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Review of the Zooplankton Sampling and Processing Methods Used during BASIS Cruises 2002

by

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Review of the zooplankton sampling and processing methods used during BASIS cruises 2002

Abstracts

This document summarizes the zooplankton and processing methods used different countries during the Bering-Aleutian Salmon International Survey (BASIS) in 2002. During the summer and fall several Canadian, Japanese, Russian and United States research vessels conducted trawling operations in the inshore, offshore and oceanic waters of the Bering sea, North Pacific Ocean and Gulf of Alaska. The objectives of these cruises were to collect data on salmon in North Pacific waters. Besides the trawling operations on all research vessels were collected zooplankton samples for estimate of salmon food base in the study areas. On first stage of zooplankton studies the major problem was calibrations of all sampling and processing methods because different countries used different gears (Big Juday net, IKS-80, Bongo nets, NORPAC and ORI net) and sampling methods (horizontal or oblique tows, different layers of tows etc.). In this document described all zooplankton gears and sampling methods used by different counties.

Introduction

In 2002 was started the Bering-Aleutian Salmon International Survey (BASIS) and purpose of this program is international ocean salmon surveys in the North Pacific. The objectives of BASIS program is to collect data on salmon distribution, abundance, stock origin, migrations, growth, food habits, zooplankton distribution (as basic food of Pacific salmons) etc. in inshore, offshore, and oceanic waters of the Bering sea and North Pacific Ocean. The performers of BASIS is North Pacific Anadromous Fish Commission-member nation (Canada, Japan, Russia and United States) and the period of program is 5 years. The first BASIS Working group meeting was held on 27-28 May 2002 at the TINRO-Centre in Vladivostok, Russia. One of the most object of discussion on this meeting was calibration of survey methods will use by the different nations (NPAFC Doc. 599). The first BASIS Working group agreed that calibration of methods is a major problem because different countries use the different methods for own surveys (such as salmon fishing gear, stock identification, oceanography etc.). Also, was noted that each country will use the different methods for sampling plankton during the 2002 BASIS surveys, and that even within Russia different methods are being used. The BWG agreed that the best method of calibration is to use all types of plankton sampling gear simultaneously on the same vessel, and possible exchanges of plankton sampling gear for 2002 cruises. But during cruise 2002 this plan to carry out it was not possible and each country used for sampling different plankton gear (Big Juday net, IKS-80, Bongo nets,

NORPAC and ORI net). Thereby, in the future may be difficult to compare the results that will received by the different countries. The objectives of this review is detail summarize of the zooplankton sampling and processing methods used of different nations during BASIS cruises 2002.

Zooplankton Survey Methods Used in the Research Program of Russia

Zooplankton sampling and processing by TINRO-Centre

Plankton sampling and processing technique in the Russian Far-Eastern seas, which is applied at TINRO-Centre since 1984 as a standard one, is represented by both instructions (Volkov 1984, 1988, 1996) and short summaries in a number of publications.

Prior to the trawl casting, plankton sampling is carried out by a Big Juday net (fig. 1) with the mouth area 0.1 m^2 (ring diameter - 37 cm), equipped with capron sieve ? 49 in Russian standard (mesh size - 0.168 mm) (table).

During the surveys, prior to the trawl casting, total plankton samplings are carried out in the hydrological stations locations at 0-200 m layers. In case when the depth is less than 200 m, samplings are carried out from the bottom up to the surface and a contact of sinker with a bottom is required. The length of released cable, that has deviation angles more than 10°, is corrected by standard tables. When deviation angles of cable are more than 30°, ship maneuvering is required to decrease them. During the salmon survey, plankton samples at 0-50 m layer are also taken in order to study salmon food supply at the epipelagic upper layers. Plankton samples are fixed in a solution of 4 % formaldehyde.

Fixed plankton samples are processed by fractions onboard the research vessel. A set of three sieves is used to divide zooplankton into the size fractions. For large fraction (specimens more than 3.5 mm in length) sieve mesh size is 1.364 mm, for medium fraction (1.1-3.5 mm) - 0.569 mm and for small one (less than 1.1 mm) – 0.1 mm.

The biomass of each fraction is defined by wet weight in volume-meter. Further processing consists of species identification, counts by species abundance for all fractions. Size-weight characteristics of plankters are defined by standard raw mass weight or by Chislenko nomograms (1968).

Since the Juday net has at certain selectivity and doesn't catch all of the plankton, the empiric coefficients for correction of fishing efficiency are introduced: for small zooplankton fraction – 1.5, for medium – 2.0. For larger size animals of large fraction the proportionally increasing corrections are accepted: copepods smaller than 5 mm – 2, larger than 5 mm – 3;

eupausiids, mysids and sagittae up to 10 mm – 2, 10-20 mm – 5, larger than 20 mm – 10, hyperiids up to 5 mm – 1.5, 5-10 mm – 3, larger than 10 mm – 5 (Volkov 1996).

