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Beaufort Sea Plankton Studies

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I. Summary of objectives, conclusions and implications with respect to OCS oil and gas development

The objectives of this project are to assess the winter density distribution of zooplankton and phytoplankton in Steffanson Sound and to analyze samples collected during the 1978 icebreaker cruise in the western Beaufort Sea.

Information concerning the abundance and distribution of phytoplankton and zooplankton and primary productivity in the western Beaufort Sea in summer (August and September) is now available. Some information will be available concerning the winter abundance and distribution of plankton at the end of the FY 79 winter field season. Still unavailable, however, is information from the spring, April through June, and including the underice community.

The winter information is important because of the State of Alaska regulation limiting drilling to the winter and there are indications that some biological activity occurs in winter, i. e. , spawning of Arctic cod *(Boreogadus saida* Lepechin) in Russian waters (Rass 1968).

II. Introduction

A. General nature and scope of study

As primary producers and primary and secondary consumers, phytoplankton and zooplankton are important in the Beaufort Sea ecosystem. R.U. 359 will provide information on the winter populations of phytoplankton and zooplankton in the nearshore area of Steffanson Sound.

B. Specific objectives

The specific objectives of this project are to assess the winter density distribution and environmental requirements of zooplankton and phytoplankton in the nearshore areas of the Beaufort Sea in an integrated sampling effort with other Research Units and to analyze samples collected during the 1978 icebreaker cruise in the Beaufort Sea.

C. Relevance to problems of petroleum development

Basic background information on standing stock, species composition, community structure, distribution, and primary production of plankton communities in the Beaufort Sea lease area in winter is generally not known. This kind of information is necessary in order to assess damage in case of a spill. Knowledge of winter biological activity is especially important in light of the State of Alaska draft regulations that limit exploratory drilling to the winter.

III. Current state of knowledge

The literature pertaining to plankton studies in the Beaufort Sea has been reviewed (English and Homer 1977) and summarized (Homer 1978).

Recent papers not previously summarized include Hsiao et al. (1977), Hsiao et al. (1978), and Hsiao (1978). Hsiao et al. (1977) determined phytoplankton standing stock and primary production in the southern Beaufort Sea during the summers of 1973, 74, and 75. They found the phytoplankton community to be dominated by diatoms in coastal waters and by flagellates farther offshore. Productivity and standing stock decreased with increasing distance from shore.

Hsiao et al. (1978) studied the effects of crude oils and the oil dispersant Corexit on primary production of Arctic marine phytoplankton and seaweeds. These authors found that the production rate varied with concentrations and types of oil, method of preparation of oil-seawater mixtures, species composition, and environmental conditions. Inhibition of production generally increased with increasing oil concentration in samples with the same species concentration. Mixtures of crude oil and Corexit were more toxic than crude oil or Corexit alone. Production of *Laminaria saccharina* and *Phyllophora truncata* was inhibited by all types and concentrations of oil tested.

Hsiao (1978) studied the effects of four crude oils on the growth of three diatoms and one green flagellate isolated from Beaufort Sea plankton. He found the green flagellate, *Chlamydomonas pulsatilla,* to be the most tolerant species, with none of the oils being lethal at any of the concentrations, temperatures, and exposure times tested. In fact, at lower temperatures and oil concentrations, growth was slightly stimulated. The growth of diatoms, Chaetoceros *septientrionalis, Navicula bahusiensis,* and *Nitzschia delicatissima,* was inhibited by all oils tested after ten days' exposure at O°C, 5"C, and 10°C and concentration of 10 ppm. *Nitzschia delicatissima* was the most sensitive of the three diatoms, followed by Navicula *bahusiensis* and *Chaetoceros septentrionalis.*

The author points out possible consequences of an oil spill in Arctic waters, suggesting that a spill in open water could result in a shading effect on the phytoplankton that would inhibit growth or the persistence of the non-volatile, water soluble aromatic hydrocarbons that might inhibit growth. If a spill happened under the ice, the oil could affect the ice algae by coating it causing direct physical damage, by producing a shading effect, and by inhibiting growth due to the persistence of more toxic volatile components. The composition of the phytoplankton community could change to one dominated by flagellates because of differential growth and sensitivity to oils and this could lead to altered zooplankton communities as well.

Perhaps the most important contribution of these papers is that the experiments were performed on species that were isolated from the Beaufort Sea. While the phytoplankton species are not usually dominant species in the phytoplankton community of the western Beaufort Sea, *Chaetoceros septentrionalis* and Nitzschia delicatissima are nearly always present in

the water column and Ch. *septentrionalis* may also be a component of the ice algae community.

IV. Study area

The study area and sampling stations during the August-September 1978 cruise of CGC *Northwind* are shown in Fig. 1.

The winter sampling site was in Steffanson Sound at 70°19'N, 147°34.4'W.

V. Sources, methods and rationale of data collection

Phytoplankton samples were collected with 5-ℓ Niskin bottles. Subsamples of the water were taken for salinity, standing stock, primary productivity, and plant pigment determinations. Standing stock samples were preserved with 5-10 ml of 4% formalin buffered with sodium acetate. Primary productivity measurements were made in 60 ml reagent bottles. Two light and one dark bottle were used for each depth. Two ml of $NaH^{14}CO_3$ solution were added to each bottle, aluminum foil was wrapped around the dark bottle and the samples were incubated in a laboratory sink under a bank of cool white fluorescent lights. Light levels were measured at the beginning and end of the incubation period with a Gossen Super Pilot photographic light meter. Low temperature was maintained by running seawater and was monitored throughout the incubation period. Following a 3 to 4 hr incubation period, the samples were filtered onto 25 mm HA (0.45 μm) Millipore filters, rinsed with 5 ml filtered seawater and 5 ml 0.01 N HC1, and placed in liquid scintillation vials.

Water for plant pigment determinations was filtered through 47 mm HA (0.45 μm) Millipore filters. A few drops of a saturated $MgCO_3$ solution were added near the end of the filtration and the filter was rinsed with filtered seawater. The filters were folded into quarters, placed in labeled glassine envelopes, and frozen.

Salinity was determined on board using a Beckman Industrial Instruments Model RS-7A portable induction salinometer. "Copenhagen" water was used as the standard. Temperatures, measured with deep sea reversing thermometers were corrected using calibration factors provided by the Coast Guard and following the procedure outlined in the U.S. Naval Oceanographic Office Publ. 607 (1968). Water transparency was measured with a Secchi disc.

Zooplankton samples were collected with bongo nets having mesh sizes of 333 and 500 μm, mouth openings of 60 cm, and areas of 0.2827 m^2. A TSK model 313 flowmeter (InterOcean Systems, Inc.) was mounted in the mouth of each net. A 45 kg rectangular weight was attached to the net frame. Tows were double oblique with the net lowered at *ca.* 40-50 m/min to a depth *ca.* 10 m from the bottom at shallow stations or to 200 m at deep stations, soaked for 30 see, and retrieved at *ca.* 20 m/min.

The samples were concentrated by gently swirling in a net collection cup to remove excess water. The samples were poured into jars and preserved

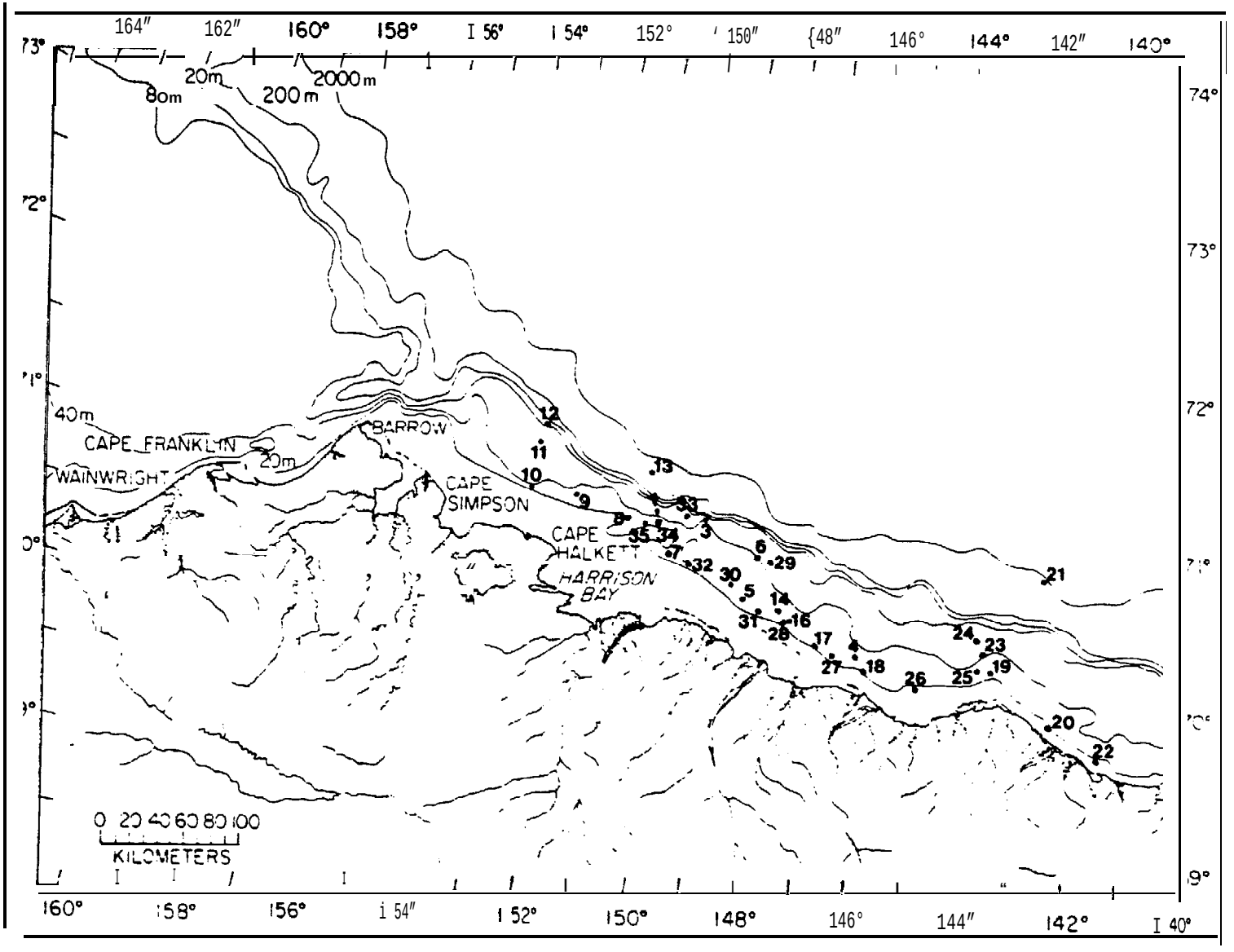

Fig. 1. Study area and station locations, USCGC *Northwind*, 15 Aug to 15 Sep 1978.

with 37% formalin and saturated sodium acetate solution. The amount of formalin and buffer depended on the jar size. A label containing collection data was put in the jar, seawater added if necessary to fill the jar, and the jar was capped for storage.

During the 1978 icebreaker cruise, stations 1-6 were collected in areas where Alaska Department of Fish and Game personnel were hunting seals (R. U.'S 230 and 232). Stations 10-12 were collected along the Pitt Point transect (R. U. 6). Other stations were taken at locations east of Prudhoe Bay where microbiologists (R. U. 's 29 and 190) needed samples, and at locations to repeat stations taken in 1976 and 1977, and to fill in gaps.

VI. Results

A. CGC *Northwind* cruise

1. Hydrography

Hydrographic data for stations taken in the Beaufort Sea are given in Table 1; vertical profiles of temperature and salinity are given in Fig. 2.

2. Phytoplankton standing stock

Phytoplankton standing stock samples have been analyzed for eight stations (68 samples). No new organisms have occurred in the 1978 samples, but all the diatoms are weakly silicified, to the extent that identification is often difficult.

The number of phytoplankton cells ranged from $< 2 \times 10^5$ to ea. 3×10^6 cells per liter. As in 1976 and 1977, small *Chaetoceros* spp. and unidentified flagellates were the most abundant organisms.

3. Primary productivity and plant pigment concentrations

Primary productivity and plant pigment concentrations are listed in Table 1 and vertical profiles are shown in Fig. 2. Integrated values for carbon assimilation and chlorophyll a are given in Figs. 3 and 4.

Primary productivity ranged from 0.01 to 2.93 mg C m^{-3} hr^{-1} with integrated productivity ranging from 1.25 mg C m^{-2} at station 7 to 32.05 mg C m^{-2} at station 29.

Chlorophyll a ranged from 0.01 to 6.11 mg m^{-3}; integrated chlorophyll a ranged from 4.63 mg m^{-2} at station 22 to 37.35 mg m^{-2} at station 16.

4. Zooplankton

Sixty-one categories of zooplankton have been identified from 16 net hauls, including 27 species and 34 other categories such as larval stages and categories where identification was made to some taxonomic rank higher than species (Table 2). Greatest emphasis has been placed on

Table 1. Summary of station locations, hydrography, ice cover, chlorophyll a and phaeopigment concentrations, and primary productivity, USC(% *Northwind*, *15* Aug to 15 Sep 1978,

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
01	17 Aug	71°11′	150°14 ′	8	∿ 1	005	-0.01*	24.16	0.13	0.05	
						015	2.55*	30.19	0.23	0.05	0.02
						025	1.95†	31.16	0.56	0.30	0.22
						035	2.39	31.55	0.40	0.17	0.17
						045	1.57	32.08	0.21	0.20	0.05
03	18 Aug	70°58.5′	149°17′	7	4-5	003	-0.27	,15.93	0.18	0.06	0.01
						010	-1.03*	29.11	0.27	0.07	0.01
						015	-0.45	29.88	0.40	0.05	0.06
						020	-0.71	30.73	0.34	0.05	0.07
						025	2.80	31.52	0.26	0.18	0.11
						030	2.40	31.68	0.38	0.20	0.17
						035	2.17	31.68	0.32	0.19	0.18
04	19 Aug	70’19.8’	146°05′	5	1	000	-0.36	28.86	0.17	0.16	0.04
						005	-0.42	29.30	0.21	0.16	0.08
						010		31.82	0.24	0.30	0.11
						015	-1.16	32.15	0.24	0.31	0.05
						020	-1.64	32.17	0.31	0.20	0.09
						025	-1.64	32.22	0.33	0.34	0.06
05	21 Aug	70°36.2′	148”20.2[1]	5	3-4	000	-0.08	22.36	0.16	0.10	0.03
						003	-0.20	26.20	0.17	0.07	
						006	-0.84	31.31	1.30	0.05	0.27
						009	-1.52*	32.06	0.70	0.24	0.27
						012	-1.45	32.09	0.81	0.36	0.23
						015	-1.52	32.10	0.49	0.91	0.21
						020	-1.53	32.08	1.05	0.68	0.24

* Temperature based on oniy one thermometer
† Temperature values questionable
Where no value is present, no data are available

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (w)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (“c)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
06	22 Aug	70°55′	148°11′	5	∿ 5	000	0.56*	9.46	0.33	0.02	
						005	-1.13	28.38	0.38	0.10	0.04
						010	-1.42	29.80	0.27	0.07	0.04
						015	-1.39	30.12	0.36	0.04	0.07
						020	-0.17*	31.05	0.34	0.08	0.12
						025	-0.64	31.32	0.24	0.08	0.06
						030	-0. 64*	31.60	0.14	0.08	0.01
						035	0.18	31.87	0.29	0.30	0.07
07	23 Aug	70°05.9′	149°54′	8	0	000	*0.56*	24.90	0.15	*0.08*	
						005	*0.49*	25.16	0.16	*0.08*	0.03
						010	*0.79*	27.93	0.26	*0.12*	0.05
						015	*3.46*	29.97	0.57	*0.20*	0.08
						020	*2.12*	30.58	0.38	*0.26*	0.21
08	23 Aug	71°03.6′	150°52.9′	9	0	000	0.89	25.33	0.25	*0.08*	0.01
						005	0.92	25.65	0.23	*0.07*	0.03
						010	3.34	28.87	0.48	*0.16*	0.08
						015	3.60	29.69	0.54	*0.20*	0.13
						020	3.54	29.77	0.55	*0.37*	0.13
09	24 Aug	71°11.1′	151°51.3′	10	0	000	1.77*	25.76	0.21	0.19	0.02
						005	1.84	26.31	0.29	0.05	0.08
						010	**1.73**	28.73	0.29	0.22	0.05
						015	**4.81**	29.30	0.28	0.42	0.17
						020	**3.51**	29.93	0.27	0.40	0.05

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg Cm^{-3} hr^{-1})
10	24 Aug	71°05′	152°51′	7	0	000	1.76*	25.46	0.14	0.07	0.02
						005	2.22	27.94	0.25	0.09	0.11
						010	2.68	30.24	0.96	0.27	0.23
						015	2.33	31.09	1.78	0.67	0.45
						020	2.38	31.13	1.69	0.72	0.60
11	24 Aug	71°19.8′	152°47.7′	10	0	000	1.96*	26.02	0.25	0.08	
						005	1.75	26.06	0.32	0.08	
						010	5.12	28.64	0.53	0.17	0.18
						015	4.91	29.23	0.32	0.08	0.09
						020	3.91*	29.72	0.44	0.16	0.16
						030	2.12	31.26	0.52	0.20	0.15
						040	2.07	31.34	0.47	0.21	0*17
						050	1.27	31.52	0.33	0.18	0.13
12	24 Aug	71°21.6′	152°41.1′	10		000	2.88*	26.11	0.29	*0.08*	0.02
						005	3.31	26.83	0.41	*0.12*	0.04
						010	4.59	28.90	0.72	*0.25*	0.15
						015	5.74	29.19	1.03	*0.29*	0.09
						020	5.88	29.22	0.69	*0.17*	0.09
						030	5.44	29.65	0.23	*0.12*	0.05
						045	2.07*	31.21	0.43	*0.16*	0.49
						060	0.72	31.60	0.30	*0.11*	0.05
						075	-1.03	31.88	0.12	0.10	0.04
						090	-1.24	32.47	0.15	0.18	

Table 1. (continued

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (w)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (“c)	S°/₀₀	Chl a (mg m^{-3})	Phaeo	Prim Prod (mg C m^{-3} hr^{-1})
13	26 Aug	71°33.5′	150°27.0′	10	2	000	0.08*	23.40	0.09	0.04	0.23
						005	0.21	24.14	0.11	0.07	0.06
						010	0.30	27.54	0.22	0.05	0,05
						015	0.62	28.80	0.27	0.05	0.06
						020	0.87	30.61	0.22	0.05	0.02
						030	-0.45	31.13	0.26	0.08	0.07
						045	-1*01*	31.72	0.14	0.09	0.04
						060	-1.43	31.98	0.06	0.06	
						075	-1, 20*	32.16	0.04	0.08	0.03
						100	-1.16	32.41	0.02	0.08	
						125	-1.30	32.67	0.03	0.09	
						150	-1.12*	32.98	0.02	0.10	
						175	-0.96	33.62	0.03	0.08	
						200	-0.30	34.09	0.01	0.03	
						1800	-0.36	34.52	0.02	0.03	
14	28 Aug	70°36′	147°38.7′	7	∿ 4	000	-0.69*	21.29	0.23	0.10	0.02
						003	-0.79	27.81	1.31	0.23	0.07
						006	-1.20	29.92	2.86	0.49	0.29
						009	-1.26	30.55			0.47
						012	-1.43	31.76	1.40	1.01	0.32
						015	-1.44	31.81	1.11	0.62	0.30
						018	-1.48	31.84	0.94	0.50	0.35
16	29 Aug	70°29 ′	147°23′	7	∿ 4	000	-0.33*	21.11	0.18	0.09	
						003	-0.80	26.37	0.65	0.16	
						006	-1.10	29.88	2.37	0.39	0.32
						009	-1*15	34.37	1.76	0.46	0.89
						012	-1.45	31.75	1.92	0.72	0.90
						015	-1. 36*	31.79	1.76	0.57	0.78
						018	-1.46*	31.79	2.86	1.11	0.72
						021	-1.49	31.80	2.08	0.54	0.85

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg Cm^{-3} hr^{-1})
17	30 Aug	70°21.9′	146°51.7′	7		000	-0.15	22.47	*0.25*	0.12	0.01
						003	-0.73	26.01	*0.49*	0.15	0.03
						006	-0.94*	29,05	*1.76*	0.23	0.18
						009	-1.28	30.60	*1.51*	0.32	0.39
						012	-1.38	31.45	*3.12*	0.59	0.88
						015	-0.99*	31.66	*2.68*	0.80	1.05
						018	-1.16	31.63	*3,45*	0.98	1.02
18	31 Aug	70°34 ′	145°51.7′	5	1-2	000	0.44	23.65	*0.24*	0.13	0.01
						003	-0.20	27.14	*0.29*	0.18	0.03
						006	-0.63*	29.37	*0.36*	0.19	0.10
						009	-0.99	30.73	1.01	0.35	0.20
						012	-0.87*	31.74	4.03	1.04	1.93
						015	-1.37	31.75	3.53	1.01	1.75
						018	-1.04	31.75	4.42	1.30	1.63
19	01 Sep	70°12.7′	143°22.6′	11	0	000	2.63	26.28	0.16	0.05	
						003	-0.12	30.10	0.21	0.05	0.05
						006	-0.54*	30.59	0.12	0.05	0.04
						009	-0.42	31.06	0.28	0.20	0.16
						012	-o .90	31.62	0.08	0.44	0.50
						015	-0.41	32.05	2.65	0.66	1.52
						018	-1.21	32.07	2.41	1.01	1.32
20	02 Sep	69°58.5’	142°15’	5	0	000	4.07	28.51	0.20	0.07	0.06
						003	1.97	30.09	0.16	0.44	0.04
						006	1.88	31.00	0.53	0.12	0.44
						009	0.43	31.02	0.60	0.81	0.25
						012	0.32	31.05	1.58	0.36	0.49
						015	0.28	31.08	2.03	0.84	0.90

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl *a* (mg m^{-3})	Phaeo	Prim Prod (mg C m^{-3} hr^{-1})
21	03 Sep	70°57.8′	142°20.8′		0	000	-1.38	27.69	0.19	0.05	0.03
						005	-1.29	30.27	0.14	0.05	0.07
						010	-1.19	30.26	0.21	0.11	0.03
						015	-1.12	30.88	0.17	0,14	0.09
						020	-1.28	31.12	0.18	0.14	0.05
						025	-1.33	31.32	0.20	0.21	
						030	-1.33	31.59	0.26	0,14	0.11
						045	-1.53	31.83	0.25	0.23	0.11
						2400	-0.39	35.01			
22	05 Sep	69°45′	141°17.5′	10	0	000	3.44	29.42	0.20	0.08	
						003	2.12	30.96	0.22	0.08	0.07
						006	1.79	31.30	0.21	0.08	
						009	0.93	31.79	0.29	0,08	0.11
						012	0.12*	31.85	0.55	0.06	0.15
						015	0.10	31.85	0.47	0.08	0.28
23	06 Sep	70°28.0′	143°33.0′		0	000	4.36	25.60	0.12	0.06	0.01
						005	3.34	28.03	0.18	0.07	
						010	0.13	30.22	0.12	0.07	0.03
						015	-1.03*	31.41	0.08	0.03	0.02
						020	-1.28	31.87	0.14	0.05	0.12
						025	-1.24;	32.26	0.11	0.14	
						030	-1.45	32.32	0.21	0.14	0.07
						035	-1.61	32.34	0.27	0.15	0.14

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (w)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (“c)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
24	06 Sep	70°28.6′	143″42.3′	15	0	000	4.18*	26.25	0.13	0.09	0.05
						005	3.02*	30.33	0.18	0.05	0,10
						010	1.75	31.08	0.16	0.05	0.01
						015	-1.11	31,34	0.13	0.05	0.02
						020	-1.26*	31.52	0.15	0.06	0,01
						030	-1.48	31.81	0.23	0.13	0.16
						045	-1.56	32.11	0.12	0.15	0.06
						055	-1.33	32,42	0.10	0.21	0,04
25	07 Sep	70°15.1′	143°40.0′			000	2.93*	27.35	0.09	0.06	0,02
						003	2.18	27.94	0.12	0.05	0.03
						006	-0.18	30.43	0.21	0.16	0.11
						009	-0.54	31.27	0.37	0.16	0.11
						012	-1.14*	31.85	0.26	0.07	0.17
						015	-1.43*	32.21	3.78	0.66	1.63
						020	-1.47	32.23	5.46	0.23	2.18
						025	-1.51	32.23	4.16	1.11	2.16
26	08 Sep	70°07.7′	144°48.4′		0	000	2.33	25.13	0.28	0.07	0.02
						003	1.13	26.36	0.16	0.07	0.07
						006	0.23	28.09	0.18	0.10	0.06
						009	-0.37	30.32	0.10	0.07	
						012	-1.24*	31.63	0.53	0.53	0.17
						015	-1.33	31.82	0.92	0.92	0.28

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (w)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (“c)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
27	08 Sep	70″17.8′	146°30.8′	8	∿ 6	000	-1.01	26.08	**0.21**	0.08	0.07
						003	-0.97	27.40	**0.24**	0.12	0.04
						006	-0.92	28.93	**0.34**	0.11	0.10
						009	-1.12	30.03	**0.47**	0.08	0.22
						012	-1.27	30.39	**0.56**	0.08	0.29
						015	-1. 38*	31.28	**3.90**	0.72	1.49
						018	-1.40	31.32	**6.11**	1.64	2.56
28	09 Sep	*70°28.0′*	*147°25.7′*	*8*	*2*	*000*	-0. 24*	15.93	**0.43**	0.09	0.07
						003	-0.77	25.60	**0.22**	0.08	0.09
						006	-1.01	28.30	**0.42**	0.06	0.10
						009	-1.06*	29.44			0.21
						012	-0.74*	29.84	**0.69**	0.03	0.30
						015	-0.65	30.37	**1.01**	0.18	0.35
						018	-1.16*	30.82	**2.55**	0.63	1.04
						021	-1.09	30.85	**3.35**	0.72	1.50
29	09 Sep	71°01′	147°56.5′	10	2-3	000	-o .05	24.40	**0.22**	*0.06*	0.01
						005	0.21	27.28	0.49	0.16	0.12
						010	4.88	29.16	0.54	0.16	0.04
						015	4.86	29.80	0.94	0.27	0.34
						020	4.22	30.19	0.31	0.75	0.60
						025	4.48	30.58	0.74	0.20	0.31
						030	2.63*	30.83	0.70	0.17	0.30
						045	0.42	31.54	0.25	0.10	2.93

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (w)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (“c)	S°/₀₀	Chl a (mg m^{-3})	Phaeo (mg m^{-3})	Prim Prod (mg C m^{-3} hr^{-1})
30	10 Sep	70°44.9′	148°34′		2-3	000	0.12	10,35	0.31	0.07	*0.08*
						003	-0.89	25.92	0.25	0.08	*0.11*
						006	-0.98	28.33	0.38	0.11	*0.13*
						009	-1.17*	29.65	0.65	0.09	*0.19*
						012	-0.91*	29.93	0.75	0.22	0.28
						015	1.89*	31.16	0.82	0.20	*0.32*
						018	1. 28*	31.39	1.27	0.37	*0.62*
						021	1.11	31.39	2.34	0.27	*1.08*
31	11 Sep	70°35.5′	148°00.0′	10	3-4	000	-0.49*	16.94	0.33	0.07	0.06
						003	-0.68	27.98	0.46	0.11	0.16
						006	0.02	30.35	0.64	0.14	0.26
						009	0.07	30.58	0.31	0.92	0.46
						012	-0.41*	31.20	2.10	0.51	0.76
						015	-0.27	31.42			1.09
						018	-0.84	31.49	2.28	0.59	1.04
32	12 Sep	70°46.6′	149°30.4′	5	6-7	000	-0.55	10.48	0.53	0.14	*0.08*
						003	-0.82	28.54	0.44	0.16	*0.15*
						006	-0.82	29.61	0.37	0.08	*0.10*
						009	-0.56	30.31	0.70	0.14	*0.24*
						012	0.45	31.00	1.30	0.30	*0.66*
						015	0.26	31.10	1.76	0.43	*0.79*
						018	0.79	31.10	1.68	0.62	*0.98*

Table 1. (continued)

Sta	Date (1978) (GMT)	Latitude (N)	Longitude (W)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	S°/₀₀	Chl G (mg m^{-3})	Phaeo	Prim Prod (mg c m^{-3} hr^{-1})
33	13 Sep	71°12.6′	149°38.4′	7	0-1	000	1.44*	27.26	0.47	0.13	0.03
						005	1.43	27.26	0.47	0.11	0.08
						010	1.54	27.3.5	0.46	0.13	0.09
						015	1.72	27.50	0.47	0.09	0.08
						020	2.59*	30.48	0.51	0.59	0.24
						030	1.68*	31.61	0.21	0.19	0.07
						045	1.27	31.47	0.13	0.18	0.07
						060	1.08*	31.64	0.14	0.20	0.11
34	13 Sep	70°52′	150°16′	8	< 1	000	-0.63	25.66	0.40	0.15	0.09
						003	-0.59	26.17	0.43	0.16	0.15
						006	-0.17	28.58	0.47	0.18	0.16
						009	0.41	29.60	0.70	0.10	0.18
						012	2.29	30.51	0.88	0.31	0.36
						017	1.66	30.53	1.17	0.34	0.32
						022	1.66	30.53			0.68
35	14 Sep	71°01′	150°25′	7	1-2	000	-0.98*	26.57	0.33	0.17	0.09
						003	-0.92*	27.35	0.39	0.14	0.10
						006	-0.95	27.39	0.44	0.13	0.15
						009	-0.53	28.11	0.59	0.26	0.15
						012	2. 37*	29.98			0.44
						015	3.62	30.17	0.89	0.34	0.40
						018	3.59*	30.18	0.98	0.34	0.49
						021	3.58	30.17	0.95	0.45	0.48

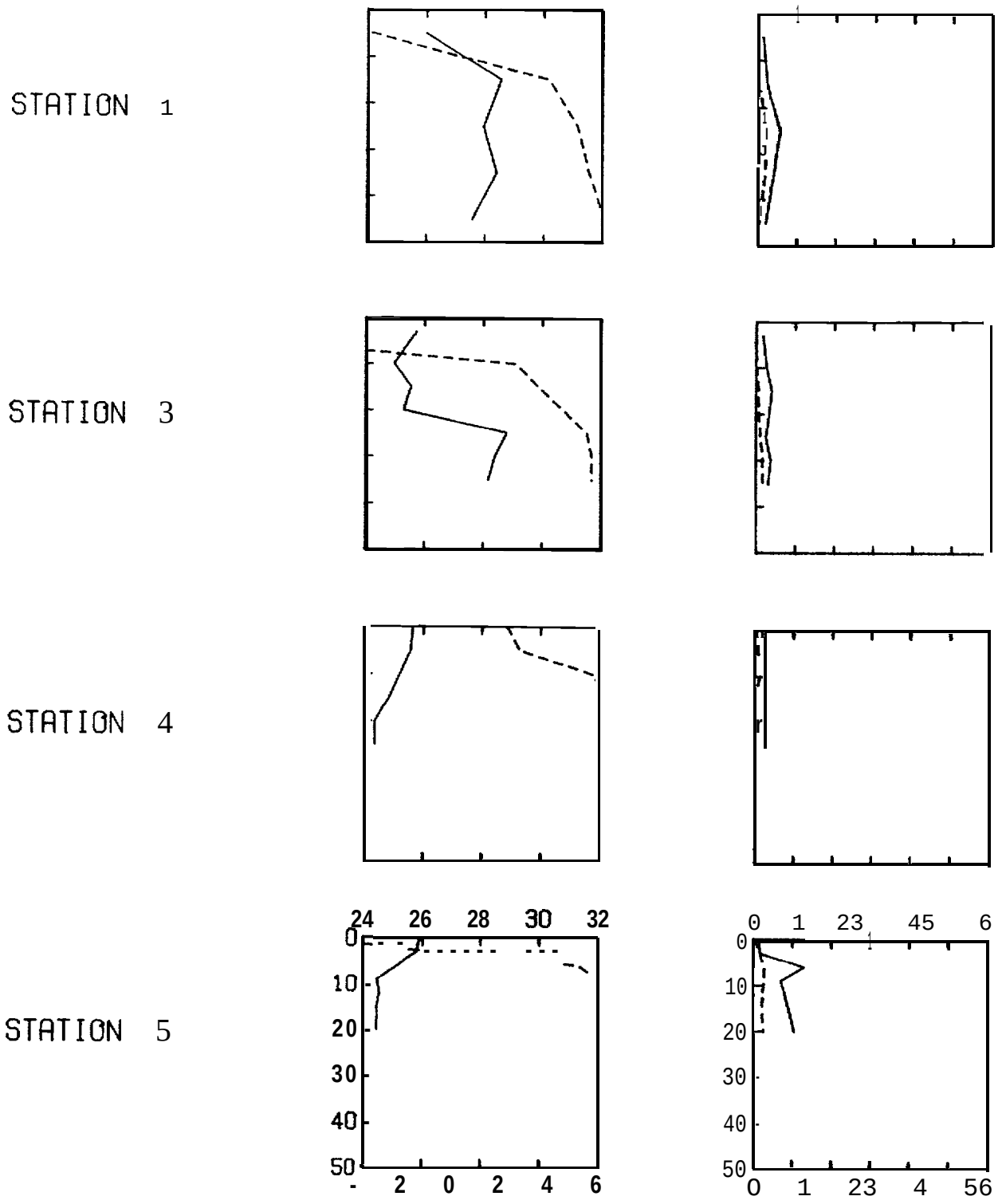

Fig. 2. Depth profiles of temperature-salinity and chlorophyll a-^{14}C assimilation in the Beaufort Sea, August-September 1978. Salinity (‰) ----; temperature (°C) ——; ^{14}C assimilation (mg C m^{-3} hr^{-1}) ----; chlorophyll a (mg m^{-3}) —.

