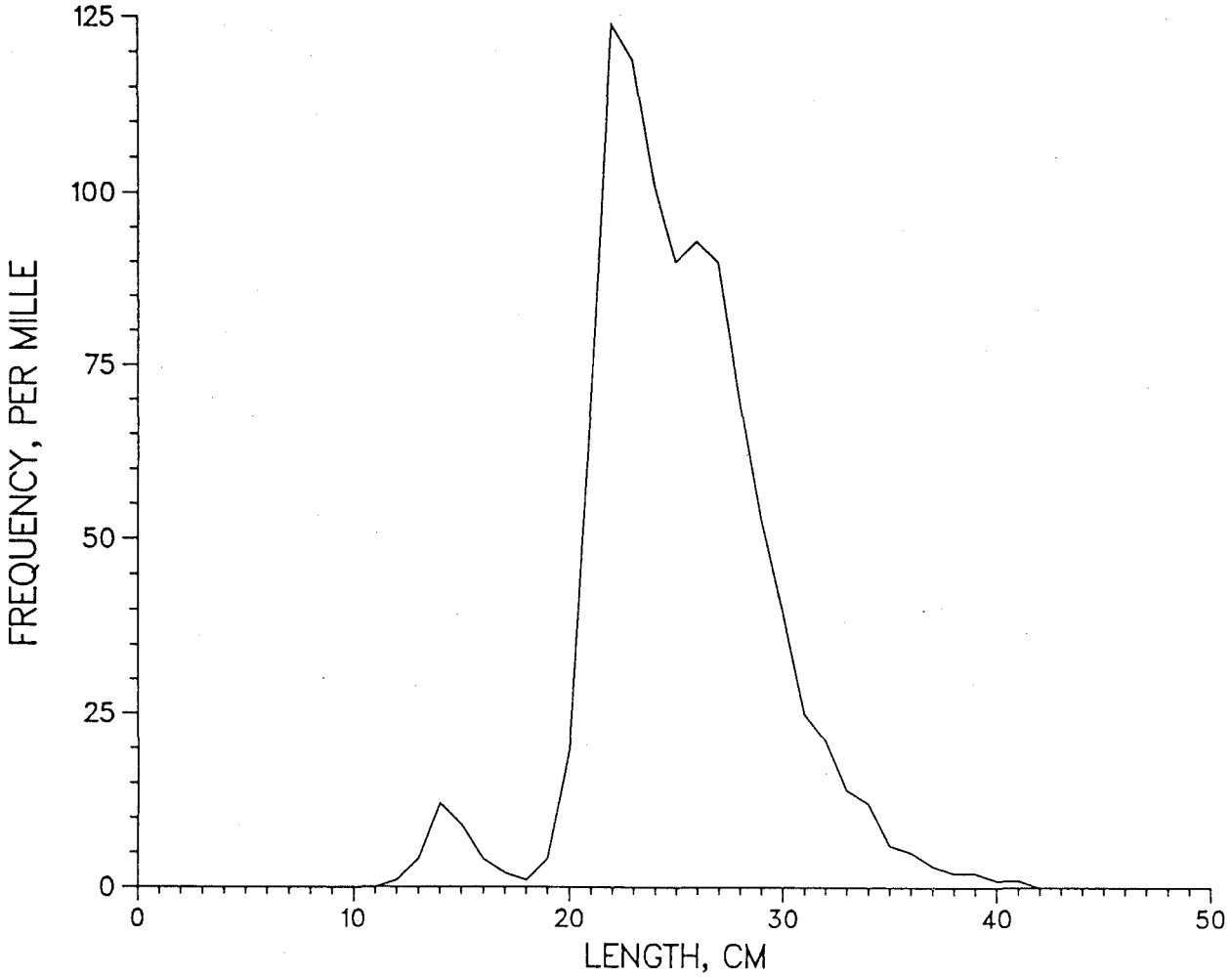

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