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Results of a Survey for Shrimp (*Pandalus borealis*) in Division 3K, July 1984

by

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Abstract

A stratified-random research survey for shrimp was conducted in Div. 3K in July 1984. Best catches were obtained at depths between 401 and 450 m where a broad range of shrimp sizes were present. Catches were highly variable resulting in an imprecise estimate of biomass. Potential for a directed shrimp fishery in the area is affected by low densities (especially at night), high proportion of small shrimp in depths of highest concentrations and large by-catches of Greenland halibut and cod which often exceeded the catch weight of shrimp. A more extensive survey would be useful to determine shrimp distribution throughout the Division.

Résumé

Une étude par échantillonnage stratifié et aléatoire des crevettes a été réalisée en juillet 1984 dans la division 3K à des fins de recherche. Les meilleures prises ont été obtenues à des profondeurs variant de 401 à 450 m; à cette profondeur, la gamme de taille des crevettes était étendue. Les prises étaient fortement variables, ce qui a entraîné une estimation imprécise de la biomasse. La possibilité d'une pêche dirigée à la crevette dans cette région est compromise par des densités faibles (surtout la nuit), par une proportion élevée de petites crevettes aux profondeurs où les concentrations sont les plus élevées et par des prises accidentelles importantes de flétans du Groenland et de morues qui, souvent, excèdent en poids la prise de crevettes. Une étude plus poussée serait utile pour déterminer la distribution des crevettes dans cette division.

Introduction

Concentrations of shrimp in NAFO Div. 3K have been known to exist for some years. Prior to 1984, research surveys directed to this area had not been carried out and therefore, no information on distribution and abundance was available for assessment purposes. In 1979, a preemptive TAC of 500 t was set arbitrarily for this area but no significant fishing effort has ever been directed at the resource.

In 1984, it was possible to conduct stratified random fishing in Div. 3K during the annual July research cruise. A diel study was conducted in the area as well. Also, in 1984, shrimpers from the Gulf of St. Lawrence fishing for groundfish in Div. 3K reported high concentrations of shrimp in the area. Subsequently, these fishermen requested permission to fish shrimp in Div. 3K on an exploratory basis. No fishing plan was implemented for 1984 but it was proposed that exploratory permits might be issued in 1985 if northern shrimp licence holders showed little or no interest in the area.

Due to this client interest, it was decided to analyze, in detail, the data collected during the 1984 survey for this meeting. By doing so, some information concerning abundance, distribution and biological characteristics becomes available for analysis and interpretation, thus providing a basis for assessment of the resource and advice on its management.

Materials and Methods

The survey was conducted onboard the 80.5 m research vessel, GADUS ATLANTICA. A Sputnik 1600 shrimp trawl with a 43 m headline and 51 m footrope was used at all fishing stations. Mesh size (stretched) ranged from around 80 mm in the wings to 40 mm in the codend. A 13 mm liner was used in the last 6 m of the codend to minimize the escape of small shrimp. The estimated horizontal and vertical openings of the trawl were 22 and 7 m, respectively.

A cursory stratification of the area was made using the navigation charts available on the vessel. Randomly selected fishing stations were designated in each of three depth strata; 351-400 m, 401-450 m and 451-500 m. These stations were fished between July 9 and 11 and on July 28 and 29. A detailed stratification chart was constructed after the cruise using the latest hydrographic charts available from the Canadian Hydrographic Service (Fig. 1). Minimum trawlable biomass was estimated by areal expansion. The standard fishing set was 30 minutes duration at a vessel speed of 3.5 knots. Warp length to depth ratio was approximately 3:1. Bottom temperatures were obtained for each survey set using an expendable bathythermograph (XBT).

Diel variability in catches have been monitored in the Hopedale Channel in surveys conducted prior to 1984. Ice on the Labrador was extremely heavy in 1984 making diel fishing difficult and hazardous. Moving ice also prevented the deployment of current meters used in the study. It was decided, therefore, that the diel fishing would best be carried out in an ice-free area, viz. Div. 3K. The diel fishing station was chosen in an area of high shrimp abundance at 51°50'N, 53°27'W in 420 m of water. Two current meters were deployed in the immediate area. An Aanderaa meter was moored just off the bottom and a Marsh-McBurney vector-averaging meter was moored just beneath the surface. Fishing at this location was conducted over a 48-hour period from July 26 to 28.

Shrimp were sampled from each set in which they occurred. Carapace lengths were measured to the nearest 0.1 mm and subsequently regrouped by 0.5 mm intervals. A random sample of 1128 shrimp were preserved in 10% formalin for detailed biological observations at the laboratory. Sex was determined by characteristics of the first pleopod (Rasmussen 1953) and maturity by observation of the gonads (Berkeley 1930). The size of the ovary in females and transitionals was noted to determine whether or not they would have spawned in 1984. Females were separated into first time spawners and multiple spawners based on the condition of the sternal spines (McCrary 1971).