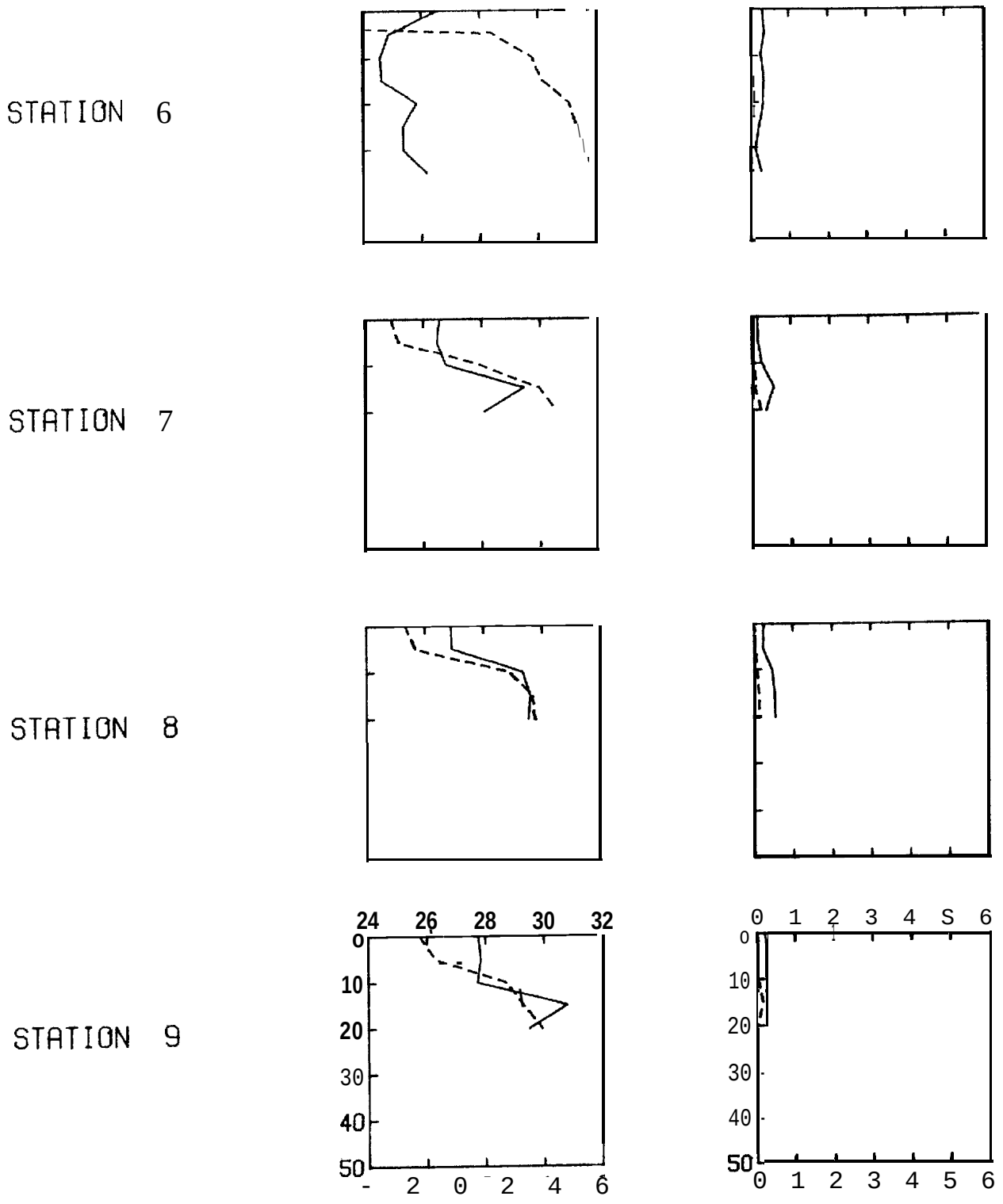

Fig. 2 (continued)

STATION 10

STATION 11

STATION 12

STATION 13

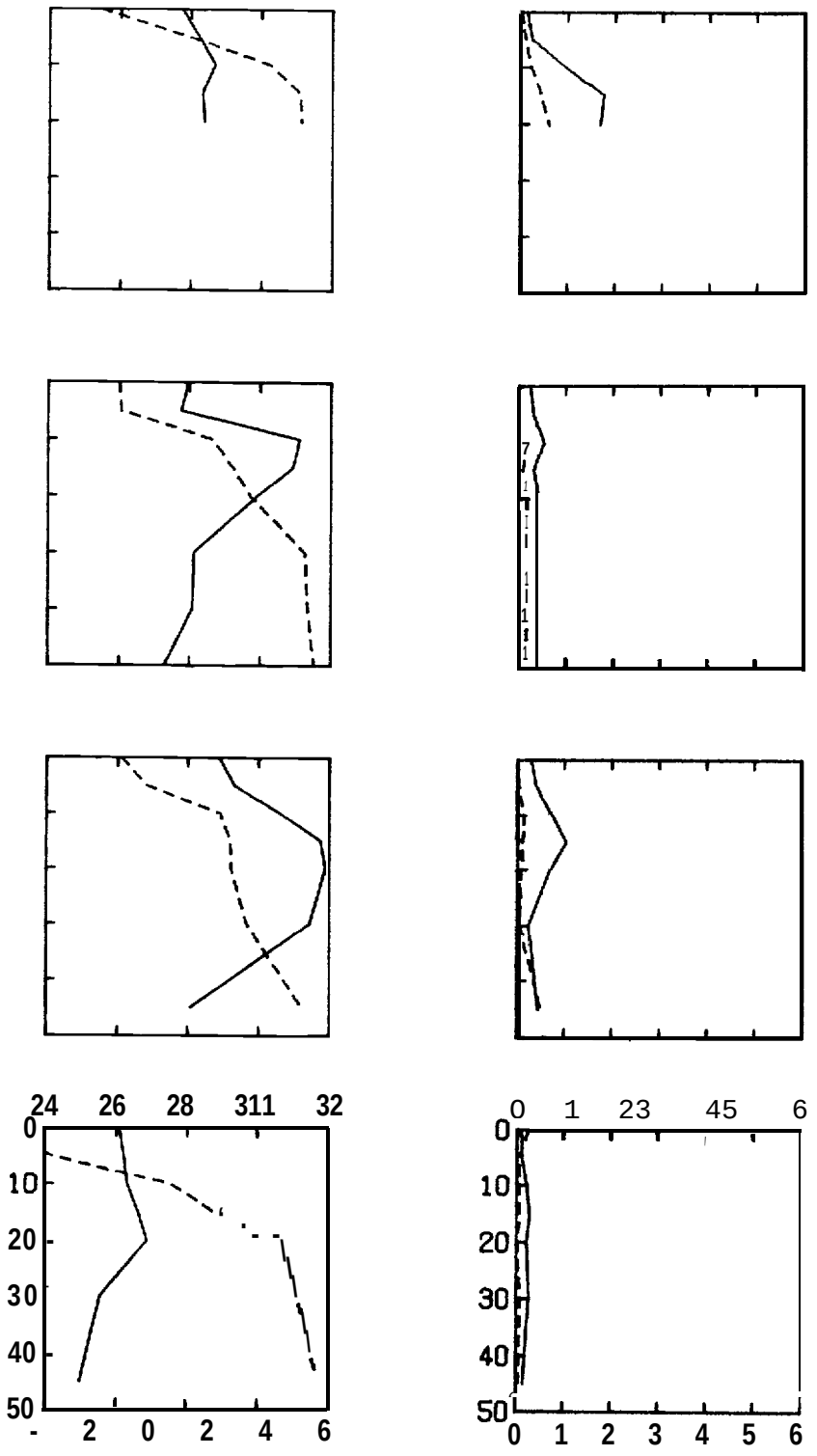

Fig. 2. (continued)

STATION 14

STATION 16

STATION 17

STATION 18

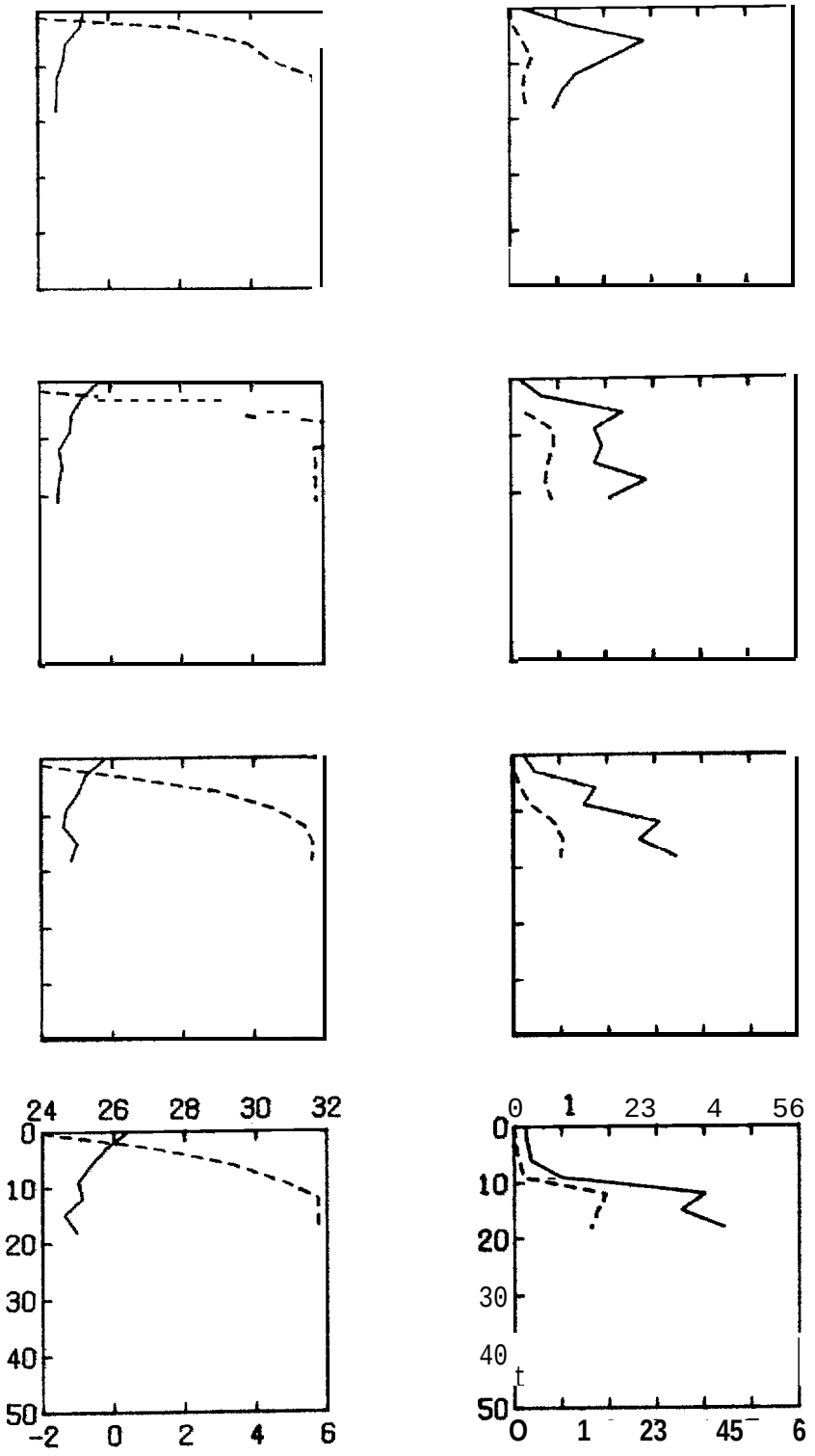

Fig. 2. (continued)

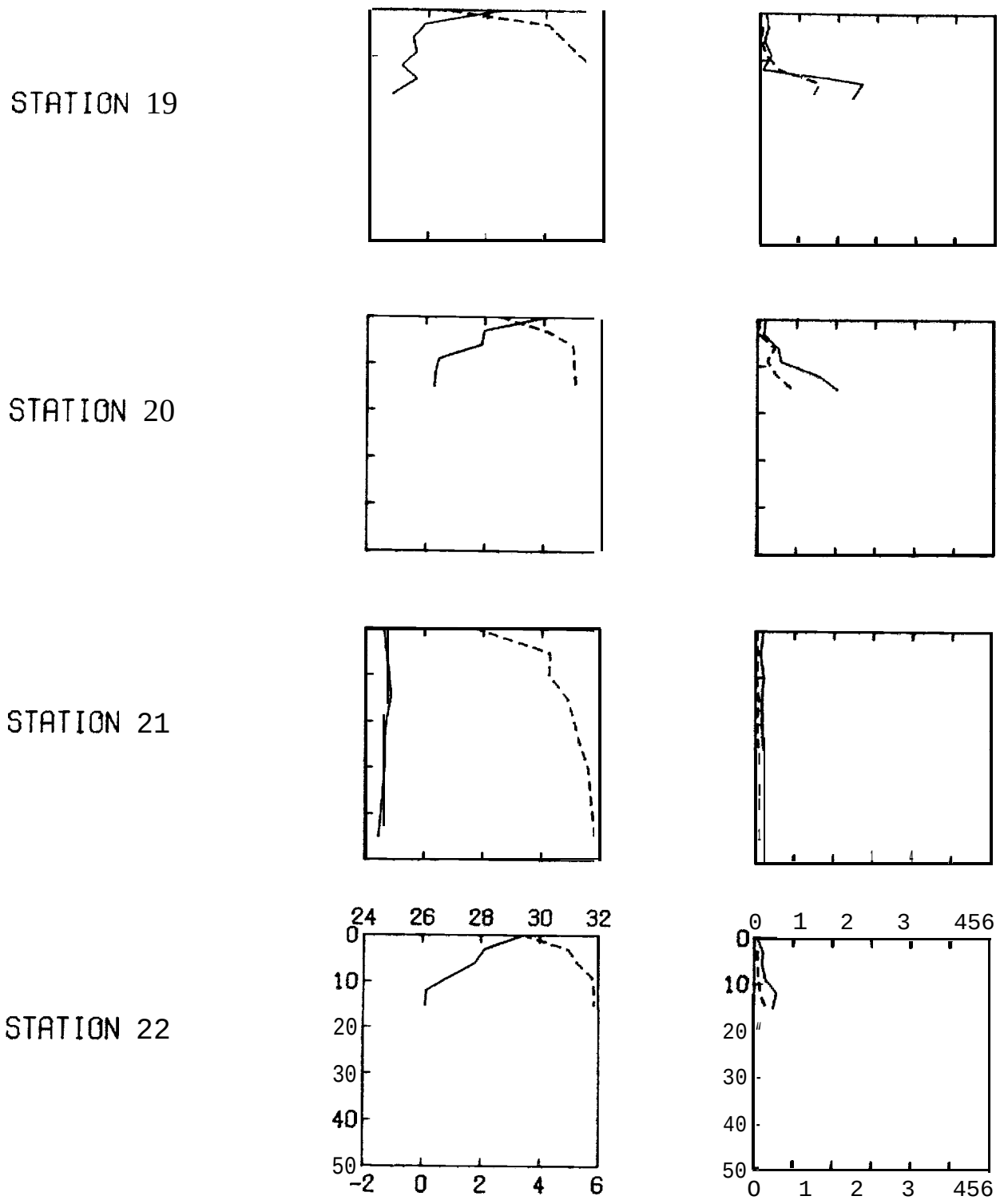

Fig. 2. (continued)

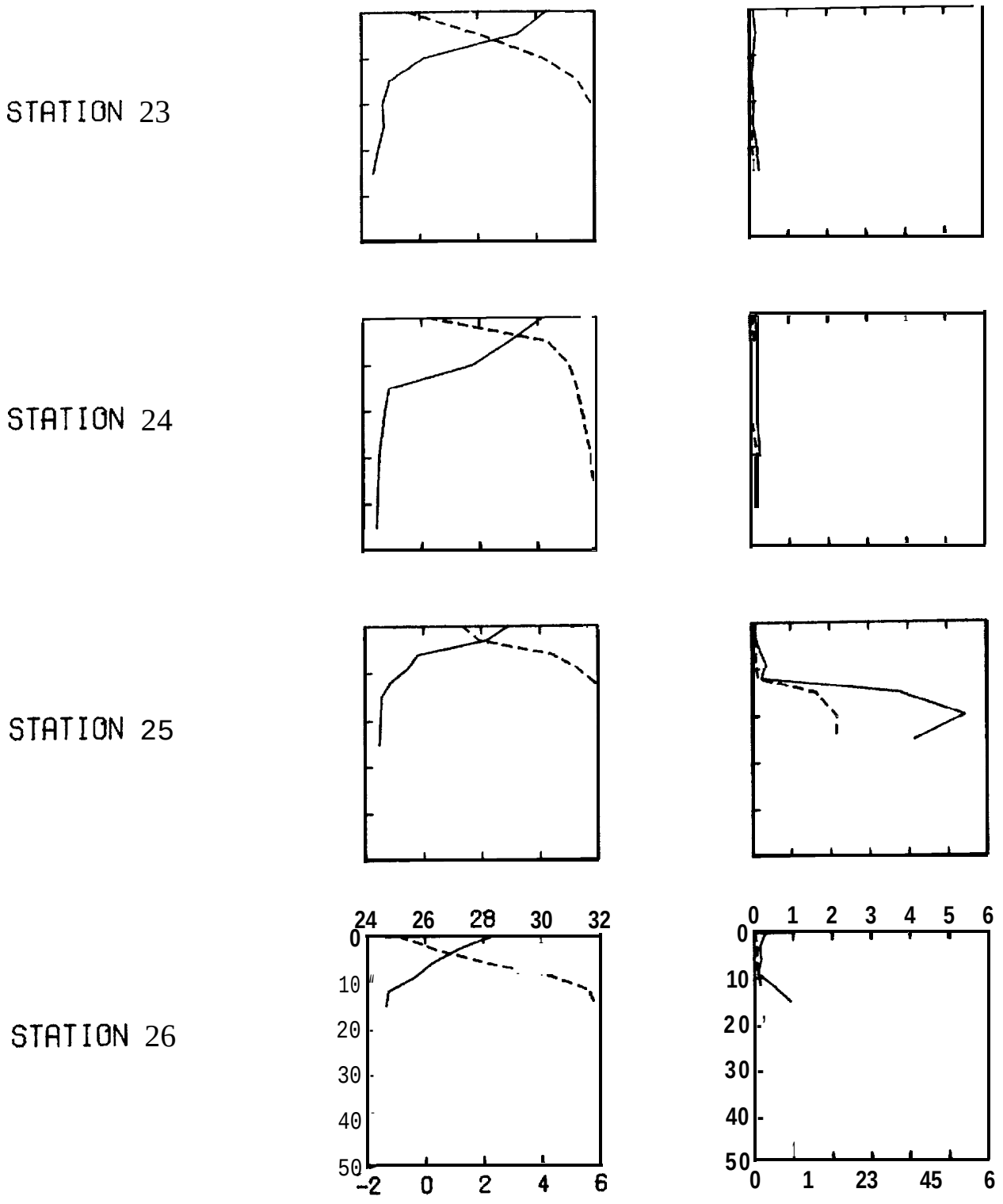

Fig. 2. (continued)

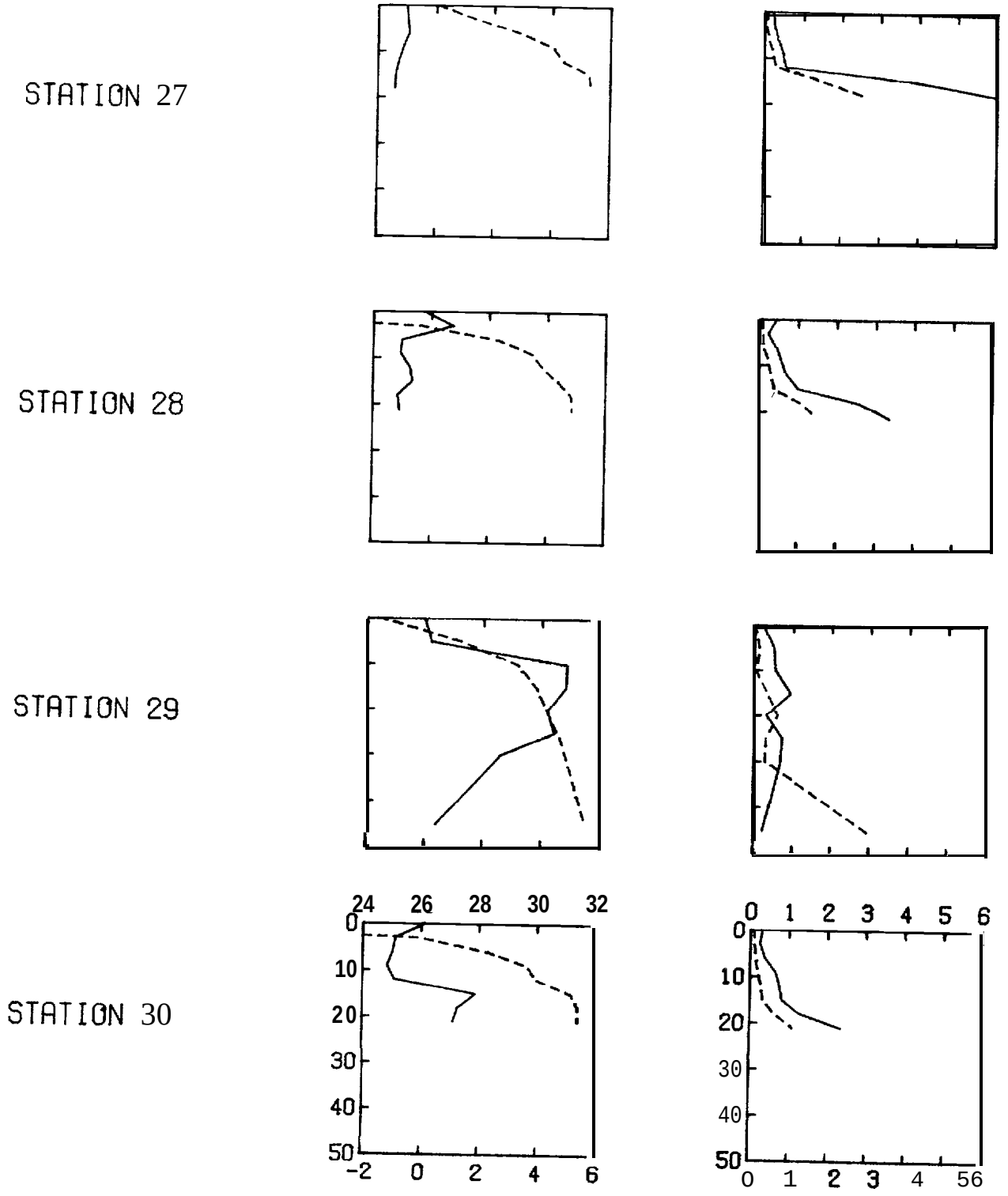

Fig. 2. (continued)

STATION 31

STATION 32

STATION 33

STRTION 34

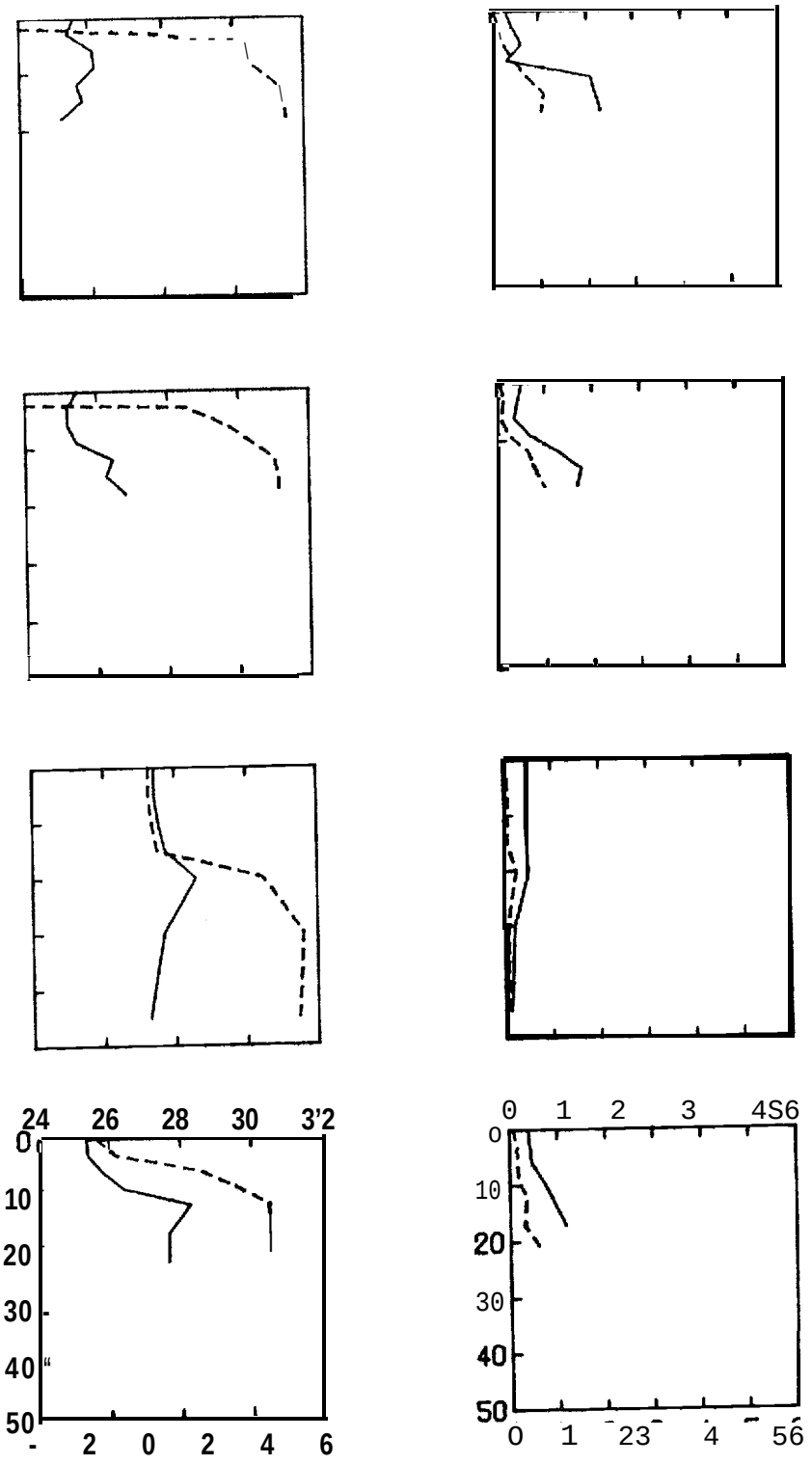

Fig. 2. (continued)

STATION 35

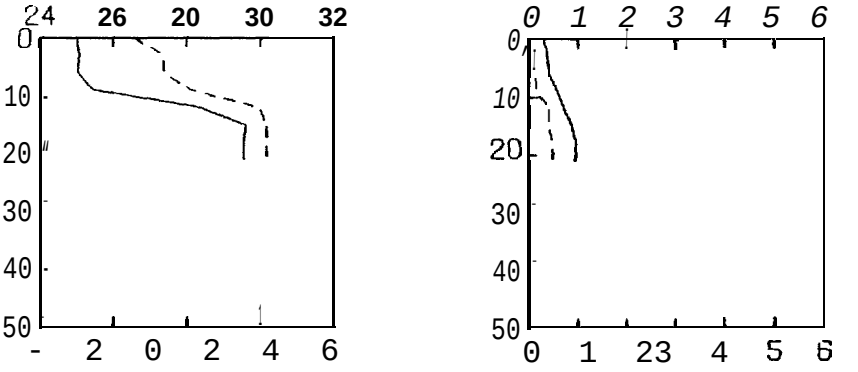

Fig. 2. (continued)

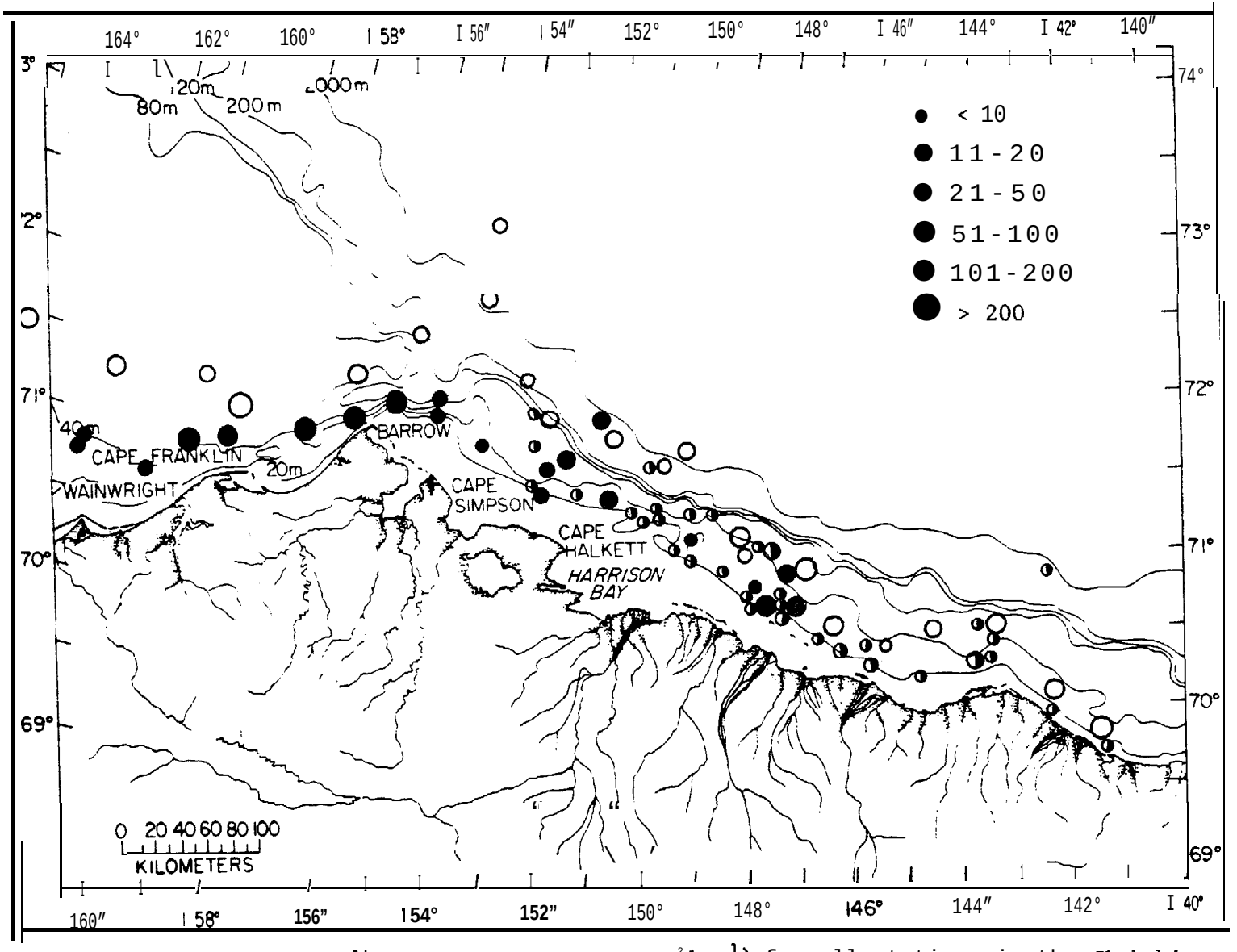

Fig. 3. Integrated ^{14}C assimilation (mg C m^{-2} hr^{-1}) for all stations in the Chukchi and Beaufort seas, August-September 1976, 1977, 1978. ● = 1976, ○ = 1977, ◑ = 1978.

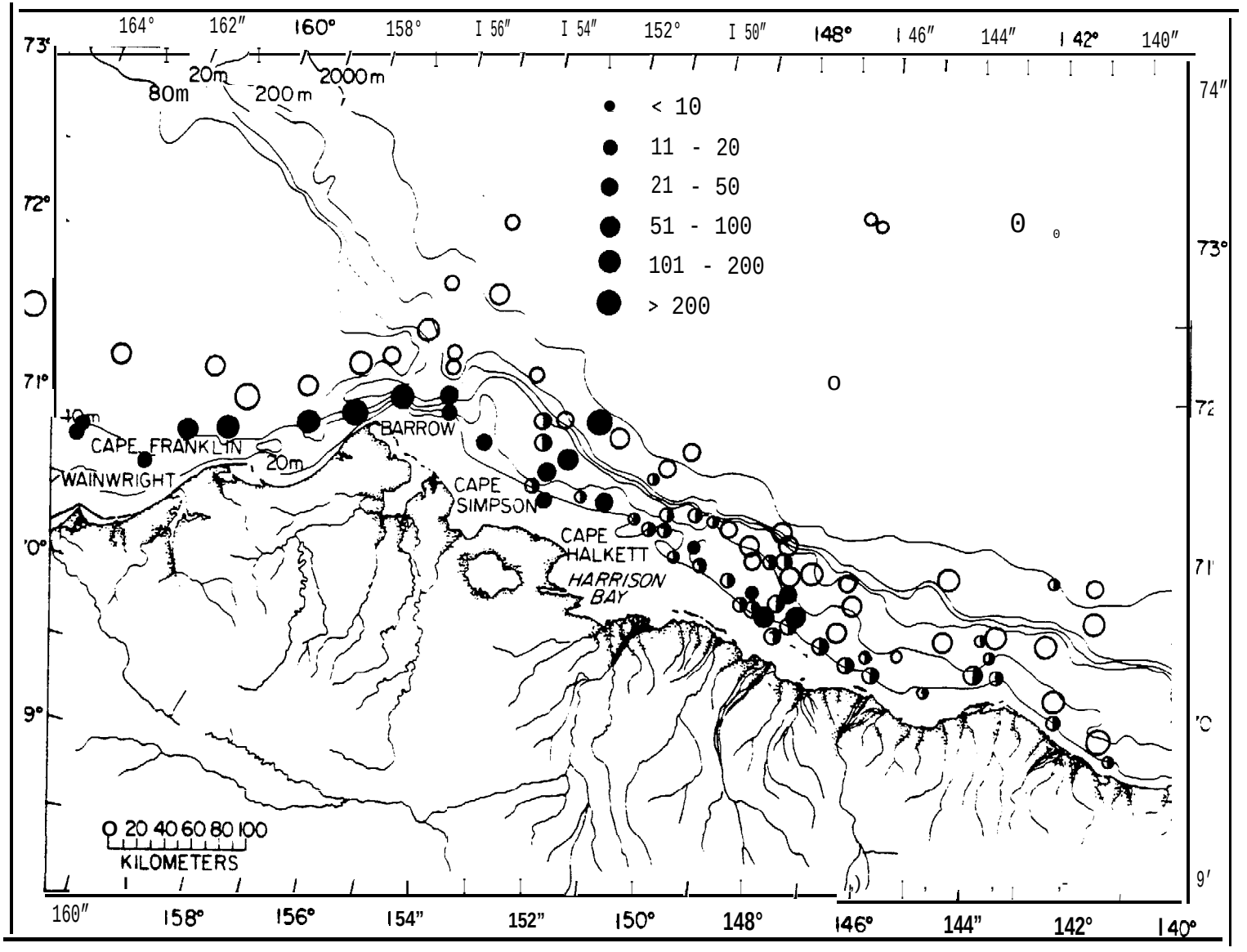

Fig. 4. Integrated chlorophyll a (mg m^{-2}) for all stations in the Chukchi and Beaufort seas, August-September 1976, 1977, 1978. ● = 1976, ○ = 1977, ◑ = 1978.

Table 2. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 500 µm. Where no number is present, no animals were found.

Taxon	Station Numbers							
	4	5	7*	8*	16	17	18	20
Coelenterata								
Hydrozoa								
Aeginopsis laurentii	470	230	600	**980**	230	**380**	1120	810
Aglantha digitale	3510	2280	15930	**23120**	2230	**520**	80	1220
Bougainvillea *superciliaris*								
Calycopsis birulai		30				50		60
Corymorpha flammea	40	70					80	30
Coryne tubulosa	20						40	
Cuspidella sp. *cf.*								
Perigonimus vesicarius	130	200	50		90	28CJ	230	410
Perigonimus yoldia-arcticae cf.								
Perigonimus spp.			50	100			80	60
Plotocnide borealis cf.	150	170			270	140	190	
Unidentified medusae	110			50	550	140	80	
Siphonophora - unidentified	20							
Ctenophora								
Pleurobrachia pileus cf.		400	270	150	230	50		
Polychaeta - unidentified	170	130	50	100	140		120	90
Mollusca								
Gastropoda - Pteropoda								
Clione limacina			50	50	90	140	80	
Spiratella helicina	150	30	380	730	140		120	30
Unidentified mollusc larvae	230	70			180		40	

* Volume of tow estimated (ship speed x mouth area of net x duration of tow).

Table 2. (continued)

Taxon	Station Number 4	5	7*	8*	16	17	18	20
Crustacea								
Copepoda								
Calanoida - adults	61020	12050	660	150	21450	54460	19770	61100
Calanoida - juveniles	45190	20000	74400	1800	41090	109300	209420	47300
Cyclopoida				50				
Harpacticoida								
Unidentified nauplii							80	90
Cirripedia								
Nauplii			110		320	330	310	
Cyprids								
Mysidacea								
Mysis litoralis					50			*380*
Mysis oculata	20	100			50			*60*
Mysis relicta								*140*
Mysis spp.								*960*
Cumacea								
Unidentified cumacea								30
Amphipoda								
Gammaridea								
Apherusa glacialis	40		50	490	50	50	80	170
Apherusa glacialis cf.			50					
Onisimus glacialis							120	60
Onisimus glacialis cf.	90							
Onisimus nanseni								
Onisimus sp.								