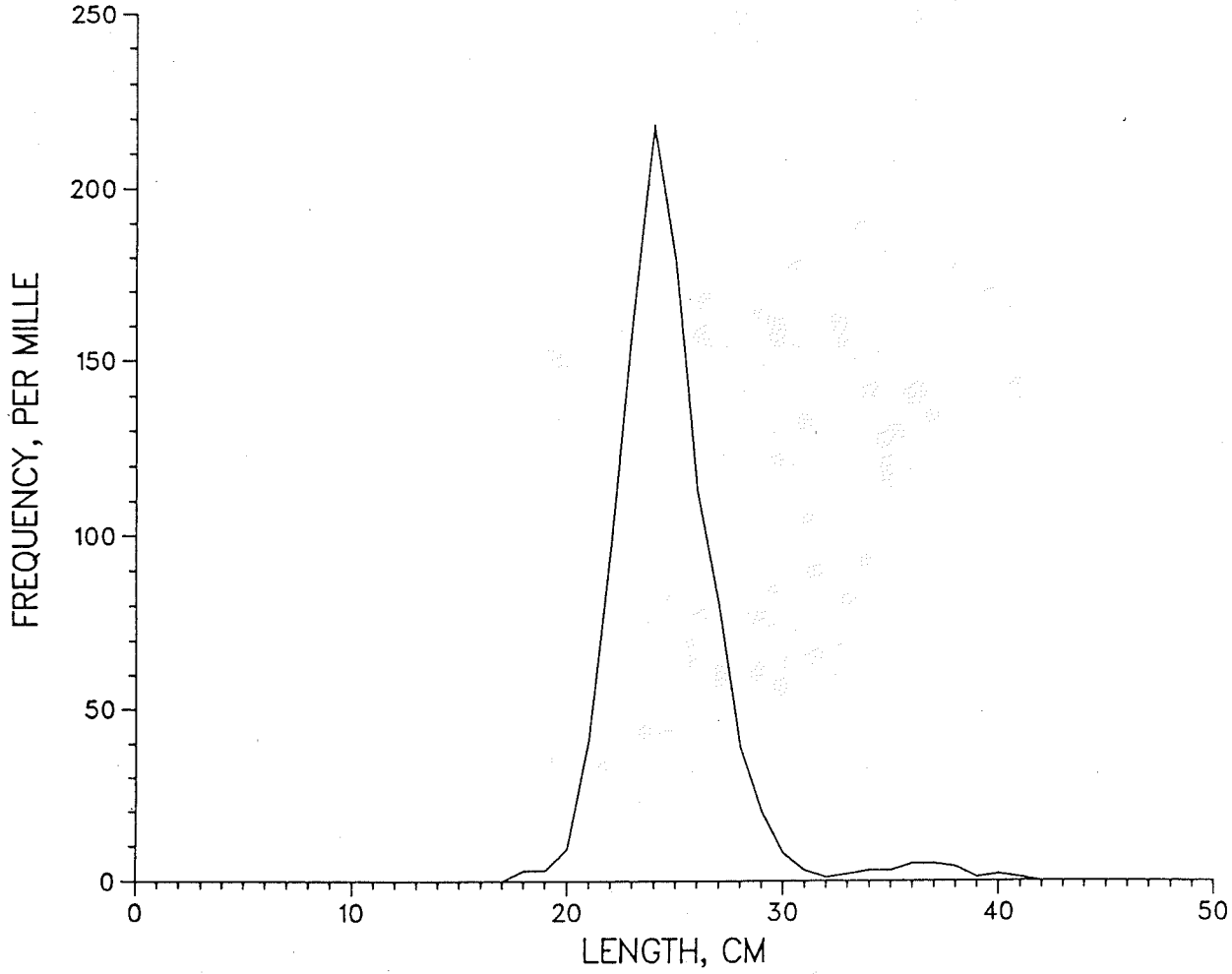

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