Results

Distribution

Details of the 18 random fishing sets (standardized for distance towed) are given in Figure 2 and Table 1. All four sets in the 351-400 m stratum produced shrimp catches of less than 15 kg. Sampling data showed that, at these depths, small shrimp between 12 and 17 mm carapace length predominated (Fig. 3). The ten stations fished in the 401-450 m stratum yielded some good catches, the highest being 398 kg. Results were highly variable, however, with the lowest catch at just 8 kg. No distinct areas of high abundance were apparent within the stratum itself, as good catches were obtained at various locations (Fig. 2). A composite length frequency from the ten sets showed a wide range of sizes occurring at these depths (Fig. 3) but the proportion of shrimp greater than 18 mm was much higher than observed in the 351-400 m stratum. Of the four sets made between 451 and 500 m, only one produced a catch of shrimp greater than 100 kg, two catches were less than 5 kg, and the other was approximately 30 kg. Most shrimp caught at these depths were large (> 21 mm) and the smaller size groups evident in the two more shallow strata were notably lacking. A few females were carrying eggs at the time of sampling.

Abundance

Because of the variability in catches described above, it was not possible to produce an estimate of biomass with narrow confidence limits ($\alpha = 0.05$). The mean estimate obtained from the three strata sampled was 2840 (± 2279) t (Table 2). Pooling all 18 sets into one large stratum increased the estimated mean biomass by almost 900 t but did not improve the confidence interval. Using eight sets made during daylight hours, an estimate of around 3,200 t was obtained for the two deepest strata but the difference between the mean and the confidence intervals was ± 107% of the mean value. It was decided, therefore, that the best estimate from the survey data was 2,840 t based on the original stratified design.

Diel Variability

A total of 31 successful sets was made in Division 3K during the diel study (Table 3). During the first 24-hour period, most catches were low from 1720 hrs (NST) to 0600 hrs ($\bar{X}$ = 27.7 kg). Catches increased from 26 kg at 0605 hrs to a high of 255 kg at 1214 hrs, then declined sharply to 33.5 kg at 1505 hrs (Fig. 4, solid line). The period of high catch rates was relatively short, approximately six hours.

The pattern observed during the second 24-hour period was not consistent with the first (Fig. 4, broken line). Catches, generally, were less variable and the period of highest catch rates more protracted. From 1800 to 0200 hrs, catches ranged from around 30 to 50 kg per 30-minute tow, then increased from 0330 to 1300 hrs, ranging from approximately 65 to 100 kg. Catches then dropped sharply during the afternoon.

Although the highest catch of the first day was more than 2.5 times the highest of the second day, the average catches for both days were not significantly different (P = 0.63). Variances, on the other hand, were significantly different (P = 0.0009) (Table 3).

Of the two current meters deployed, only the Aanderaa, positioned near the bottom, functioned. The data from this meter have not yet been analyzed along with catch data and other environmental variables.

Sex and Maturity

Detailed separation of maturity stages (Table 4) showed that males were either maturing or mature and comprised over 65% of the sample. No juveniles or immature males were present. Transitionals and females with sternal spines, considered to be a single year-class, accounted for 17% of the sample. Based on the sampling data, about 98% of these first time spawners would have produced eggs in 1984. Females without spines also comprised 17% of the sample but only 87% were capable of spawning in 1984. According to McCrary (1971) this group had spawned in the previous year(s) and could represent more than one age group. Of the 385 potential spawners observed in the sample, up to 7.3% would not have produced eggs in 1984. Only five (0.44%) females in the sample were ovigerous.

A total length frequency for the sample and a breakdown into males, first time spawners (transitionals and females with sternal spines) and multiple spawners (females without spines) are given in Fig. 5. Males ranged in size from 12 to 23 mm (CL) with two prominent modes at 17 and 19.5 mm. There is also indication of a smaller mode around 13-14 mm. First year females ranged from 18.5 to 27 mm with a single mode at 22.5 mm. Multiple spawners were also unimodal (23.5 mm) and ranged from 19 to 28 mm. The platykurtic nature of the distribution likely results from the overlapping of two (or more) age groups.

By-catches

A number of finfish species were present in the catches from this area and the most important are listed in Table 1. Greenland halibut (Reinhardtius hippoglossoides) and cod (Gadus morhua) were, by far, the major by-catch species and in most sets one or both exceeded the catch weight of shrimp. In stratified random trawling, cod catches ranged from less than 2 kg to over 450 kg, while Greenland halibut ranged from less than 1 kg to 1322 kg. Two other commercially important species occurring in most catches were American plaice (Hippoglossoides platessoides) and witch flounder (Glyptocephalus cynoglossus). Neither species accounted for a substantial proportion of the total catch weight in any set.

Hydrography

A line of stations was chosen to provide a hydrographic profile in the survey area (Fig. 6). Temperatures at depths where shrimp were abundant (> 400 m) were greater than 3°C. In the shallowest stratum (351-400 m) temperatures were slightly colder.