Table 2. (continued)

Taxon	Station Number 4	5	7*	8*	16	17	18	20
Hyperiidae								
Hyperia galba	40	100	160	50				120
Parathemisto abyssorum	40	300		100	90	50	150	90
Parathemisto abyssorum cf.								
Parathemisto libellula	110	170			270	330	230	170
Unidentified Hyperiidea		70						
Unidentified Amphipoda					50			
Euphausiacea								
Thysanoëssa inermis						50		
Thysanoëssa longipes cf.		30						
Unidentified furcilia	20		50					30
Decapoda								
Anomura - unidentified larvae	20	30			90	50		30
Brachyura - unidentified larvae		70	160	440				
Caridae - unidentified larvae	130	100		100	270	230	390	90
Echinodermata								
Unidentified larvae								
Appendicularia (Larvacea)								
Fritillaria borealis	1450	70	16480	32880	3360	15020	7950	10780
Fritillaria spp.	90	1850	550	930	2050	2160	230	4700
Oikopleura labradoriensis					500			
Oikopleura vanhöffeni	510		110		230	470	1540	1970
Oikopleura spp.	1020	70	1100	100	410	1690	4940	15300

Table 2. (continued)

Taxon	4	5	7*	8*	16	17	18	20
Chaetognatha								
Eukrohnia hamata	170				50		80	
Sagitta elegans	470	5000	7580	5320	7180	850	390	460
Unidentified chaetognaths	90		4290	9370	50		120	
Pisces								
Unidentified larvae			50			50	150	
Other organisms								
Unidentified animals	40		330	240			190	
Unidentified Nematoda	20							
Unidentified Foraminifera								

Table 2. (continued)

Taxon	Station Number 22	25	27	28	30	31	34	35
Coelenterata								
Hydrozoa								
Aeginopsis laurentii	900	380	930	240	660	30	740	640
Aglantha digitale	6390	4080		320	1500	870	144980	303400
Bougainvillea superciliaris								40
Calycopsis birulai								
Corymorpha flammea	180							
Coryne tubulosa								
Cuspidella sp. *cf.*		30						
Perigonimus vesicarius			130	40		30		
Perigonimus yoldia-arcticae cf.		30						
Perigonimus spp.			100			60	250	
Plotocnide borealis cf.		30						
Unidentified medusae	180		370	20			490	380
Siphonophora - unidentified								
Ctenophora								
Pleurobrachia pileus cf.	120	130		120	210		60	40
Polychaeta - unidentified							280	340
Mollusca								
Gastropoda - Pteropoda								
Clione limacina						30		
Spiratella helicina	1510	470	30	40	210	120	310	110
Unidentified mollusc larvae							60	

Table 2. (continued)

Taxon	Station Number 22	25	27	28	30	31	34	35
Crustacea								
Copepoda								
Calanoida - adults	5180	13480	1060	3330	6110	3830	3450	2720
Calanoida - juveniles	32710	138370	28570	112480	78080	77370	75320	48910
Cyclopoida		60					180	
Harpacticoida							30	
Unidentified nauplii				80		240		
Cirripedia								
Nauplii		30	170	20	30	210	90	
Cyprids					30	120		
Mysidacea								
Mysis litoralis								
Mysis oculata		30			30			40
Mysis relicts		30						
Mysis spp.		220			30			
Cumacea								
Unidentified cumacea								
Amphipoda								
Gammaridea								
Apherusa glacialis		60	30		60		60	
Apherusa glacialis cf.								
Onisimus glacialis	60	30						
Onisimus glacialis cf.			30					
Onisimus nanseni	60							
Onisimus sp.						30		

Table 2. (continued)

Taxon	Station Number 22	25	27	28	30	31	34	35
Hyperiidea								
Hyperia galba	60		30	40	120		30	
Parathemisto abyssorum		560	30	80	120	420	120	260
Parathemisto abyssorum cf.				40				
Parathemisto libellula	60	90	330	510	30	360	120	110
Unidentified Hyperiidea							30	
Unidentified Amphipoda								40
Euphausiacea								
Thysanoëssa inermis								
Thysanoëssa longipes cf.								
Unidentified furcilia					30		30	
Decapoda								
Anomura - unidentified larvae					270		30	
Brachyura - unidentified larvae				20	150	120		
Caridea - unidentified larvae	480	90	170	60	360	480	30	
Echinodermata								
Unidentified larvae		30						
Appendicularia (Larvacea)								
Fritillaria borealis	840	3010	10370	5940	1560	6410	10090	8450
Fritillaria spp.	60	1380	2590		480	15390	740	600
Oikopleura labradoriensis								
Oikopleura vanhöffeni	7590	8030	4190	280	1260	120	2220	910
Oikopleura spp.	19160	16740	8370	3090	2750	6230	5170	910

Table 2. (continued)

Taxon	Station Number							
	22	25	27	28	30	31	34	35
Chaetognatha								
Eukrohnia hamata		*380*	*30*					
Sagitta elegans	*360*	*446*	*800*	*630*	*10120*	5750	*37690*	*48910*
Unidentified chaetognaths	60	190	330	2060	1860	8380	12060	9060
Pisces								
Unidentified larvae			30	20	30	30		
Other organisms								
Unidentified animals	120				90		*890*	*300*
Unidentified Nematoda		30						
Unidentified Foraminifera						30		

those organisms known to be important prey species for birds and mammals. Copepods have been separated into adults and juveniles and counted; they are not being identified to species.

Distribution and abundance of some zooplankton categories for 1976 and 1977 are given in Figs. 5-56.

B. Winter sampling in Steffanson Sound

1. November 1978

a. Phytoplankton standing stock and plant pigments

Few phytoplankton cells were found in samples collected in November 1978. Unidentified flagellates, mostly < 6 μm in diameter, were the most common organisms. A few *Chaetoceros* spp. spores were found along with a few pennate diatoms, primarily *Nitzschia* spp. and *Navicula* spp. The diatoms contained chloroplasts, but did not appear to be healthy cells.

Plant pigments are given in Table 3.

b. Zooplankton standing stock

Zooplankton *standing* stock is given in Table 4. Based on the total number of animals, calanoid copepods, primarily juveniles, comprised > 99.5% of the population.

2. February 1979

Because of logistic and weather problems, phytoplankton standing stock and plant pigment samples were collected once. Zooplankton standing stock samples *were* not collected. The phytoplankton standing stock samples contained a few unidentified small flagellates and a few pennate diatoms. There were many small detritus particles in the sample collected near the underside of the ice which made phytoplankton counting difficult. Not as much detritus was present in the sample collected near the sea floor. Ken Dunton (pers. comm.) indicated that the underside of the ice consisted of a thick, brashy, dirty layer in some areas near the sampling site which probably accounted for the detritus in the samples.

The plant pigment samples have not been analyzed.

3. March 1979

a. Phytoplankton standing stock and plant pigments

Phytoplankton samples collected 12 and 16 March have been enumerated. Small unidentified flagellates were the most abundant organisms, averaging about 44,000 cells per liter. A few unidentified choano-flagellates were found along with a few diatoms. The number of individual diatom cells and the number of diatom species increased from February to March with species such as *Cylindrotheca closterium* (Ehrenb.) Reimann and

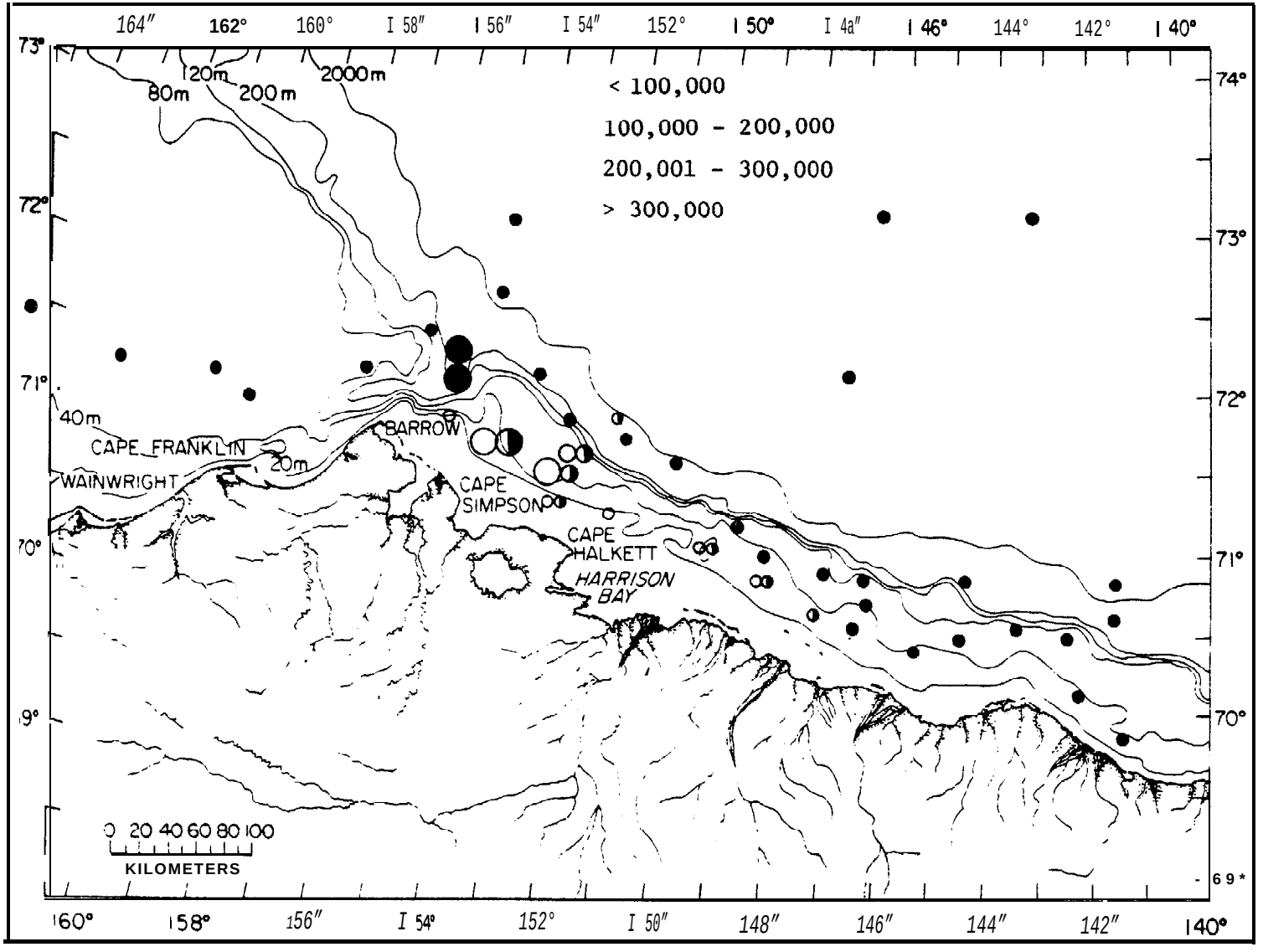

Fig. 5. Abundance (number per 1000 m^3) of *Aglantha digitale* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

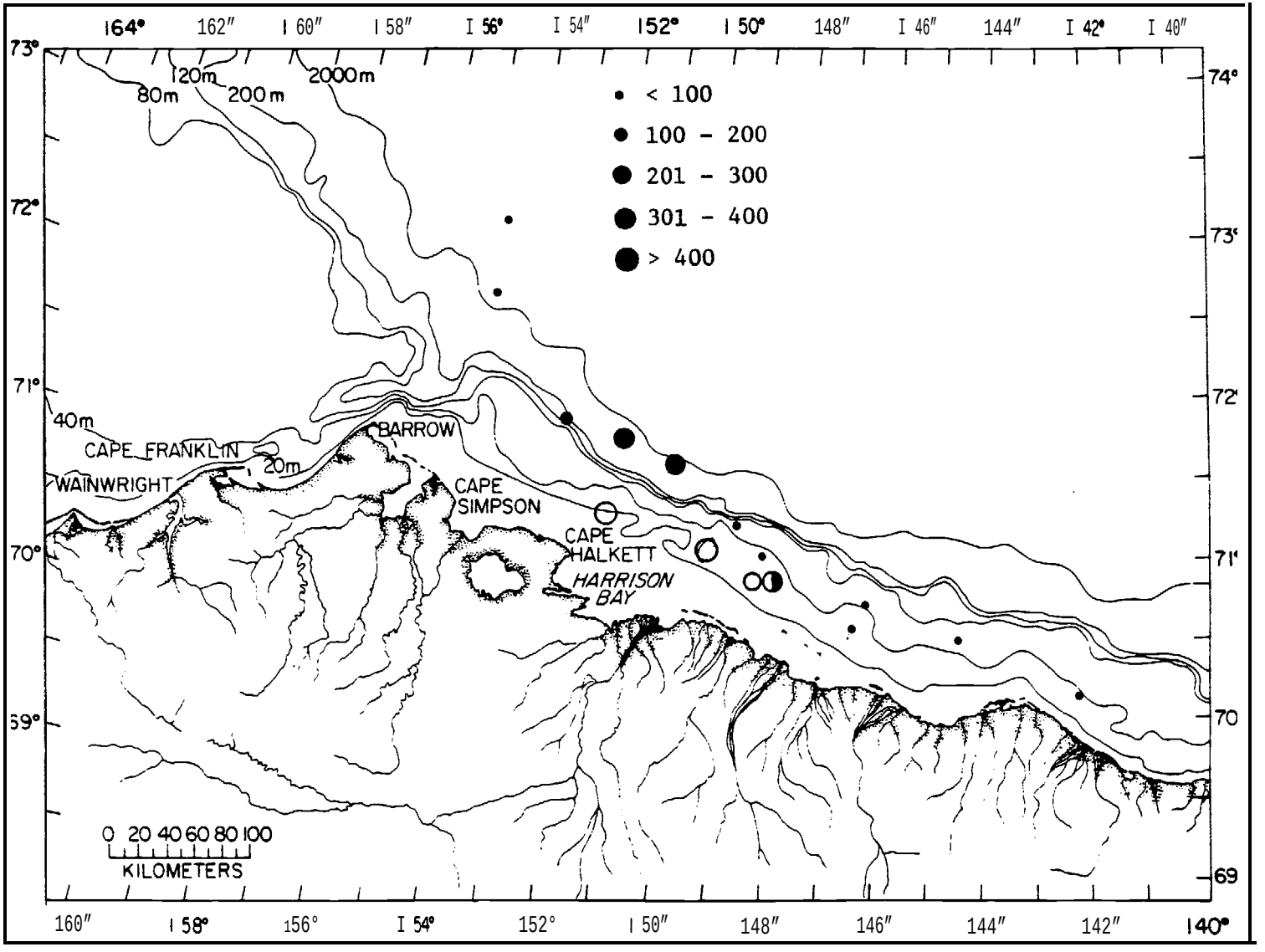

Fig. 6. Abundance (number per 1000 m^3) of *Perigonimus* SPP. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

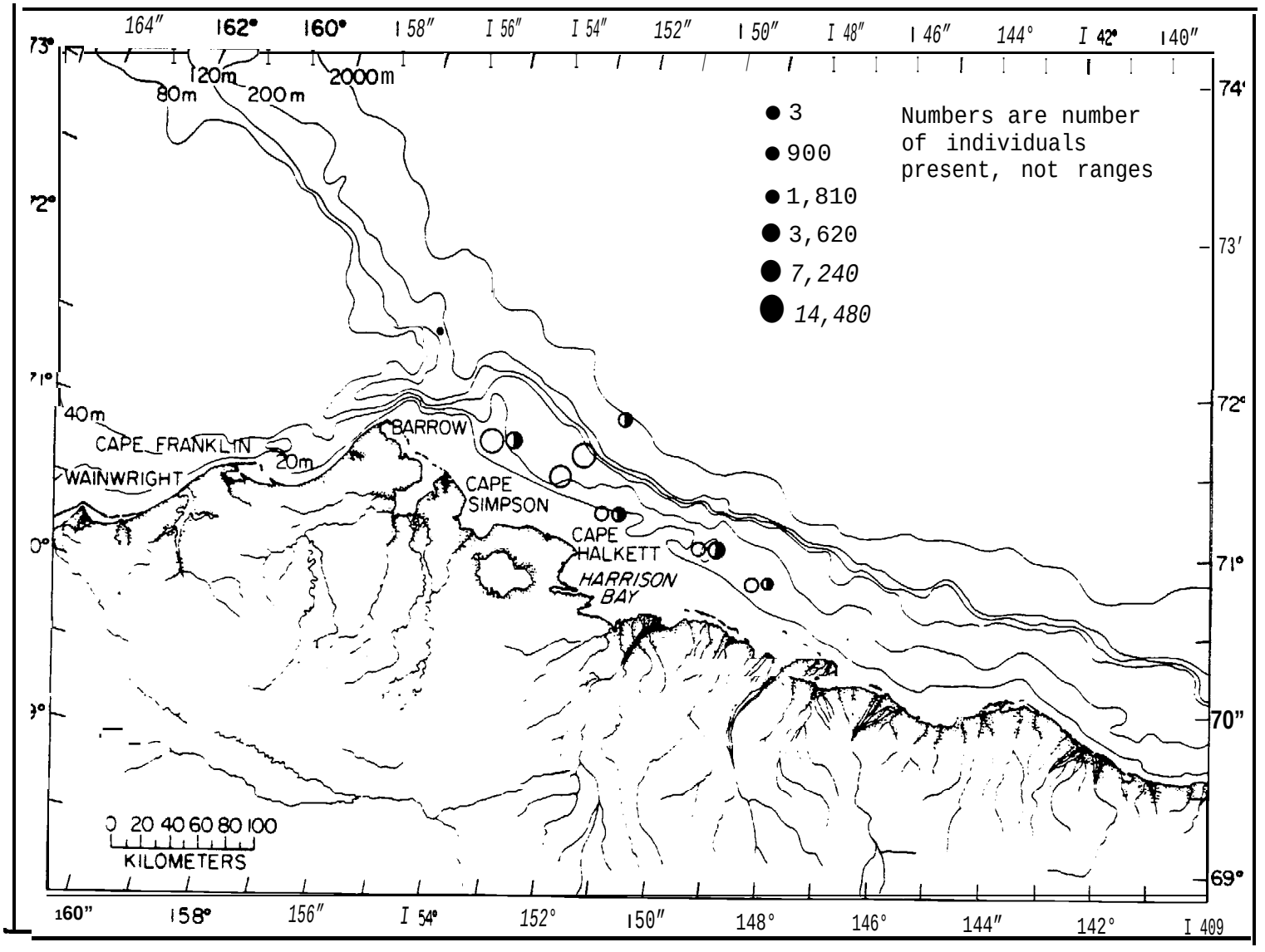

Fig. 7. Abundance (number per 1000 m^3) of *Rathkea* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

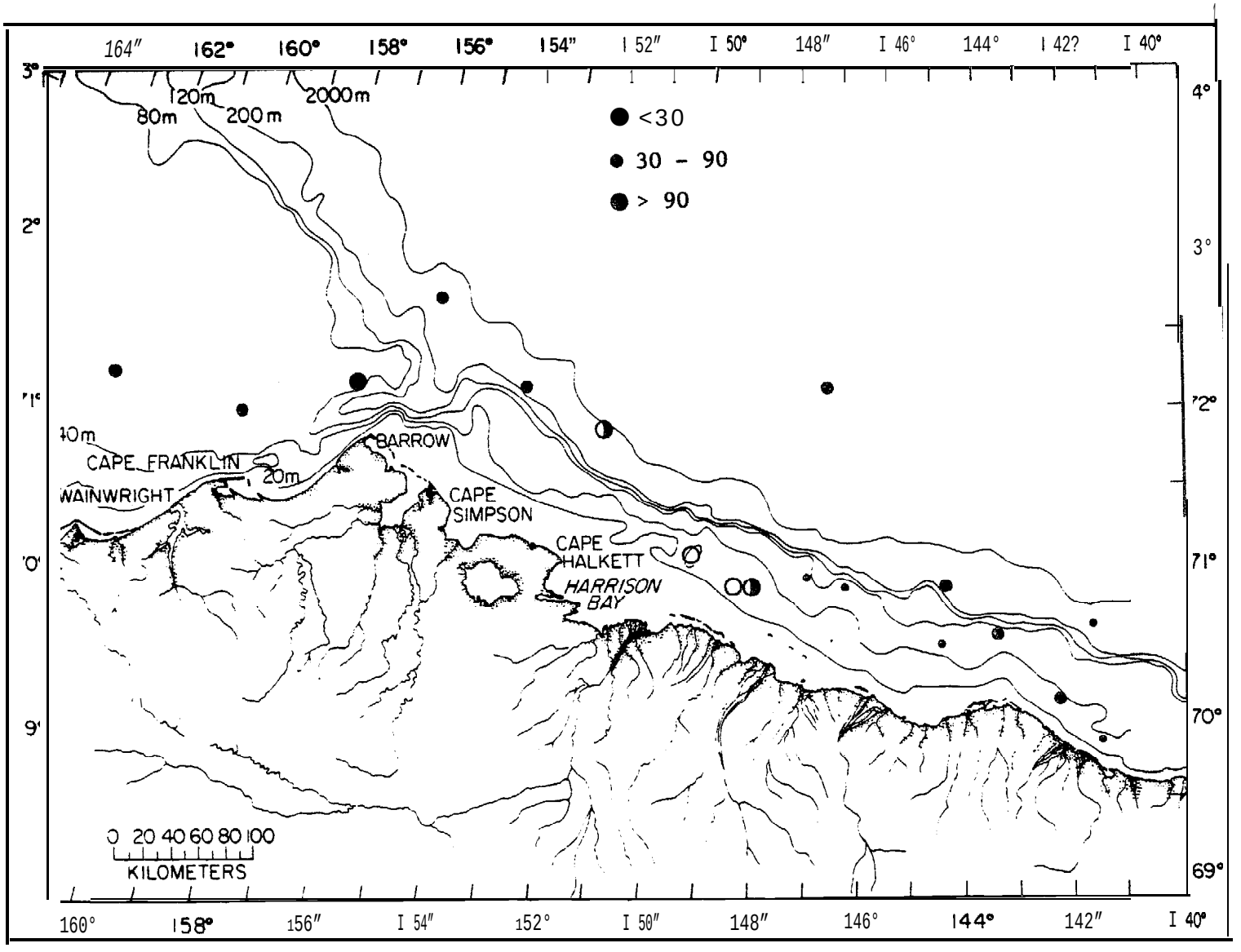

Fig. 8. Abundance (number per 1000 m^3) of ctenophores at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

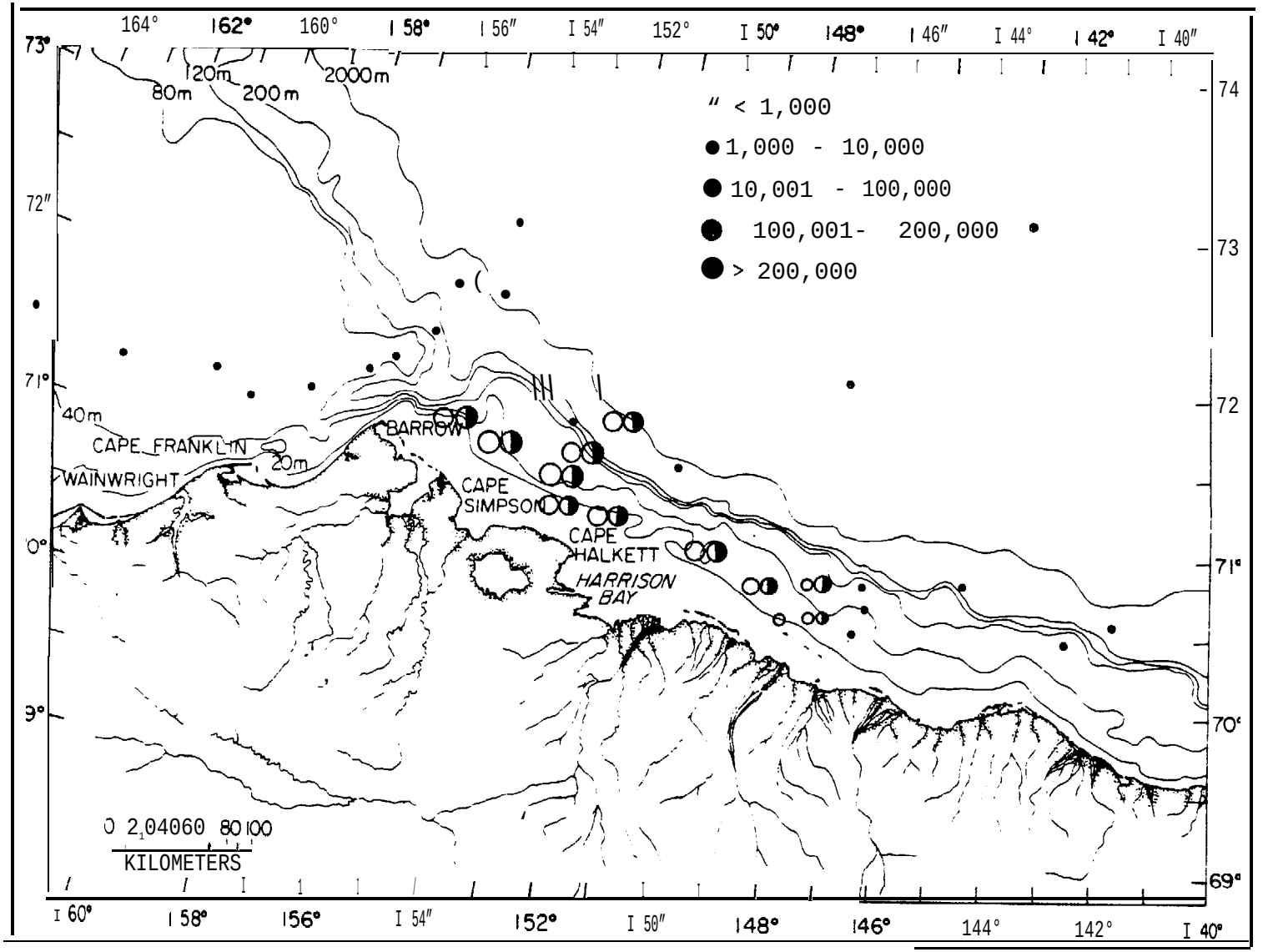

Fig. 9. Abundance (number per 1000 m^3) of polychaetes at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, lo-Ore 1976; ◑ = ring net 20-0 m 1976; ● = bongo net 1977.

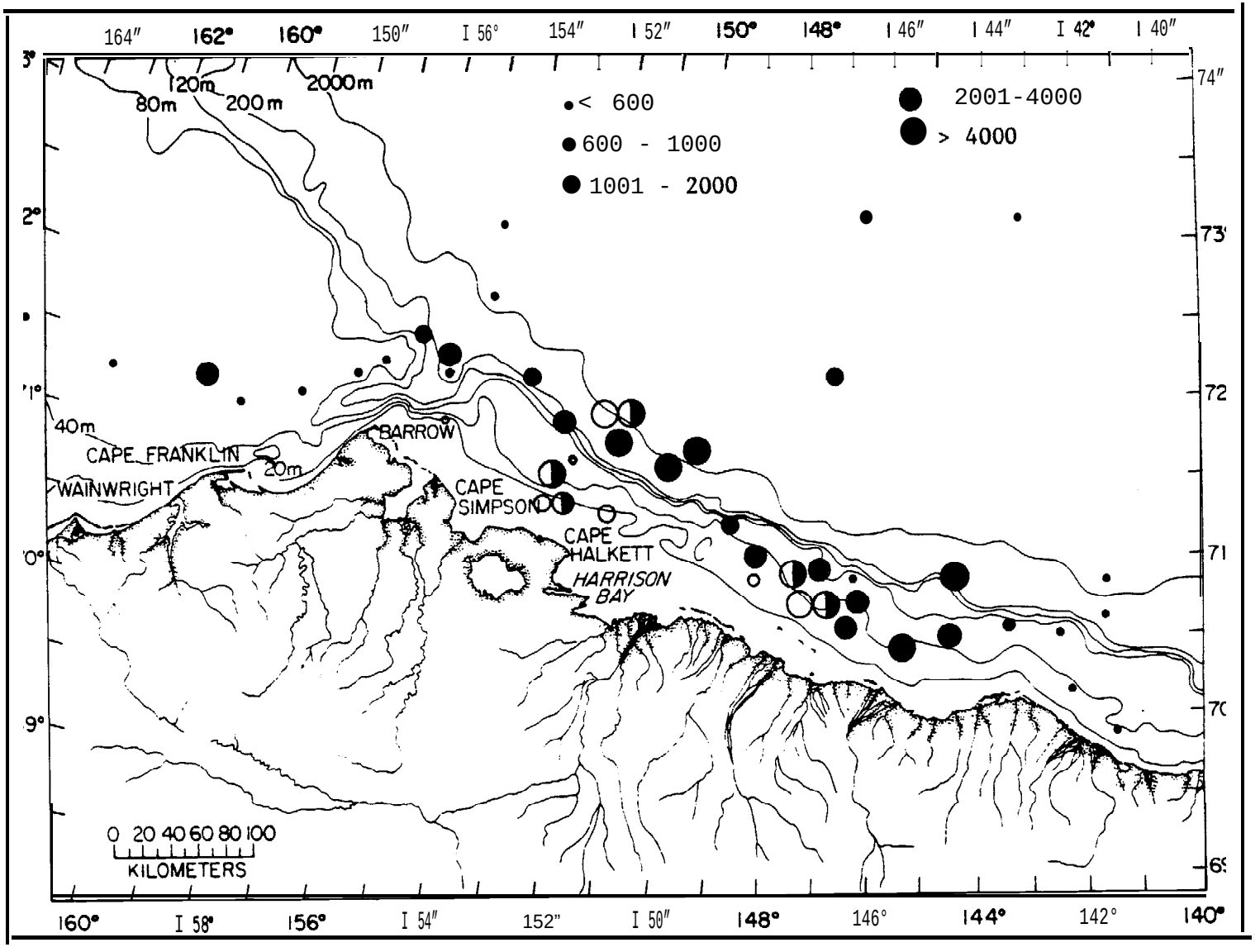

Fig. 10. Abundance (number per 1000 m^3) of all pteropods at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1977; ● = bongo net 1977.

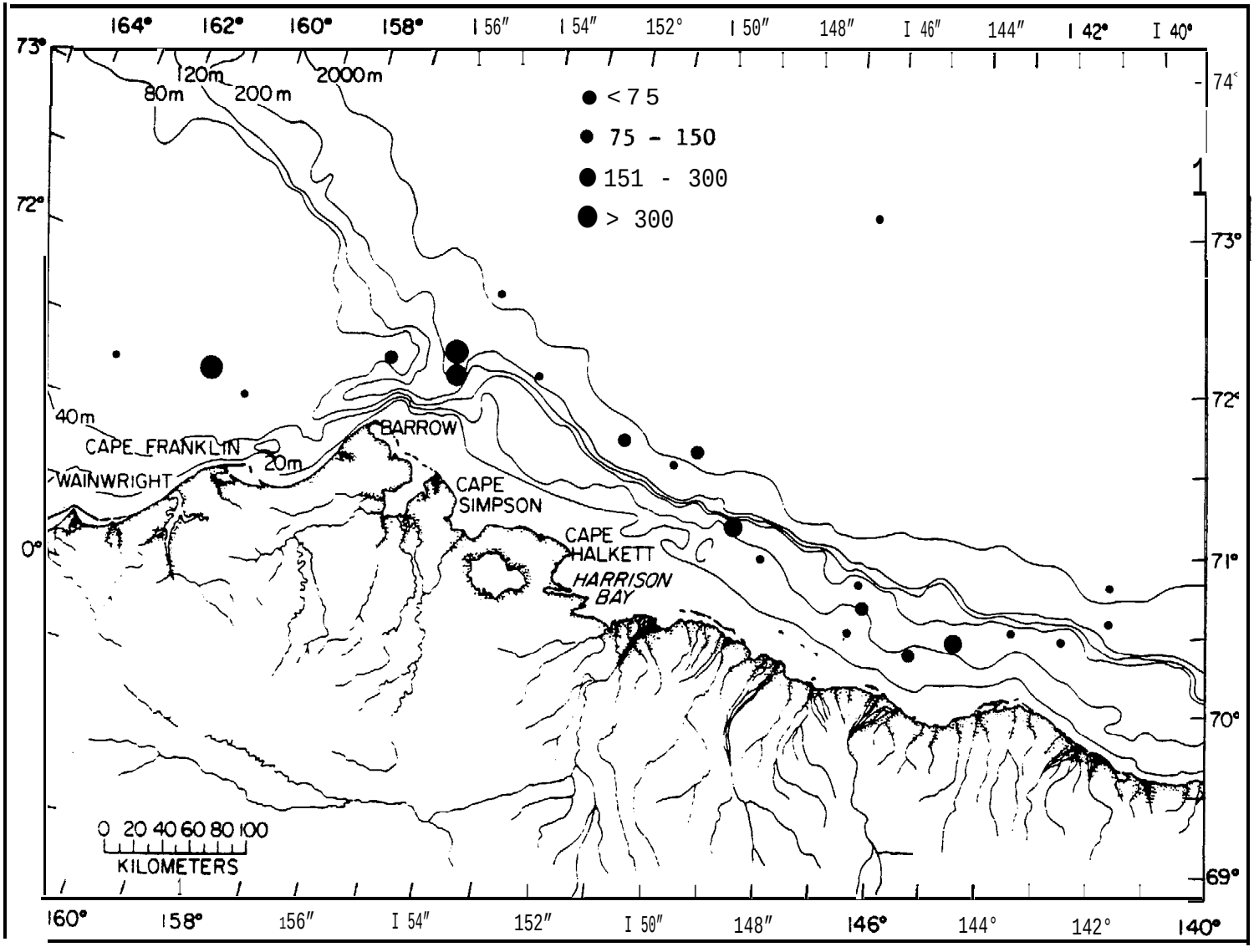

Fig. 11. Abundance (number per 1000 m³) of *Clione limacina* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, lo-ore″ 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

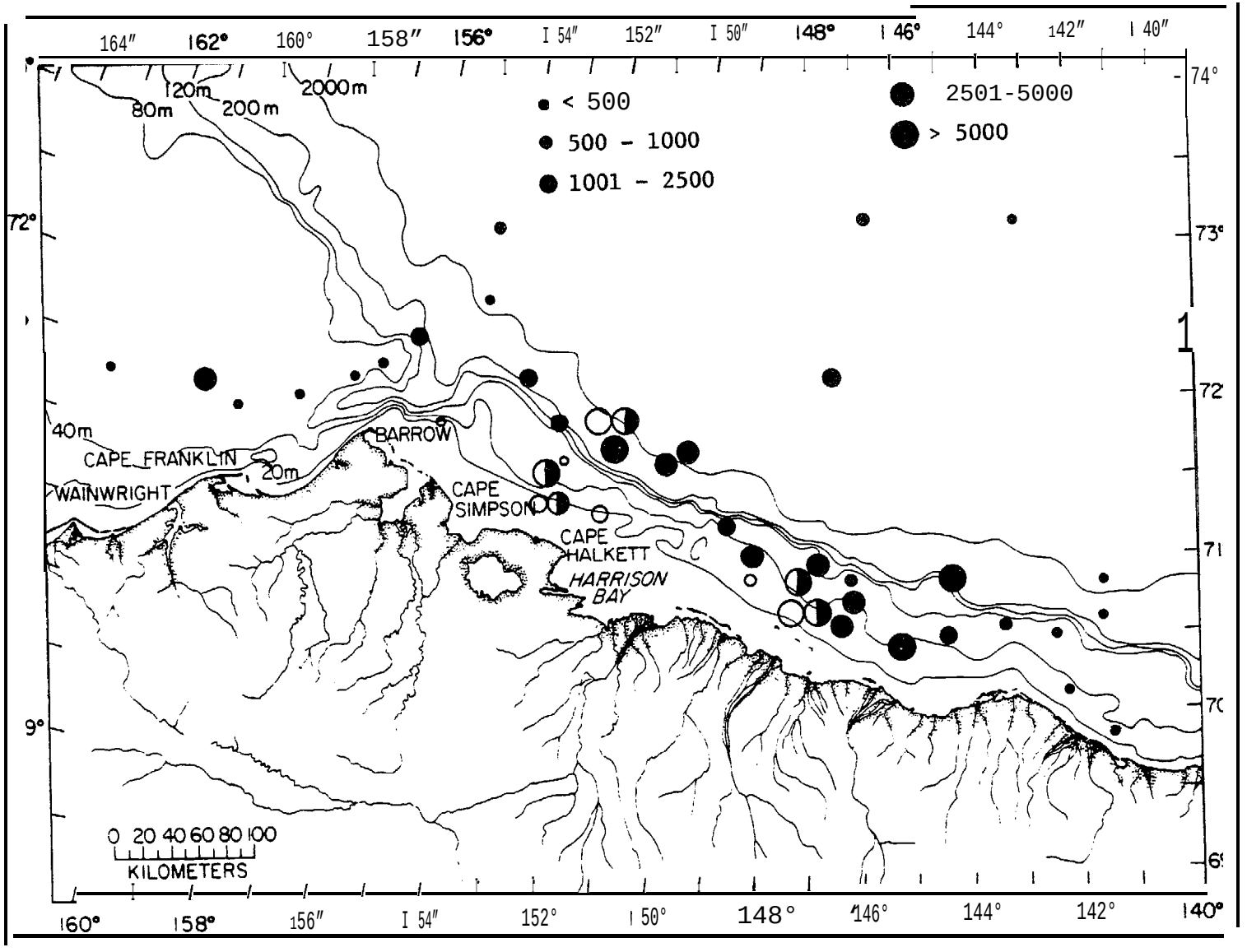

Fig. 12. Abundance (number per 1000 m³) of *Spiratella helicina* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