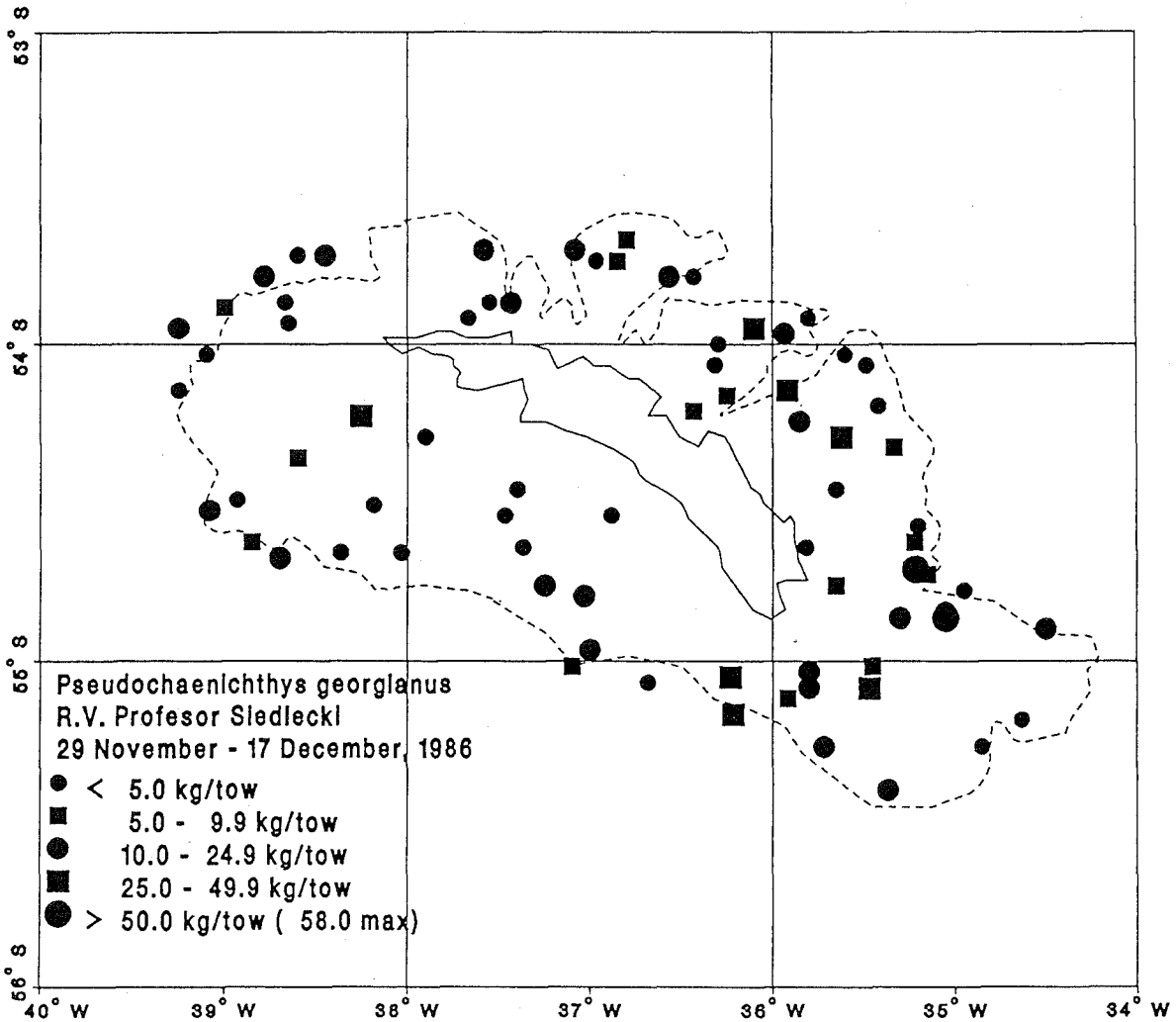

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