Discussion

The 1984 survey results show that, in the area surveyed in Div. 3K, good catches were obtained at some locations at depths between 401 and 450 m. Both the survey data and diel study demonstrate extreme variability in the catches in both time and space. This variability is reflected in the wide confidence limits for the estimate of biomass. Therefore, the usefulness of the biomass estimate to provide advice on management, in terms of total allowable catch and/or effort control, is limited. The area, itself, is larger than the Cartwright Channel but shrimp densities, even under virgin conditions, appear to be much lower than those observed in the latter from 1979 to 1982 (Parsons and Tucker 1984). Thus, from a fishery point-of-view, the area does not appear overly productive for shrimp compared to some other areas.

The demonstrated diel variability in catches suggest that fishing at night would result in low catch rates and that during some days, good catches might only be maintained for a few hours. Highest concentrations occurred in relatively deep water (>400 m) which might pose some problems to small vessels. Also, the shrimp caught at these depths covered a wide size range. This might well represent a discard problem for larger vessels in the northern shrimp fishery but not for smaller vessels which bring the catch ashore for processing.

Another potential problem exists in the by-catch of other fish species. The main species by weight in most survey sets was either Greenland halibut or cod. If the commercial gear produced similar by-catches and if restrictions on the percent of by-catch were enforced for shrimpers in this area, then it is likely that fishing would have to be stopped. No data are available, however, on the seasonal changes in abundance of either shrimp or finfish and the situation observed in July might not necessarily apply year round.

Data on sex and maturity showed that females in Division 3K were slightly smaller than those observed in the Hopedale and Cartwright Channels farther north (D. G. Parsons, unpublished data; Parsons and Tucker 1984). Also, the male size groups were more readily distinguishable as normal components than those of the Hopedale Channel (see Parsons and Veitch 1984). This might suggest some differences in growth rate and maturity between areas even though bottom temperatures appear similar in Div. 3K and Hopedale Channel. It must be cautioned, however, that these observations are quite preliminary and a detailed analysis of biological characteristics between areas is necessary to investigate these possible differences.

Finally, it should be noted that only a small area within Div. 3K has been surveyed. Indeed, it may not be the area referred to by the Gulf shrimpers as no details of their findings were available. The topography of other regions within the Division suggests that other shrimp concentrations might be present. A more extensive survey is necessary to cover a larger area and determine shrimp distribution and abundance throughout the Division. This would best be accomplished during the annual summer research cruise to the Labrador Channels.

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Table 1. Details of stratified random fishing in Division 3K, July 1984.

Set no.	Lat.	Long.	Date	Time	Dur.	Depth (m)	Catch (kg) Shrimp	Cod	Turbot	Plaice	Witch
5	5131.7	5351.0	7/09	1310	30	367	14.47	49.54	93.62	1.09	5.99
7	5145.3	5345.4	7/09	2041	30	379	3.18	8.62	0.10		
8	5149.4	5334.1	7/09	2237	30	440	12.92	136.53	234.96	4.31	7.48
9	5158.4	5349.6	7/10	114	30	380	7.97	453.60	104.55	12.02	3.86
10	5155.2	5337.5	7/10	348	30	427	8.03	153.77	1322.24	12.47	24.72
11	5201.3	5338.1	7/10	547	30	419	24.27	77.57	202.30	9.75	7.48
12	5202.1	5330.5	7/10	747	30	404	85.73	187.56	193.91		
13	5203.5	5332.5	7/10	938	30	415	111.37	113.40	152.41	4.08	9.53
14	5149.3	5330.4	7/10	1305	30	426	22.68	127.46	159.21	6.80	1.81
15	5144.1	5323.7	7/10	1543	30	429	398.00	76.66	139.25	5.44	9.53
16	5136.4	5311.6	7/10	2053	30	442	116.76	118.39	258.10	12.25	5.22
17	5140.4	5313.3	7/10	2230	30	455	106.20	92.53	470.83	8.16	4.54
18	5142.6	5313.5	7/11	22	30	448	51.43	95.71	378.75	1.36	5.90
19	5139.8	5327.6	7/11	306	30	467	4.66	1.81	11.34		
20	5135.0	5324.1	7/11	605	30	442	37.67	58.06	51.26		
21	5140.6	5336.4	7/11	828	30	464	4.86	42.18	31.30		1.36
170	5135.2	5336.2	7/28	2202	30	453	30.61	35.83	395.08	3.63	3.18
171	5124.5	5343.7	7/29	27	30	371	10.59	18.14	8.17	1.81	-

Table 2. Estimate of shrimp biomass (t) in Division 3K, July 1984.

Stratum	Area (sq. n mi)	No. sets	Total catch (kg)	Av. per set	Var.	Total (t)	95% upper	C.I. lower
107	676	4	36.21	9.05	22.46	286		
108	579	10	868.86	86.89	13521.86	2354		
109	117	4	146.33	36.58	2302.54	200		
						2840	5119	561
Total	1372	18	1051.40					

Table 3. Results of the diel survey in Division 3K, July 1984.