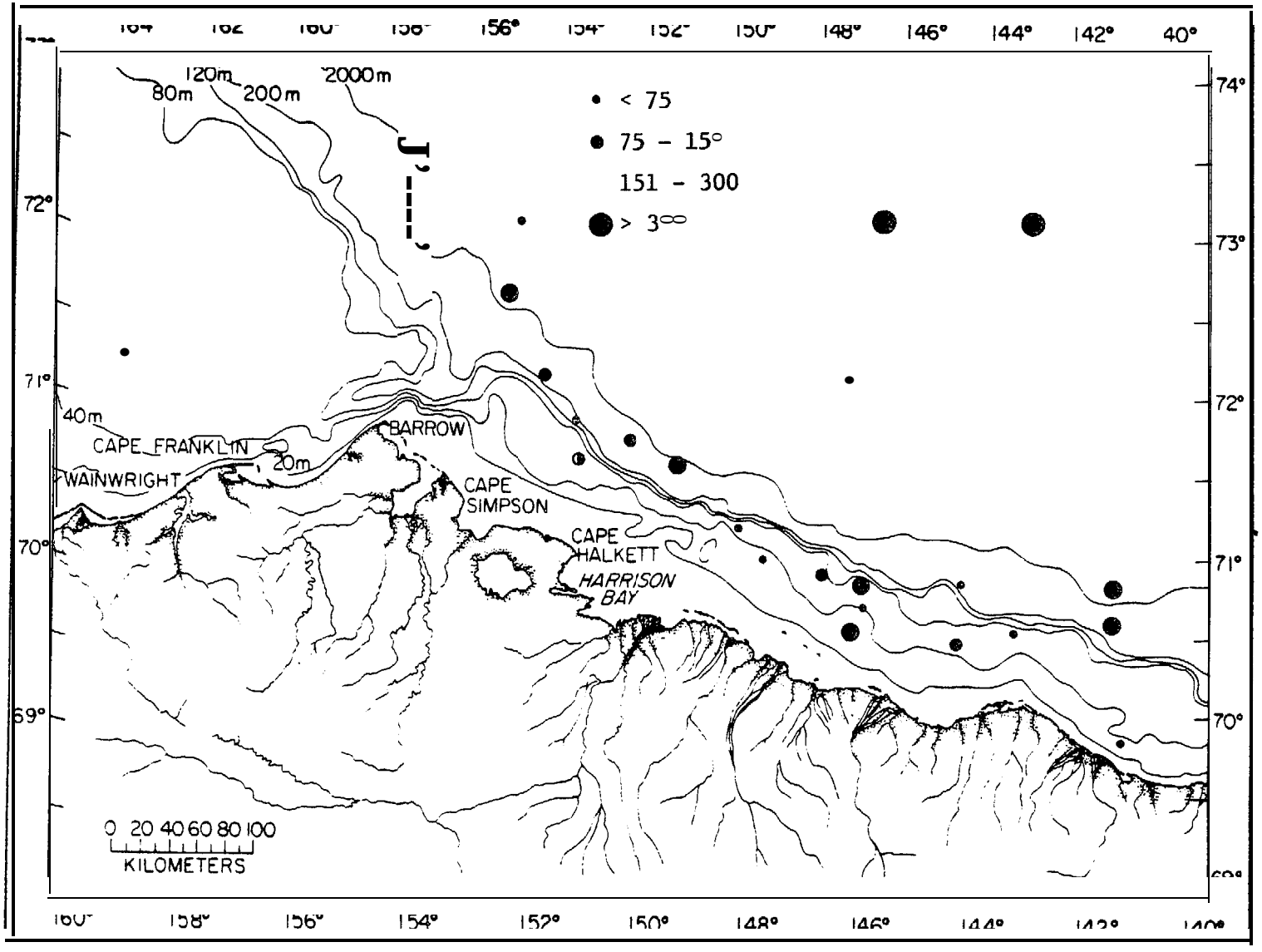

Fig. 13. Abundance (number per 1000 m^3) of ostracods at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

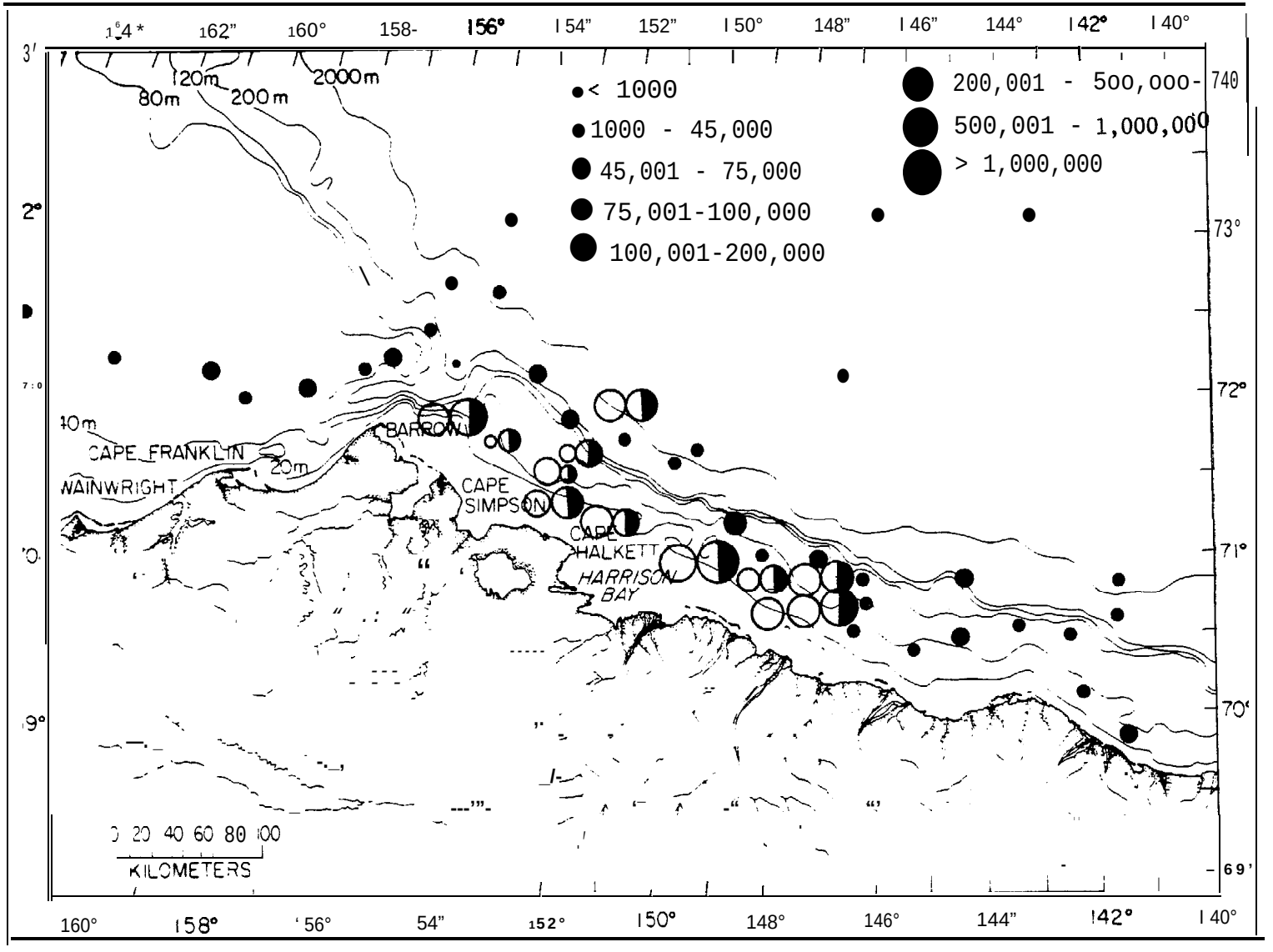

Fig. 14. Abundance (number per 1000 m^3) of all copepods at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

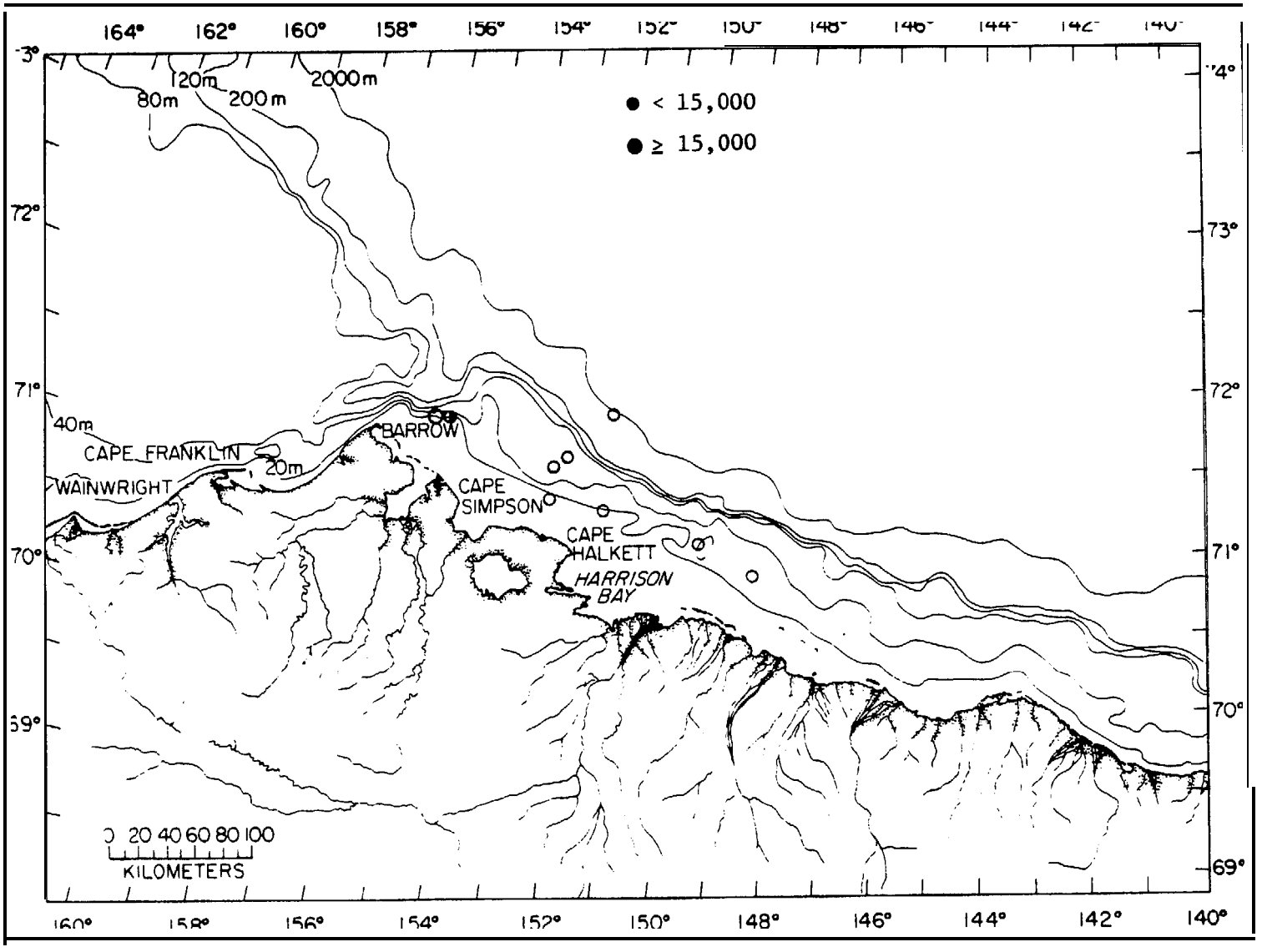

Fig. 15. Abundance (number per 1000 m^3) of *Acartia* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

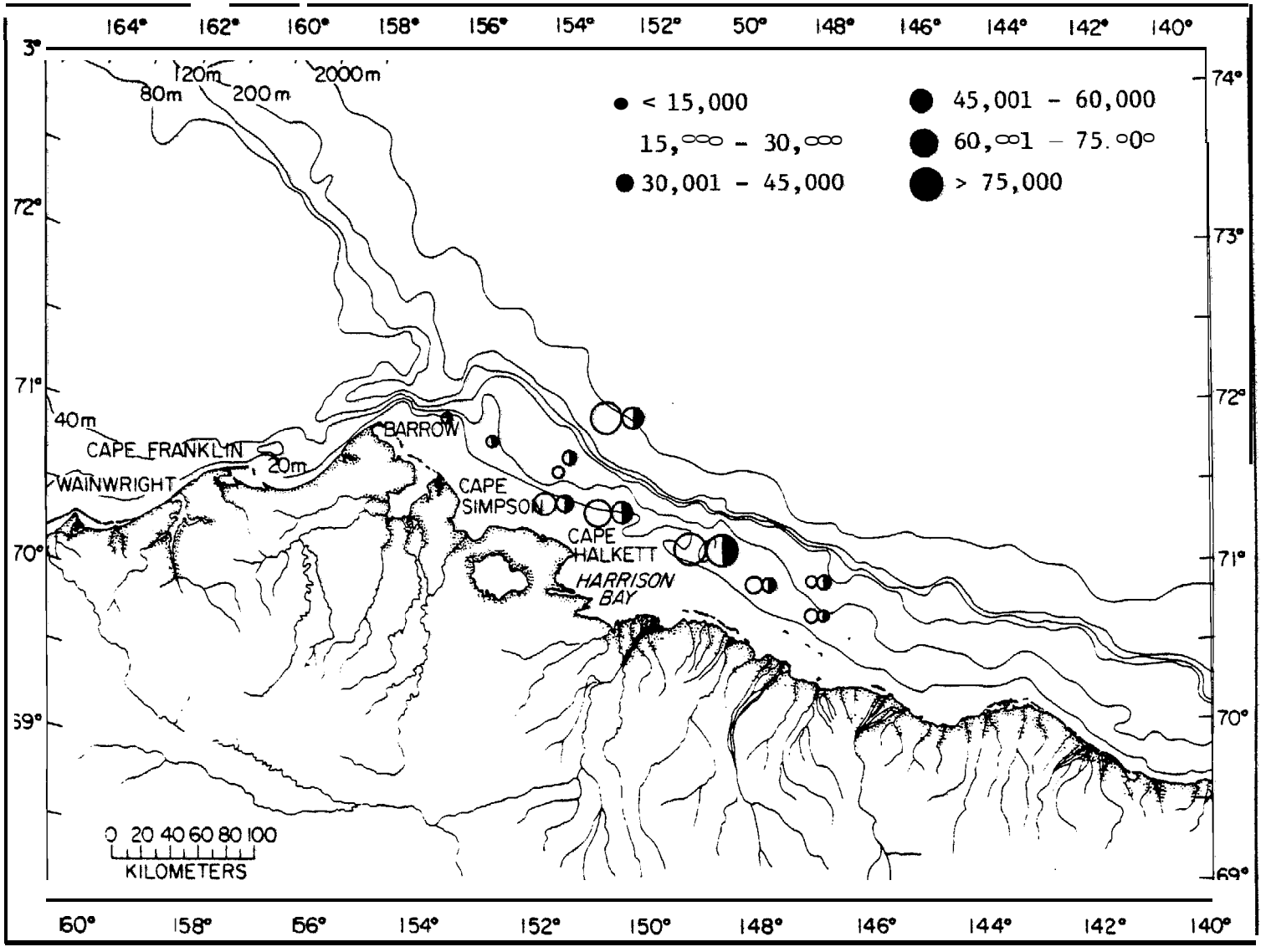

Fig. 16. Abundance (number per 1000 m^3) of *Calanus glacialis* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

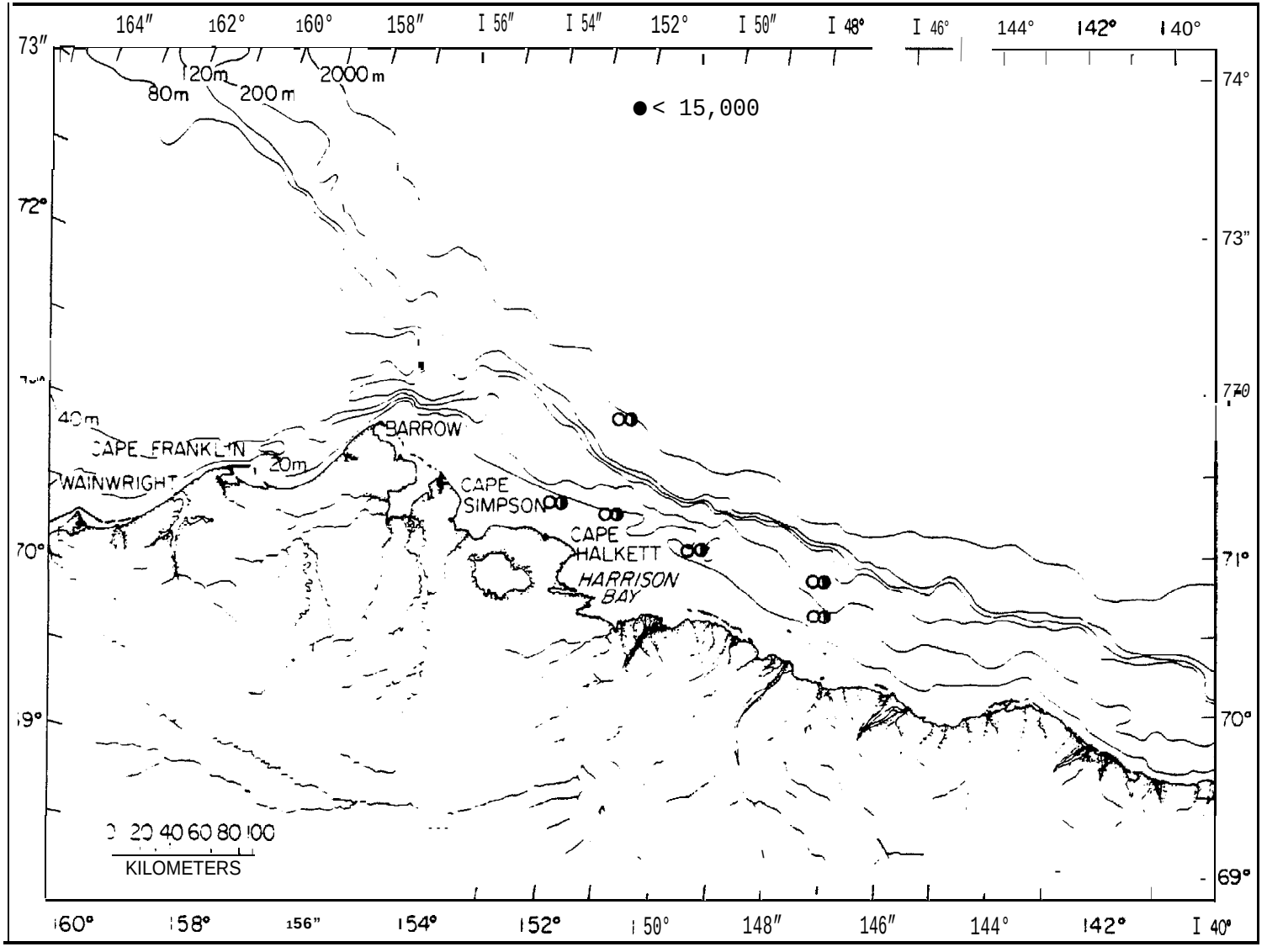

Fig. 17. Abundance (number per 1.000 m^3) of *Calanus hyperboreus* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

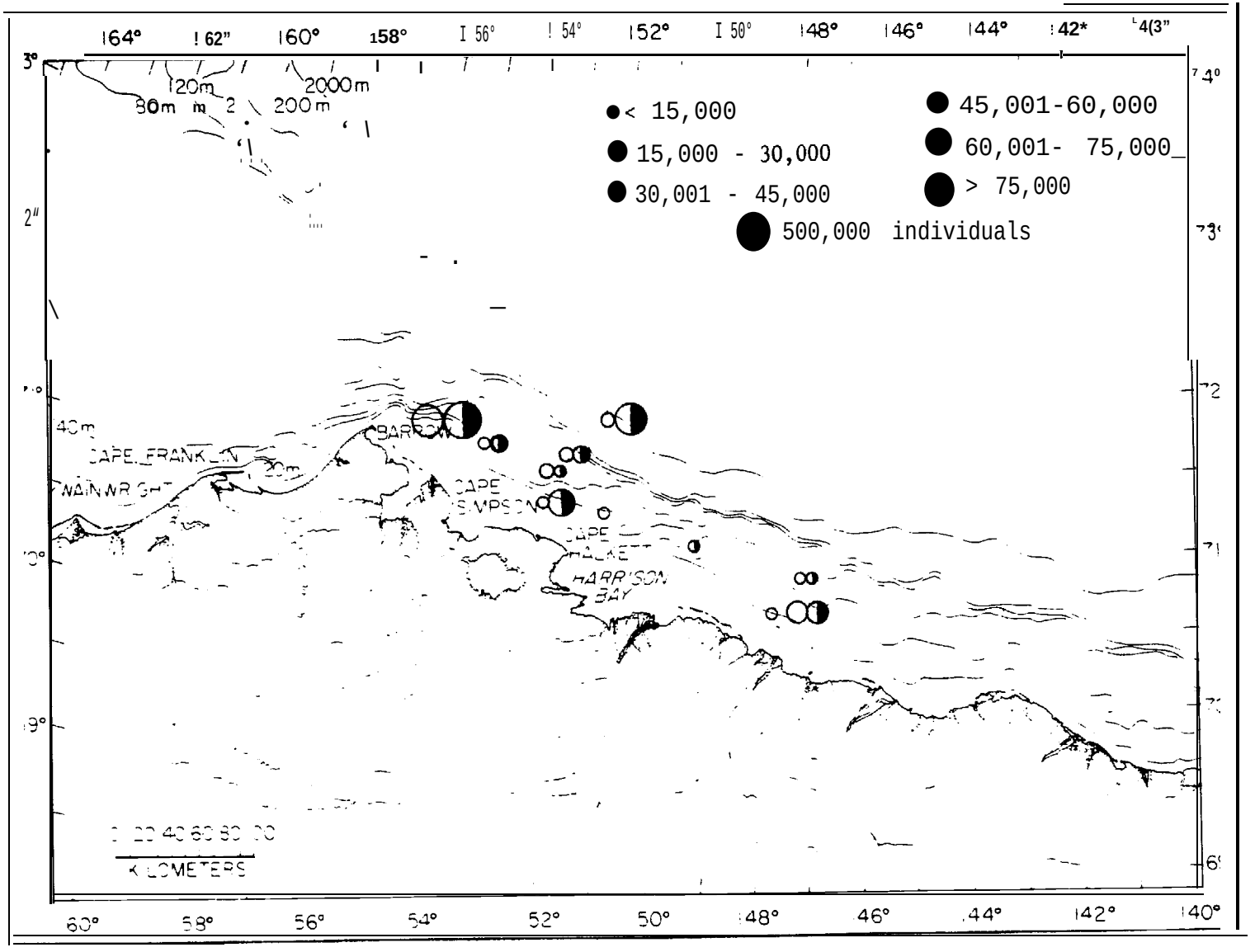

Fig. 18. Abundance (number per 1000 m^3) of *Oithona similis* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

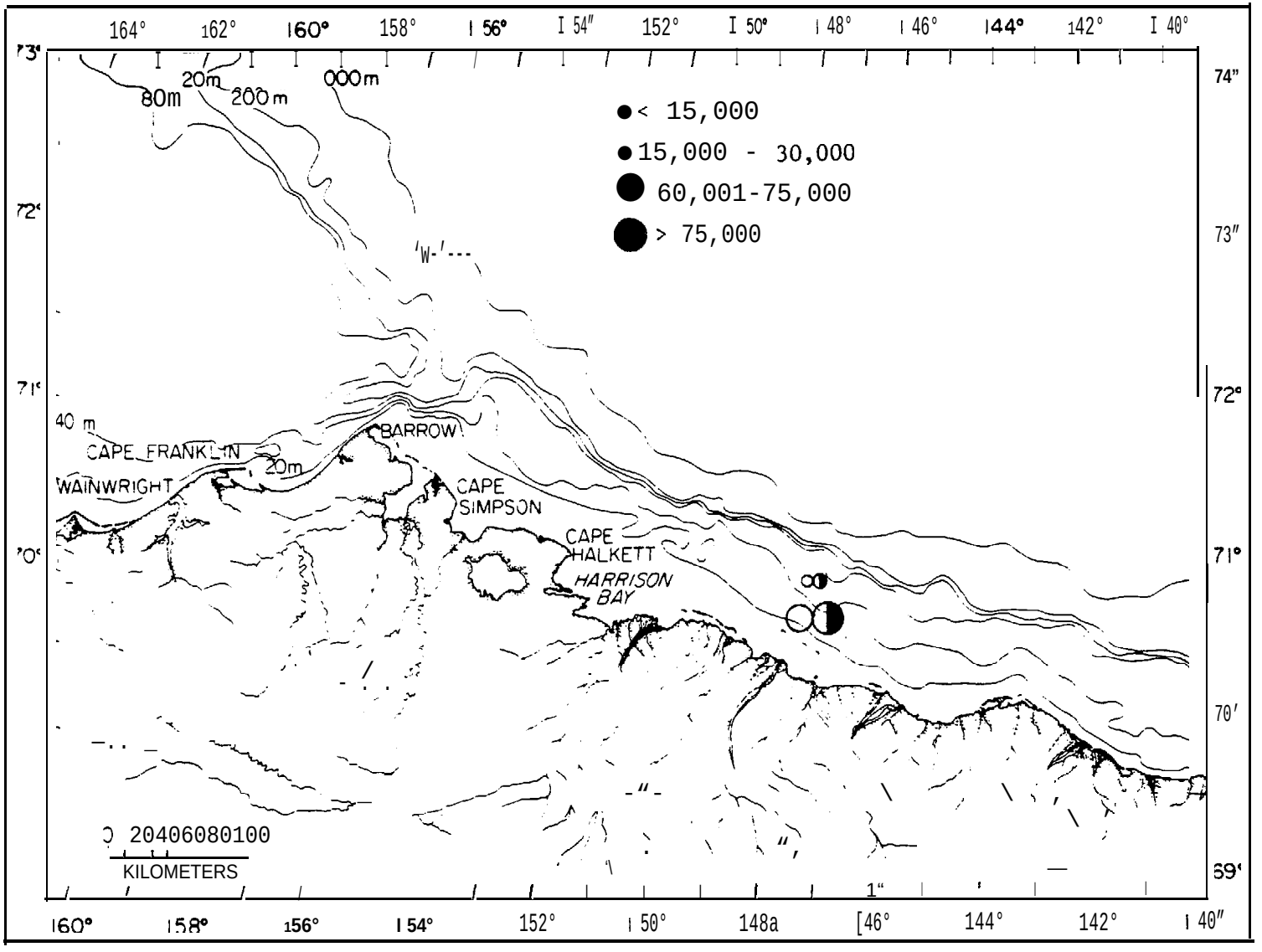

Fig. 19. Abundance (number per 1000 m³) of *Microcalanus pigmaeus* at-stations in the Chukchi and Beaufort seas, August-September 1976, 1977. O = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

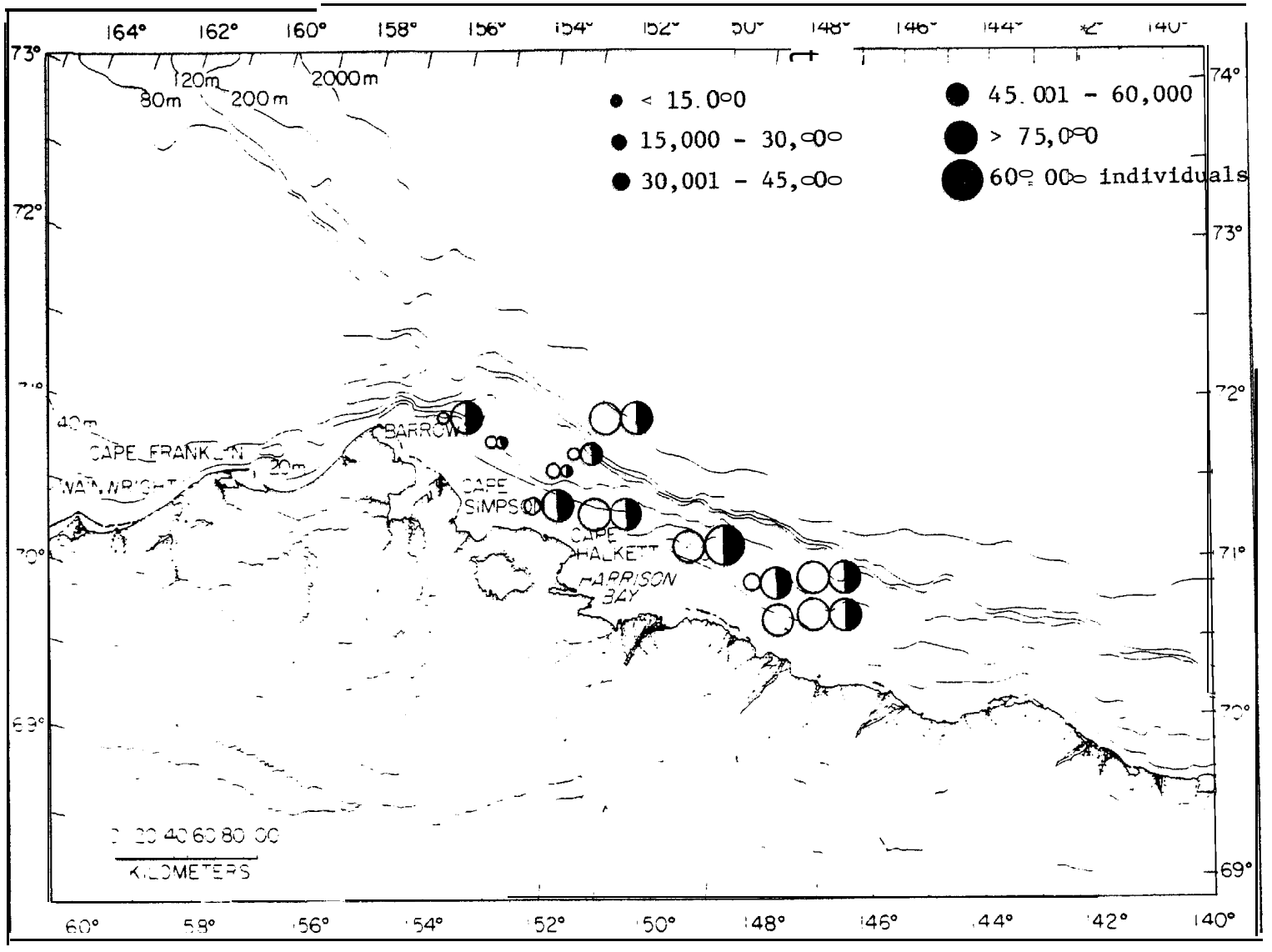

Fig. 20. Abundance (number per 1000 m^3) of *Pseudocalanus* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◐ = ring net, 20-0 m 1976; ● = bongo net 1977.

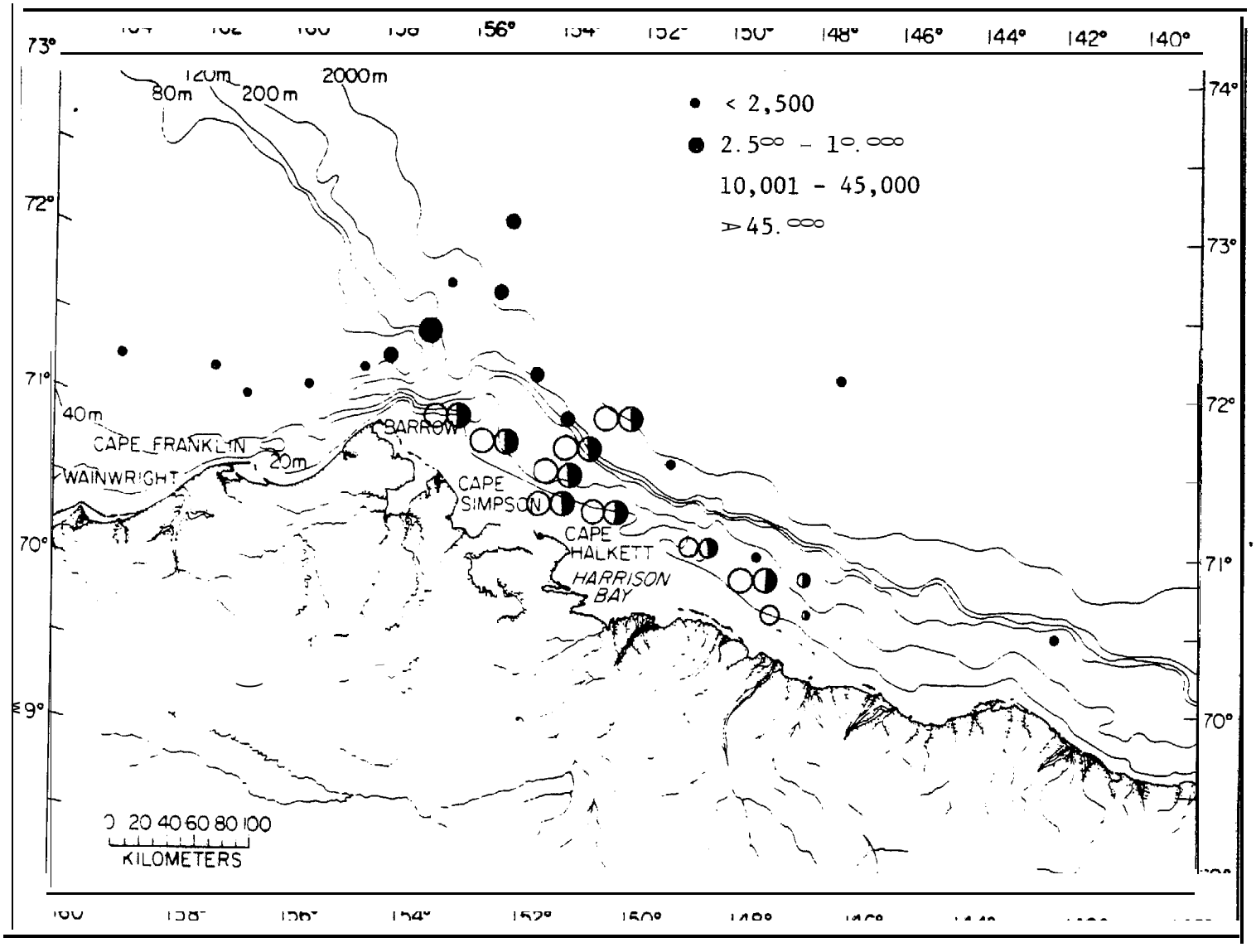

Fig. 21. Abundance (number per 1000 m^3) of barnacle larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10 - 0 m 1976; ◑ = ring net, 20 - 0 m 1976; ● = bongo net 1977.