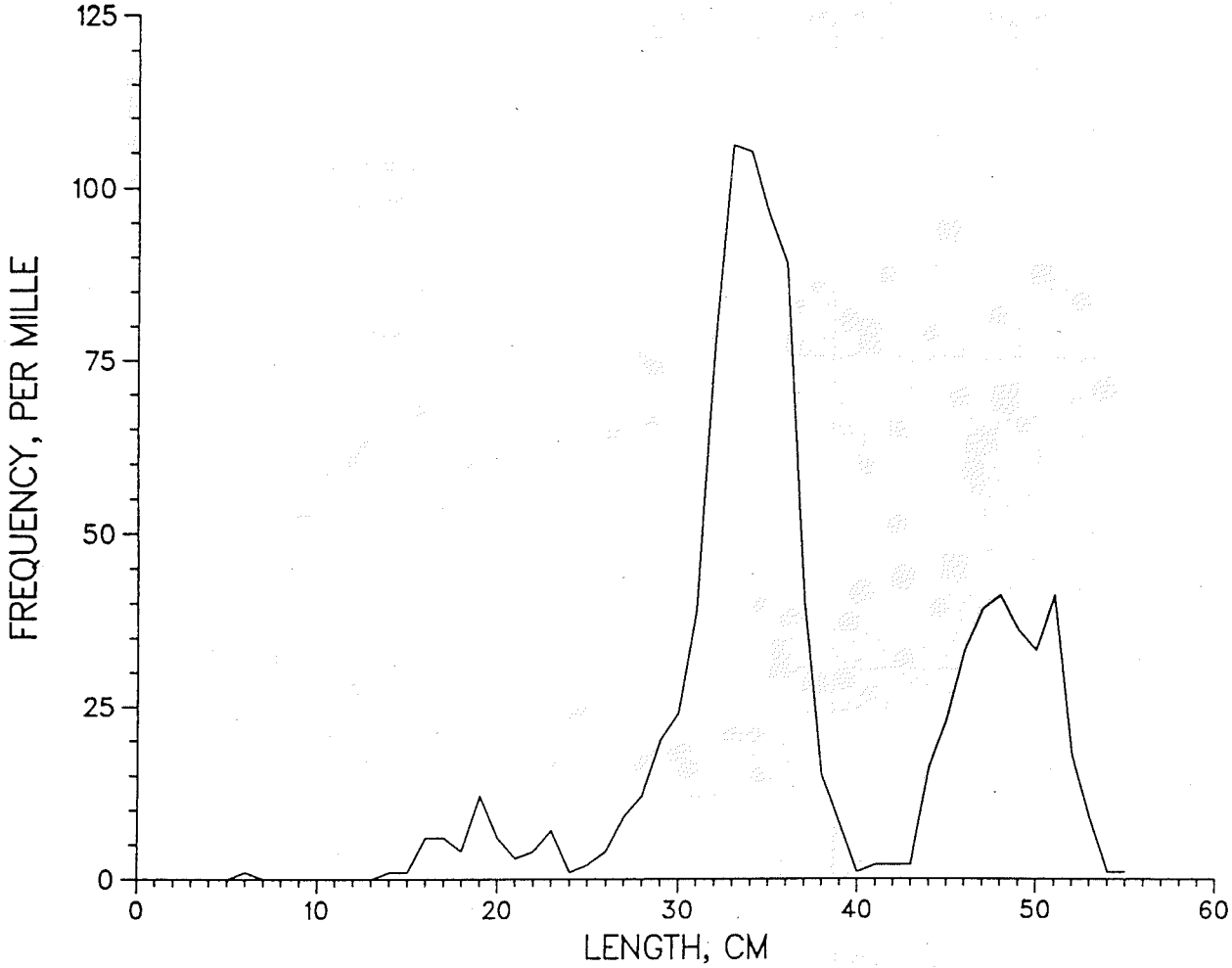

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