Northwest Atlantic Fisheries Organization

Serial No. N204

NAFO SCR Doc. 80/IX/130

ANNUAL MEETING OF SCIENTIFIC COUNCIL - SEPTEMBER 1980

Comparison of the Composition of Larval Herring Prey Items Selected by Bongo Nets in the Standard Array of Samplers used on Larval Herring Survey Cruises

by

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INTRODUCTION

The Recruitment Processes Task of the Northeast Fisheries Center in Woods Hole, Massachusetts, has been involved in an intensive multidisciplinary study of sea herring (*Clupea harengus* L.) in the Georges Bank - Gulf of Maine region to investigate the physical and biological factors influencing larval survival. The field sampling program developed through ICNAF (International Commission for the Northwest Atlantic Fisheries), has produced a large data base of information on the seasonal and geographic changes in zoo- and ichthyoplankton distribution and abundance. The present study utilizes a portion of this information to compare species, developmental stage, size, and number of potential larval herring prey items (determined from a concurrent study, see Cohen et al. 1979 and 1980, and Table I) collected by 20 cm and 60 cm bongo frames fitted with .053 and .165 mm, and .333 and .505 mm mesh nets, respectively, during two spawning seasons, September through February 1974-75 and 1975-76. Davis (1980) has calculated estimates of extrusion of *Pseudocalanus* sp. and copepod nauphli by the 0.333 and 0.165 mm mesh Bongo samples, using a subset of the same data analyzed in the present paper.

METHODS

The ICNAF larval herring surveys were conducted on a standard grid of stations 15-20 miles apart (Figure 1), covering the region at least once a month from September through December since 1971; February surveys were added in 1974. At each standard station minimum sampling has included double oblique hauls with 61 cm diameter bongo nets (.505 and .333 mm mesh nets) and temperature-salinity profiles. Since autumn 1974, 20 cm bongos (.253 or .053 and .165 mm mesh nets) were added to the sampling array (Figure 2) to sample smaller organisms. A standard ICNAF haul consisted of lowering the bongo array at 50 m/min to a maximum depth of 100 m or within 5 m of the bottom, and retrieving at 10 m/min while the ship is underway at 3.5 knots. Ten minute neuston hauls (1x2, or .5x1 m rectangular frame fitted with a .505 m net) were usually made simultaneously with each bongo haul during the 1974-77 seasons.

Volume of water filtered was plotted against duration of tow for all net hauls in order to detect evidence of clogging.

In this study we included only those stations at which no clogging was evident. The .333 mm mesh samples were sorted by the Polish Sorting and Identification Center in Szczecin, Poland; selected .505, .165, .053, and Niskin bottle samples were sorted by the Recruitment Processes Group in Woods Hole. A summary of survey dates and samples is presented in Table II.

Histograms comparing species abundances at each station from each mesh size were prepared for the following taxa:

1. Pseudocalanus sp. - CI-CVI
2. Paracalanus parvus - CV&CVI
3. Centropages typicus - CIV-CVI
4. Centropages hamatus - CIV-CVI
5. Centropages spp. - CI-CIII
6. Calanus finmarchicus - CV&CVI
7. Oithona spp. - CV&CVI
8. Copepod nauplii

Figure 3 compares the relative sizes of all the above species with the sampler mesh sizes.

For each taxon, randomized paired comparisons of the differences in abundance (number/m^3) between samplers at each station with sufficient data for a valid comparison were carried out using a two-tailed t-test. The samplers were paired as follows: Niskin bottle and .053, .053 and .165, .165 and .333, .333 and .505.

RESULTS

Table III presents the results of the paired t-test comparisons.

1. .053 versus .165 - There were no significant differences between these two mesh sizes for all stages of Pseudocalanus sp., Paracalanus parvus adults and CV's, Centropages typicus adults and CIV and CV's, and Centropages spp. CI-CIII's. There was not enough data to compare catches of Calanus finmarchicus adults and CV's, and Centropages hamatus CIV and CV's. The difference in catch of Oithona spp. adults and CV's was significant at the .025 level, and the difference in catch of copepod nauplii was significant at the .005 level. There was a significant different (.05 level) in the catch of Centropages hamatus adults which is the only case of a coarser mesh net retaining more organisms than a finer mesh net.

