FFIS
Intern rapport S-o3
Reference: 136
Date: December 196o

FALLOUT IN NORWEGIAN MILK IN 1959

by

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Kjeller, 7 December 196o

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SUMMARY:

Radioactive fallout in Norwegian milk has been measured during 1959. This report presents results of analyses of weekly samples from three localities.

1 INTRODUCTION

When the first measurements of fallout activities in milk were made at the NDRE towards the end of 1956, attention was focused on the nuclides Sr 9o, Cs 137 and I 131. After about one year, however, further measurements of I 131 were abandoned, while determinations of Sr 9o, Cs 137 and partly Sr 89 have been carried out quite regularly, apart from a temporary break in 1958. Results from the measurements prior to 1959 have been reported before (1,2), and also some of the data from 1959 (3,4).

Up to 1959 only radiochemical methods were used to measure fallout radioactivity in milk. After a gamma spectrometer was installed in the NDRE Division for Physics in 1958, it became possible to replace the rather tedious radiochemical Cs 137 procedure by the more simple method of gamma spectrometry. Up to now, however, parallel determinations of Cs 137 have been made radiochemically in order to compare the two techniques.

2 EXPERIMENTAL

2.1 Sampling

During 1959 there have been three sampling stations, Bergen, Lillestrøm and Røros, shown on the map in figure 2.1. Five litre samples from each of the dairies have been collected weekly. At the dairies in Lillestrøm and Bergen a random sample has been taken of the day's production. At Røros the sample was taken by slowly dripping milk from the pipeline until 5 litres had been collected. Other relevant data concerning the sampling stations are given in table 2.1 below.

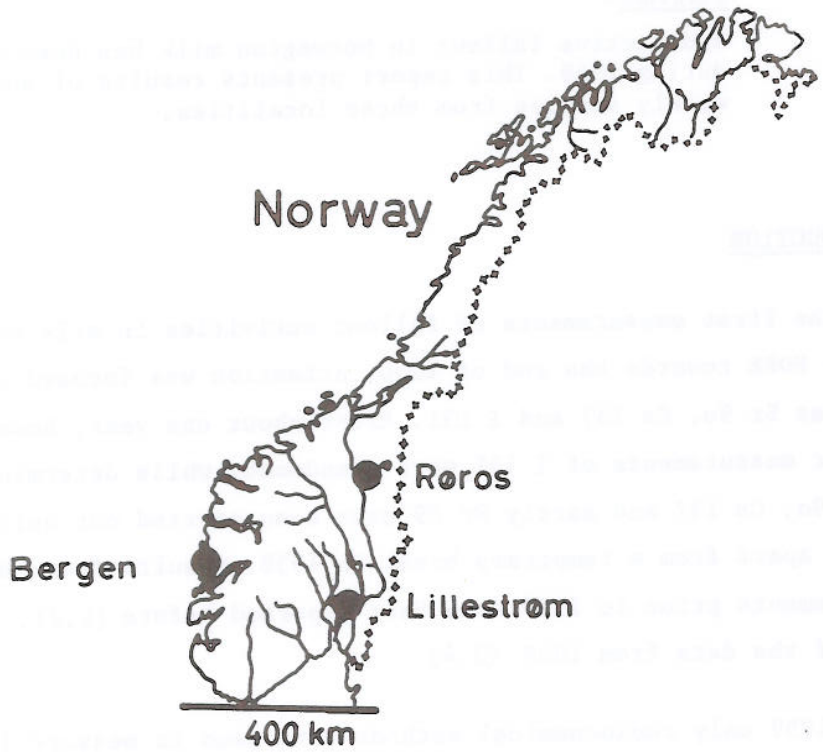

Figure 2.1 Sampling stations

	Røros	Lillestrøm	Bergen
Total production in 1959 kg	4 25o ooo	3 5oo ooo	37 5oo ooo
Fraction of total Norwegian production	o,34%	o,29 %	3,o4 %
Grazing season	Jun - Oct	May - Oct	May - Oct
Winter food	About equal amounts of locally grown hay and ensilage and high protein food		
Drinking water	Supplied from rivers, brooks, wells and local water works		

Table 2.1 Data concerning milk samples from Lillestrøm, Bergen and Røros dairies

To each sample half a gram of sodium chromate was added for preservation. By kind permission of Toten Cellulosefabrikk the milk was spray dried at their laboratory, and then sent to NDRE for further treatment.

2.2 Analytical procedure

The dried milk was ashed at a maximum temperature of 450° C. An amount of ash corresponding to two litres of milk was used for gamma spectrometric measurement. The rest of the ash was analyzed radiochemically.