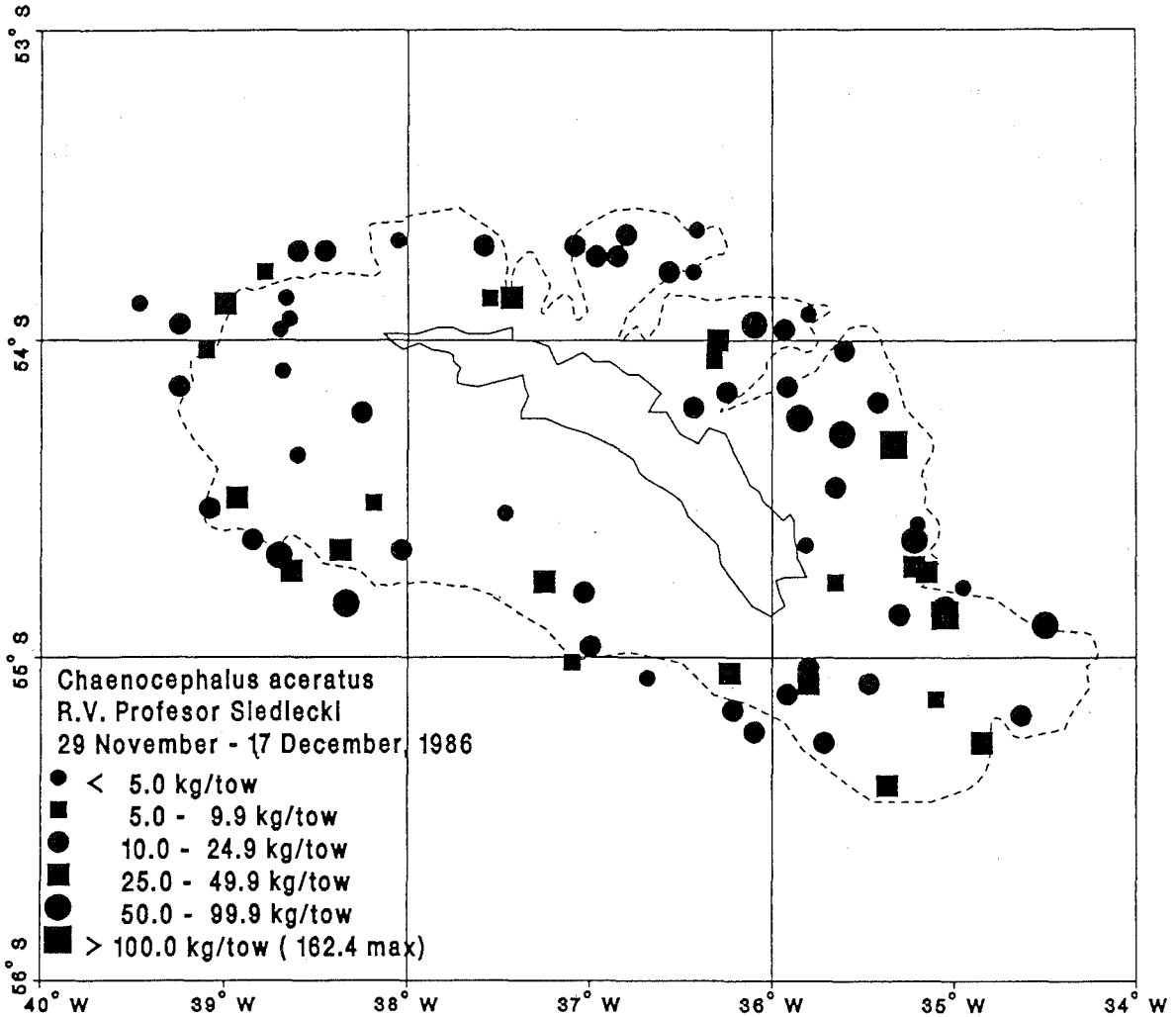

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