Because of the presence of plankton species with large amplitude of daily vertical migrations, biomass values are calculated for night period (in mg/m^3) by means of coefficients representing a ratio between average biomass values for day and night samplings at the each survey region.

Zooplankton sampling and processing by KamchatNIRO

Since 1972 KamchatNIRO uses IKS-80 net in the Russian Far-Eastern seas for study of distribution eggs and larvae pelagic fish (mostly pollock). As a standard one for collection information about food base of salmon fish, IKS-80 applied at KamchatNIRO since 1995.

During the surveys, prior to the trawl casting, total plankton samplings are carried out in the hydrological stations locations at 0-100 m layer. In case when the depth is less than 100 m, samplings are carried out from the bottom up to the surface and a contact of sinker with a bottom is required. The length of released cable, that has deviation angles more than 5°, is corrected by tables. When deviation angles of cable are more than 30°, ship maneuvering is required to decrease them.

Prior to the trawl casting, plankton sampling is carried out by IKS-80 net (fig. 2) with the mouth area 0.5 m^2 (ring diameter - 80 cm) (table), equipped with capron sieve ? 15 in Russian standard (mesh size - 0.550 mm) (Rass and Kazanova 1966; Sokolovskaya and Belyaev 1987). During the BASIS cruise 2002 by KamchatNIRO are carried out of one daily station then were conducted 12 synchronous IKS-80 and BJN (fig. 1) tows (in layer 0-100 m) for compare of their catchability.

Plankton samples are fixed in a solution of 4 % formaldehyde and transportation to laboratory for processing. Fixed plankton samples are processed by standard laboratory method applied at Russian plankton studies (Instruction… 1971, 1980; Karedin 1982). Biomass of separate components in the sample calculated by count number of animals and multiplication this number to average weight of each component. Average weight of each species zooplankton organisms were determined experimentally or in tables of standard weights (Lubny-Gertsyc 1953). All large components, mainly euphausiids, hyperiids, large molluscs, polyhaets etc. weighed on torsion or electronic balance to within 1 mg.

Like the Big Juday net, IKS-80 has at certain selectivity and doesn't catch all of the plankton but catchability of IKS-80 some bigger than Juday net because the mouth area of BJN is smaller (Pogodin, 1980). As basis for calculation of our empiric coefficients we used the empiric coefficients by TINRO-Centre for BJN (Volkov 1996). In our opinion, the given method for calculation of empiric coefficients will allow to receive the values of zooplankton biomass that will

be comparable by TINRO-Centre data. In KamchatNIRO we use following empiric coefficients: for copepods smaller than 5 mm – 1.2, larger than 5 mm – 1.4; eupausiids, mysids, chaetognaths and fish larvae up to 10 mm – 1.3, 10-20 mm – 2.1, larger than 20 mm – 3.5, hyperiids up to 5 mm – 1.1, 5-10 mm – 1.4, larger than 10 mm – 2.1. For the rest species using empiric coefficients equal 1 (Koval 2002). Zooplankton biomass in the study areas are calculated for daily period (in mg/m^3) because all sample was collected during the day time.

Zooplankton Survey Methods Used in the Research Program of the United States

During 2002 BASIS United States research cruises zooplankton samples were collected at each trawl station immediately prior to each trawl haul. Plankton samples collected with 60-cm diameter Bongo samplers fitted with 0.505- and 0.333-mm mesh nets (fig. 3). The Bongo nets was towed obliquely between the surface and 200 meters at each station (table). In case when the depth was less than 200 m, samplings are carried out from near surface to approximately 10-m from the bottom. Estimated depth of each Bongo tow was calculated by wire angle and length of wire. Volume of water filtered by each net was estimated by flow meters (by General Oceanics) (Davis 1998).

The zooplankton samples were split aboard the vessel with 1/2 of the sample frozen and the other 1/2 put in formaldehyde. The frozen zooplankton samples were sent to UAF (University of Alaska Fairbanks) for stable isotope analysis. All samples fixed in formaldehyde were sent to a laboratory in Poland for species identification.