A few details of the gamma-spectrometrical technique of analysis employed shall be described here. The spectrometer used has a 50 channel pulse height analyzer in connection with a Na I (Tl) crystal 1 1/2" x 1". In addition to Cs 137 it also served to measure the potassium (K 40) content of milk. The spectrometer was calibrated by adding known amounts of Cs 137 and K_2CO_3 to milk samples. Calculation of Cs 137 and potassium was performed as follows. The potassium content was determined by comparison with the potassium calibration spectrum in the range 0.8 to 1.6 MeV after subtraction of the background. The contribution of K 40 in the range 0.25 to 0.8 MeV could now be determined. After subtraction of this contribution, the net activity of Cs 137 was calculated by comparison with the calibration spectrum of Cs 137.

This procedure is only valid if there are no significant concentrations of other radioactive nuclides with gamma energies above 0.25 MeV. So far none of the spectra have shown indications of such nuclides.

The radiochemical procedures have been described in detail in an earlier report (1), and shall not be repeated here. The calcium determinations have been performed as described by Cheng and Bray (5).

3 RESULTS

The results are given in tables 3.1 - 3.3 and as graphical presentations in figures 3.1 - 3.5.

4 COMMENTS

It is felt necessary to give a few particulars about the data presented in the tables.

The samples have come in regularly once a week except for the period June 25 to July 26 when no samples were received. This possibly misses the maximum value of the year.

The ratio Cs 137/Sr 9o in the tables is based on radiochemically determined values for both nuclides. The values for Cs 137 obtained with the gamma spectrometer are on an average 2o% higher. This discrepancy may be due to calibration errors which are now under examination.

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- Prøvetaking og analyse av radioaktivt nedfall i nedbør, myrjord, planter, drikkevann og melk, Svensk Kemisk Tidsskrift, 71, 695 (1959)

(5) Cheng, K L and
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- Determination of Calcium and Magnesium in Soil and Plant Materials, Soil Science, 72, 449 (1951)

LILLESTRØM

Sampling date	Cs 137 pC/l		K g/l	pC Cs 137 / g K	Sr 90 pC/l	Ca g/l	pC Sr 90 / g Ca	Cs 137 / Sr 90	Sr 89 pC/l
	R	G	G	G	R		R	R	R
16/1	16	34	2,00	17	7,6	1,12	6,8	2,1	13,1
23/1	35	18	1,97	9	7,4	1,23	6,0	4,7	8,1
29/1	16	24	1,93	12	7,7	1,38	5,6	2,1	11,1
6/2	11	25	1,75	14	6,9	1,11	6,2	1,6	5,5
13/2	25	29	1,59	18	7,5	1,28	5,9	3,3	9,2
18/2	20	27	1,68	18	6,0	1,12	5,4	3,3	~ 0
25/2	32	42	1,72	24	8,6	1,27	6,8	3,7	5,1
7/3	20	23	1,59	14	6,5	1,43	4,5	3,1	3,1
13/3	19	37	1,56	24	7,8	1,29	6,0	2,4	4,0
17/3	14	23	1,54	15	7,3	1,17	6,2	1,9	5,2
2/4	20	21	1,75	12	9,0	1,19	7,6	2,2	~ 0
9/4	20	34	1,60	21	16,7	1,29	12,9	1,2	2,4
14/4	15	30	1,46	21	9,9	1,22	8,1	1,5	~ 0
22/4	58	62	1,55	10,5	6,9	1,25	5,5	8,4	2,8
30/4	92	113	1,63	69	6,6	1,13	5,8	13,9	~ 0
8/5	26	49	1,50	33	6,2	1,28	4,8	4,2	6,6
15/5	72	82	1,36	60	6,7	1,12	6,0	10,7	2,9
22/5	52	49	1,54	32	11,7	1,33	8,8	4,4	40,9
29/5	65	111	1,71	65	n.d.	1,24	-	-	n.d.
5/6	32	47	1,68	28	13,1	1,27	10,3	2,4	30,3
12/6	29	42	1,50	28	6,1	1,21	5,0	4,8	64,2
19/6	81	54	1,48	36	11,2	1,16	9,7	7,2	36,7
26/6	62	88	1,43	62	11,5	1,24	9,3	5,4	36,8
25/7	65	66	1,50	44	17,2	1,13	15,2	3,8	14,4
31/7	54	51	1,62	32	16,9	1,19	14,3	3,2	~ 0
7/8	74	58	1,31	44	13,6	1,12	12,1	5,4	18,0
14/8	19	28	1,21	23	7,8	1,04	7,5	2,4	18,2
21/8	29	41	1,52	27	8,9	1,04	8,6	3,3	13,4
25/8	44	46	1,87	25	9,2	1,23	7,5	4,8	32,8
4/9	45	46	1,78	26	11,5	1,21	9,6	3,9	4,7
9/9	34	33	1,67	20	12,1	1,09	11,1	2,8	~ 0
24/9	80	75	1,79	42	17,2	1,20	14,3	4,7	~ 0
7/10	26	33	1,50	22	10,2	1,20	8,6	2,5	~ 0
19/10	32	34	1,59	21	9,2	1,29	7,1	3,5	2,0
9/11	32	41	1,59	26	8,3	1,28	6,5	4,0	4,2
19/11	42	33	1,74	19	8,4	1,34	6,3	5,0	5,3
27/11	29	33	1,78	19	9,8	1,32	7,4	3,2	~ 0
5/12	27	27	1,76	15	9,2	1,29	7,1	2,9	2,6
14/12	59	10	1,56	6	14,2	n.d.	-	4,2	~ 0
28/12		56	1,74	32	19,5	n.d.	-	-	5,5