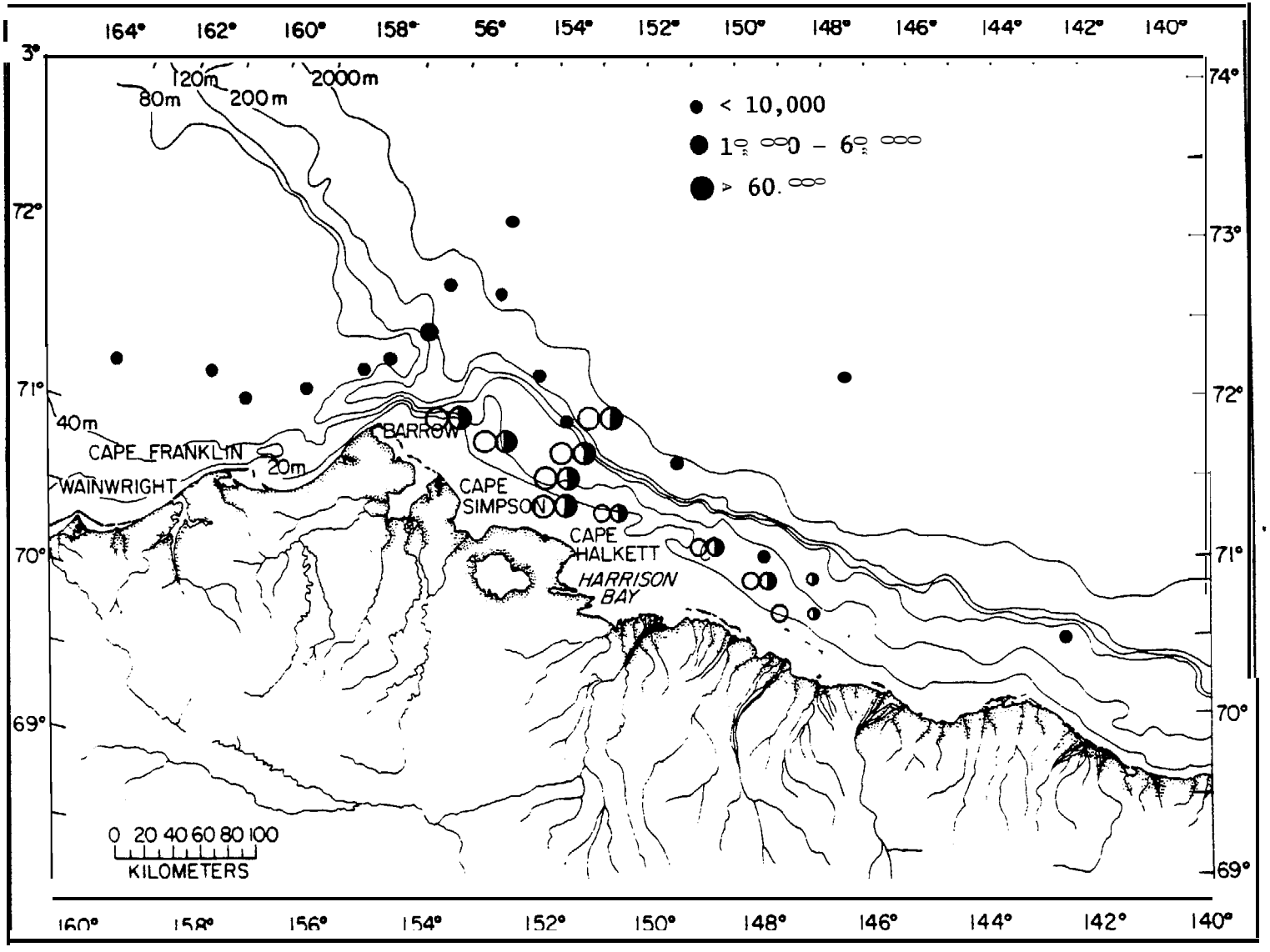

Fig. 22. Abundance (number per 1000 m^3) of barnacle nauplii at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

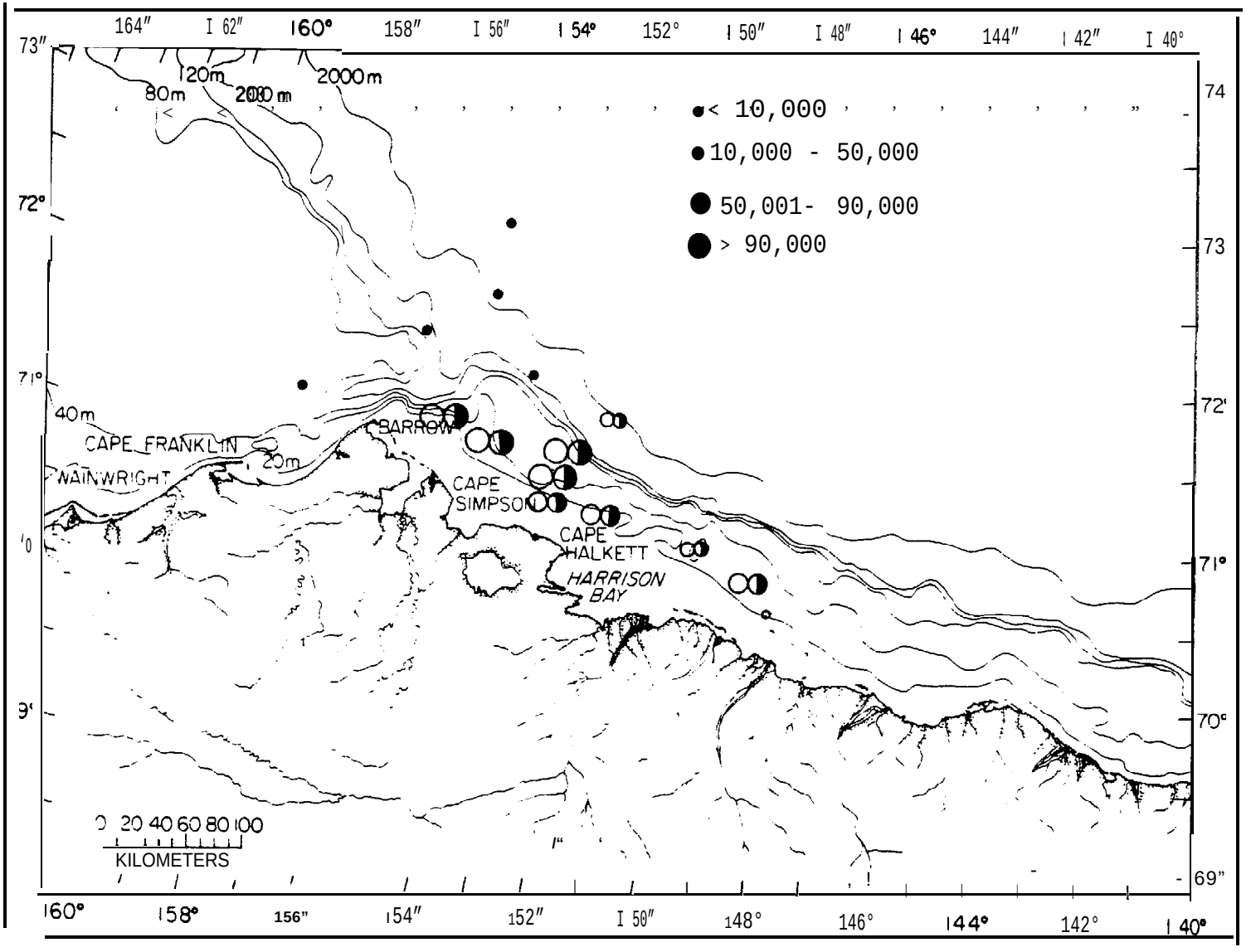

Fig. 23. Abundance (number per 1000 m³) of barnacle cyprids at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. O = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

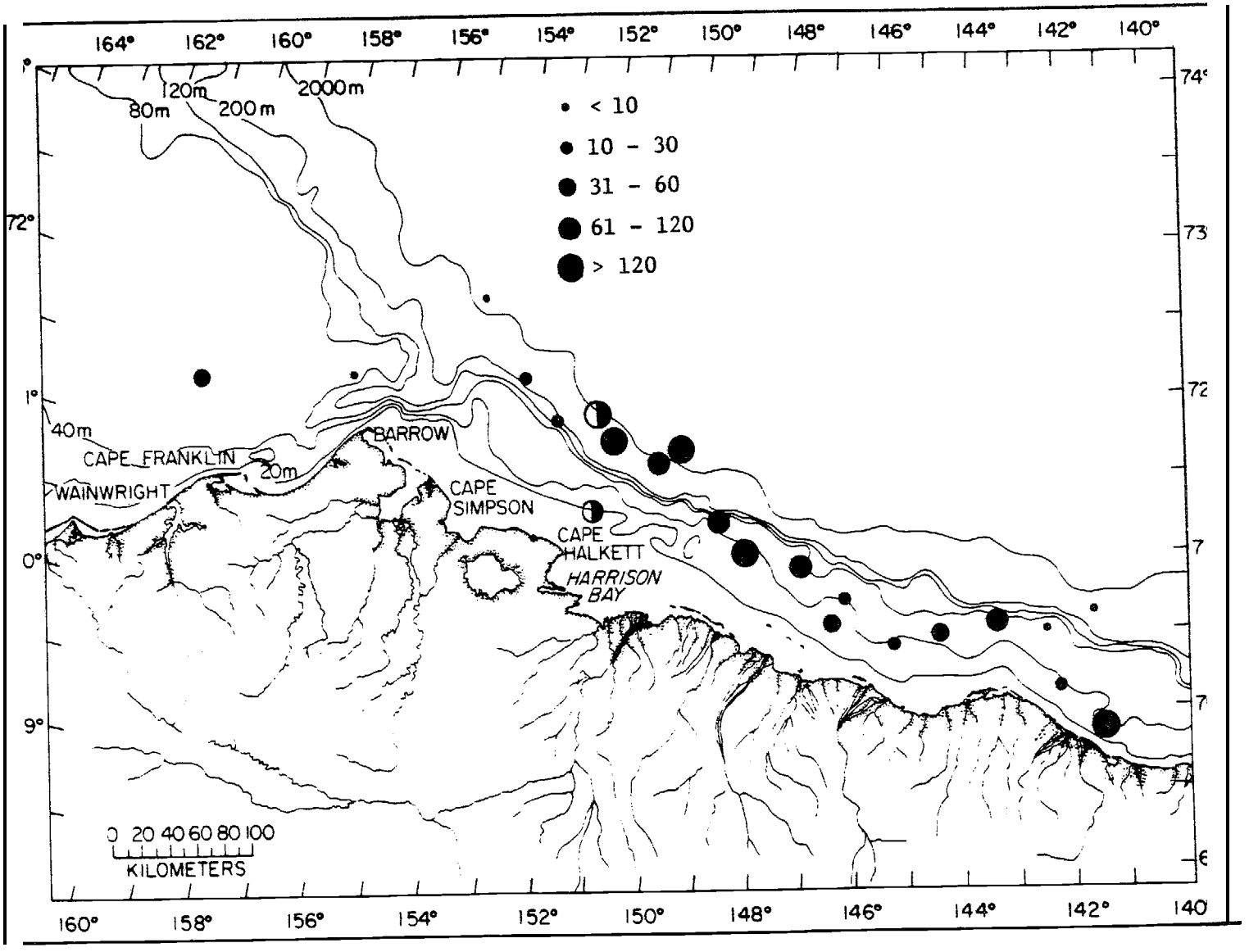

Fig. 24. Abundance (number per 1000 m³) of all mysids at station in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

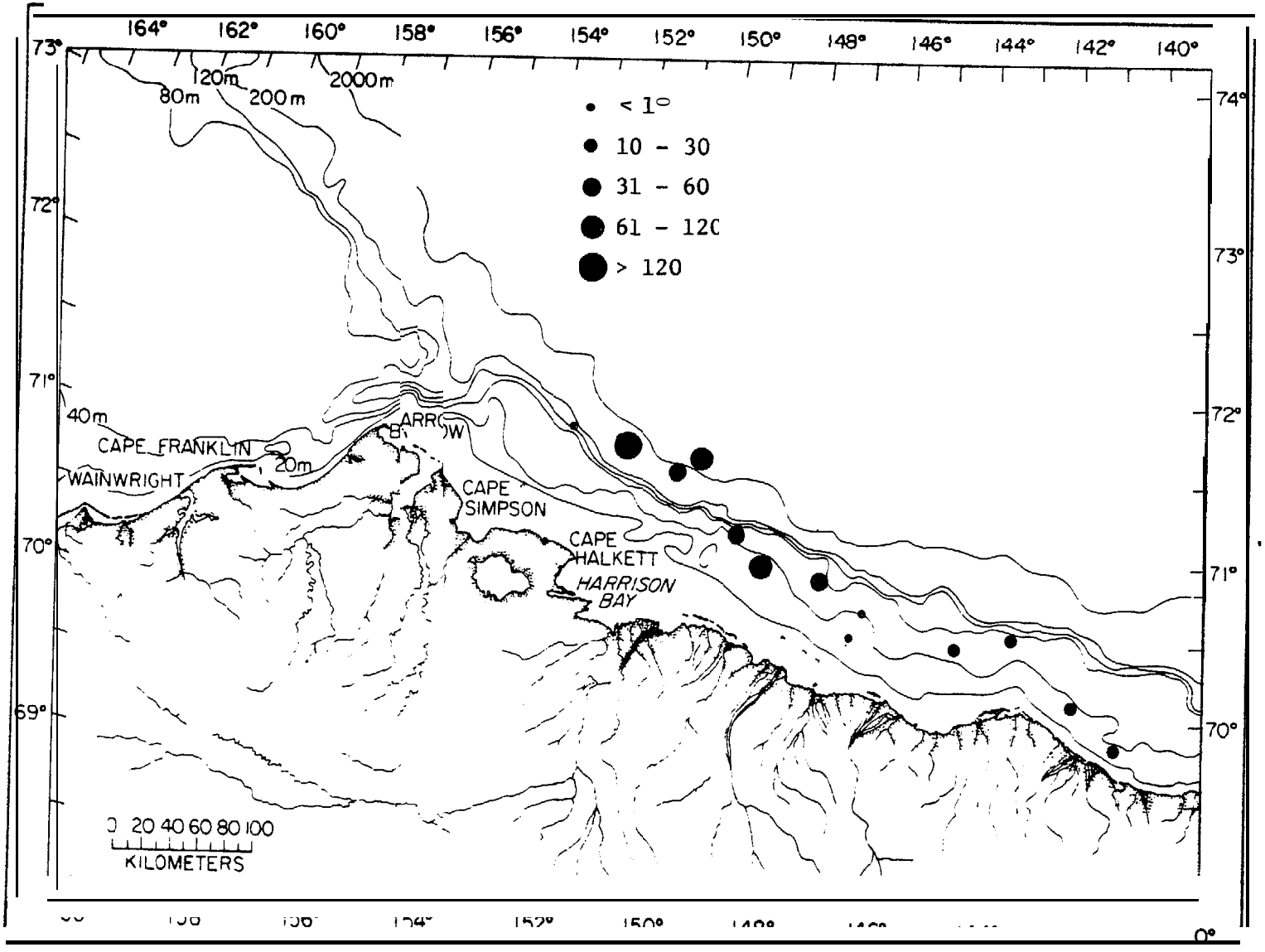

Fig. 25. Abundance (number per 1000 m^3) of *Mysis litoralis* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

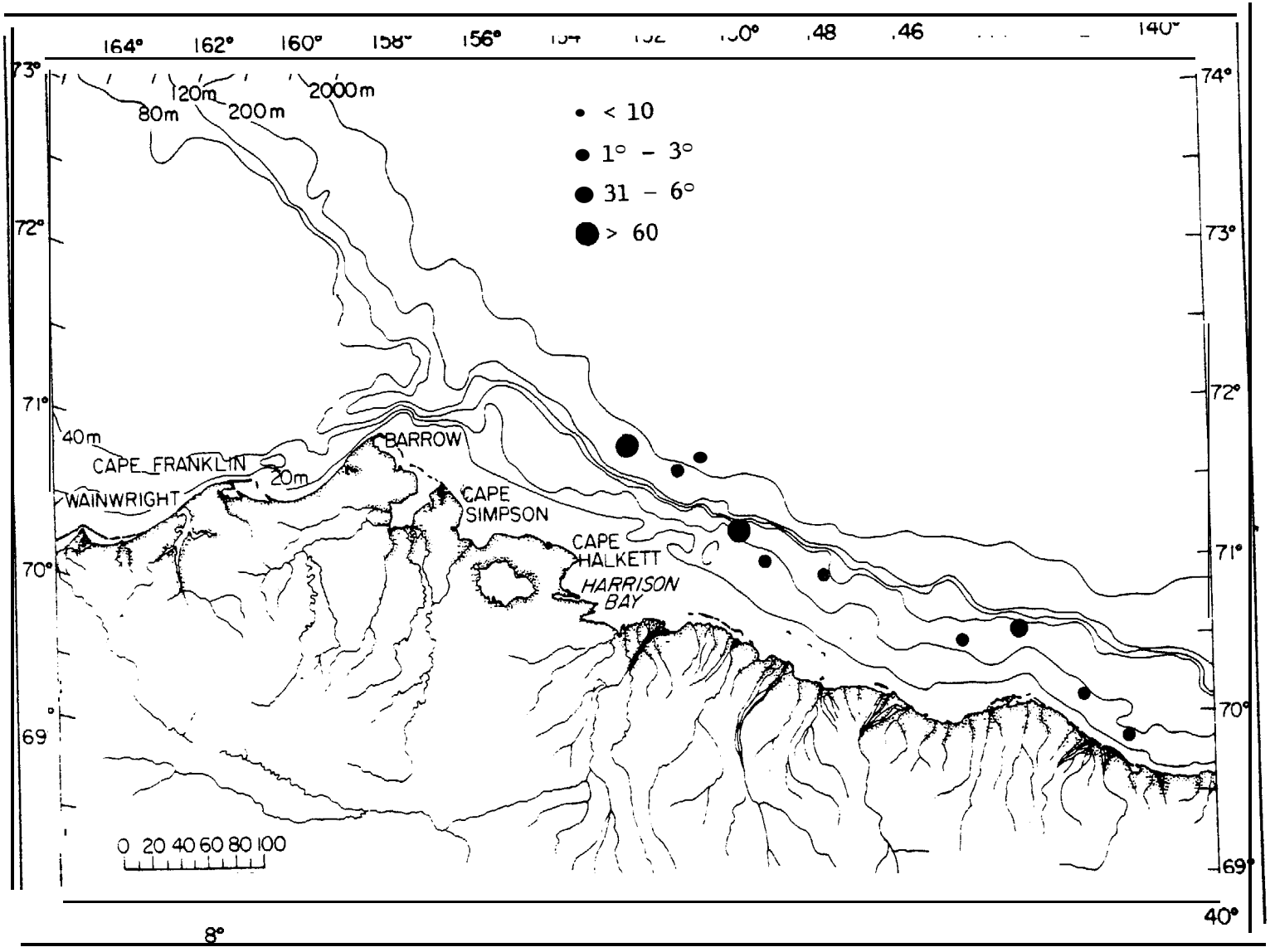

Fig. 26. Abundance (number per 1000 m^3) of *Mysis oculata* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ⊕ ⊞ ring net, 20-0 m 1976; ● = bongo net 1977.

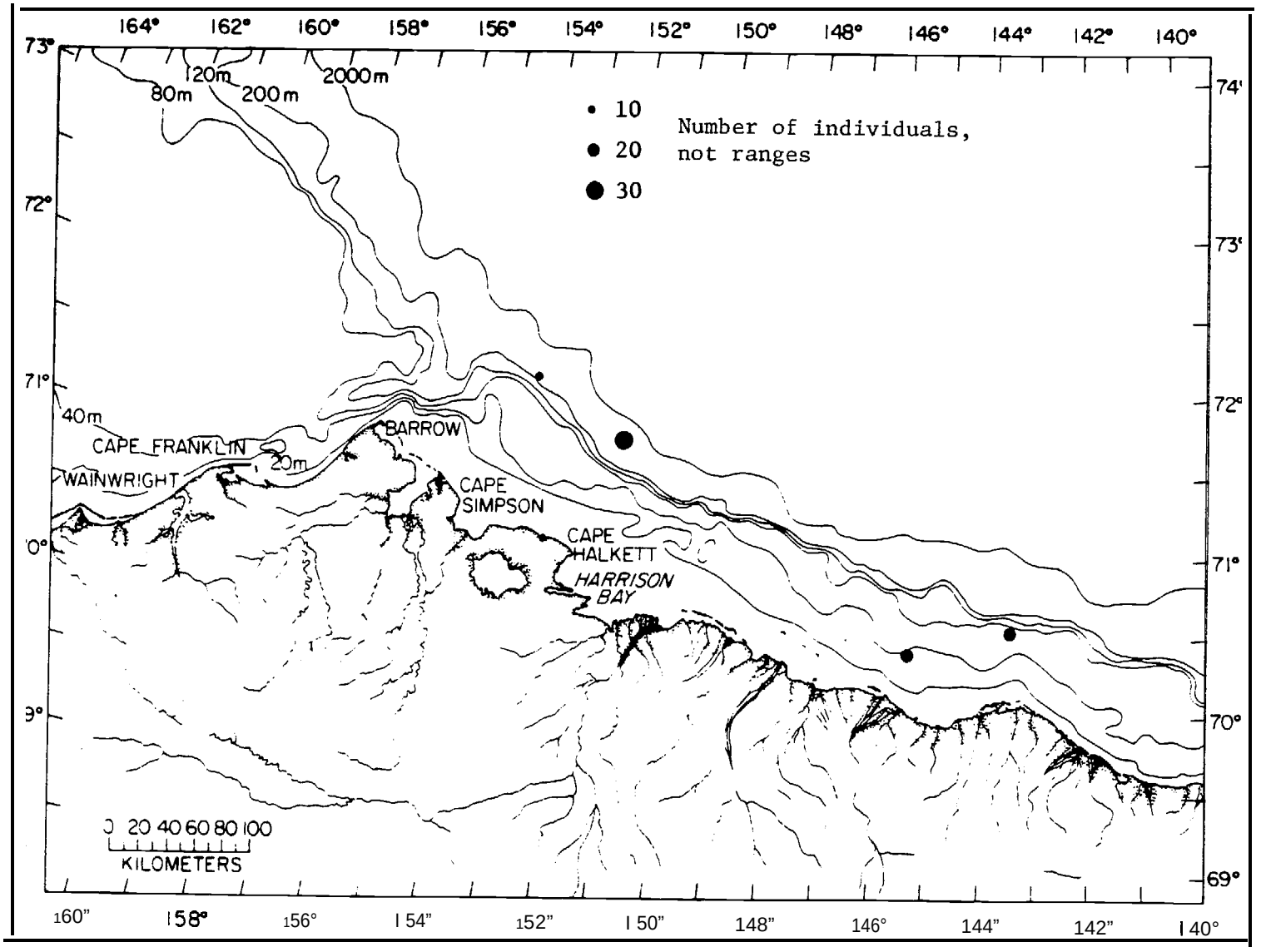

Fig. 27. Abundance (number per 1000 m³) of *Mysis relicta* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

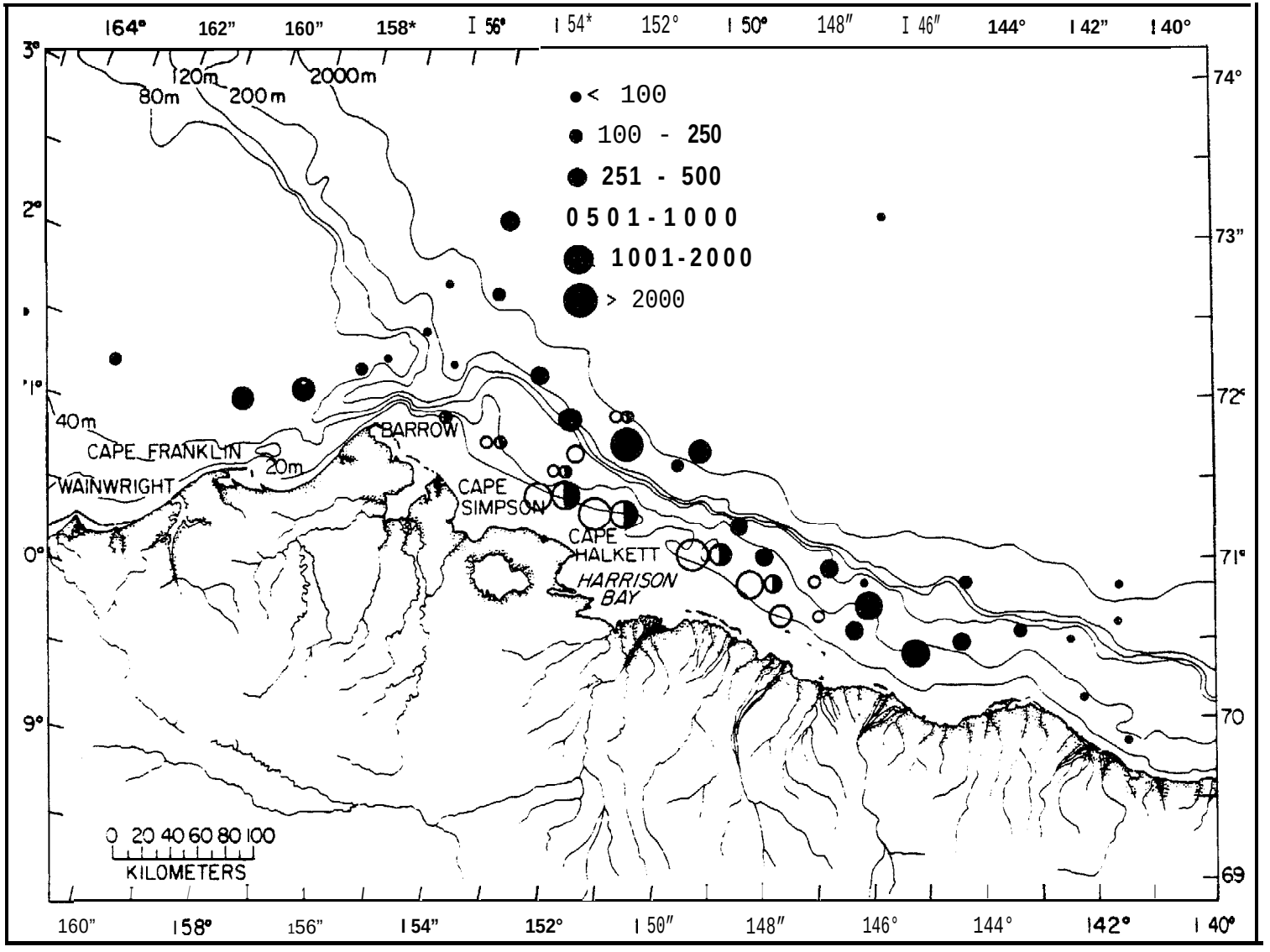

Fig. 28. Abundance (number per 1000 m^3) of all gammarid amphipods at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

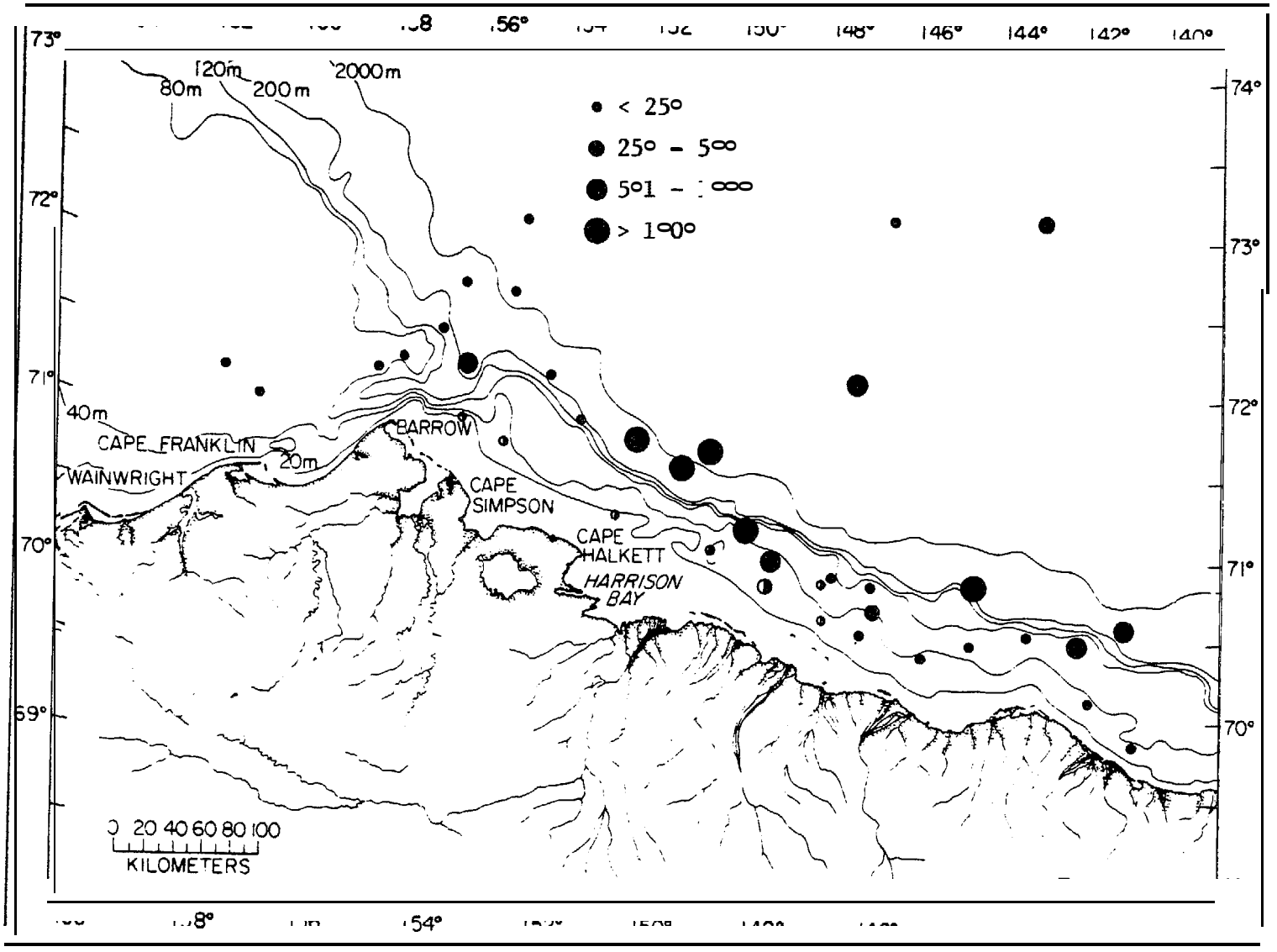

Fig. 29. Abundance (number per 1000 m^3) of all hyperiid amphipods at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ⊙ = ring net. 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

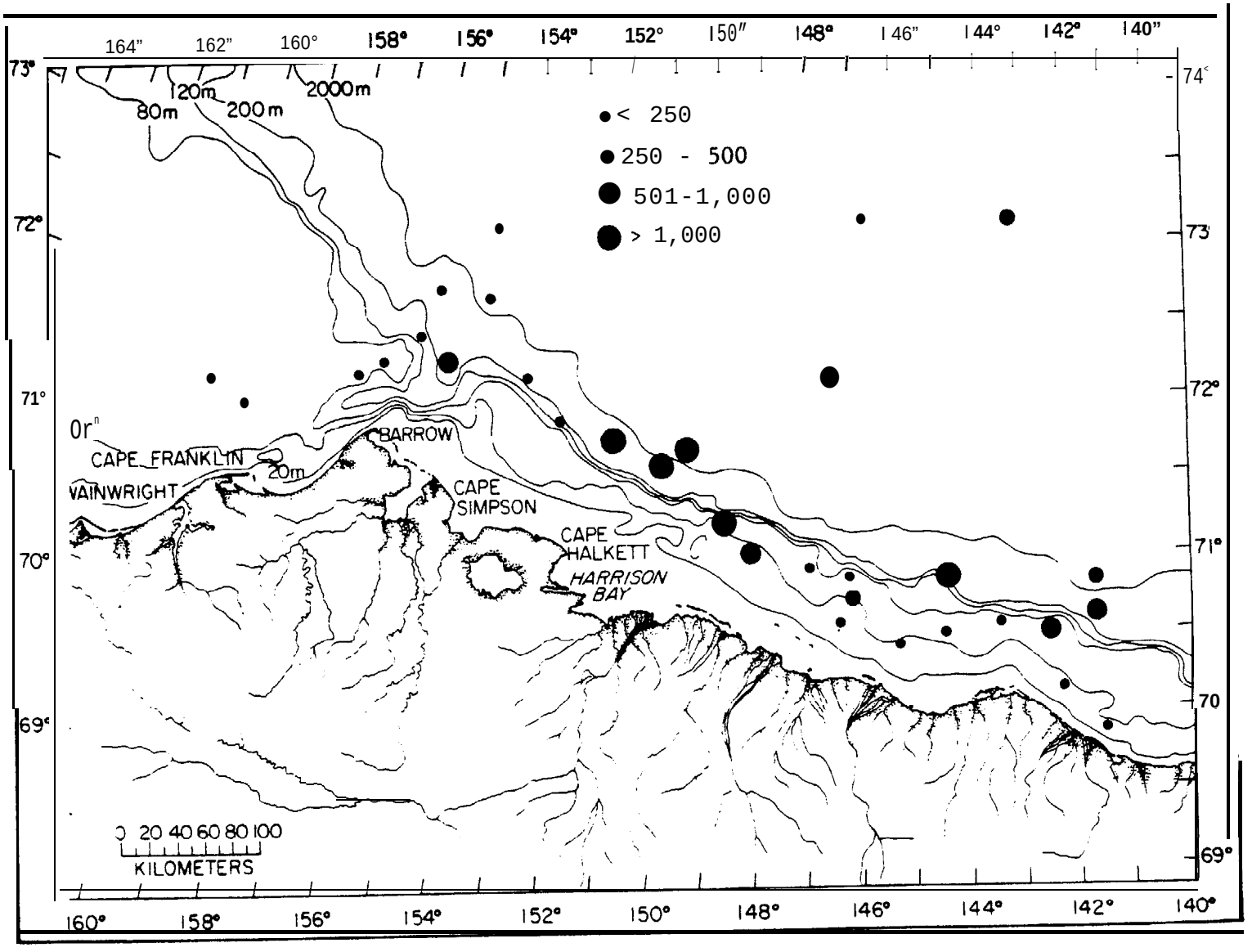

Fig. 30. Abundance (number per 1000 m³) of all *Parathemisto* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-o m 1976; ● = bongo net 1977.