Day 1	Time (NST)		Catch (kg)	Day 2	Time (NST)		Catch (kg)
26/07	1722		57.1	27/07	1805		41.7
26/07	1855		27.5	27/07	1951		29.4
26/07	2037		26.1	27/07	2125		51.6
26/07	2212		20.6	27/07	2255		39.8
26/07	2343		13.7	28/07	0025		38.2
27/07	0108		47.0	28/07	0206		49.9
27/07	0236		7.9	28/07	0334		68.8
27/07	0432		23.3	28/07	0505		94.7
27/07	0605		25.9	28/07	0656		75.2
27/07	0738		84.1	28/07	0825		63.8
27/07	0913		108.7	28/07	0958		69.7
27/07	1046		109.0	28/07	1127		73.5
27/07	1214		254.8	28/07	1255		100.3
27/07	1340		127.0	28/07	1423		39.2
27/07	1505		33.5	28/07	1556		12.6
27/07	1635		72.4				
		$\bar{X}$	64.9			$\bar{X}$	56.6
		s	63.0			s	24.3

Ho:	F	t	D.F.	P
$\sigma_1^2 = \sigma_2^2$	6.73		15 and 14	0.0009
$\mu_1 = \mu_2$[a]		0.49	19.6	0.63

[a]Assuming unequal variances.

Table 4. Sex and maturity of shrimp in Division 3K, July 1984.

Sex	Maturity	No.	% of total
Juvenile	Immature	0	0.00
Male	Immature	0	0.00
Male	Maturing (small V.D.)	123	10.90
Male	Mature (large V.D.)	620	54.97
Transitional	Small ovary	3	0.27
Transitional	Large ovary	156	13.83
Female (non-ovigerous)	Sternal spines, small ovary	1	0.09
Female (non-ovigerous)	Sternal spines, large ovary	29	2.57
Female (non-ovigerous)	No spines, small ovary	24	2.13
Female (non-ovigerous)	No spines, large ovary	167	14.80
Female	Ovigerous	5	0.44
TOTALS		1128	100.00