2. .165 versus .333 - There were significant differences between net collections of all stages of Pseudocalanus sp. (.001 level during both seasons), except for the adults during the 1975-76 season; Paracalanus parvus adults and CV's (.001 level during 1974-75 and .01 during 1975-76); Centropages typicus CIV and CV's (.01 level in 1974-75 and .05 level in 1975-76); Centropages hamatus adults (.05 level in 1974-75); Oithona spp. adults and CV's (.001 level both seasons); and copepod nauplii (.001 level both seasons).

There were no significant differences in numbers of Pseudocalanus sp. adults during the 1975-76 season, Centropages typicus adults during both seasons, Centropages hamatus adults during the 1975-76 season and CIV and CV's during both seasons, and Calanus finmarchicus adults and CV's during both seasons.

3. .333 versus .505 - There was only enough data for valid comparisons between adults of Pseudocalanus sp., both species of Centropages, and Calanus finmarchicus, and no significant differences were found.

4. Niskin bottles (5 depths) versus .053 (vertical haul)

Only two stations were available for comparison:

	Station 1	Station 2
Integrated Number of Copepod Nauplii in the Water Column	Net: $1.6x10^5/m^2$	Net: $2.6x10^5/m^2$
	Bottle: $2.53x10^5/m^2$	Bottle: $4.12x10^5/m^2$

DISCUSSION

During the fall and winter seasons in the Georges Bank-Gulf of Maine area clogging is not a serious problem, and the different mesh nets perform as expected. Water bottle samples and .053 mm mesh nets are required to sample *Oithona* spp. and copepod nauplii. They are probably also necessary to collect younger copepodite stages of *Oithona* spp. and *Paracalanus parvus*. The .165 net appears to sample all the other groups adequately.

It would be useful to be able to determine the "true" abundance of each species based upon estimates obtained from the different samplers employed. Unfortunately not enough .053 mm and water bottle samples are available at this time to permit us to calculate calibration factors for the abundances of an important fraction of the larval herring prey items, based upon the nets we used here. Future work should compare results obtained from .165 and .053 mm nets and Niskin bottles. Other important variables to consider in these studies are season and towing speed. Colton and Green (1979) concluded that extrusion of small zooplankton was reduced during tows at a ship speed of 1.5 knots instead of 3.5 knots, when comparing the catch of .333 and .253 mm mesh nets. They suggest using a .165 mm net in the Georges Bank-Gulf of Maine area, and a .053 mm net in areas where plankton densities are lower, in order to sample many of the smaller larval herring prey items which the larger mesh nets miss or undersample. The critical dimensions for retention appear to be width of organism in comparison to diagonal of mesh size, but retention will vary with tow speed, abundance and composition of the plankton, morphology of the organisms, etc. (see Tranter, 1968 for a complete review).

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Table 1. Percent abundance of larval herring prey items in the guts processed from each survey cruise.