Zooplankton Survey Methods Used in the Research Program of the Canada

During 2002 BASIS Canadian research cruises zooplankton samples were collected with Bongo nets (fig. 3) in the Strait of Georgia, British Columbia, and very few on the west coast of Vancouver Island or in the Strait of Juan de Fuca (between Vancouver Island, Canada and Washington, United States). Zooplankton sampling and processing were performed at the biological station when also was conducted analysis of salmon stomachs. All data was stored for the each biological station. Vertical and oblique tows were performed to a depths of 50 m and 200 m (Mackas et al. 1997). The Bongo nets diameter was 56-58 cm, area - 0.25 m^2 per net (total area 0.5 m^2), mesh size - 0.230-0.350 mm (black mesh) (table). The each Bongo net was equipped by TSK or General Oceanics flowmeters. Samples immediately preserved in formaldehyde, and zooplankton was generally identified to the genus level.

Zooplankton Survey Methods Used in the Research Program of the Japan

During Japanese research cruise in Bering sea on board research vessel Kaiyo-maru zooplankton samples were collected with standard NORPAC net (Motoda 1994) and ORI net (Omori 1965) before trawling stations. The NORPAC net (mouth area- 0.16 m^2, ring diameter - 45 cm, mesh size – 0.315 mm – Japanese standard No. GG54) was main sampling gear and used on each hydrobiology station generally towed vertically in layer from 0 to 150 m (table, fig. 4, A-B). The estimate of depth of tow of NORPAC net was calculated on wire angle and length of wire. The ORI net (mouth area – 2.0 m^2, ring diameter – 160 cm, mesh size – 0.670 mm) used for collecting zooplankton in the surface layer with speed 2.0 knots while ten minutes (table, fig. 4, C). Filtering volume for both nets was measured using flowmeters (by TSK). All samples were preserved with 10% seawater formaldehyde (buffered) and transportation to laboratory for processing.

"In the 1994 were discussions regarding plankton nets suitable for offshore zooplankton research among FAJ fisheries scientists, and it was agreed that NORPAC net should be used (Mori 1992; Motoda 1994). The NORPAC net performs well in terms of the open area ratio (6.5) and the filtration ratio (91.4%). On the basis of on this agreement, scientists at the Tohoku National Fisheries Research Institute (TNFRI) of FAJ wrote a manual of techniques for everything from collection of zooplankton to arrangement of data for Japanese fisheries scientists (TNFRI 1994). The National Research Institute of Far Seas Fisheries has conducted plankton sampling and sorting of offshore samples in accordance with this manual. Zooplankton are sorted and identified into 12 categories (EU – euphausiids; CO – copepods; AM – amphipods; PT – pteropods; AP – appendicularians; CH – chaetognaths; OS – ostracods; JE – jellyfishes (medusae, ctenophores); SA – salps; FI – fishes; SQ – squids; OT – others) and weighed (mg/m^3). This procedure was not followed in some recent Japanese salmon research cruises. However, it has been recommended to Japanese fisheries scientists that they follow this manual for their basic plankton sampling for offshore fisheries research" (Mackas et al. 1997).

To compare the historical data and domestic data in other fields of fisheries, the plankton sampling conducted during offshore salmon research should follow the manual of TNFRI. Various types of plankton nets have been were used for sampling zooplankton in others countries, therefore, it is necessary to develop a conversion table of efficiencies among the currently employed and widely-used plankton nets in order to compare the zooplankton data among the NPAFC-member countries.

References

Chislenko, L.L. 1968. Nomograms for determination of weight water organisms on proportions and forms of body. Leningrad. Nauka. 106 p. (in Russian)

Davis, N.D. 1998. Sampling methods used on U.S. salmon research vessel, 1997-1998. NPAFC Doc. 356. Fisheries Research Institute. University of Washington. Seattle. 9 p.

Guide and key to pelagic animals of Baikal (with ecological notes). 1995. Novosibirsk. Nauka. 693 p. (in Russian with English abstracts)

Instruction for primary zooplankton sampling and processing at sea. 1980. Vladivostok. TINRO. 46 p. (in Russian)

Instruction for zooplankton sampling and processing. 1971. Moscow. VNIRO. 82 p. (in Russian)

Karedin, E.P. 1982. Instruction for quantitative processing of zooplankton at sea. 1980. Vladivostok. TINRO. 29 p. (in Russian)

Koval, M.V. 2002. The composition and distribution of macroplankton in the waters adjacent to Kamchatka in spring-fall periods for 1996-1998. Researches of water biological resources of Kamchatka and northwest part of Pacific Ocean. Petropavlovsk-Kamchatsky. KamchatNIRO. Vol. 6. P. 33-54 (in Russian with English abstracts)

Lubny-Gertsyc, E.A. 1953. Weight characteristic of basic zooplankton organisms from Okhotsk and Bering seas. Rep. AN USSR. Vol. XCI. N 4. P. 949-953. (in Russian)

Mackas, D., Y. Ueno, V. Karpenko, and N.D. Davis. 1997. Ocean salmon survey methods, 1995-1997. (NPAFC Doc. 256. Rev.2) Institute of Ocean Sciences, Sydney. National Research Institute of Far Seas Fisheries, Shimizu. Kamchatka Research Institute of Fisheries & Oceanography (KamchatNIRO), Petropavlovsk-Kamchatsky. Fisheries Research Institute. Univ. of Washington. Seattle. 37 p.