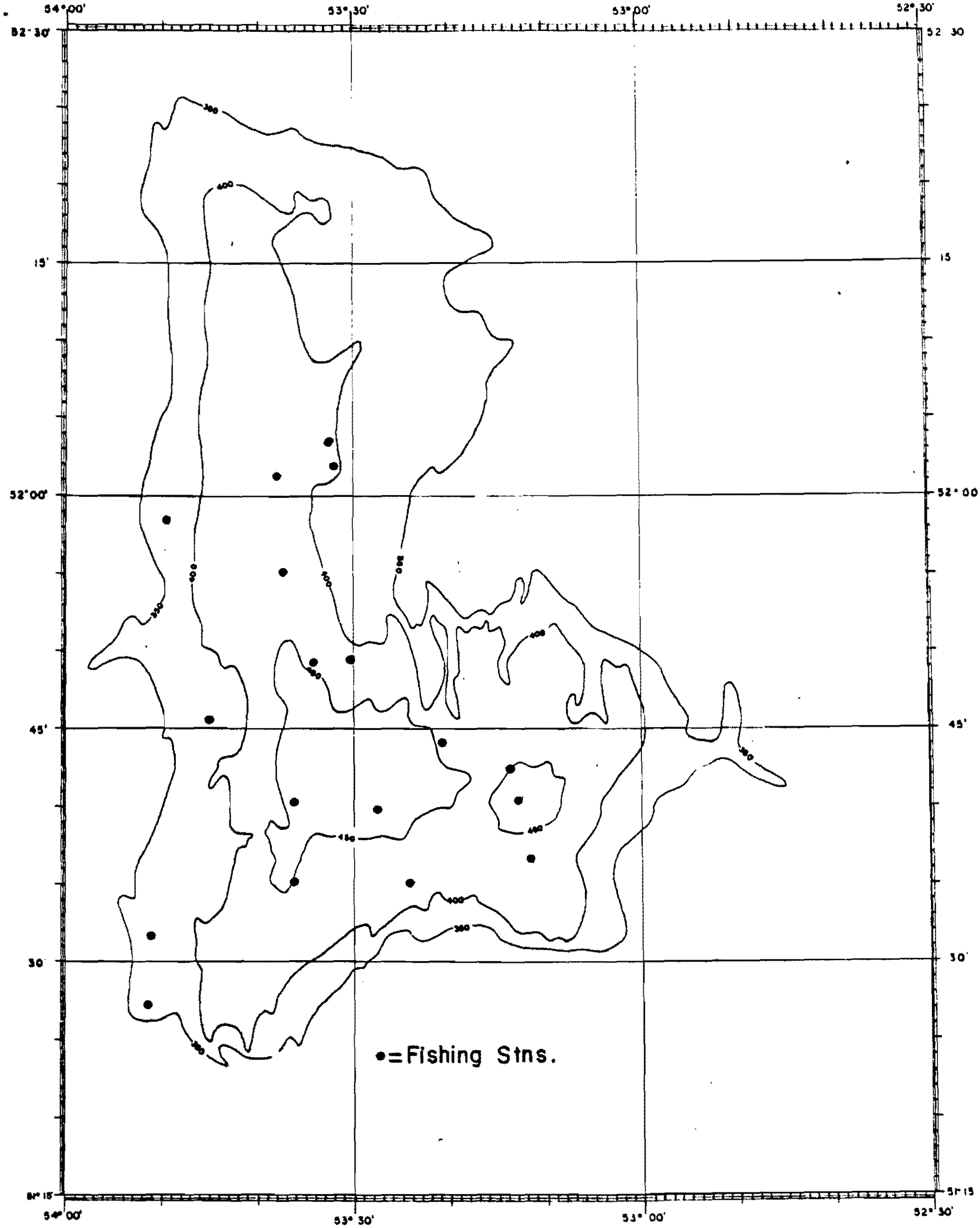

Fig. 1. Area surveyed and stations sampled for shrimp in Division 3K, July 1984.