Species	Stage	Seasons: 1974-75 Cruise: Cryos 74-04	Prognoz 74-01	Dohrn 74-01	AlbIV 74-13	AlbIV 75-02	Year Total	Seasons: 1975-76 Cruise: Belogorsk 75-02	Belogorsk 75-03	Dohrn 75-187	AlbIV 75-14	AlbIV 76-01	*Wieczno 76-01	Yearly Total	Seasons: 1976-77 Cruise: Wieczno 76-03	Dohrn 76-02	Researcher 76-01	Mt. Mitchell 77-01	Yearly Total
Pseudo-calanus minutus	nauplius	36.7	3.0		2.3		2.1		8.1	1.6				0.4					
	copepodite		6.1		0.5	3.1	1.4			4.9	1.7	0.8		1.7			37.5		3.3
	adult			2.2	5.2	56.1	19.7			2.5	10.8	16.3	27.7	11.4	12.1	42.9	37.5	47.7	33.7
Para-calanus parvus	nauplius				0.5		0.3												
	copepodite			2.2	2.6		1.8			13.1	7.6			5.4	3.0				
	adult		9.1	15.6	10.1	1.2	7.5			13.9	29.6	3.0	3.6	18.3	6.1	42.9	25.0	2.3	24.2
Pseudo-para	nauplius	3.3			2.0		1.4		13.5					0.4					
	copepodite		3.0		1.2		0.9		2.7	2.5	1.4	1.0		1.4	6.1				6.1
	adult				1.0	0.5	0.8				3.2	4.5	0.6	3.2	3.0				3.0
Centro-pages typicus	nauplius	26.7					0.4		2.7					0.08					
	copepodite		3.0	33.3	19.3	1.4	14.2			1.6	7.9	1.0	1.2	4.7	6.1				6.1
	adult			6.7	1.7	2.6	2.0				0.3	1.5	0.6	0.7		14.3			3.0
Centro-pages hamatus	nauplius																		
	copepodite				15.2	5.1	11.4												
	adult				5.1	10.8	6.5						1.8						
Centro-pages spp.	nauplius		3.0		0.08		0.1												
	copepodite				5.7	0.5	3.9			1.6				0.2	9.1				3.3
	adult				0.7	1.6	0.9												
Oithona spp.	nauplius		3.0				0.05												
	copepodite		3.0		1.8		1.2		5.4				3.6	0.2	12.1				4.3
	adult		9.1	2.2	5.2	0.7	3.8			4.1		4.3	3.0	1.8					
Calanus finmar-chicus	nauplius				0.3		0.2			4.1				0.7					
	copepodite											0.3	5.4	0.08					
	adult									0.8			10.2	0.08					
Unidenti-fied calanoid	nauplius	33.3	3.0	11.1	2.0		2.2		43.2	17.2				3.1					
	copepodite		39.4	13.3	3.6		3.3		5.4	8.9	4.0	0.8		3.4	9.1				3.3
	adult		9.0	13.3	6.5	14.3	8.9		10.8	23.8	31.1	24.3		27.5	33.3			50.0	35.9
Copepod eggs					2.8	1.7	2.3				0.2	41.3		13.7					
Invertebrate eggs					3.5		2.3		2.7		1.2	1.3	25.9	1.2					
Mollusc larvae					0.08		0.05		2.7		0.2			0.2					
Spiratella retroversa					0.2		0.1												
Mysids													7.2						
Euphausiids													7.8						
Hyperiids													0.6						
Fish larvae					0.2		0.2												
Candacia armata											0.2			0.08					
Acartia longiremis													0.6						
Unident. invertebrate					0.08	0.2	0.1		2.7		0.2			0.2					
# Stations		4	3	3	34	23	67	3	2	15	32	35	14	101	8	4	4	9	25
#/% larvae feeding		16/ 5.1	17/ 11.3	28/ 18.7	475/ 15.2	198/ 16.1	734/ 14.8	0	14/ 9.3	64/ 8.1	355/ 28.0	85/ 10.8	60/ 38.0	518/ 17.3	20/ 8.4	4/ 9.0	5/ 8.9	25/ 29.0	54/ 12.7

* Not included in yearly total.

Table 2. Number of samples available from each survey cruise.

Vessel & Cruise No.	Dates	Mesh size(mm): Number of stations available for comparison				
		.053	.165	.333	.505	Water bottles
CRYOS 7404	9/07-9/24/74		3	3		
WIECZNO 7401	9/27-10/18/74		3	3		
ANTON DOHRN 7401	11/11-11/23/74		3	3		
ALBATROSS IV 7413	12/04-12/19/74		5	5		
ALBATROSS IV 7502	12/12-12/28/75	7	30	30	12	
BELOGORSK 7502	9/15-10/08/75		6	6		
BELOGORSK 7503	10/17-10/30/75		8	8		
ANTON DOHRN 75187	11/01-11/18/75		4	4		
ALBATROSS IV 7514	12/05-12/17/75		10	10		
ALBATROSS IV 7601	2/10-2/25/76		9	9		
ALBATROSS IV 7813	10/16-11/10/78	2				2

Table 3. Paired mesh comparisons of larval herring prey items in the plankton from two spawning seasons@.