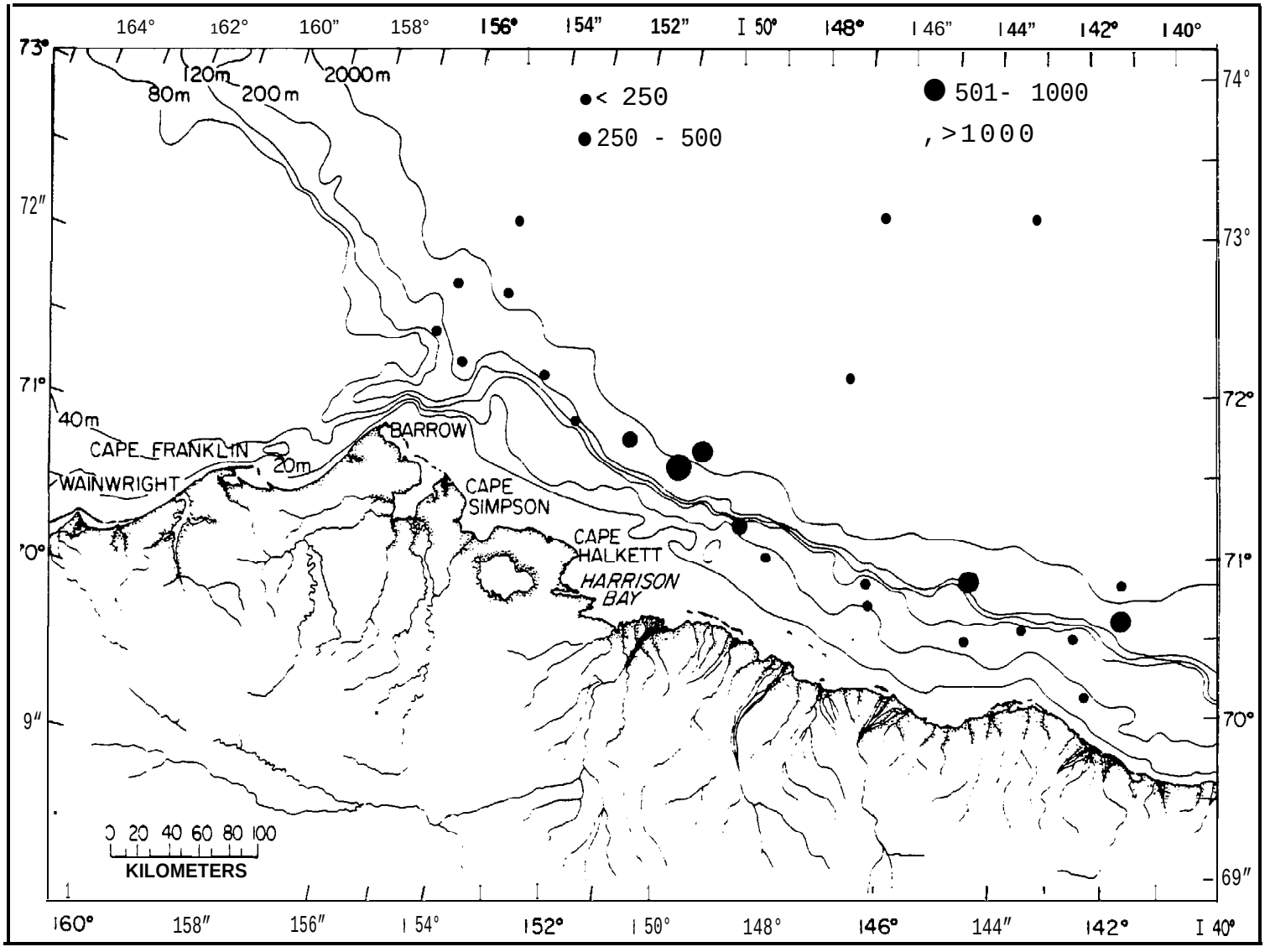

Fig. 31. Abundance (number per 1000 m^3) of *Parathemisto abyssorum* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

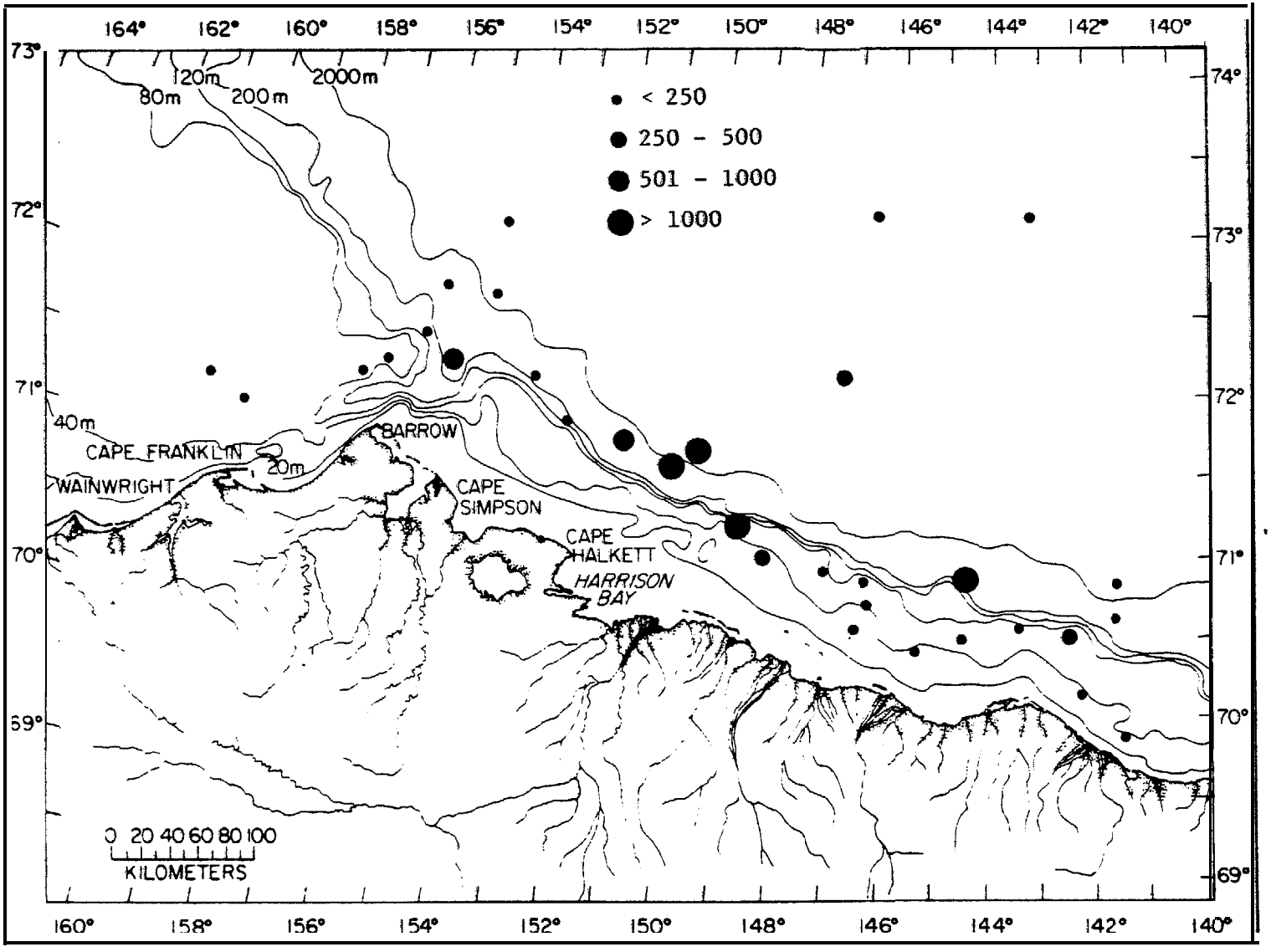

Fig. 32. Abundance (number per 1000 m^3) of *Parathemisto libellula* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

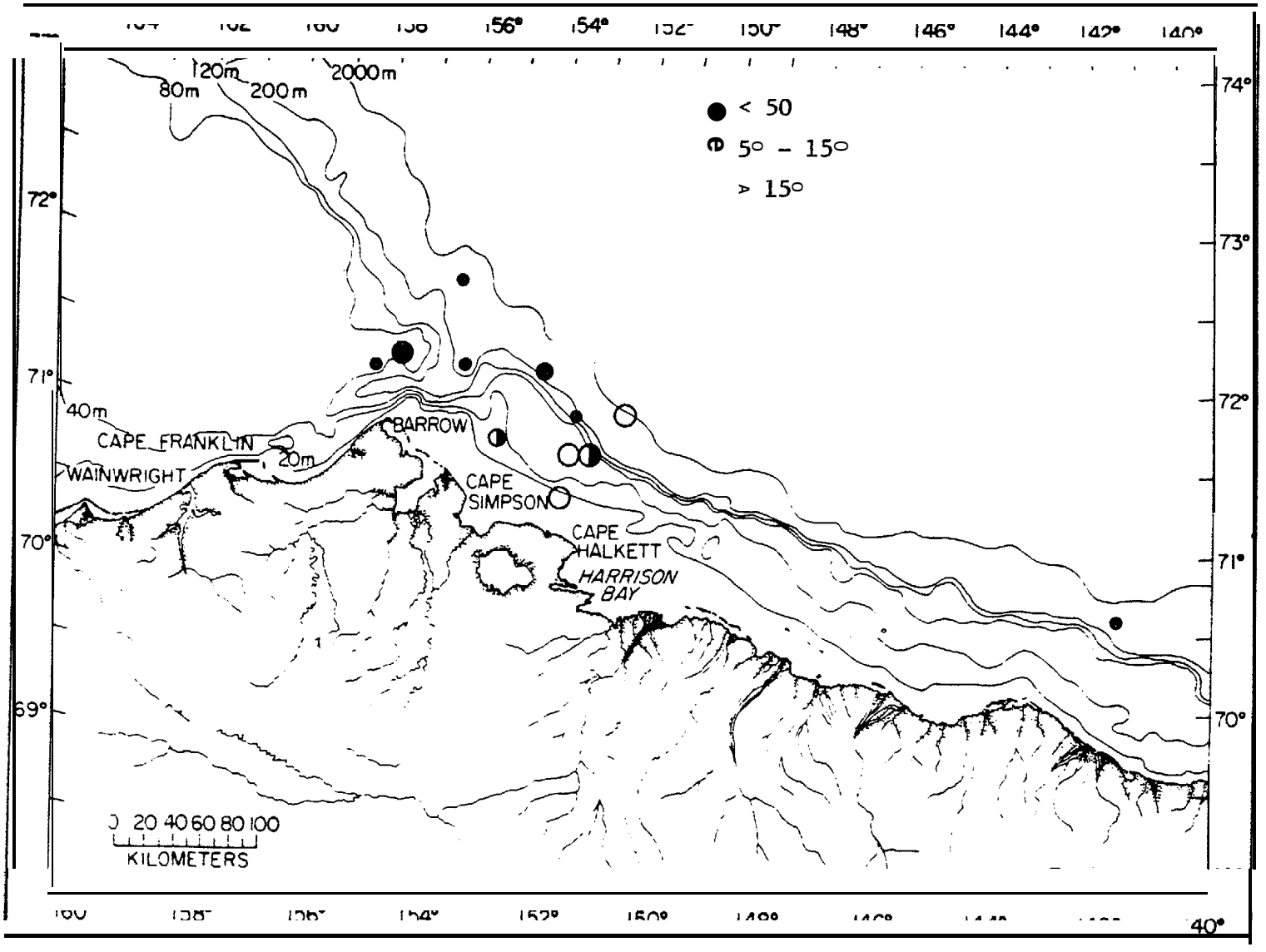

Fig. 33. Abundance (number per 1000 m^3) of all euphausid larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

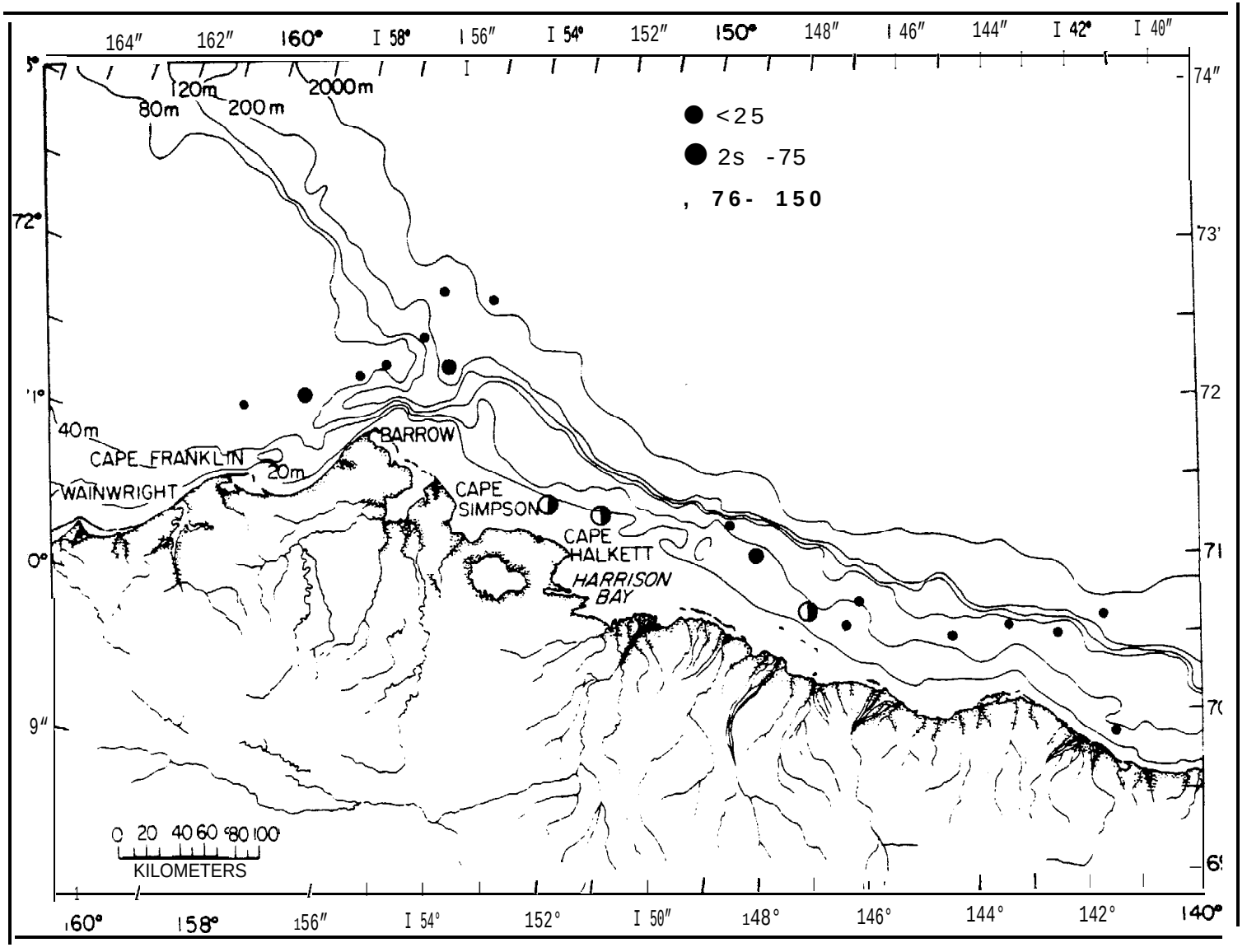

Fig. 34. Abundance (number per 1000 m^3) of *Thysanoëssa inermis* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

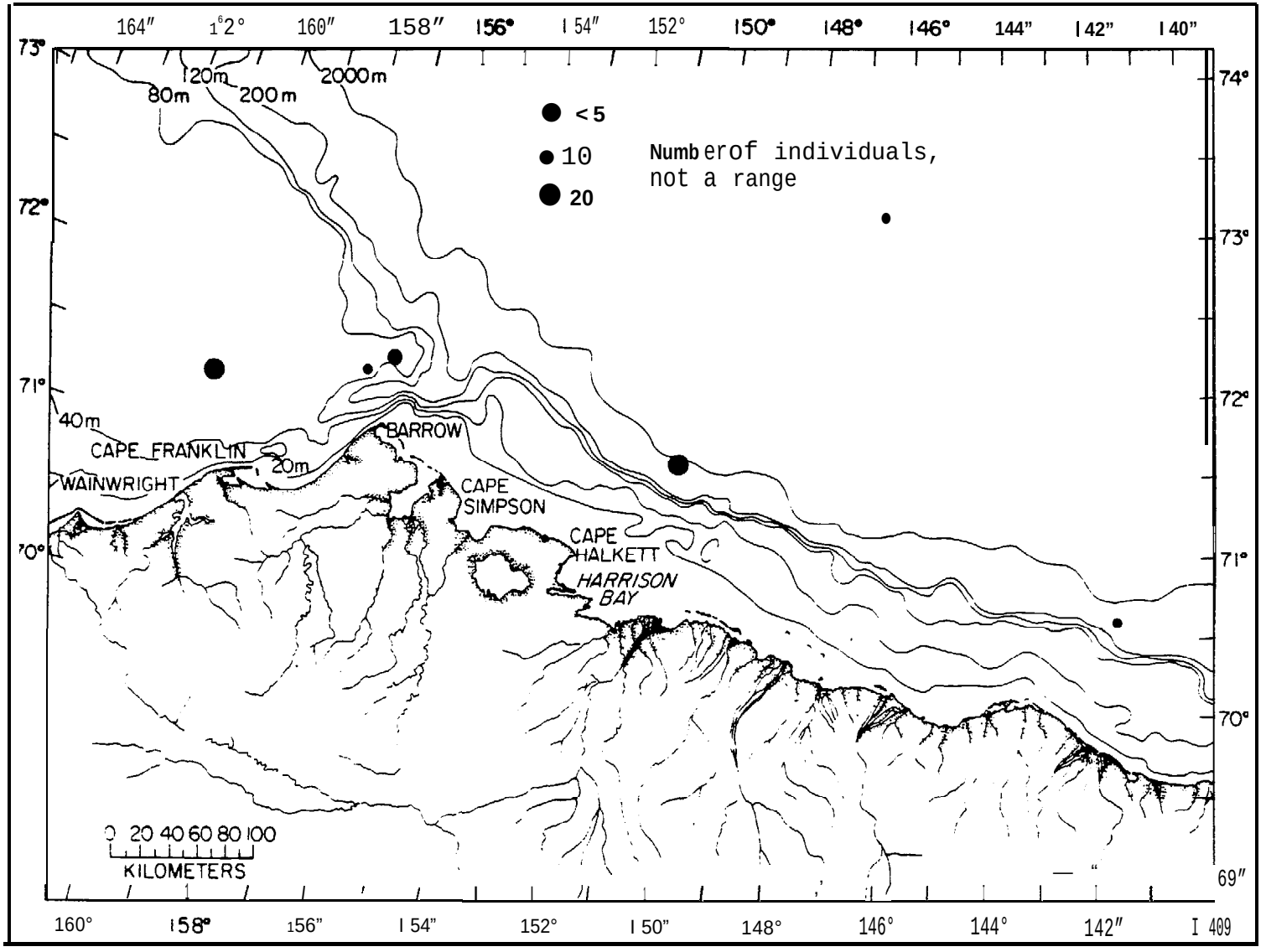

Fig. 35. Abundance (number per 1000 m³) of *Thysanoëssa longipes* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

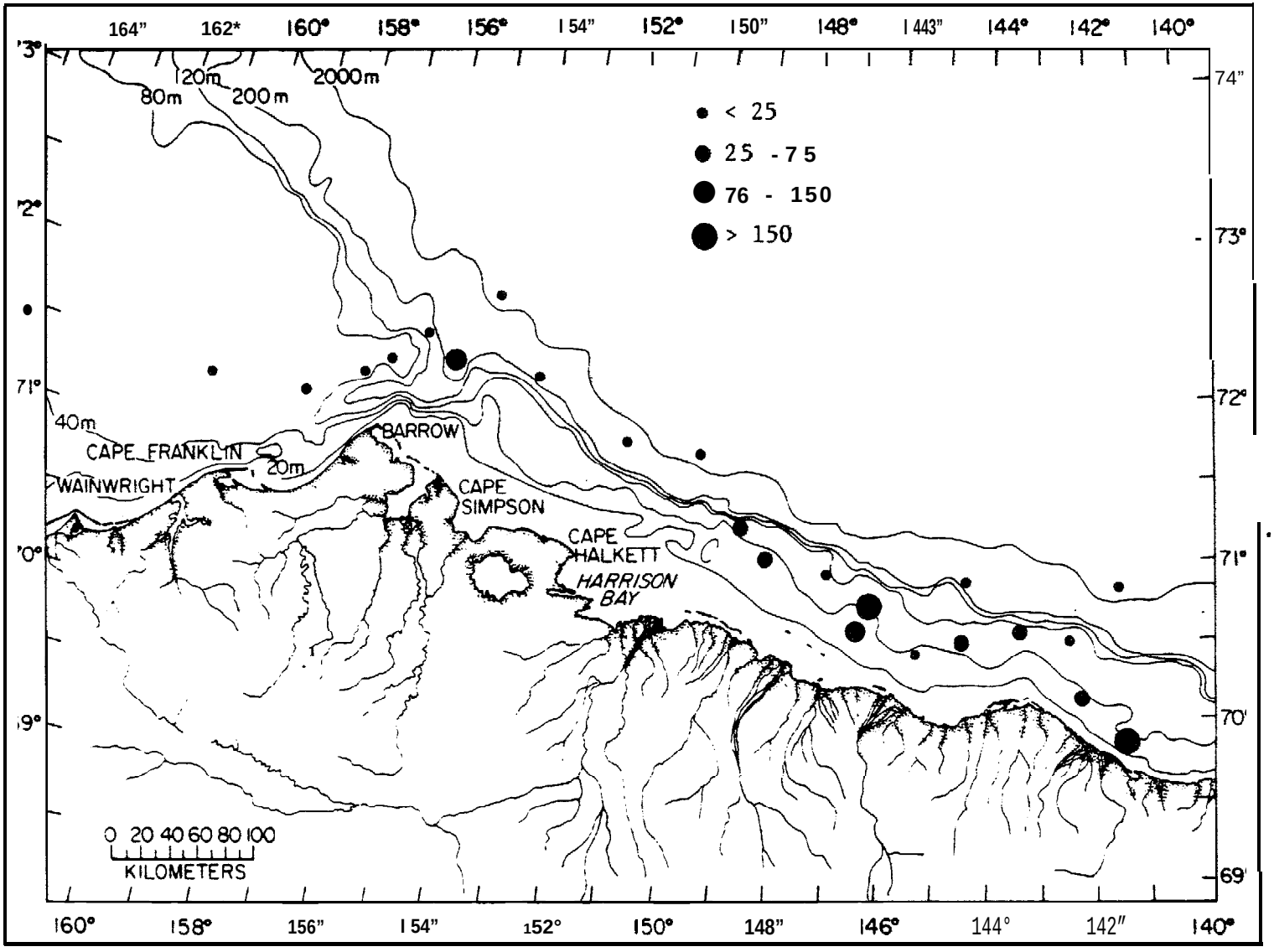

Fig. 36. Abundance (number per 1000 m^3) of *Thysanoëssa raschii* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

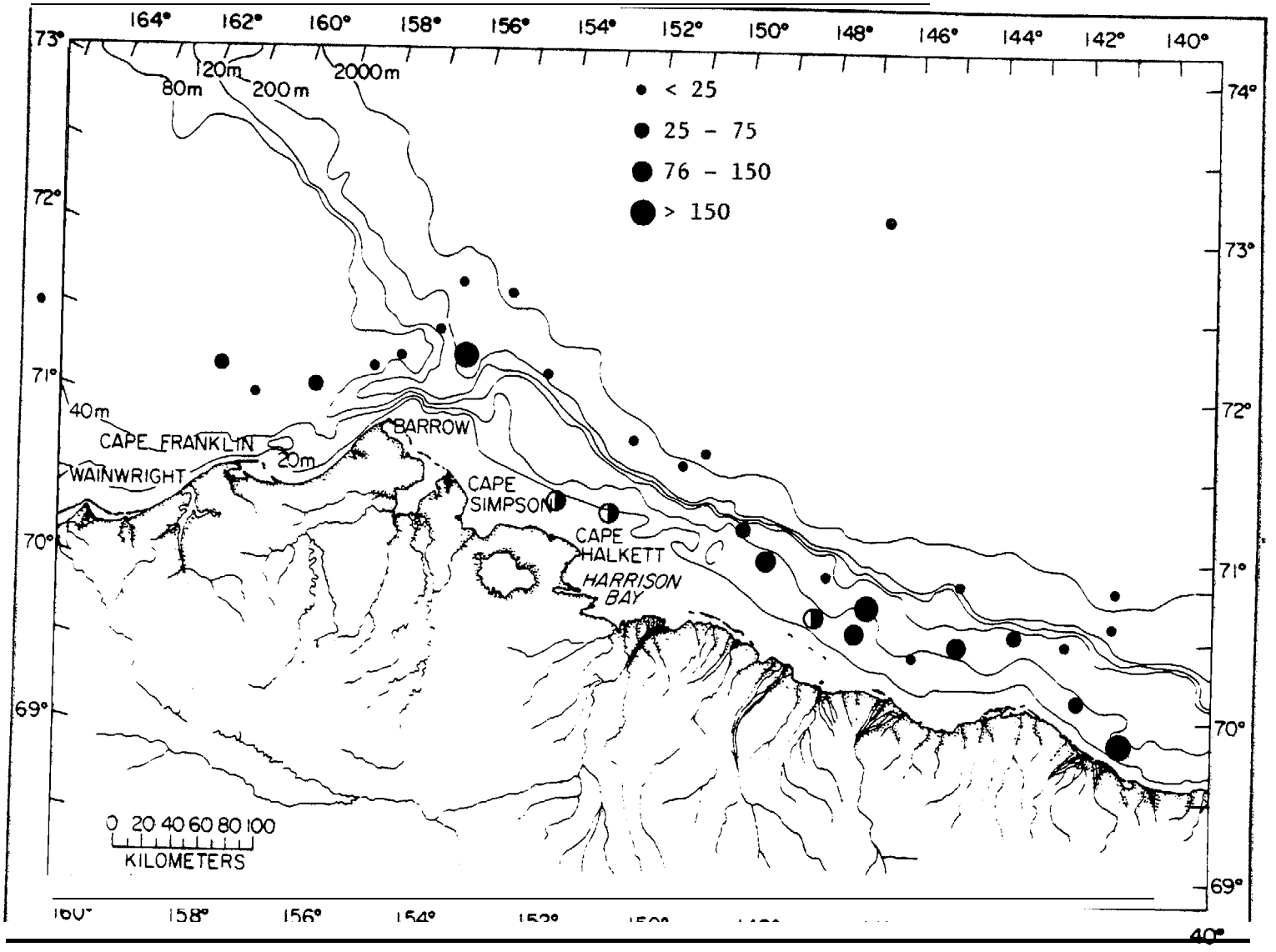

Fig. 37. Abundance (number per 1000 m^3) of all *Thysanoëssa* spp. (excluding larvae) at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net 20-0 m 1976; ● = bongo net 1977.

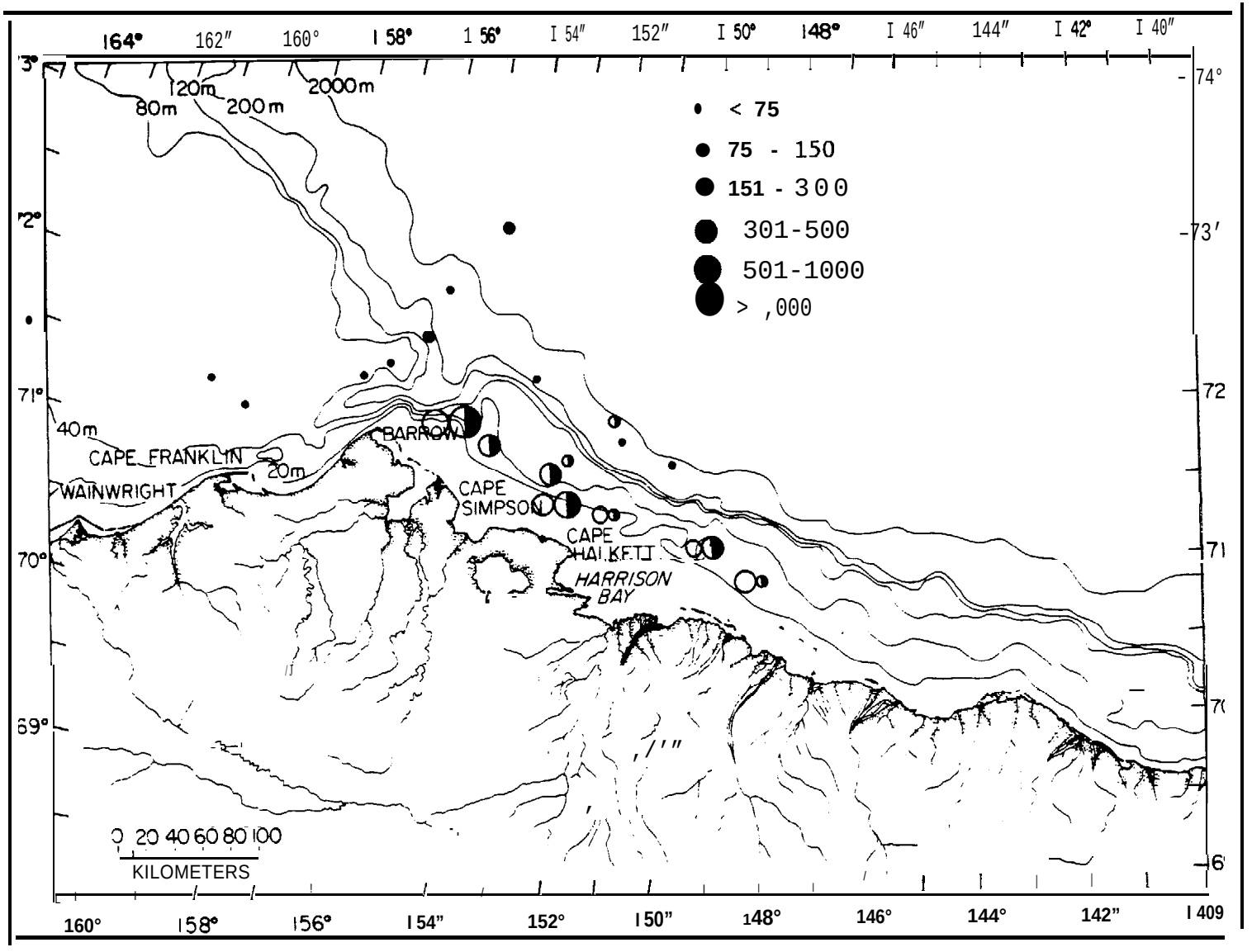

Fig. 38. Abundance (number per 1000 m^3) of anomuran larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, **20-0 m 1976;** ● = bongo net 1977.

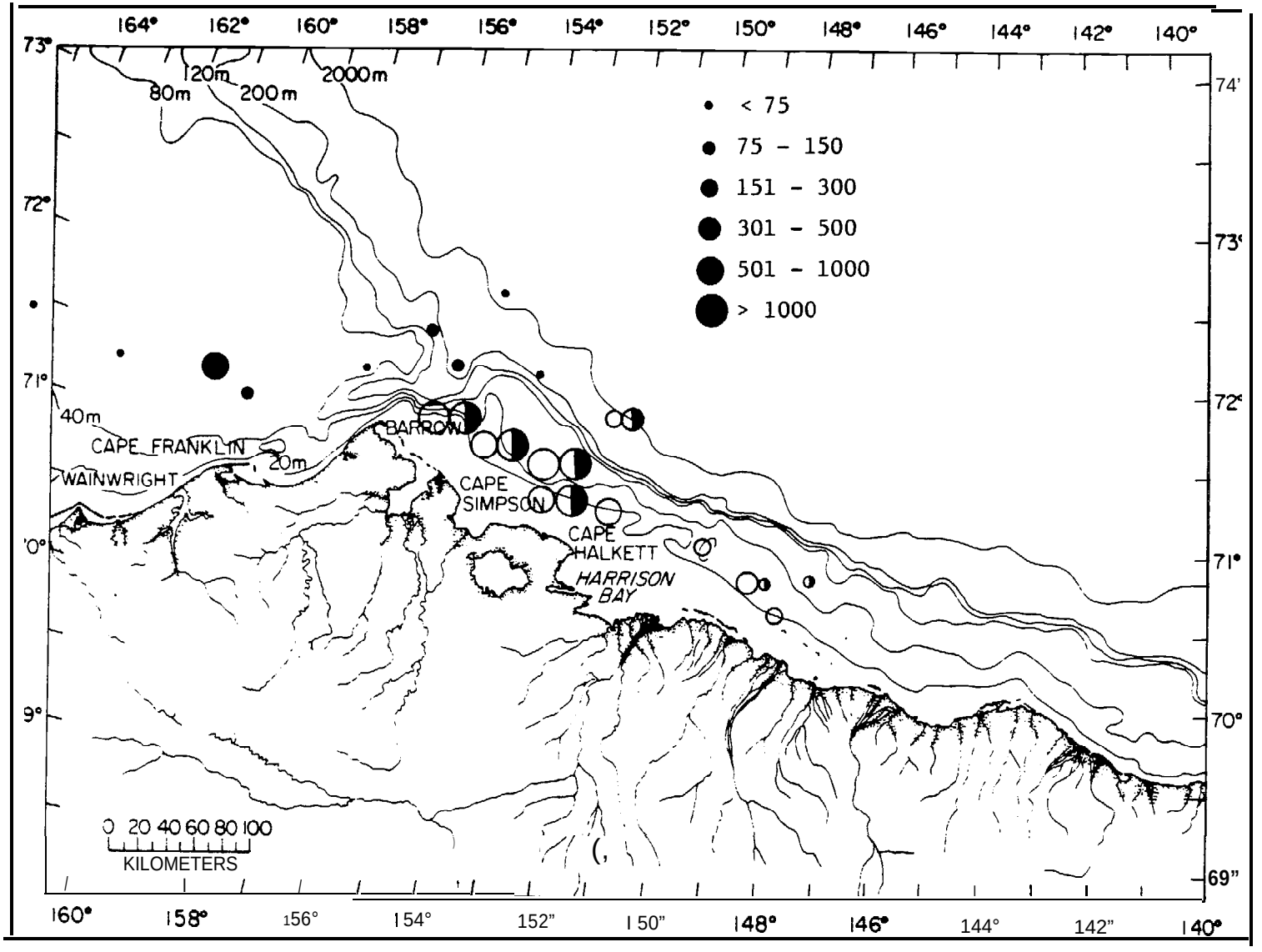

Fig. 39. Abundance (number per 1000 m^3) of brachyuran larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

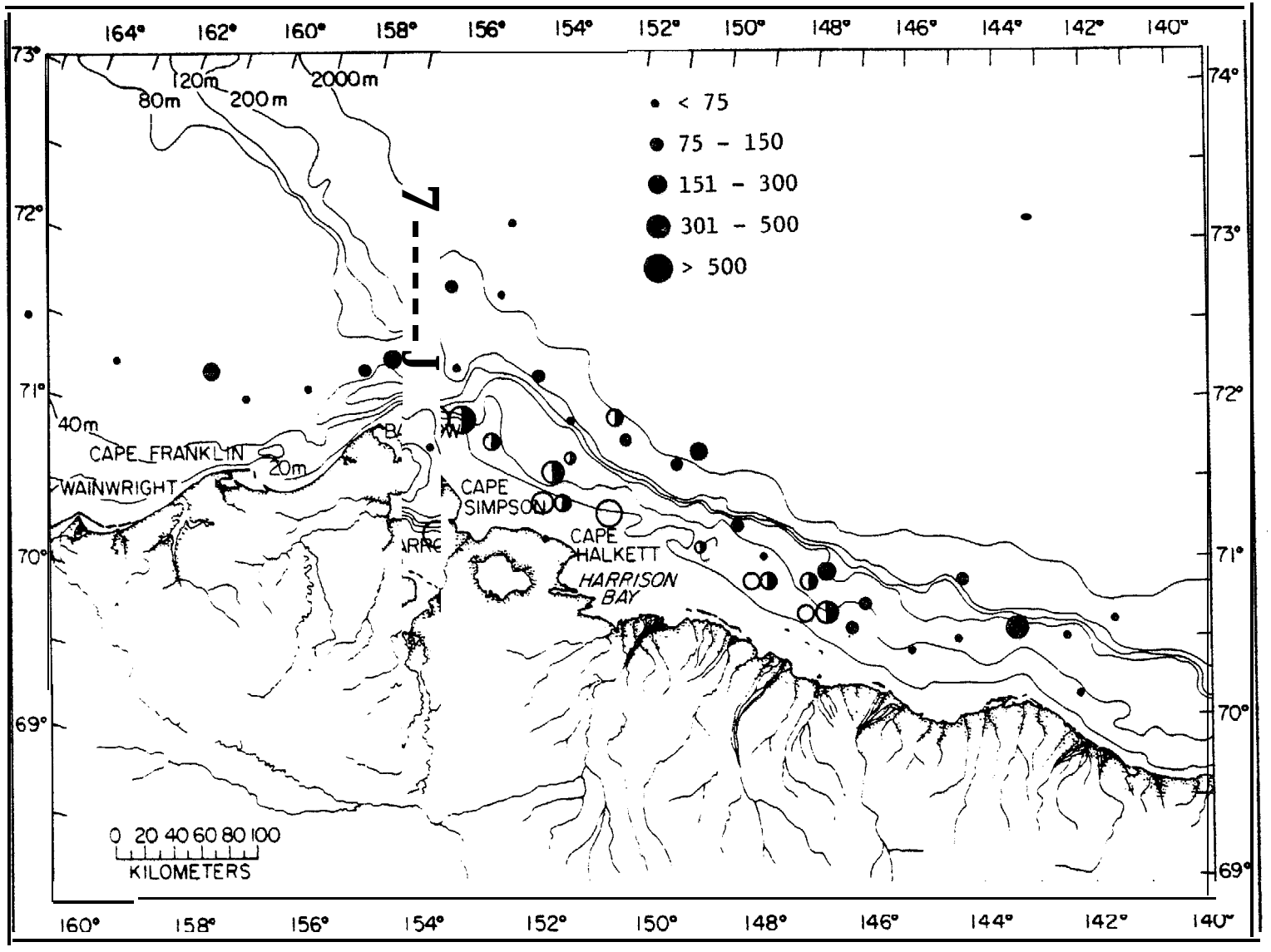

Fig. 40. Abundance (number per 1000 m^3) of Caridea at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 100-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

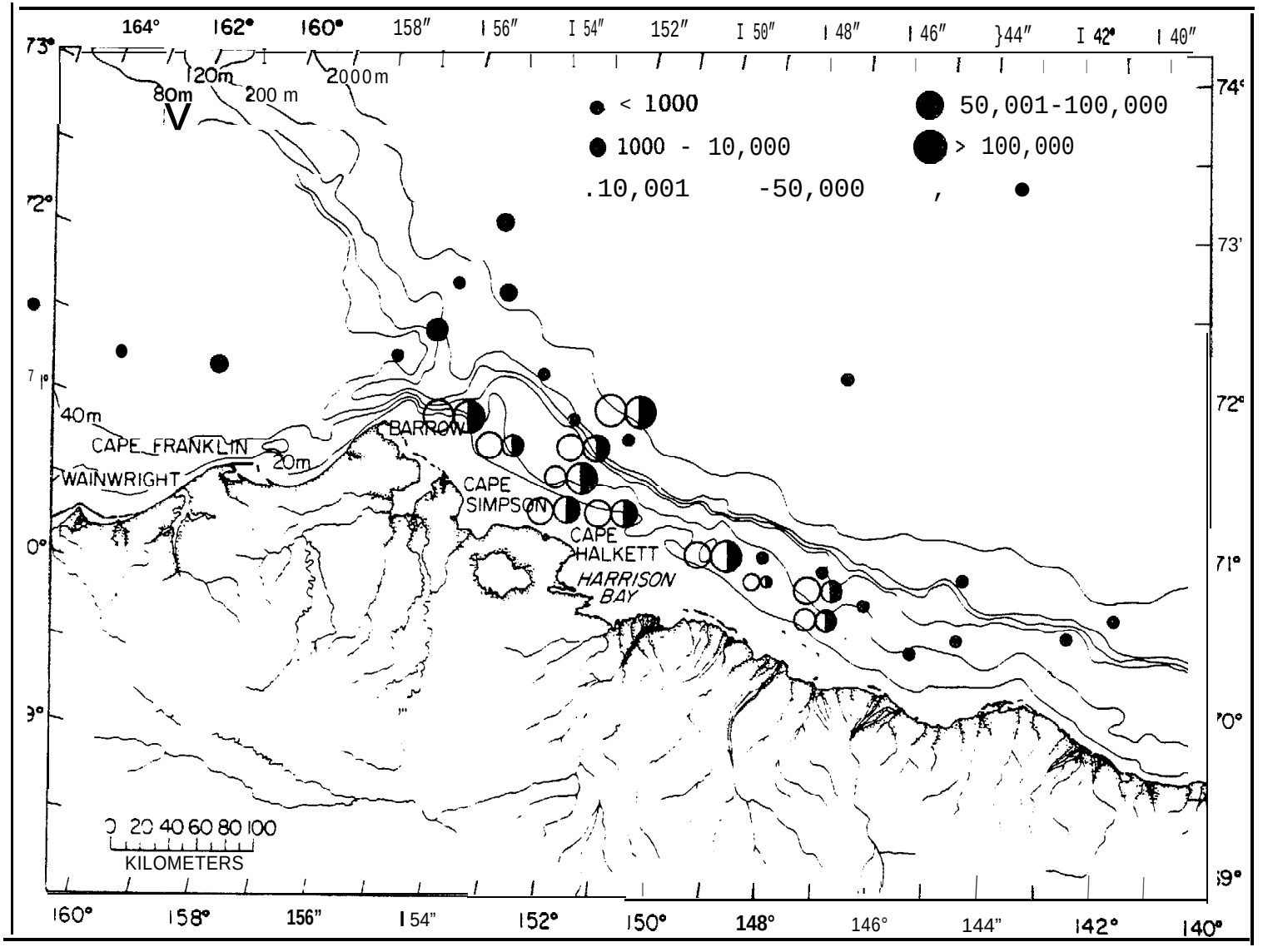

Fig. 41. Abundance (number per 1000 m³) of *Friti llaria* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. O = ring net, 10-0 m 1976; ◑ . ring net, 20-0 m 1976; ● = bongo net 1977.