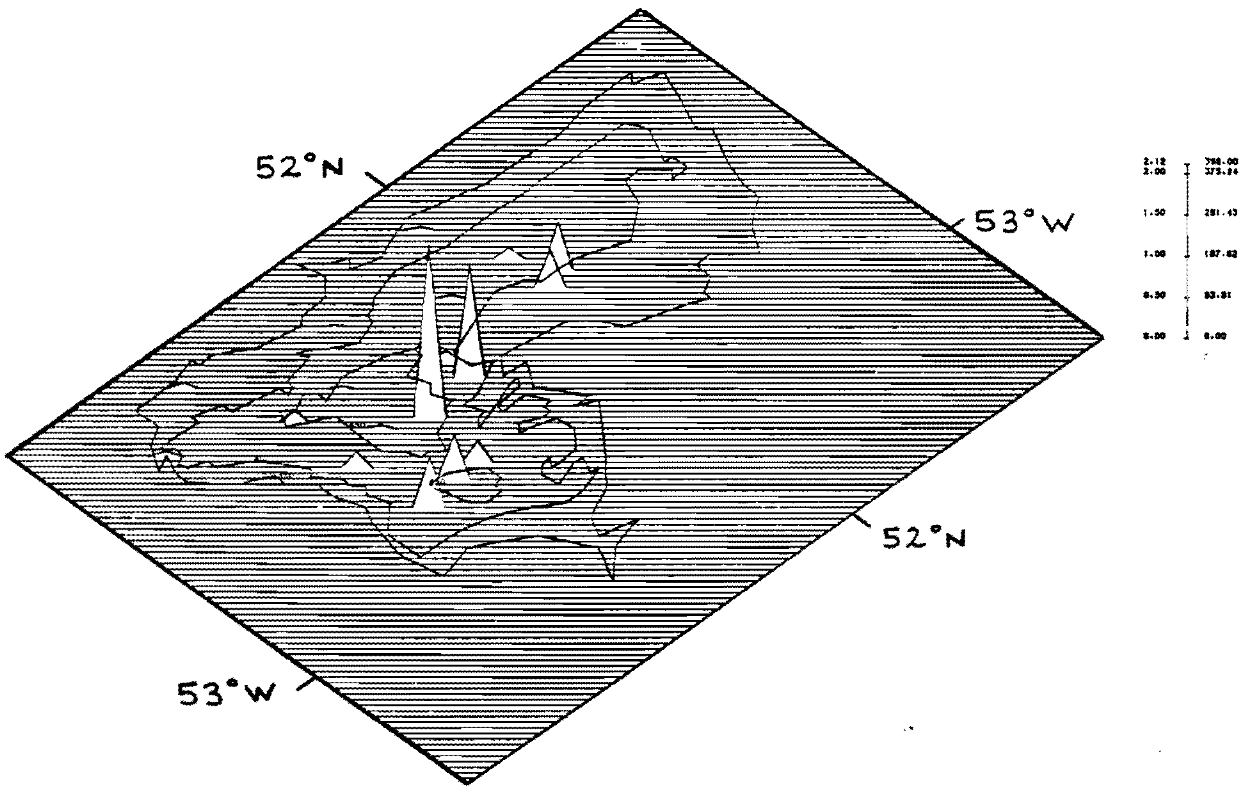

Fig. 2. SHRIMP CATCHES PER 30 MIN TOW DIVISION 3K GADUS 1984

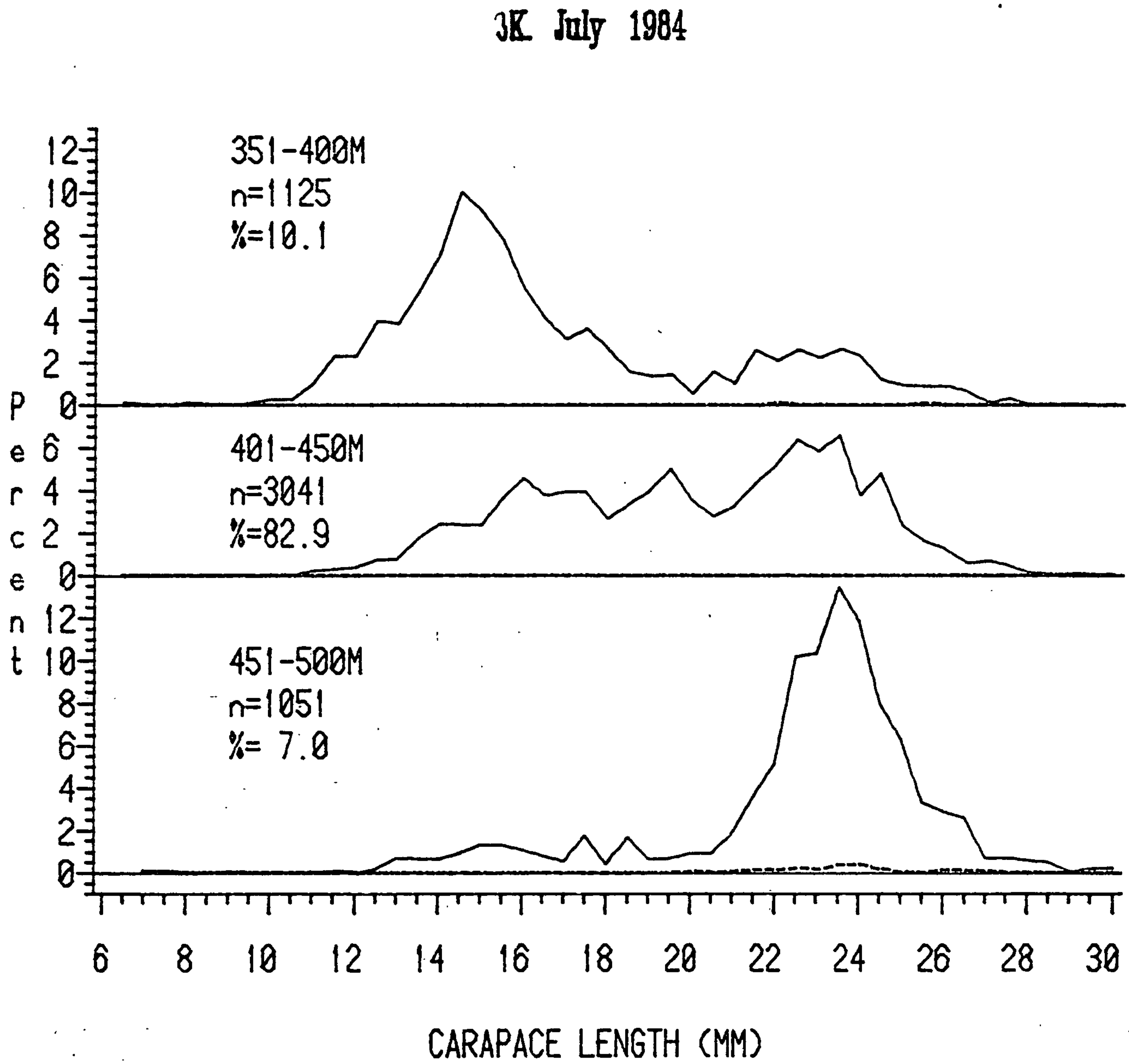

Fig.3. Length frequencies of shrimp from three depth strata fished in Division 3K, July 1984 (broken line = ovigerous).