Mori, K. 1992. Vertical towing of small caliber nets. Manual on collection and research for eggs and larvae of pelagic fishes. National Research Institute of Fisheries Science. 12-4. Fukuura 2-chome. Kanazawaka.Yokohama. 236 p. (in Japanese)

Motoda, S. 1994. Devices of simple plankton apparatus. VIII. Bulletin of the Plankton Society of Japan. Vol. 40(2). P. 139-150.

Omori, M. 1965. A 160 cm opening closing plankton net. I: Description of the gear. J. oceanogr. Soc. Japan. Vol. 21(5). P. 212-218.

Pogodin, A.G. 1980. Comparison of Two Planktonic Nets Capacity for Euphausiidae. Ecology of sea. Vol. 3. Kiev. Naukova dumka. P. 69-73. (in Russian with English abstracts)

Posgay and Marak. 1975. The Bongo samplers for zooplankton sampling. Guide of MARMAP (Survey 1). 5 p.

Rass, T.S. and I.I. Kazanova. 1966. Methodical manual for sampling of fish eggs, larvae and fry. Moscow. Pishevaya Promishlennost. VNIRO. 42 p. (in Russian)

Report of the Bering-Aleutian Salmon International Survey (BASIS) Working Group Meeting. 2002. NPAFC Doc. 599. Vladivostok. Russia. May 27-29. 12 p.

Smith, P.E. and S.L. Richardson. 1977. Standard method for sampling of eggs and larvae of pelagic fishes. Food and Agriculture Organization of the United Nation. Rome. 11 p.

Snyder, D.E. 1983. Fish eggs and larvae. In L.A. Neilsen, and D.L. Johnson (eds.). Fisheries Techniques. Amer. Fish. Soc., Bethesda. pp. 165-197.

Sokolovskaya, T.G. and V.A. Belyaev. 1987. Recommendations for sampling and processing of ichthyoplankton from Kuroshio current area. Vladivostok. TINRO. 69 p. (in Russian)

TNFRI (Tohoku National Fisheries Research Institute). 1994. Manual of techniques from collection of zooplankton to arrangement of data. Report of the research meeting on plankton and productivity in the Northwestern Pacific Ocean. Appendix 1-14. TNFRI 27-5. Sinhamacho 3-chome. Shiogamashi. Miagi-ken. 985 p. (in Japanese)

Volkov, A.F. 1984. Recommendations for express zooplankton processing method at sea. Vladivostok. TINRO. 31 p. (in Russian)

Volkov, A.F. 1988. Recommendations for express zooplankton processing method at sea. Vladivostok. TINRO. 31 p. (in Russian)

Volkov, A.F. 1996. Methods of zooplankton sampling. Izv. TINRO. Vol. 119. P. 306-311. (in Russian with English abstracts)

Table Zooplankton sampling and processing methods used different countries during BASIS cruises 2002.

Country	**Russia**			**United States**	**Canada**	**Japan**	
	KamchatNIRO		**TINRO-Centre**				
Net types	IKS-80	Big Juday Net (BJN)	Big Juday Net (BJN)	Bongo nets	Bongo nets	NORPAC	ORI-net
Ring diameter, (cm)	80	37	37	60	56-58	45	160
Mouth area, (m^2)	0.5	0.1	0.1	0.25 x 2 (0.5)	0.25 x 2 (0.5)	0.16	2.0
Mesh size, (mm)	0.550	0.168	0.168	0.333, 0.505	0.230, 0.350	0.315	0.670
Towing method	vertical	vertical	vertical	oblique	vertical, oblique	vertical	horizontal
Towing speed, (m/sec)	0.8	0.8	1.0	lowered at 1.0, vessel speed 2.0 kts; retrieved at 1.0, vessel speed 1-1.5 kts	?	0.5	2.0 kts
Depth range, (m)	0-100, 0-bottom	0-100, 0-bottom	0-50, 0-100, 0-bottom	0-200, 0-bottom	0-50, 0-200	0-150	surface
Estimate depth of tow	wire angle and length of wire	wire angle and length of wire	wire angle and length of wire	wire angle and length of wire	wire angle and length of wire	wire angle and length of wire	-
Measurement of filtration volume	-	-	-	flowmeter	flowmeter	flowmeter	flowmeter
Method for sample preservation	5% seawater formaldehyde (buffered)	5% seawater formaldehyde (buffered)	4% seawater formaldehyde (buffered)	5-10% seawater formaldehyde (buffered), freezing	10% seawater formaldehyde (buffered)	10% seawater formaldehyde (buffered)	10% seawater formaldehyde (buffered)
Comments	Organisms are identified by species in laboratory		Organisms are separated into 3 size groups: <1.5 mm, 1.5-3.2 mm, >3.2 mm and then identified by species on board research vessel	The samples fixed in formalin brought in laboratory The frozen zooplankton samples for stable isotope analysis	The samples fixed in formalin brought in laboratory	The zooplankton are sorted and identified into 12 categories	The zooplankton are sorted and identified into 12 categories