Species	Mesh size (mm)					
	.053	.165	.165	.333	.333	.505
Pseudocalanus sp.						
Adults	ND	ND	^{1}*/ND	-/ND	ND	ND
CV	ND	ND	^{1}*	-	-	-
CIV	ND	ND	^{1}*	-	-	-
CIII	ND	ND	^{1}*	-	-	-
CII	ND	ND	^{1}*	-	-	-
CI	ND	ND	^{1}*	-	-	-
Paracalanus parvus						
Adults & CV	ND	ND	$^{1+3}$*	-	-	-
Centropages typicus						
Adults	ND	ND	ND	ND	ND	ND
CIV & CV	ND	ND	$^{3+5}$*	-	-	-
Centropages hamatus						
Adults	-	^{5}*	^{2}*/ND	-/ND	ND	ND
CIV & CV	-	-	ND	ND	-	-
Centropages spp.						
CI - CIII	ND	ND	^{1}*	-	-	-
Calanus finmarchicus						
Adults & CV	-	-	ND	ND	ND	ND
Oithona spp.						
Adults & CV	^{4}*	-	^{1}*	-	-	-
Copepod nauplii	^{2}*	-	^{1}*	-	-	-

Key

* - = Significant difference between nets with * indicating larger catch
\- - = Not enough data for a comparison
ND = No significant difference

@Seasons = 1974-75/1975-76
Levels of significance of two-tailed t-test:
^{1}.001 ^{2}.005 ^{3}.01 ^{4}.025 ^{5}.05

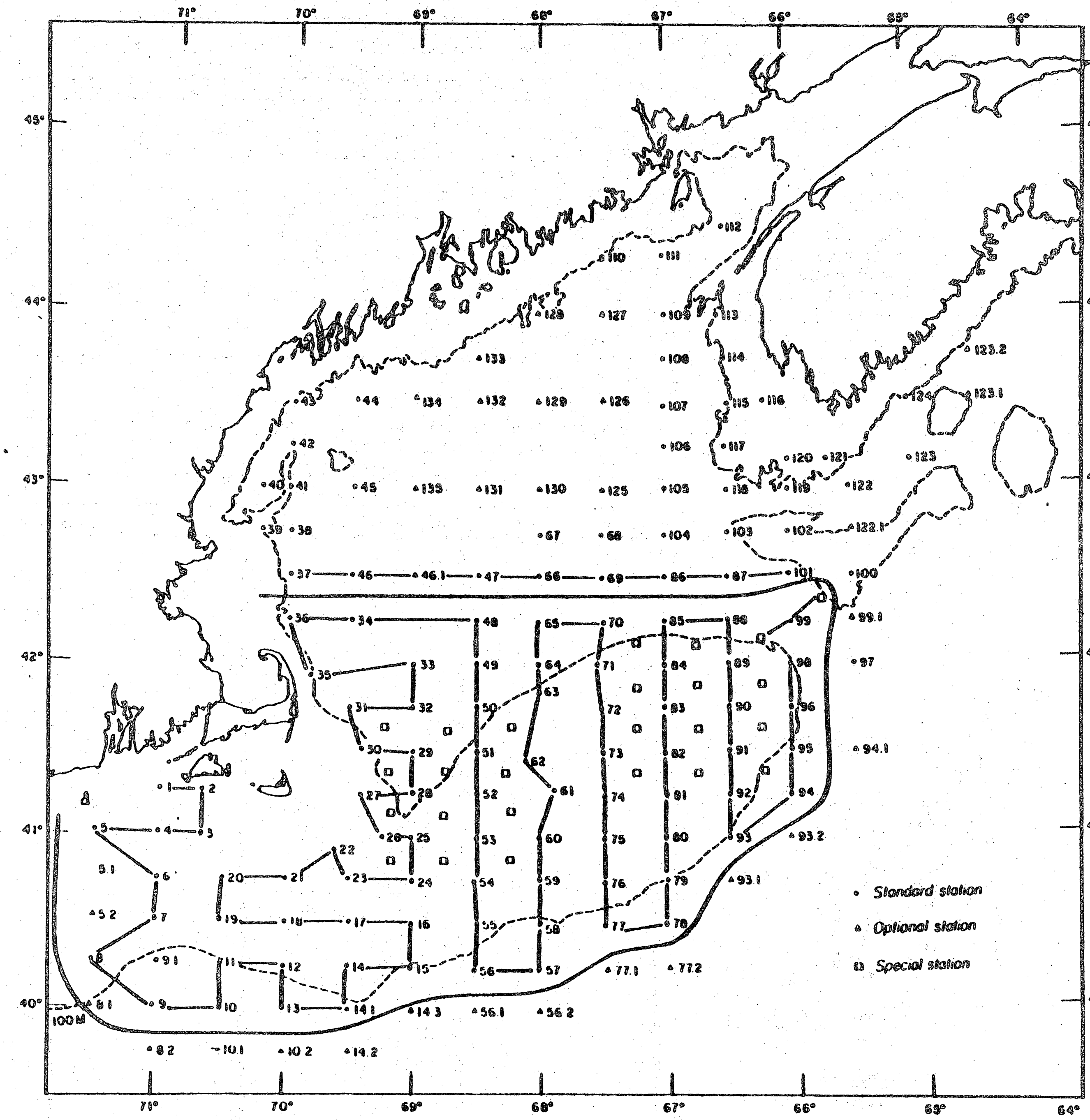

Figure 1. Standard station grid of Georges Bank-Gulf of Maine area.