Table 3.1 Cs 137, Sr 90, Sr 89, K and Ca in Milk from Lillestrøm, Norway 1959

(Methods: R - Radiochemical, G - Gammaspectrometric, n.d. - not determined)

BERGEN

Sampling date	Cs 137 pC/l		K g/l	pC Cs 137 / g K	Sr 90 pC/l	Ca g/l	pC Sr 90 / g Ca	Cs 137 / Sr 90	Sr 89 pC/l
	R	G	G	G	R		R	R	R
14/1	141	334	2,02	165	20,8	-	-	6,8	25,9
21/1	133	194	1,84	105	15,7	1,25	12,6	8,5	9,3
28/1	218	248	1,96	127	16,0	1,34	11,9	13,6	6,5
4/2	216	289	1,75	165	32,3	n.d.	-	6,7	6,1
12/2	61	132	1,41	94	16,5	1,11	14,9	3,7	6,0
20/2	101	123	1,76	70	16,5	1,28	12,9	6,1	n.d.
27/2	184	255	1,85	138	20,9	1,27	16,5	8,8	8,6
4/3	159	214	1,86	115	15,4	1,31	11,8	10,3	8,6
11/3	113	164	1,57	104	20,9	1,61	13,0	5,4	2,8
31/3	124	165	1,57	105	7,6	1,16	6,6	16,3	6,1
8/4	140	210	1,64	128	8,6	1,41	5,7	17,3	~ 0
16/4	93	191	1,60	119	17,3	1,33	13,0	5,4	9,4
25/4	178	180	1,45	124	15,9	1,25	12,7	11,2	10,4
2/5	166	129	1,55	83	16,3	1,39	11,7	10,2	6,1
6/5	148	155	1,48	105	n.d.	1,29	-	-	n,d.
14/5	207	268	1,66	161	24,1	1,23	19,6	8,5	11,8
27/5	276	255	1,73	143	39,3	1,23	32,0	7,0	169,3
3/6	202	231	1,61	143	47,7	1,26	37,9	4,2	170,1
12/6	262	320	1,59	201	57,6	1,23	46,8	4,5	222,0
17/6	307	317	1,41	225	50,6	1,30	38,9	6,1	260,6
25/6	342	382	1,46	262	70,1	n.d.	-	4,9	224,2
24/7	329	420	1,53	275	52,5	1,34	39,2	6,3	111,9
30/7	343	359	1,45	248	36,8	1,28	28,8	9,3	108,3
5/8	377	416	1,57	265	31,6	1,26	25,1	11,9	91,6
12/8	228	336	1,64	205	29,4	1,12	26,3	7,8	47,4
19/8	317	370	1,94	191	38,7	1,14	33,9	8,2	69,9
26/8	337	390	1,59	245	25,3	1,23	20,6	13,3	27,3
3/9	279	329	1,82	181	32,3	1,28	25,2	8,6	48,2
10/9	464	365	1,54	237	33,4	1,19	28,1	13,9	45,3
17/9	335	372	1,82	204	27,2	1,26	21,6	12,3	30,4
23/9	308	341	1,98	172	39,0	1,27	30,7	7,9	~ 0
5/10	318	338	1,61	210	21,8	1,21	18,0	14,6	29,0
8/10	249	264	1,69	156	31,8	1,16	27,4	7,8	n.d.
16/10	152	153	1,53	100	18,4	1,13	16,3	8,3	7,5
23/10	227	251	1,62	155	19,7	1,25	15,8	11,5	34,9
4/11	270	237	1,64	145	29,2	1,23	23,7	9,2	5,2
10/11	-	265	1,69	157	28,6	1,17	24,4	-	5,3
14/11	413	434	2,04	213	38,2	1,37	27,9	10,8	30,7
18/11	274	267	1,70	157	26,2	1,24	21,1	10,5	29,3
25/11	210	223	1,72	130	24,5	1,27	19,3	8,6	23,8
3/12	246	215	1,72	125	31,8	1,29	24,7	7,7	12,7
10/12	228	249	1,63	153	22,3	1,13	19,7	10,2	30,4
14/12	361	445	1,77	251	36,4	n.d.	-	9,9	~ 0
28/12	290	309	1,60	193	44,7	n.d.	-	6,5	~ 0