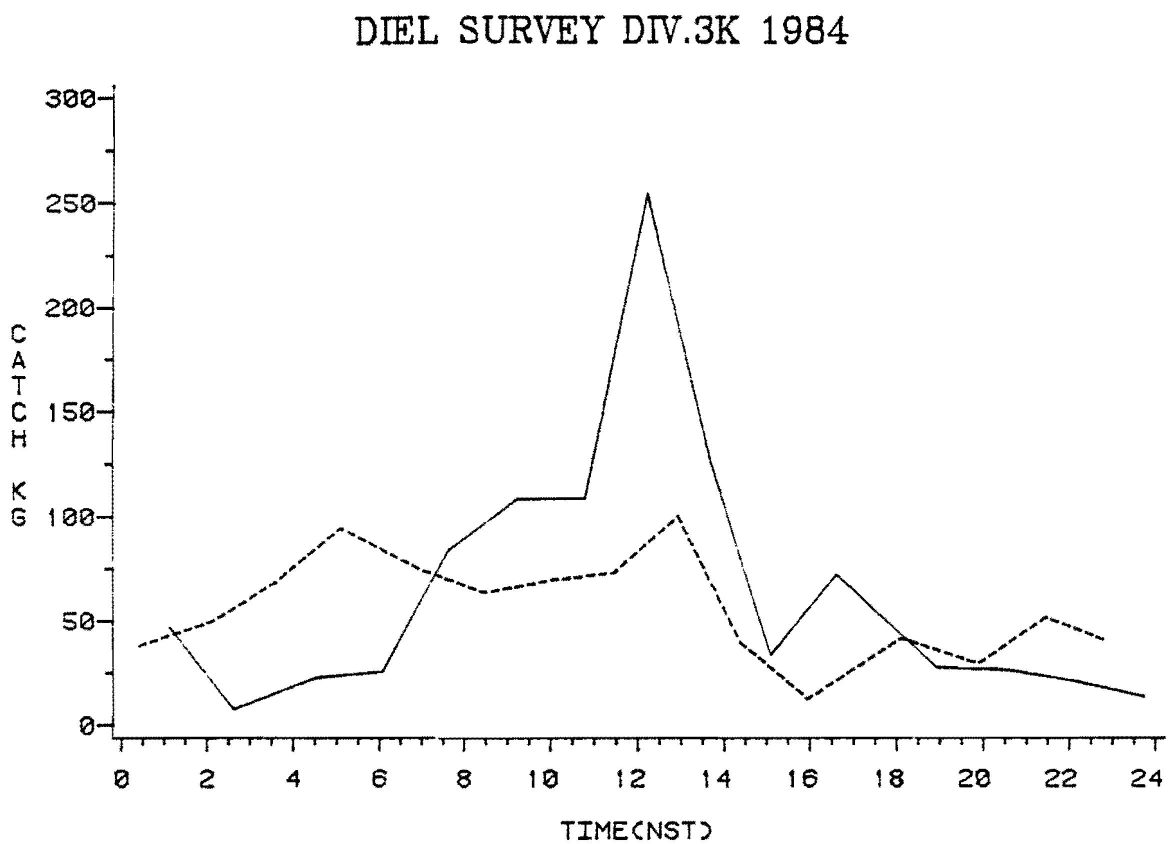

Fig. 4. Diel variability in shrimp catches from Division 3K, July 26-28, 1984. Day 1 = solid line, Day 2 = broken line.