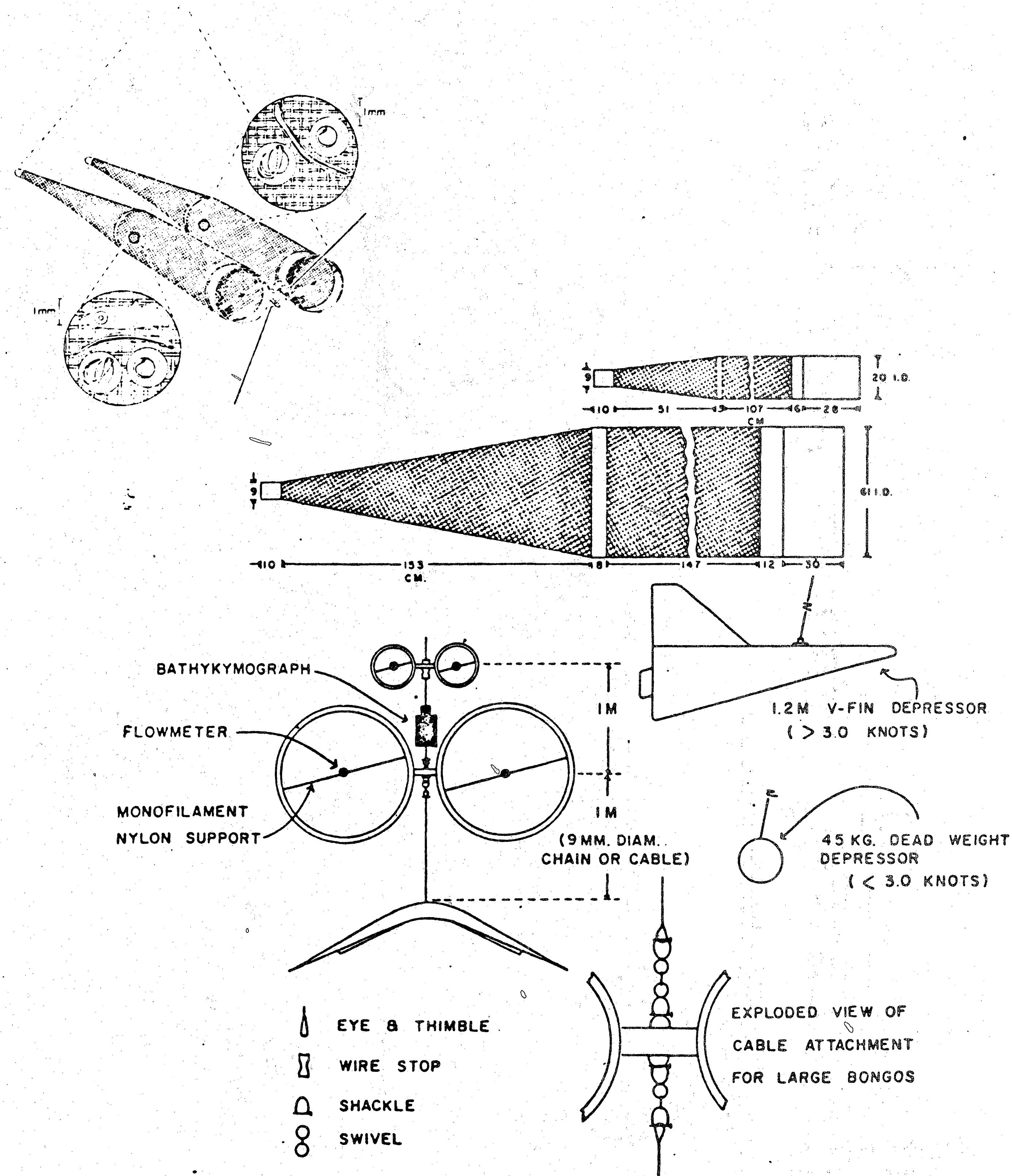

Figure 2. Standard bongo net array (Smith and Richardson, 1977).