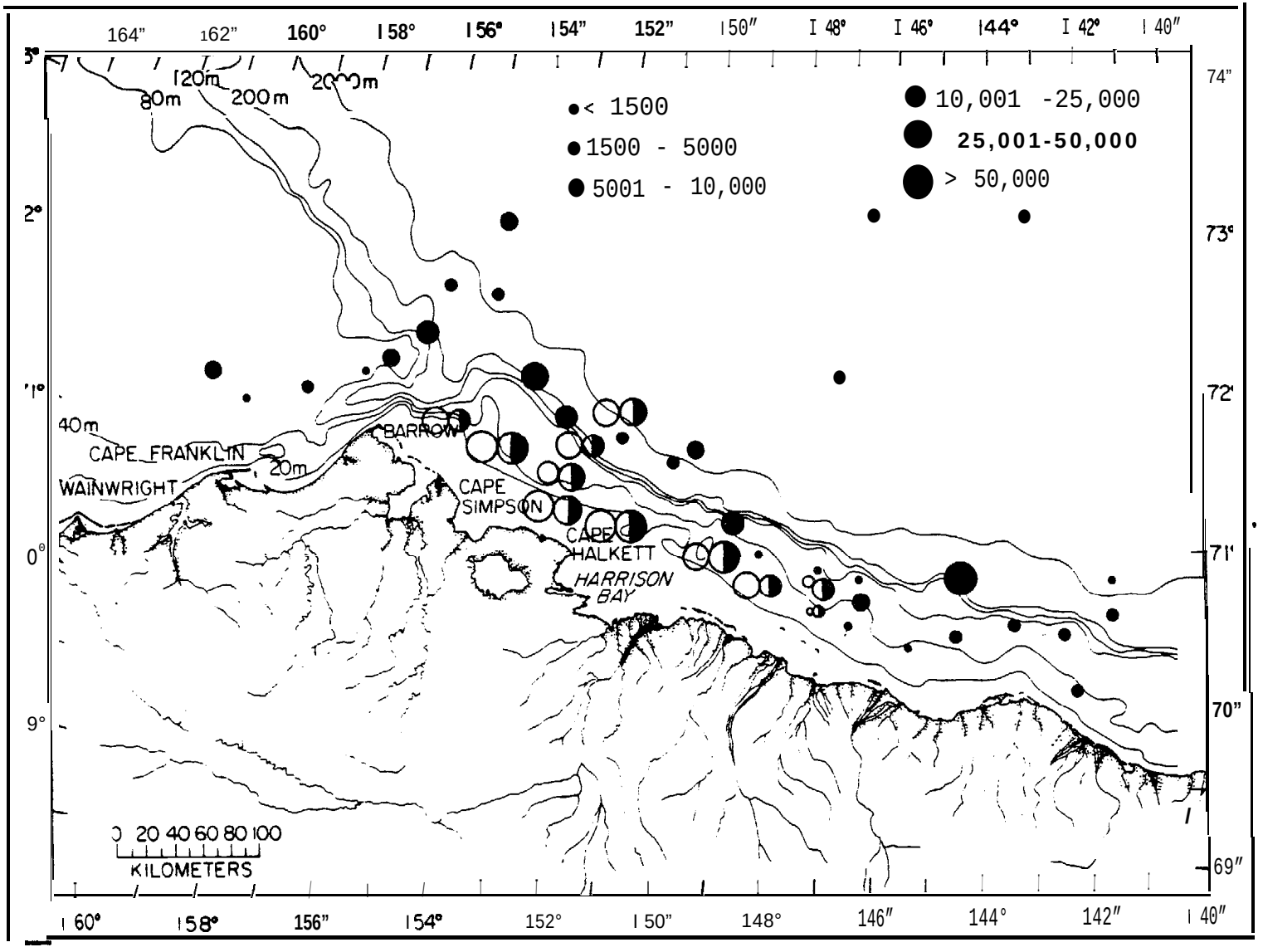

Fig. 42. Abundance (number per 1000 m³) of all *Oikopleura* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

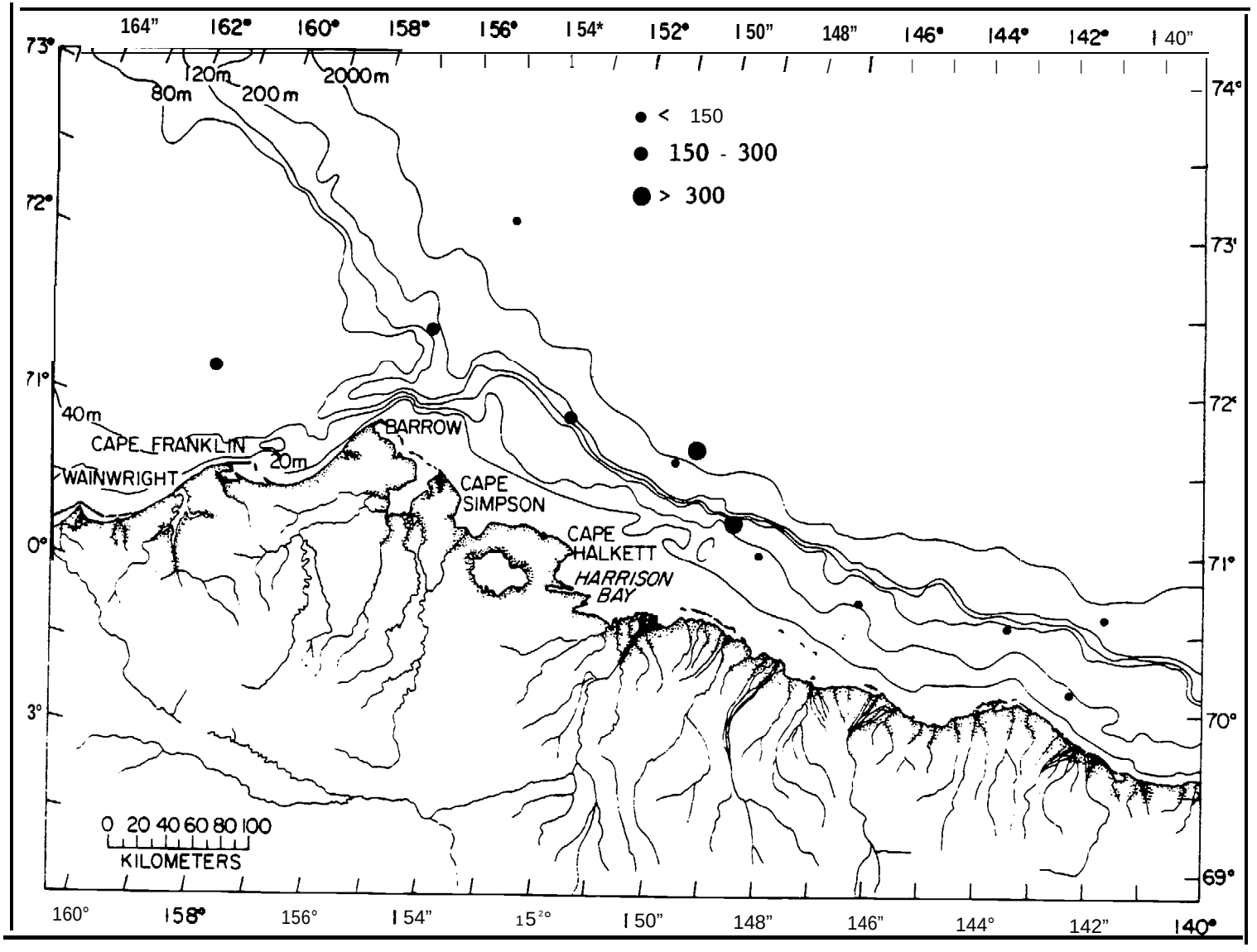

Fig. 43. Abundance (number per 1000 m³) of *Oikopleura labradoriensis* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

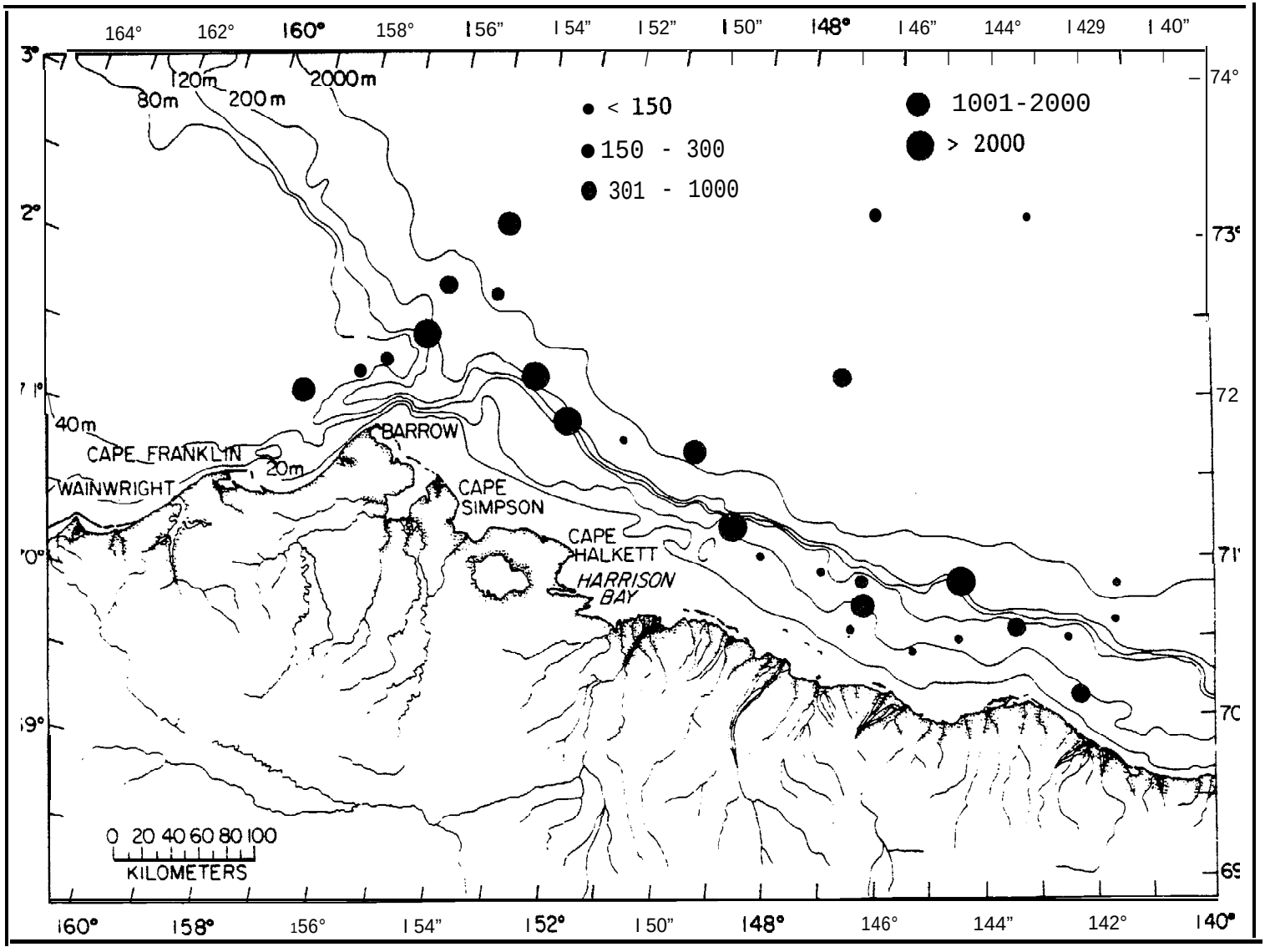

Fig. 44. Abundance (number per 1000 m^3) of *Oikopleura vanhöffeni* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

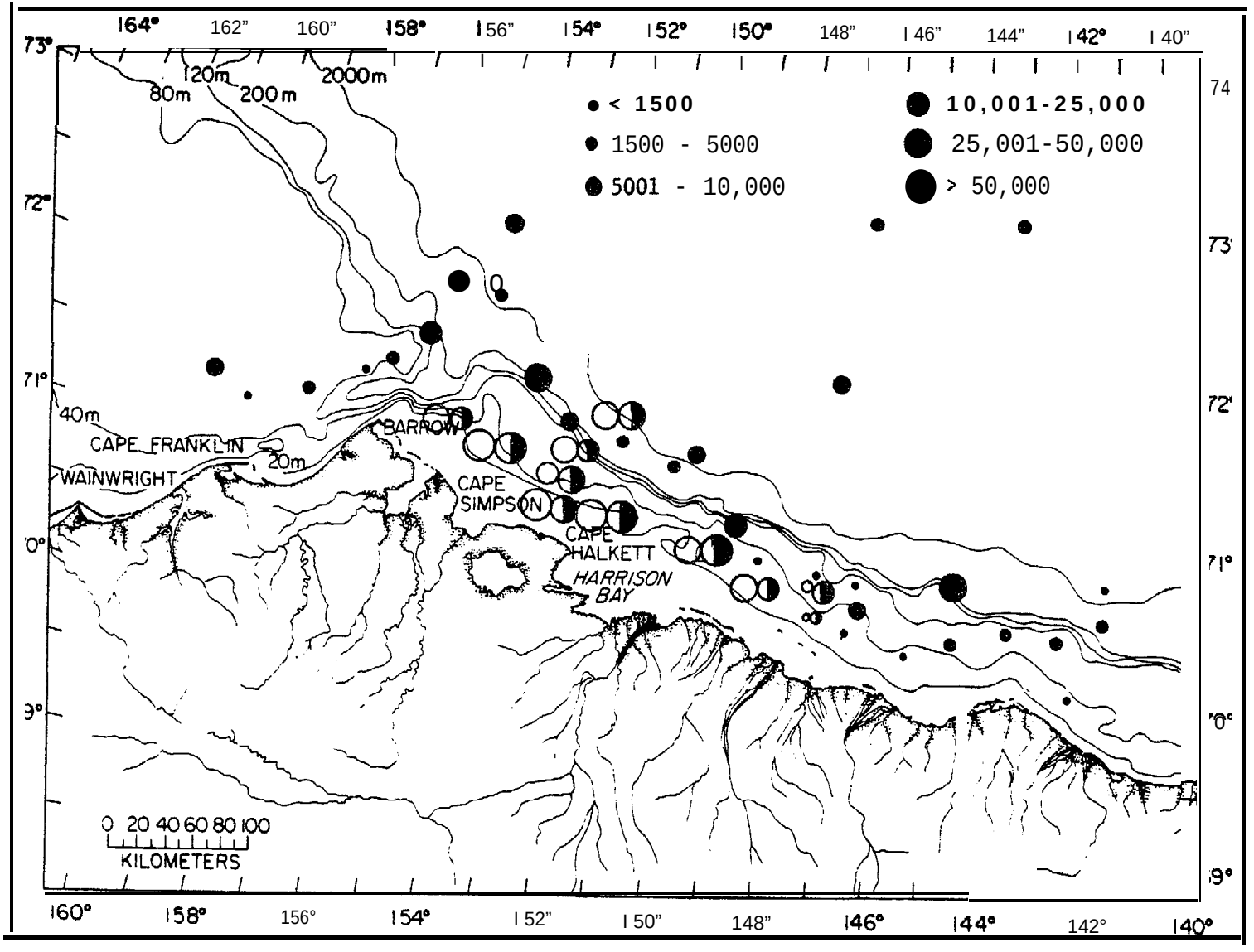

Fig. 45. Abundance (number per 1000 m^3) of unidentified *Oikop leura* species at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

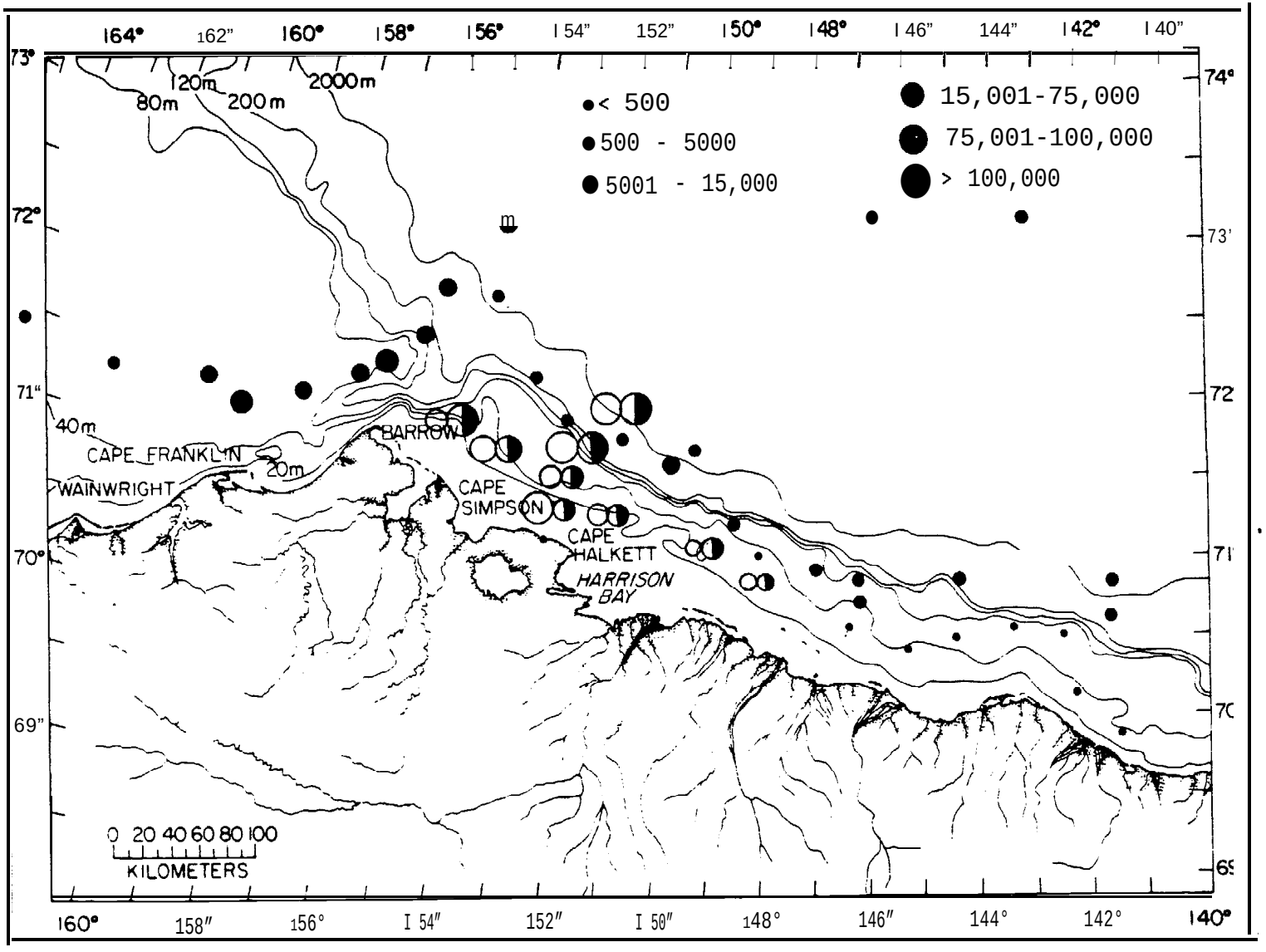

Fig. 46. Abundance (number per 1000 m^3) of all chaetognaths at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

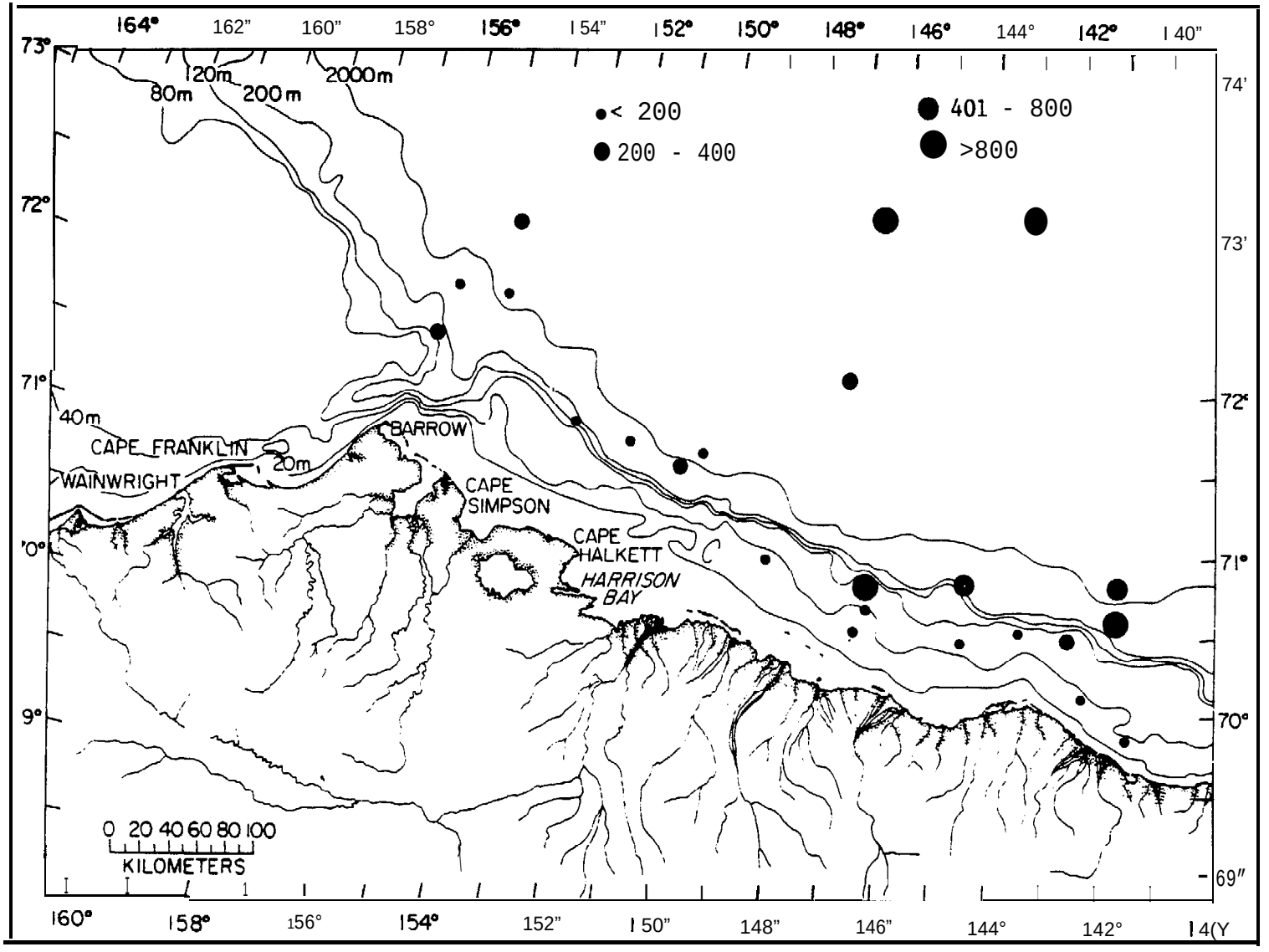

Fig. 47. Abundance (number per 1000 m^3) of *Eukrohnia hamata* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

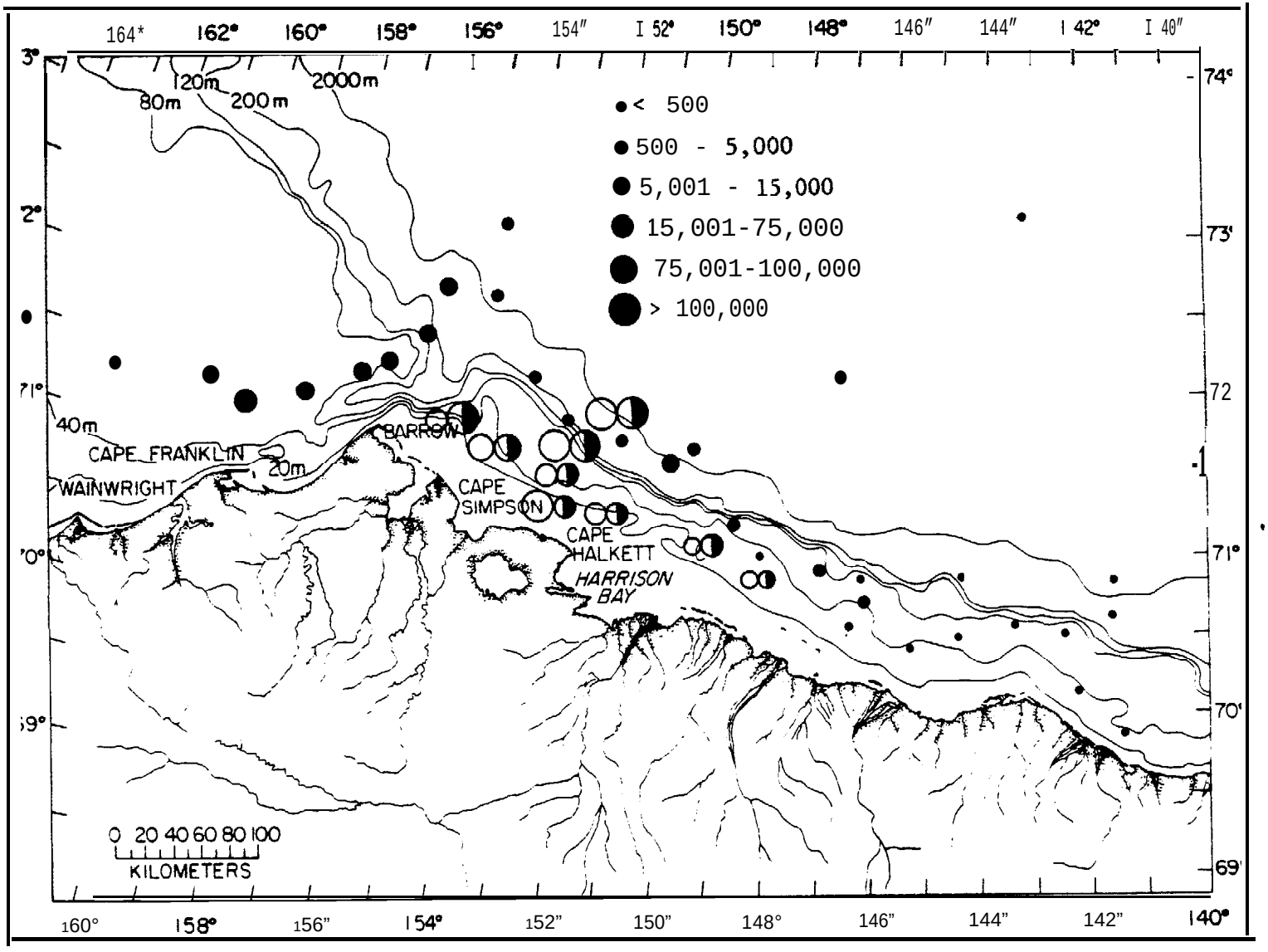

Fig. 48. Abundance (number per 1000 m^3) of *Sagitta elegans* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

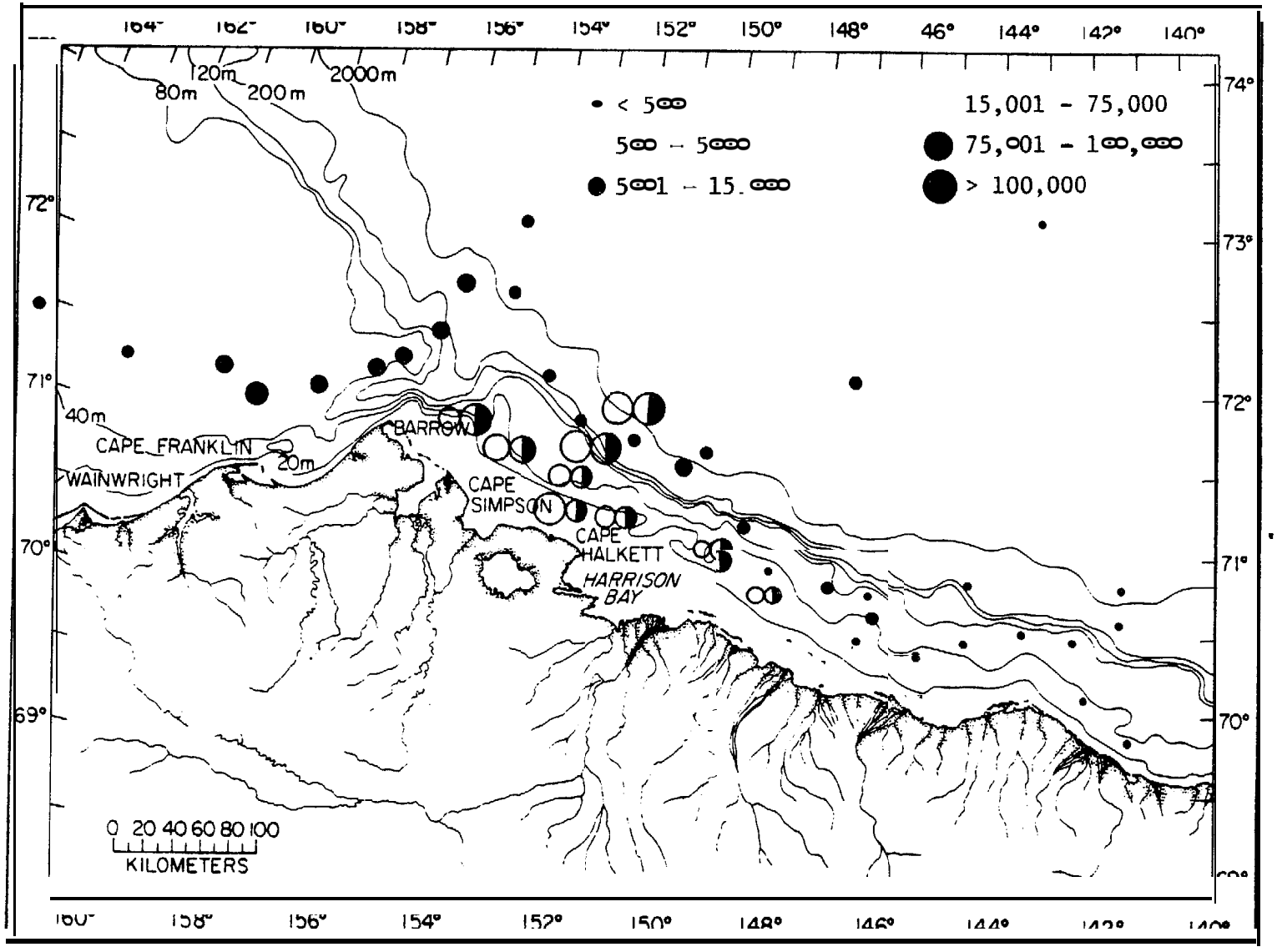

Fig. 49. Abundance (number per 1000 m³) of *Sagitta* spp. at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

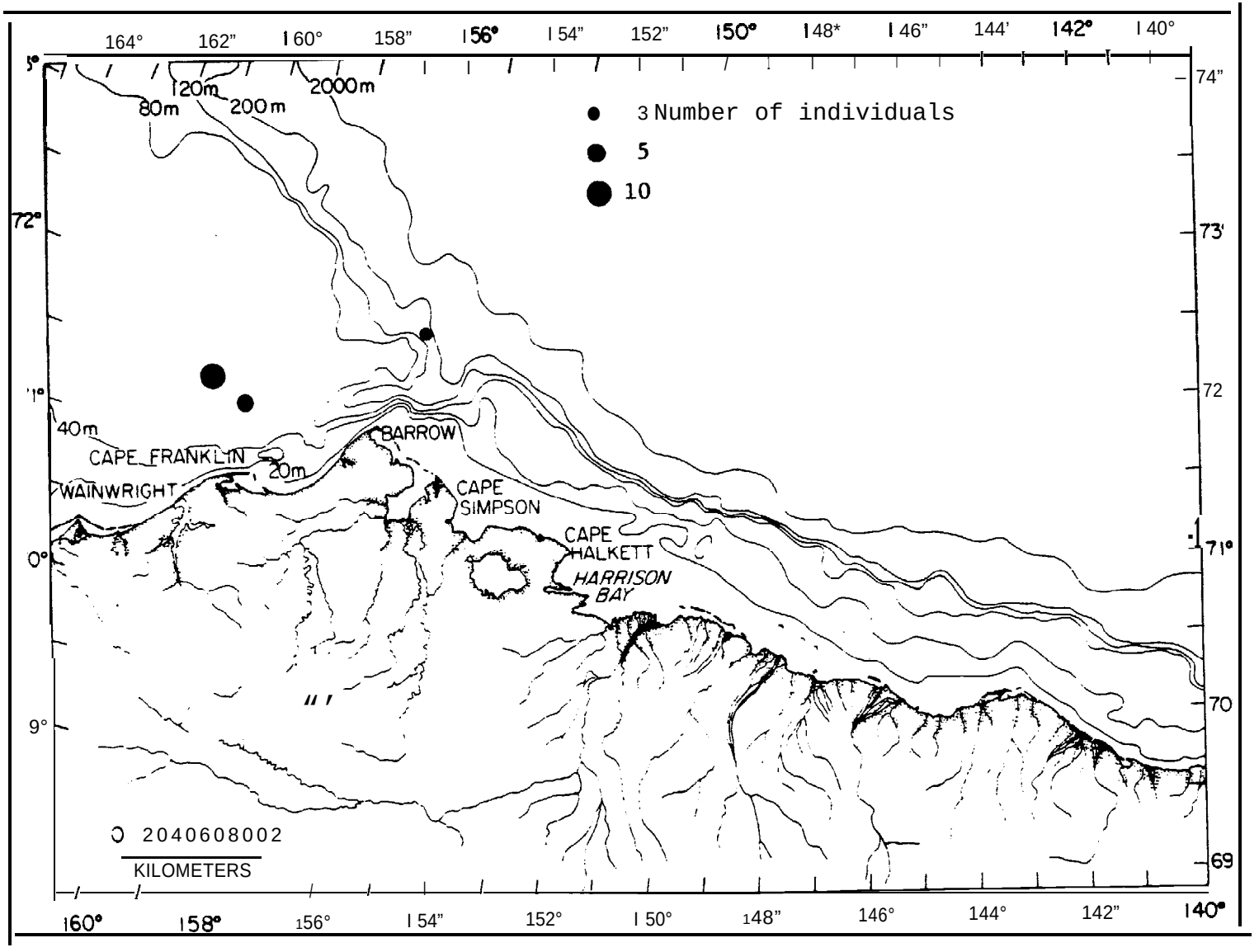

Fig. 50. Abundance (number per 1000 m^3) of fish eggs collected in bongo nets at stations in the Chukchi Sea, August-September 1977.