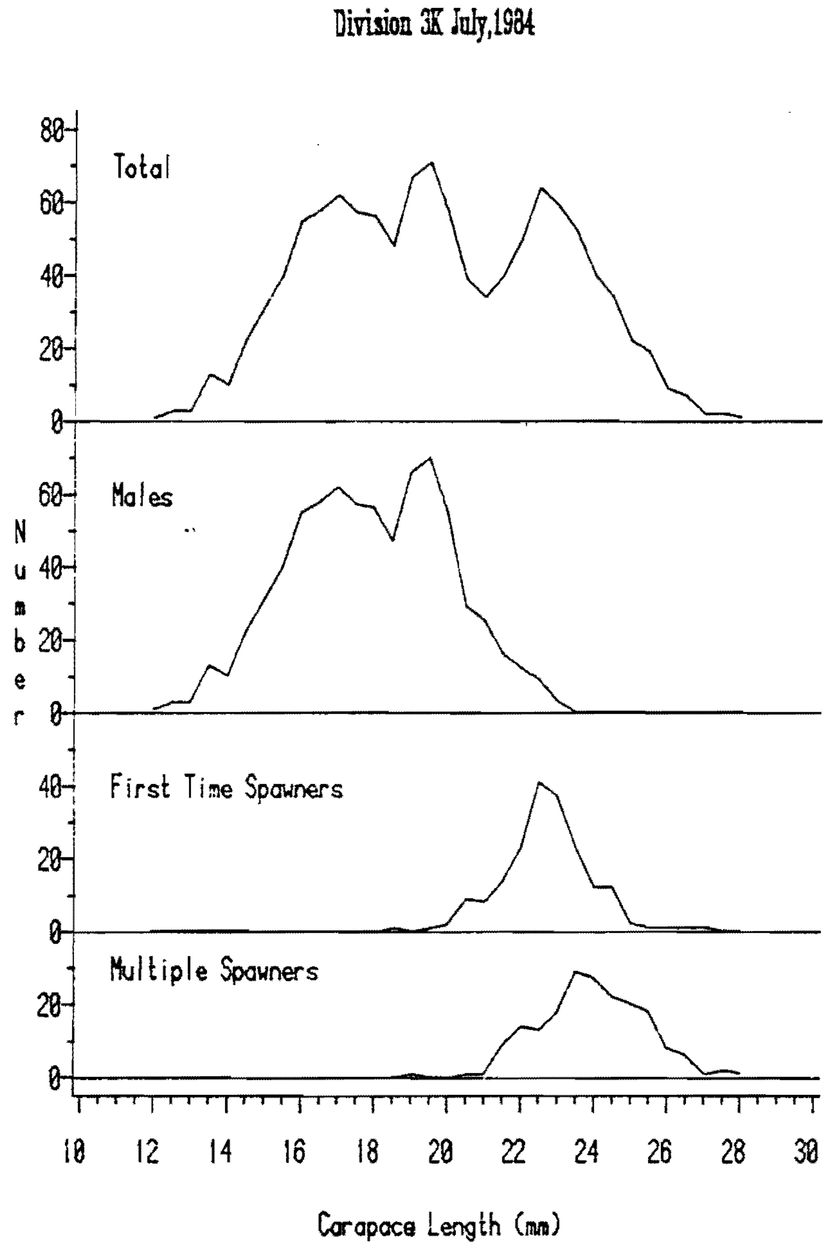

Fig. 5. Separation of a shrimp sample obtained in Division 3K, July 1984, by stages of sexual development. First time spawners include transitionals and first year females. Five ovigerous females were not included.

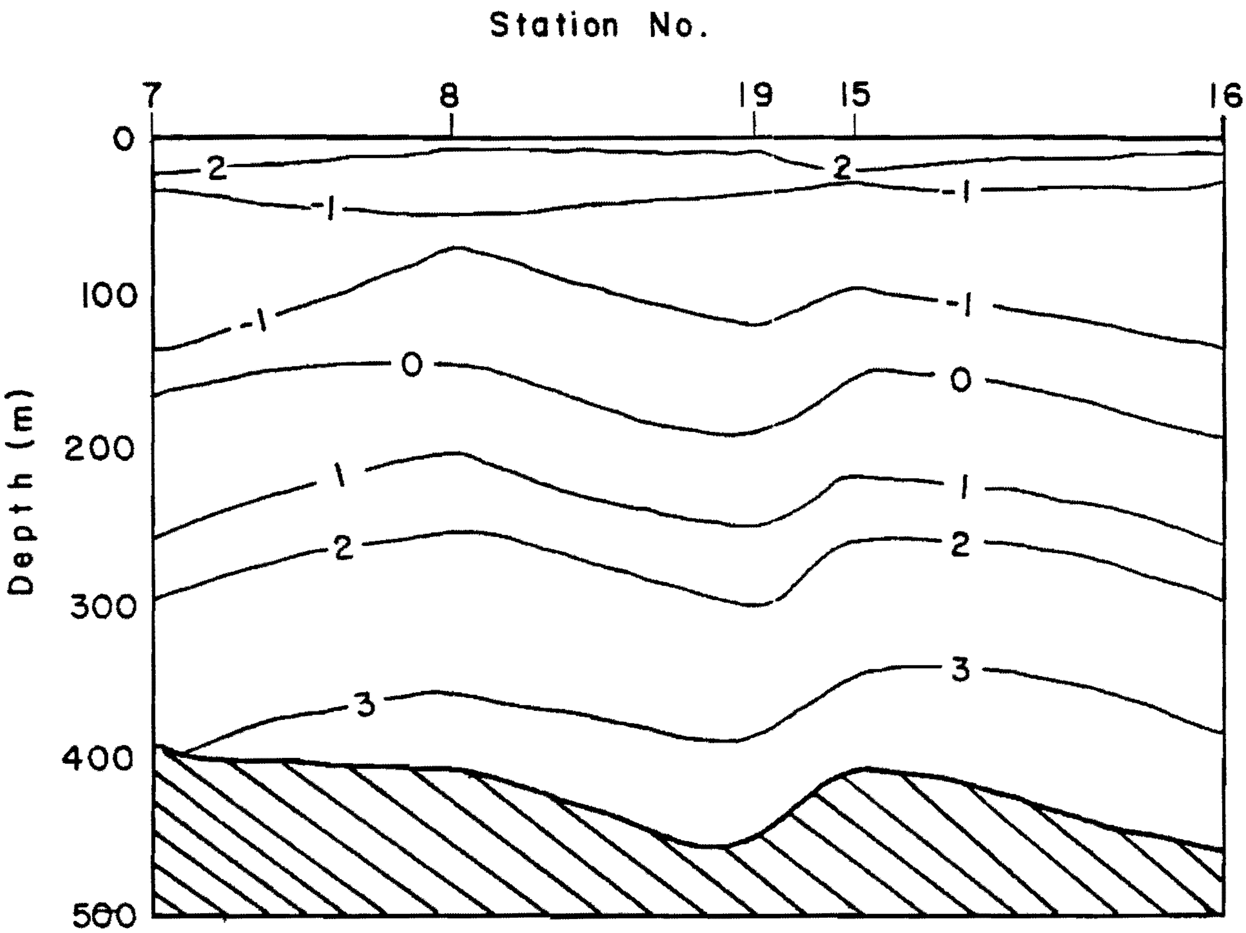

Fig. 6. Hydrographic profile from a line of stations sampled in Division 3K, July 1984.