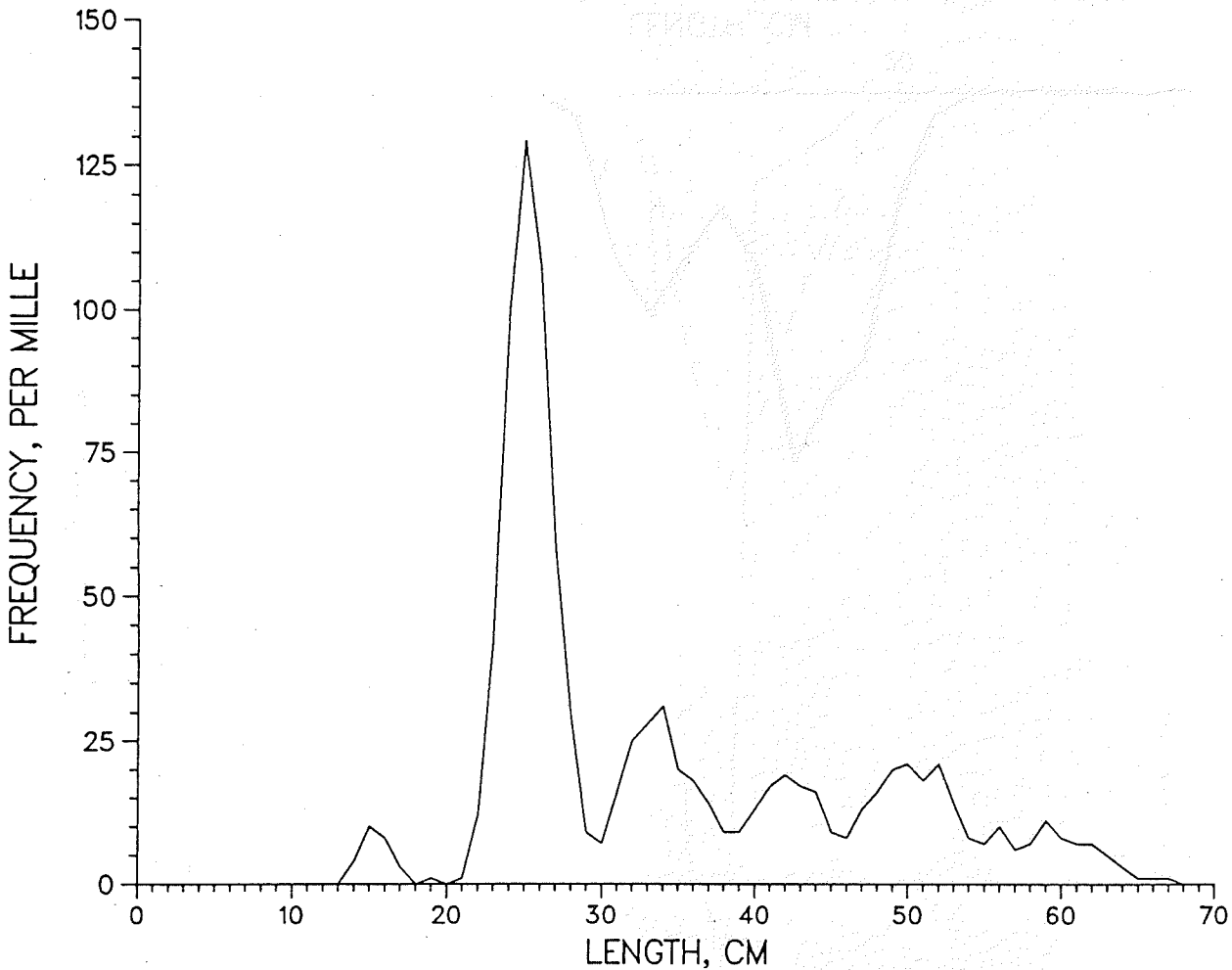

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