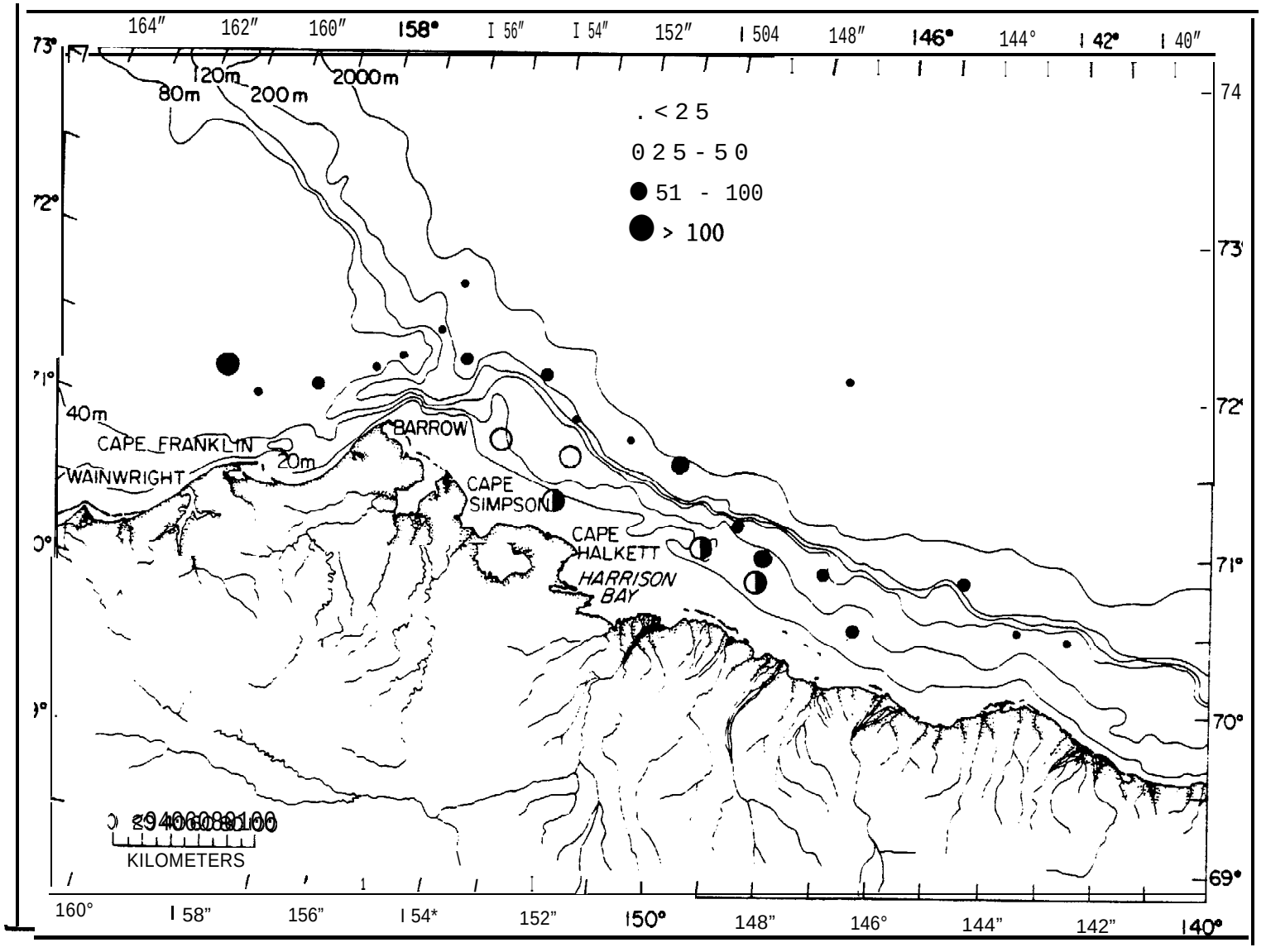

Fig. 51. Abundance (number per 1000 m³) of all fish larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

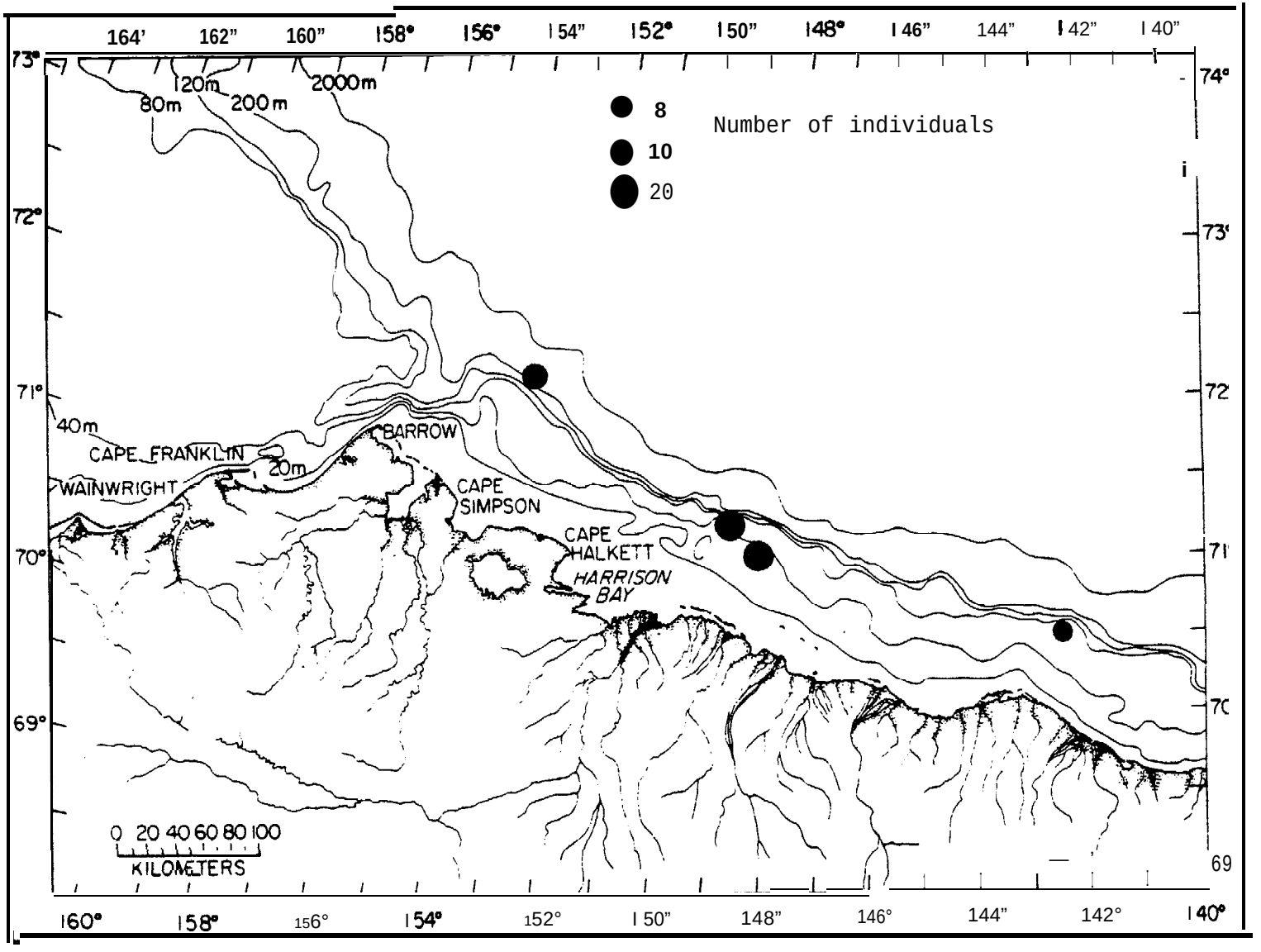

Fig. 52. Abundance (number per 1000 m^3) of cottids at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10–0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

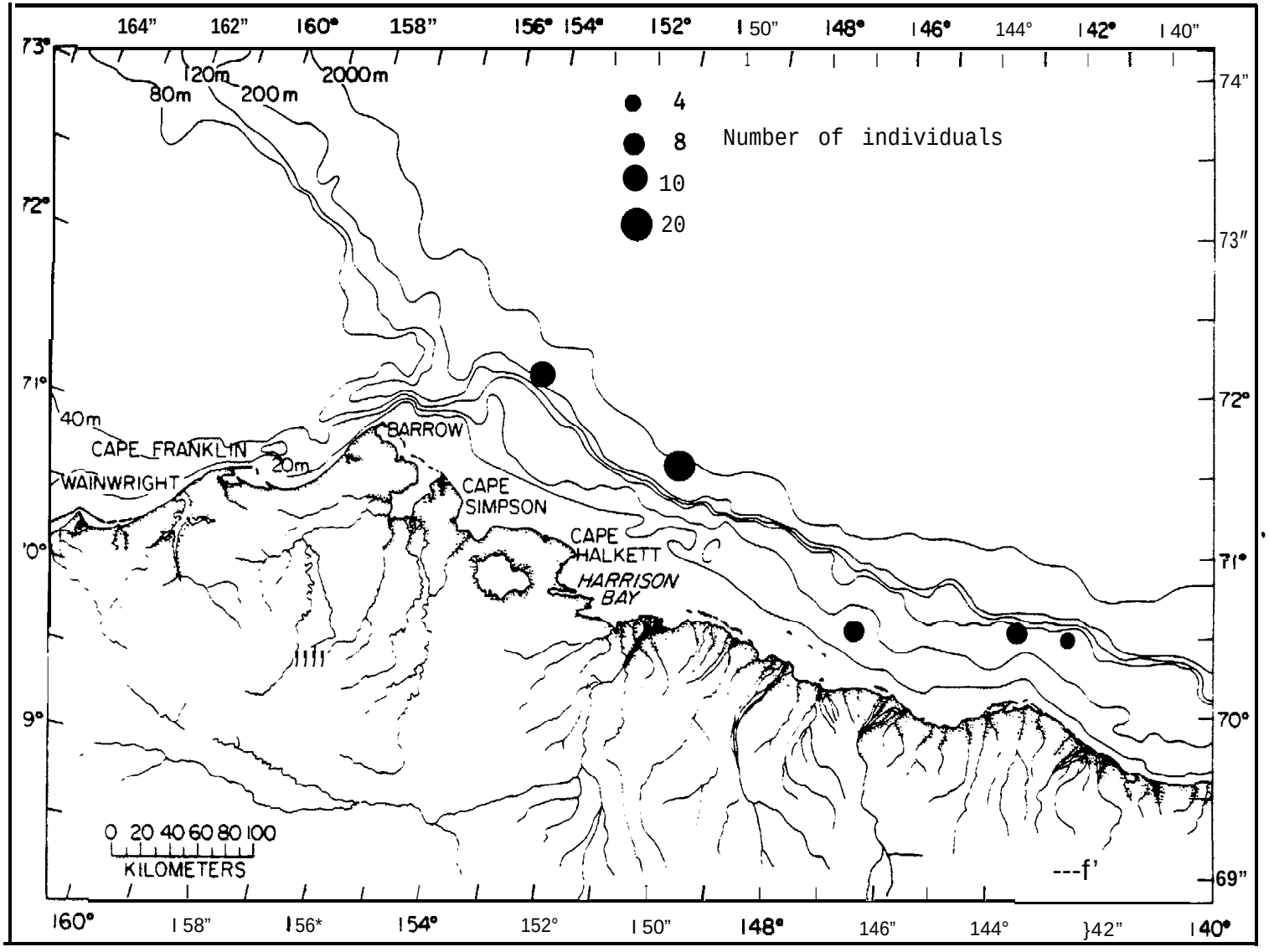

Fig. 53. Abundance (number per 1000 m^3) of cyclopterid larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

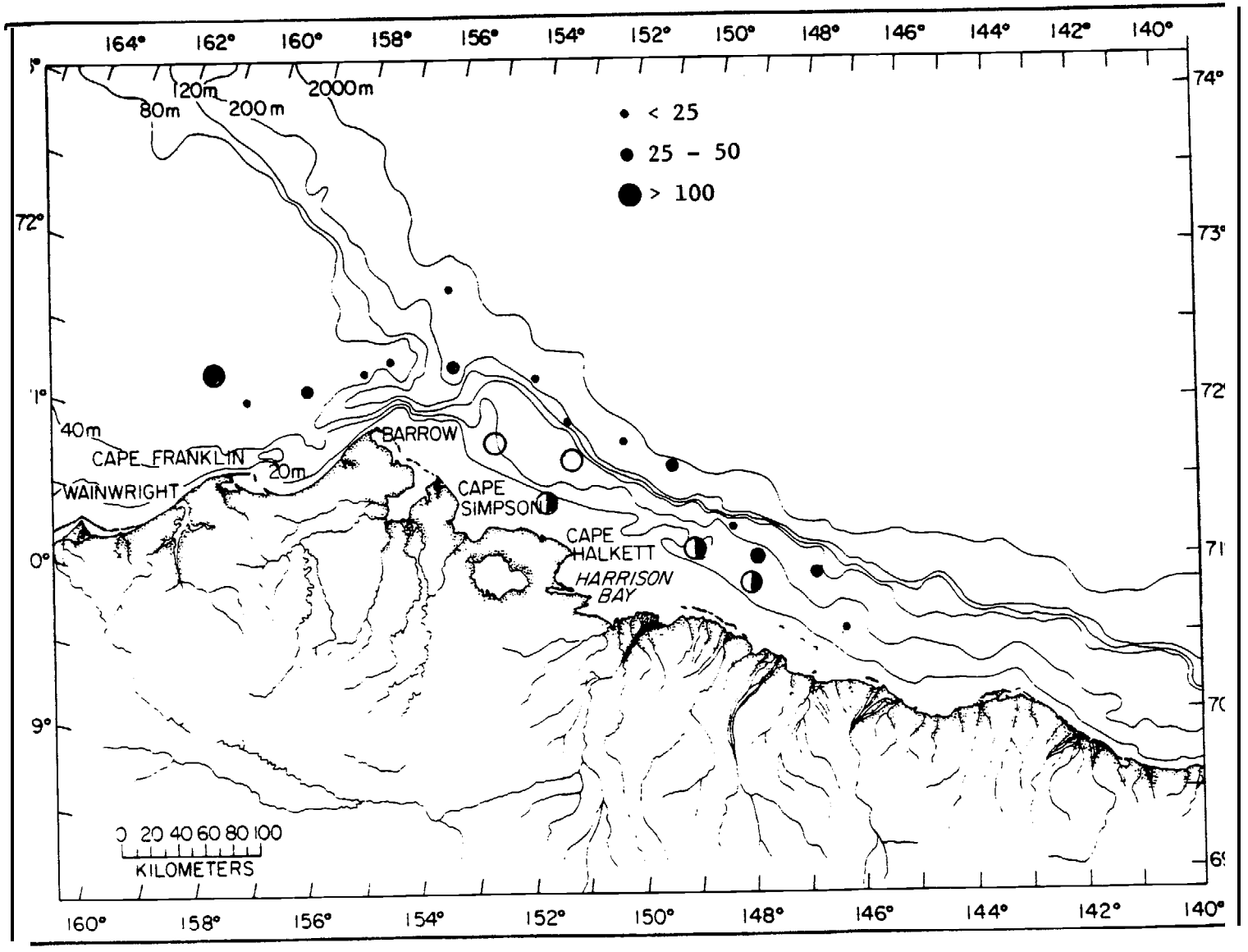

Fig. 54. Abundance (number per 1000 m^3) of gadid larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

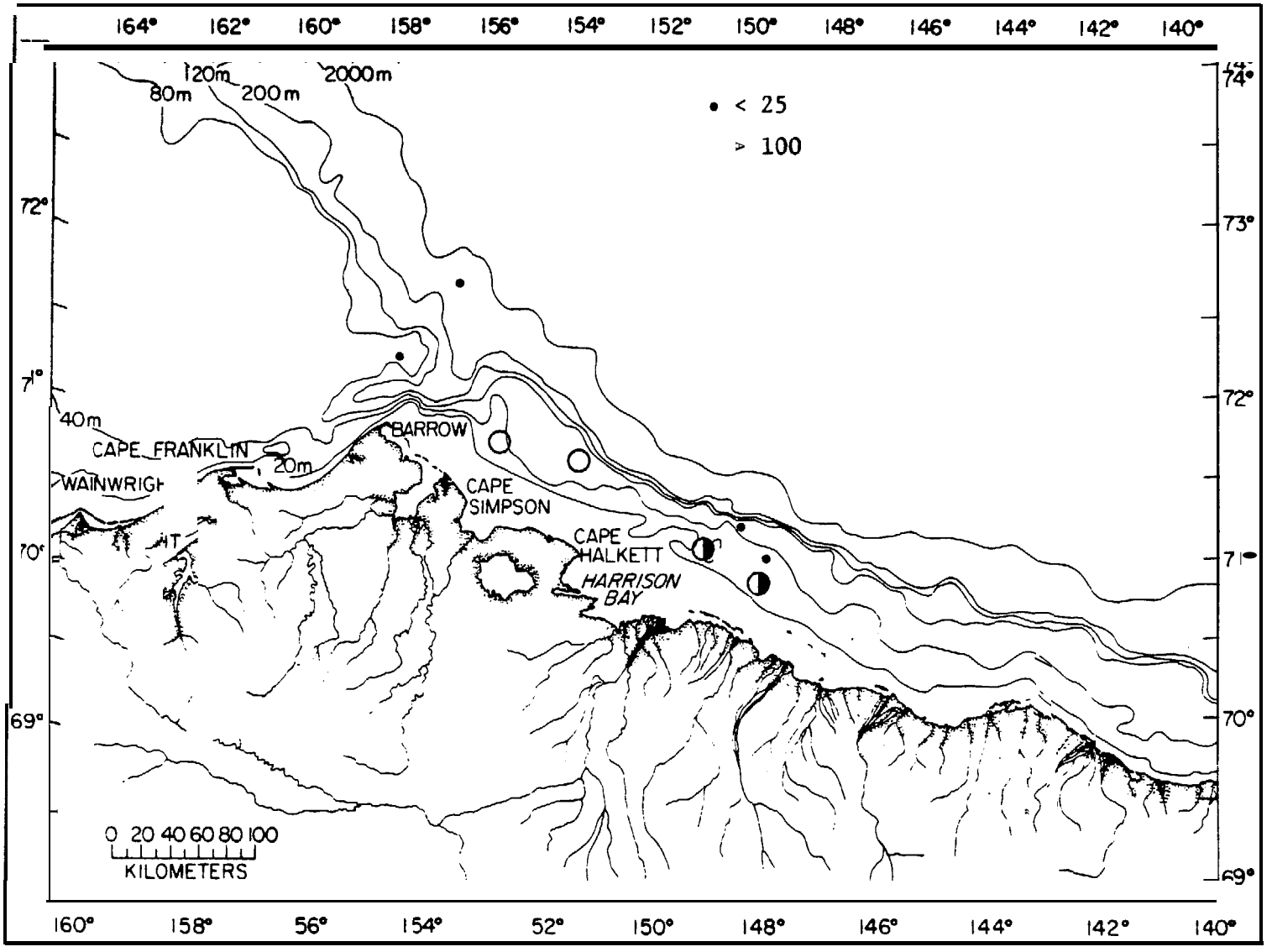

Fig. 55. Abundance (number per 1000 m^3) of *Boreogadus saida* at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

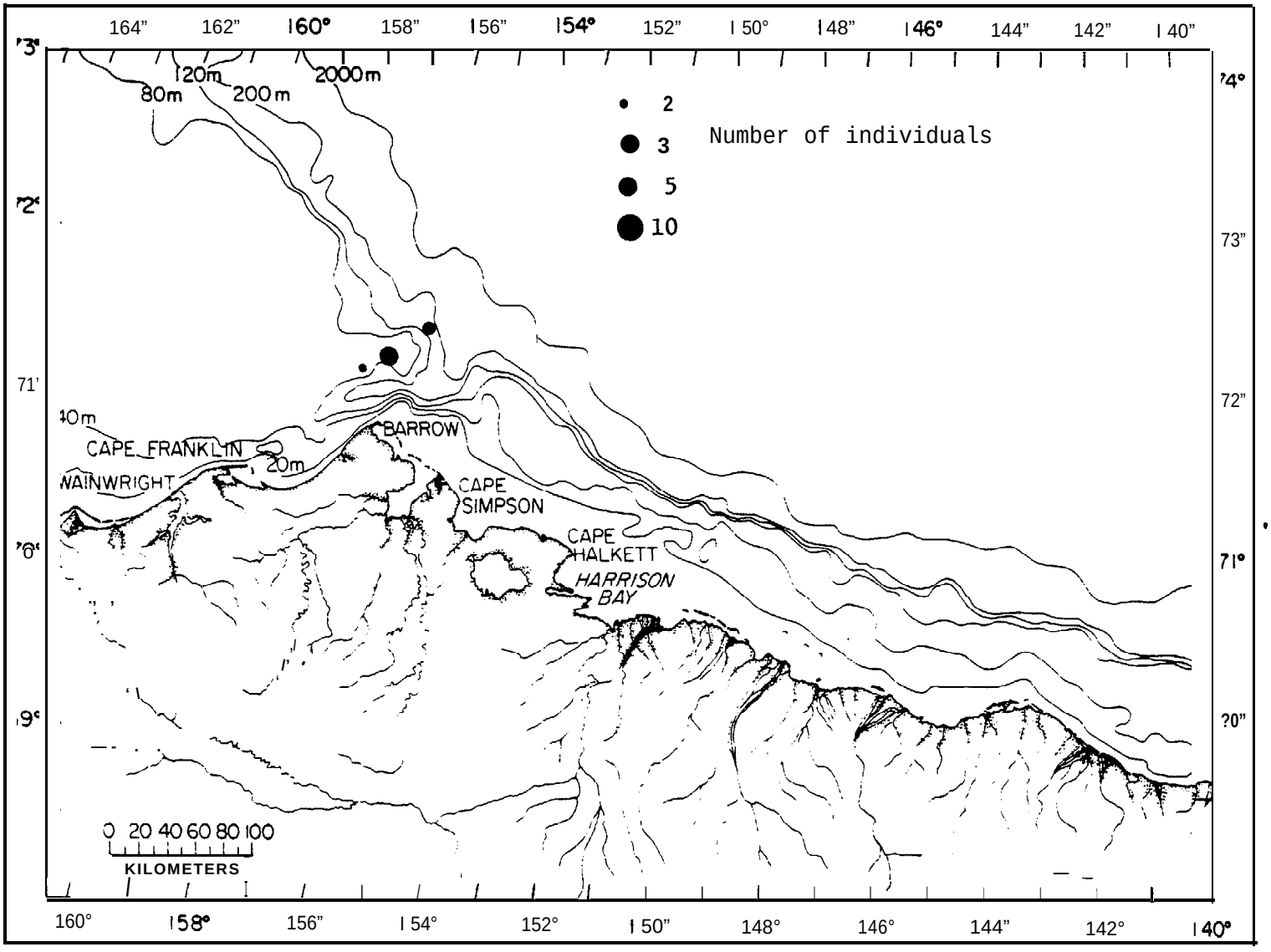

Fig. 56. Abundance (number per 1000 m^3) of stichaeid larvae at stations in the Chukchi and Beaufort seas, August-September 1976, 1977. ○ = ring net, 10-0 m 1976; ◑ = ring net, 20-0 m 1976; ● = bongo net 1977.

Table 3. Chlorophyll a and phaeopigment concentrations, Steffanson Sound, 8-11 Nov 1978.

Date (Nov 1978)	Depth (m)	Chl a (mg m^{-3})	Phaeo (mg m^{-3})
08	0	0.06	0.07
09	0	0.02	0.12
	4.5	0.02	0.12
10	0	0.06	0.06
	4.5	0.06	0.08
11	0	0.05	0.04
	4.5	O*O5	0.05
12	0	0.06	0.07
	4	0.04	0.06
13	0	0.06	0.05
	4	0.04	0.06
14	0	0.07	0.05
	4	0.04	0.05
15	0	0.05	0.06
	4	0.06	0.06
16	0	0.06	0.05
	4	0.06	0.05

Table 4. Abundance (number per 1000^3) of zooplankton taxa found in net hauls from Steffanson Sound (Boulder Patch). All samples were collected with a 0.75 m ring net, mesh size 308 µm. Where no number is present, no animals were found. Tows are vertical unless otherwise noted.

Taxon	8 Nov	10 Nov	14 Nov	16 Nov*
Crustacea				
Copepoda				
Calanoida - adults	474070	263370	188240	242530
Calanoida - juveniles	6505350	9692180	3742990	5107690
Cyclopoida			1360	680
Harpacticoida	410		450	230
Cirripedia				
Cyprids		820	2710	
Mysidacea				
Mysis litoralis			450	
Mysis relicts		410		
Mysis spp.	820	410	1810	
Amphipoda				
Gammaridea				
Calliopiidae cf.				230
Eusiridae cf.				450
Gammaridae				
Gammarus wilkitzkii				230
Lysianassidae cf.			1360	
Euphausiacea				
Thysanoessa raschii				230
Unidentified calyptopis	410			
Chaetognatha				
Sagitta elegans	820	410	1360	230
Other organisms				
Unidentified animals	410	410	450	
Unidentified invertebrate eggs			7690	8370

* Horizontal tow

Lewin and *Chaetoceros wighami* Brightwell that are common in the spring and summer beginning to appear.

One ice core sample, core # *8* collected 14 March, has also been analyzed. The core was about 30 cm in length and about 2.5 cm in diameter and was collected from the brash ice layer near the dive hole. About 38,000 cells per liter were found, including *Navicula* sp. , *Nitzschia* spp., unidentified small pennate diatoms, and *ca.* 18,000 cells per liter of *Thalassiosira*, some of which were probably *Th. Antarctica* Comber. The *Thalassiosira* cells were difficlut to identify with certainty because of the large amount of detrital material associated with them.

Plant pigment samples have not been analyzed.

b. Zooplankton standing stock

Three zooplankton samples have been analyzed. Copepods, primarily juvenile calanoids, were the most abundant organisms, although cyclopoid copepods were also common. A few other organisms were present, including hydrozoans, polychaete larvae, isopods, amphipods, and chaetognaths (Table 5).

VII. Discussion

Phytoplankton standing stock, chlorophyll a, and primary productivity were considerably lower than in 1976 and 1977. Reasons for this are unclear. Sampling in the area between Harrison and Prudhoe bays started about the same time, mid-August, in 1977 and 1978, and about a week later in 1976. Ice cover was somewhat heavier in 1976 and 1978 then in 1977. The same species *were* present all years, although diatoms in the 1978 samples were weakly silicified and *Ebria tripartita* (Schumann) Lemmermann, a silicoflagellate with a skeleton composed of silicon, often did not have skeletons, suggesting low silicon concentrations. Unfortunately, no nutrient samples were collected.

In both 1977 and 1978, highest primary productivity in the western Beaufort Sea occurred off Prudhoe Bay between the 40 and 80 m isobaths, moving inshore between the 2C and 40 m isobaths eastward to Barter Island in 1978 and to Demarcation Point in 1977 (Fig. 3).

Small species of the genus *Chaetoceros*, approximately 6 µm along the apical axis, *Thalassiosira* spp. , including *Th. nordenskioeldii* Cleve and *Th. gravida* Cleve, and *Nitzschia grunowii* Hasle are the major diatoms present in the 1978 samples. Small flagellates, usually < 10 µm in diameter, are also common. These species were also the most abundant in 1976 and 1977.

Species that were relatively common in 1977 that have not been seen in the 1978 samples include the diatom *Thalassiosira antarctica* Comber and the silicoflagellate *Diet?.jocha speculum* Ehrenberg. *Dictyocha speculum* is not usually common in nearshore waters, so perhaps its occurrence there in 1977 was anomaous and its absence in 1978 represents the usual situation.

Table 5. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from Steffanson Sound (Boulder Patch) in March 1979. All samples were collected with a 0.75 m ring net, 216 μm mesh. Where no number is present, no animals were found. All tows were vertical.

Taxon	13 Mar	14 Mar	16 Mar
Coelenterata			
Hydrozoa			
Coryne tubulosa	450		
Perigonimus yoldia-arcticae	450		
Perigonimus spp.		910	
Polychaeta - unidentified larvae	450		
Crustacea			
Copepoda			
Calanoida - adults	1360	910	450
Calanoida - juveniles	74240	268450	90540
Cyclopoida	62020	53420	38930
Harpacticoida	2720	2260	1810
Unidentified nauplii	12220	14490	4980
Isopoda - unidentified isopod	450	450	
Amphipoda			
Gammaridea			
Onisimus glacialis		450	
Onisimus spp. Cf.	450	450	
Chaetognatha			
Sagitta elegans			910

Zooplankton standing stock and species present were similar to 1977. From preliminary comparison of the two years, it appears that more hydrozoans were present in 1978, with *Aglantha digitale* being the major species both years. Fewer pteropods were present in 1978. Copepods were abundant both years. Slightly fewer crustaceans of all kinds were present in 1978, although when all the 1978 samples are analyzed, this di-fference may not remain. There were more appendicularians and chaetognaths, especially *Sagitta elegans* in *1978.* About the same number of fish larvae were present both years.

By November, few phytoplankton cells were present in the lagoon system and those that were present, mostly small flagellates, were probably not photosynthetic. The chlorophyll *a* concentration was very low. Juvenile and adult calanoid copepods were present in large numbers, while a few mysids, amphipods, euphausids, and chaetognaths were aiso present.

In March more phytoplankton cells were beginning to appear, including diatom species that are common in the spring and summer plankton. Few cells were present in the water samples however. The sediment-laden brashy layer of ice contained some cells, but will probably not have much of an ice algae community because of the large amount of sediment that reduces light. Juvenile calanoid copepods were the most abundant animals present in the system. Other organisms present included hydrozoans, polychaete larvae, isopods, amphipods, and chaetognaths.

VIII . Conclusions

No new conclusions can be suggested based on the 1978 icebreaker samples collected in August and September.

Annual production for the western Beaufort Sea for 1978 has been estimated. This estimate assumes 24 hr days in June and July, 20 hr days in August, and 15 hr days in September. It is also assumed that twice as much production occurs in June during the spring bloom as occurs at other times during the summer and that no production occurs at other times of the year. Annual production was estimated to be ea. 2 g C m^{-2} yr^{-1}. This is considerably lower than the 9 g C m^{-2} yr^{-1} estimated for 1976 and 14 g C m^{-2} yr^{-1} estimated for 1977. Low chlorophyll *a* concentrations and cell numbers indicate that the low production in real.

IX. Needs for further study

There are two major data gaps with regard to plankton distribution and abundance and primary productivity in the western Beaufort Sea. One is the area between the barrier islands and the 20 m (10 ftm) isobath. R.U.'S 172, 356, and 467 have, as part of their programs, studied zooplankton inside the barrier islands. No OCSEAP project studied the phytoplankton although there was some earlier work on phytoplankton and zooplankton from the lagoon areas (Alexander 1974; Homer *et* aZ. 1974). R.U. 359 has studied the phytoplankton and zooplankton in the area outside the 20 m isobath. One reason for this data gap is the lack of an adequate sampling platform.

The second major gap now that winter studies are being done in FY79, is the spring in all areas, although the lagoon system is the most important for the upcoming lease sale. The gap here is not just for zooplankton and phytoplankton data, but also for the ice algae community which is probably a major component of the ecosystem during April and May.

X. Summary of January-March quarter

A. Ship or laboratory activities

1. Ship or field trip schedule

a. Dates

1. 12-18 February 1979
2. 11-16 March 1979

b. No vessel

c. Aircraft - helicopters

d. NOAA or chartered

1. February - chartered Seair Bell Jet Ranger II
2. March - NOAA Bell 205

2. Scientific party

Thomas Kaperak, Assistant Oceanographer

3. Methods

a. Field sampling

1. February

There was only one sampling day in February because of logistic and weather problems. The sampling hole was too small to accommodate the 0.75 m ring net, so only water samples were collected. Samples were collected just beneath the ice, 0 m, and about 1 m above the bottom, 4 m, with a PVC water sampling bottle. A 250 ml portion was preserved with 4% formalin buffered with sodium acetate for a phytoplankton standing stock sample. Another portion of the sample was drained into a 4-ℓ polyethylene bottle and returned to the shore laboratory to be filtered through 47 mm, 0.45 μm Millipore filters for plant pigment determinations. A few drops of saturated $MgCO_3$ solution were added near the end of the filtration and the filter tower was rinsed with Millipore-filtered seawater. The filters were frozen in a dessicator for later processing.

2. March

Sampling, done on 5 days, was accomplished using

the dive hole cut by R.U. 356 personnel. Water temperature was measured by suspending a laboratory thermometer at the water surface for about 5 min.

Phytoplankton standing stock and plant pigment samples were collected just beneath the bottom of the ice, 0 m, and at 4 m with a PVC sampling bottle. Water for the standing stock sample was preserved with 4% formalin buffered with sodium acetate. Water for pigment determinations was stored in 4-ℓ polyethylene bottles and returned to the shore laboratory where it was filtered through 47 mm, 0.45 μm Millipore filters. A few grains of $MgCO_3$ were added to the last few milliliters of water filtered and the filter tower was rinsed with filtered seawater. The filters were frozen in a dessicator for later processing.

Zooplankton was sampled with a 0.75 m ring net having a mesh size of 216 μm. The net was lowered to the bottom and vertically hauled to the surface by hand. Hauls were timed using a stopwatch to obtain an approximate speed of tow. The net was washed by raising and lowering it in the hole several times and the sample was drained into a plastic bucket. The samples were warmed slowly when necessary to melt ice. The samples were concentrated by gently swirling in a net collection cup and preserved in 250 ml jars with 10 ml 37% formalin and buffered with 5 ml each of saturated sodium acetate and sodium borate solutions.

Two individual amphipods were collected on 12 March, one from under the ice by a diver using a small hand net and one dipped from the surface of the hole with a 250 ml jar. These animals were placed in Millipore filtered seawater and kept in a laboratory refrigerator for 4 days before being preserved. The seawater will be examined microscopically for fecal pellets to try to determine what the animals were eating.

Two ice cores were collected by divers using plastic corers, ea. 30 cm long and 2.5 cmwide. The cores were thawed and preserved with 10 ml 4% formalin buffered with sodium acetate.

b. Laboratory analysis

Phytoplankton standing stock samples are being analyzed using a Zeiss phase-contrast inverted microscope and Zeiss 5 and 50 ml counting chambers. Rare and large organisms (> 100 μm) are counted at 125 X magnification in 50 ml chambers and abundant, small organisms (< 100 μm) are counted at 312 X magnification in 5 ml chambers. For the March 1979 samples, all cells seen in the 50 ml chambers were counted regardless of size. The ice core sample was settled the same way, but only the 5 ml chamber was counted because of the large amount of sediment in the 50 ml chamber.

All organisms in the zooplankton samples are being identified and counted using a dissecting microscope. Voucher specimens have been kept for all taxa.

4. Sample locations

a. February - the LGL site approximately 300 yds south of the Western Washington State University dive site at the boulder patch.

b. March - 70°19'N, 147°34.4'W, the Western Washington dive site.

5. Data collected and analyzed

	February		March	
	No. Coil .	No. Anal.	No. Coil .	No. Anal.
Plant pigments	2	0	10	0
Phytoplankton standing stock	2	2	10	4
Zooplankton standing stock				
0.75 m ring net, 308 µm				
0.75 m ring net, 216 µm			10	3
Individual amphipods			2	0
Ice cores			2	1

XI. Auxiliary material

A. References cited

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B. Papers in preparation or print: None

C. Oral presentations: Outside Review Panel
Santa Cruz, CA.
17-20 Apr 78

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