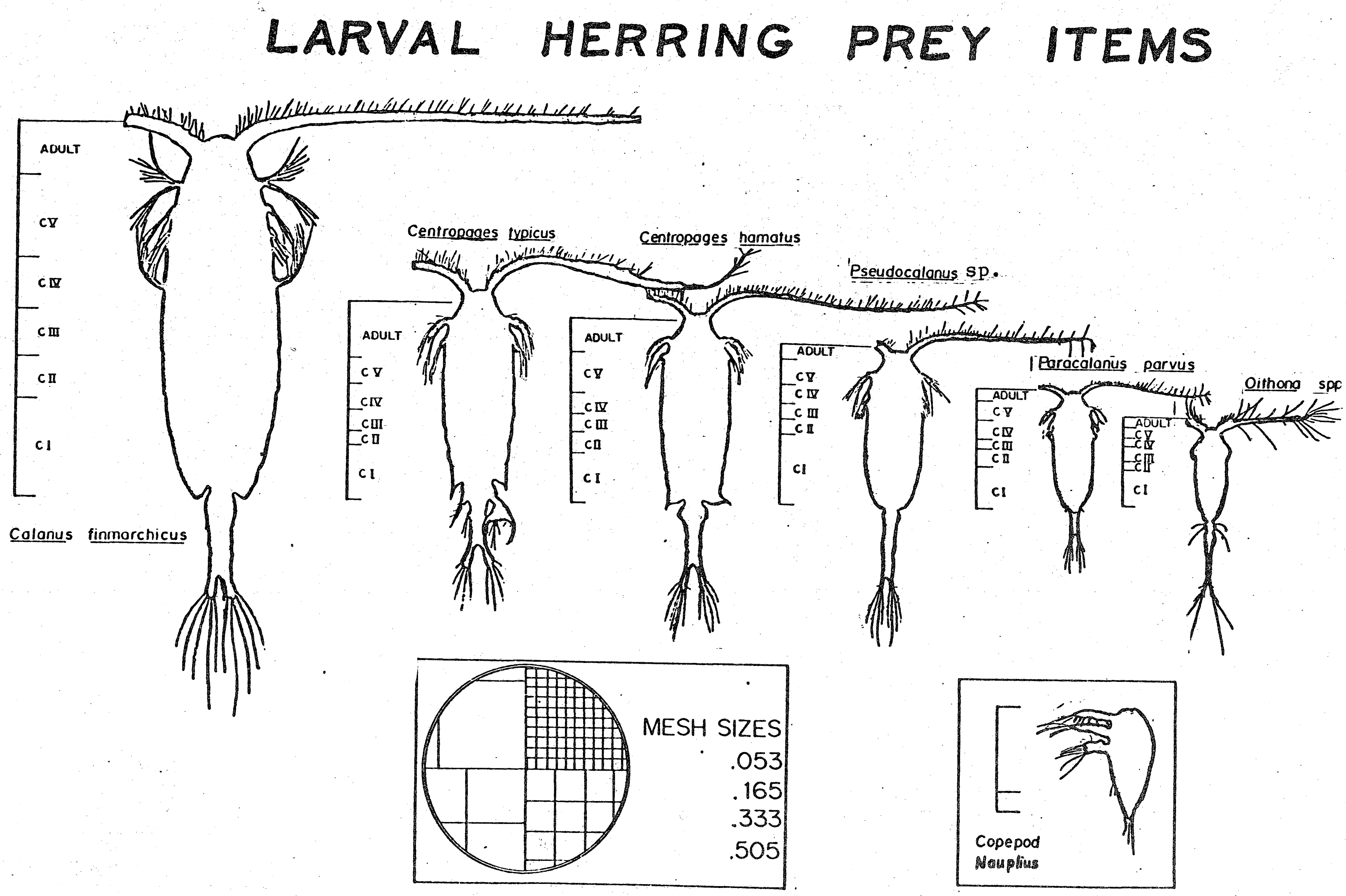

Figure 3. Relative size of larval herring prey items and meshes.