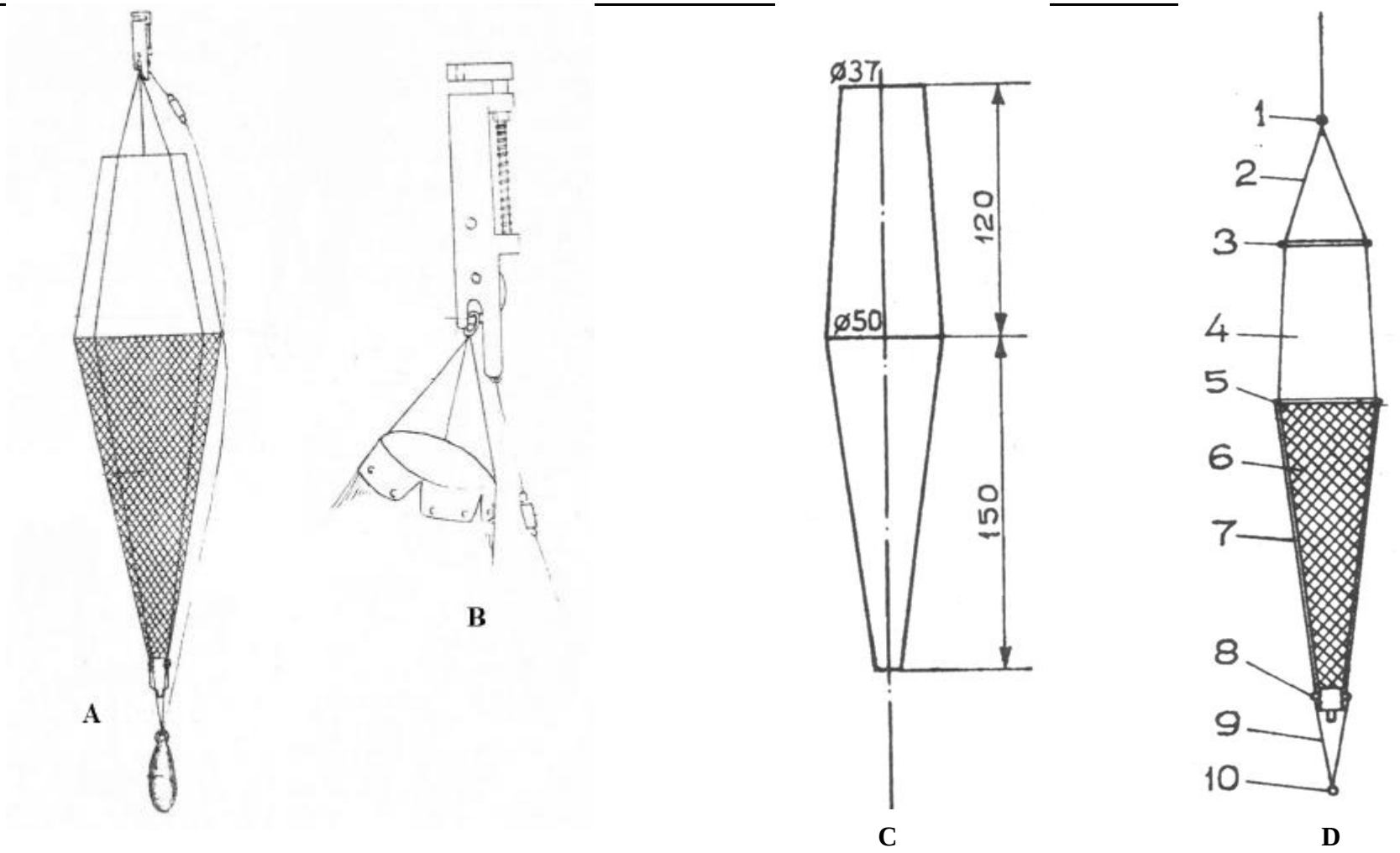

Fig. 1. Big Juday net (BJN) for vertical tow (used during 2002 TINRO-Centre and KamchatNIRO plankton surveys in Bering sea).