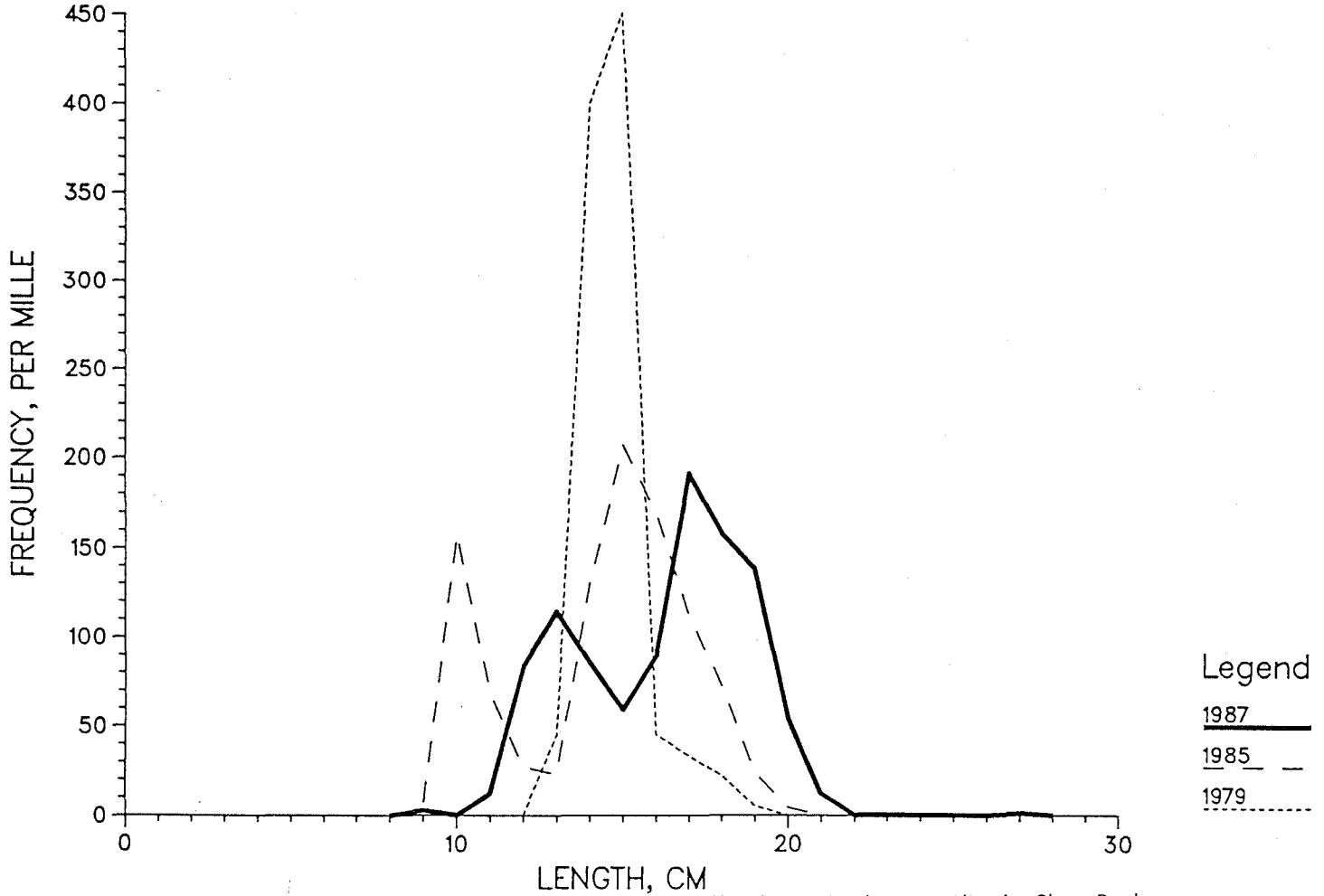

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