? – Basic view; B – The lock for closing net; C, D – Specification of big Juday net: 1 – ring or swivel, 2 – bridle, 3 – mouth area, 4 – canvas socket (nose cone), 5 – mouth ring of the filtering cone, 6 – filtering cone (mesh size - 0.168 mm), 7 – lower slings, 8 – composition-metal cod-end, 9 – slings, 10 – ring for attaching lead weight. Net size in cm. (A-B – from Instruction… 1971; C-D – from Guide… 1995).

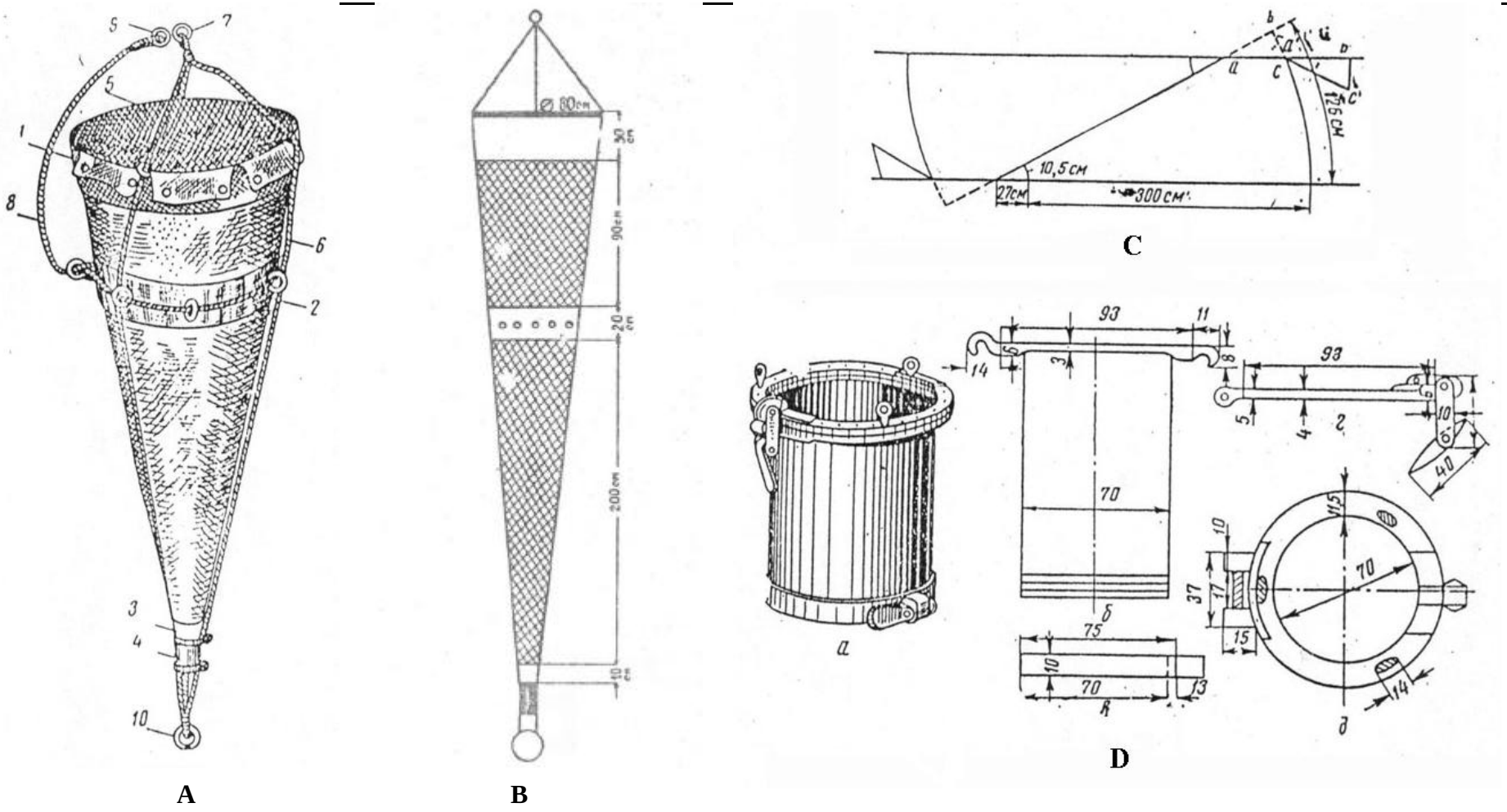

Fig. 2. IKS-80 net for vertical tow (used during 2002 KamchatNIRO plankton surveys in Bering sea and northwest part of Pacific Ocean).

? , B – Basic view and specification open-closing model (filtering cone with mesh size - 0.550 mm): 1 – 30 cm canvas band, 2 – 20 cm canvas throttling band, 3 – 10 cm end canvas band, 4 – composition-metal cod-end, 5 – mouth area, 6 – slings, 7 – ring or swivel, 8 – throttle with IKS-80 closing system, 9 – ring of closing system, 10 – ring for attaching lead weight (B - net size in cm); C – measures of filtering cone (size in cm); D – measures of composition-metal cod-end (size in mm). (A,C,D – from Rass and Kazanova 1966; B – from Sokolovskaya and Belyaev 1987).

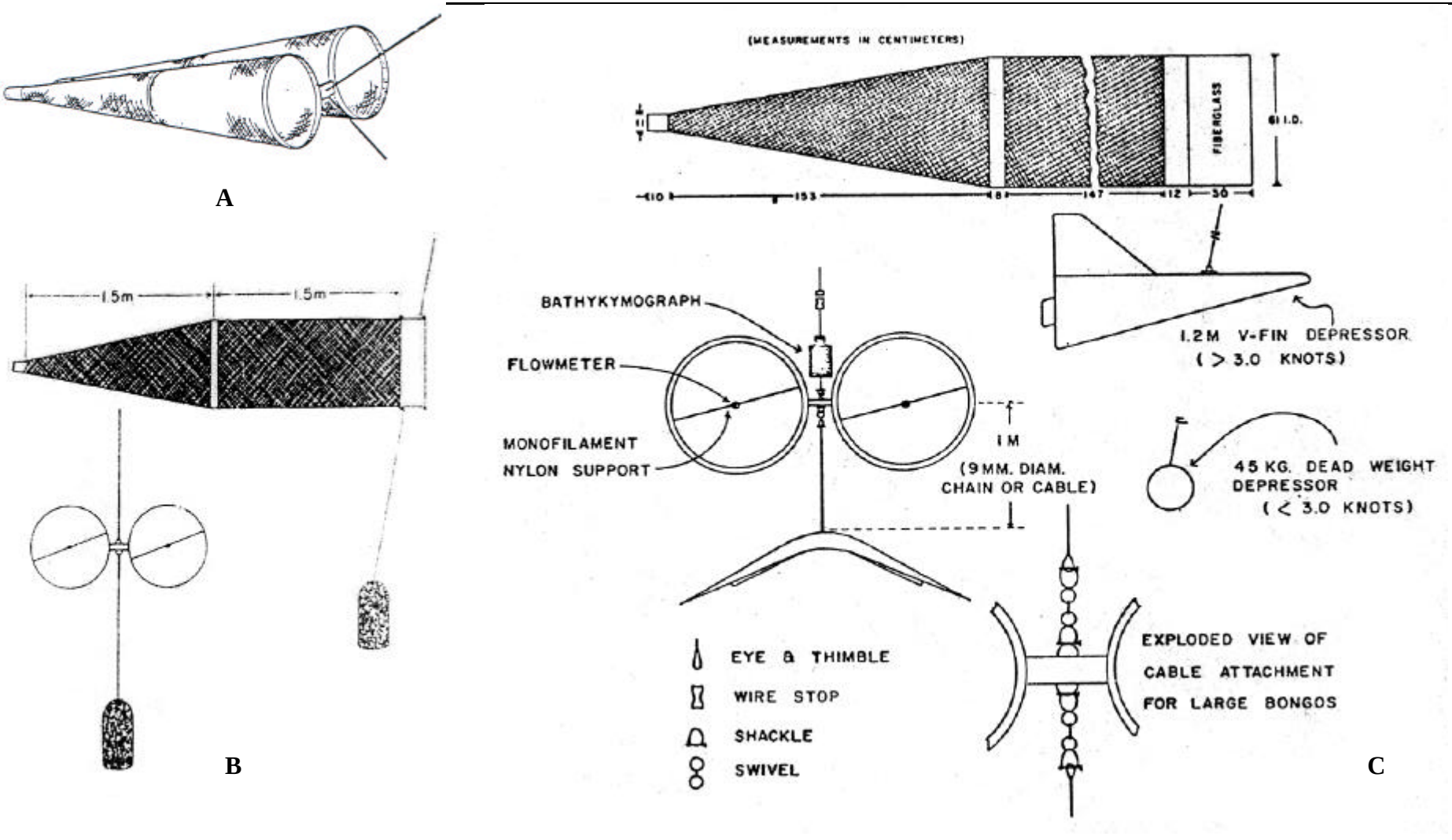

Fig. 3. Bongo nets for horizontal tow (used during 2002 US and Canada plankton surveys in Bering sea and northeast part of Pacific Ocean).

? – Basic view of Bongo nets (filtering cones with mesh size – 0.333 and 0.550 mm); B – Position of Bongo nets during the tow; C – measures of standard Bongo net (size in cm) (A – from Snyder 1983; B – from Smith and Richardson 1977; C – from Posgay and Marak 1975).

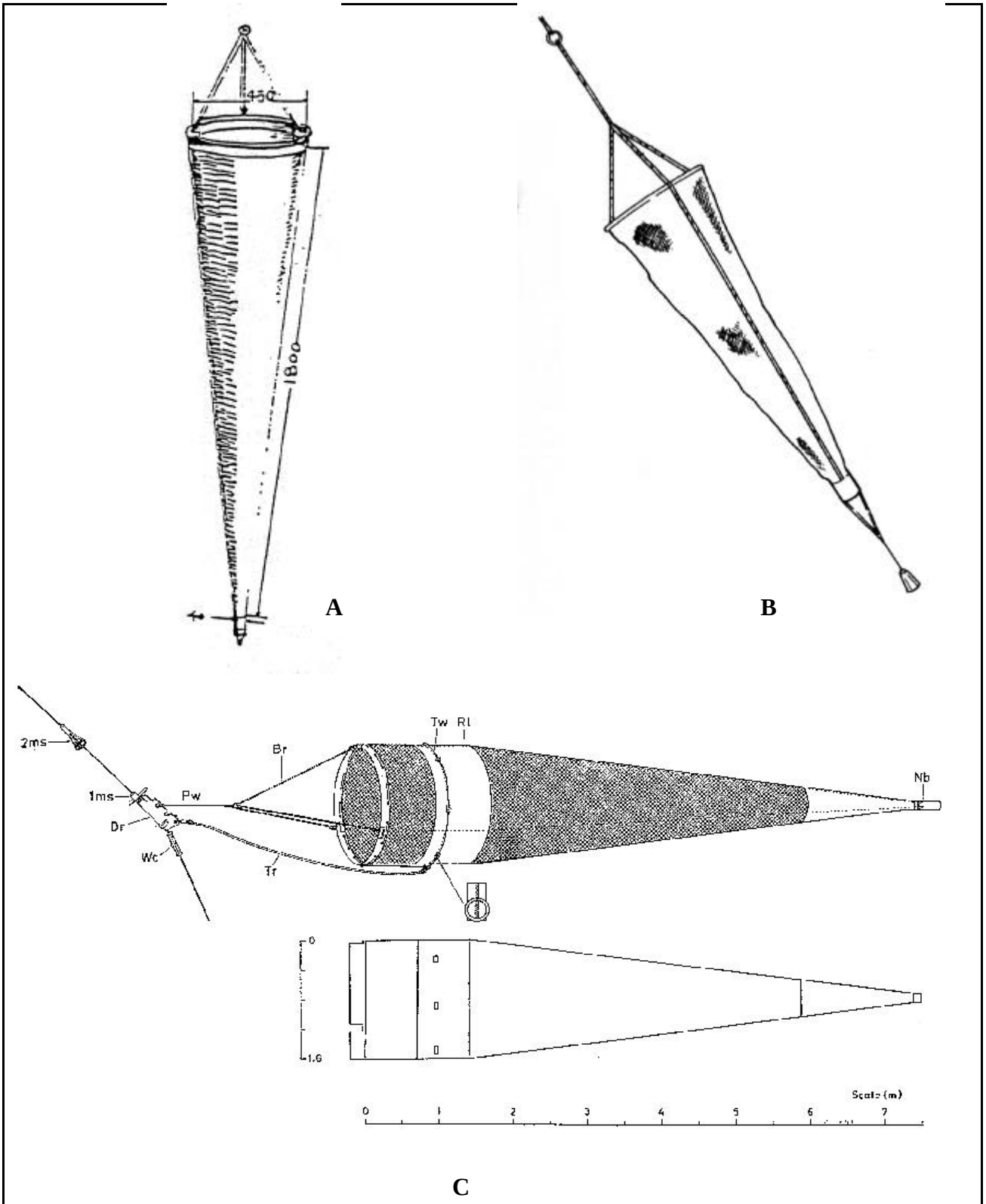

Fig. 4. NORPAC and ORI net (used during 2002 Japanese plankton surveys in Bering sea).

? – Basic view of standard NORPAC net (size in mm) (from Motoda 1994); B – Position of NORPAC net during the tow; C – Basic view of ORI net and measures of filtering cone (size in m) (Br – bridles; Dr – double release gear; Nb – net bucket; Pw – pendant wire; Rl – rib lines; Tr – throttling rope; Tw – throttling wire; Wc – wire clamp; 1ms – 1st messenger; 2ms – 2nd messenger) (from Omori 1965).