Table 3.2 Cs 137, Sr 90, Sr 89, K and Ca in Milk from Bergen, Norway 1959

(Methods: R - Radiochemical, G - Gammaspectrometric, n.d. - not determined)

RØROS

Sampling date	Cs 137 pC/l		K g/l	pC Cs 137 / g K	Sr 9o pC/l	Ca g/l	pC Sr 9o / g Ca	Cs 137 / Sr 9o	Sr 89 pC/l
	R	G	G	G	R		R	R	R
15/1	73	125	2,o8	6o	9,5	1,47	6,5	7,7	7,1
22/1	97	118	2,o2	55	9,5	1,38	6,9	1o,2	8,8
3o/1	87	13o	2,oo	65	8,8	1,26	7,o	9,9	5,2
5/2	99	116	2,o5	57	9,4	1,37	6,9	1o,5	2,2
11/2	1o1	121	1,53	79	n.d.	1,32	-	-	n.d.
19/2	93	1o2	1,81	56	11,2	1,27	8,8	8,3	n.d.
26/2	96	121	1,95	62	8,1	1,3o	6,2	11,9	4,5
6/3	79	79	1,65	48	9,o	1,3o	6,9	8,8	4,9
12/3	8o	133	1,66	8o	9,5	1,36	7,o	8,4	6,8
18/3	57	93	1,55	6o	1o,6	1,23	8,6	5,4	~o
1/4	82	115	1,67	69	17,o	1,25	13,6	4,8	1,4
3/4	71	111	1,74	64	12,5	1,33	9,4	5,7	~o
8/4	93	127	1,62	78	13,3	1,3o	1o,2	7,o	~o
17/4	75	1o2	1,57	65	13,5	1,32	1o,2	5,6	~o
24/4	1o1	134	1,65	81	11,o	1,29	8,5	9,2	~o
3o/4	91	129	1,64	79	9,4	1,28	7,3	9,7	5,6
6/5	74	171	1,5o	114	9,8	1,36	7,2	7,6	o,9
14/5	115	184	1,59	116	1o,5	1,32	8,o	11,o	3,7
21/5	81	1o2	1,73	59	11,7	1,23	9,5	6,9	~o
28/5	8o	1o7	1,79	6o	1o,9	1,28	8,5	7,3	~o
4/6	89	96	1,59	6o	13,8	1,23	11,2	6,4	~o
11/6	84	118	1,38	86	14,2	1,18	12,o	5,9	13,5
18/6	152	118	1,58	75	13,7	1,18	11,6	11,1	54,o
24/6	129	115	1,47	78	18,2	1,24	14,7	7,1	95,5
23/7	166	141	1,o9	129	16,7	n.d.	-	9,9	36,6
29/7	189	199	1,43	139	18,9	n.d.	-	1o,o	3o,6
6/8	161	164	1,32	124	17,4	1,o9	16,o	9,3	32,9
13/8	159	174	1,62	1o7	21,3	1,33	16,o	7,5	63,5
2o/8	164	183	1,23	149	2o,2	1,17	17,3	8,1	32,8
2/9	173	2o2	1,85	1o9	19,7	1,19	16,6	8,8	24,8
16/9	141	172	1,59	1o8	16,5	1,24	13,3	8,5	~o
25/9	12o	124	1,94	64	27,2	1,29	21,1	4,4	1,8
6/1o	47	115	1,41	82	14,6	1,o2	14,3	3,2	~ o
9/1o	56	179	1,67	1o7	25,4	1,25	2o,3	2,2	o
15/1o	1o3	131	1,7o	77	17,6	1,22	14,4	5,9	12,9
26/1o	124	139	1,61	86	18,o	1,22	14,8	6,9	~ o
28/1o	82	74	1,42	52	9,4	1,oo	9,4	8,7	o,5
1o/11	99	112	1,85	61	13,2	1,29	1o,2	7,5	~ o
18/11	121	11o	1,69	65	12,o	1,21	1o,9	1o,1	2,6
26/11	94	7o	1,73	4o	n.d.	1,33	-	-	n.d.
4/12	111	95	1,97	48	12,4	1,31	9,5	9,o	42,2
28/12	89	175	1,95	9o	15,4	n.d.	-	5,8	4,9

Table 3.3 Cs 137, Sr 9o, Sr 89, K and Ca in Milk from Røros, Norway 1959

(Methods: R - Radiochemical, G - Gammaspectometric, n.d. - not determined)

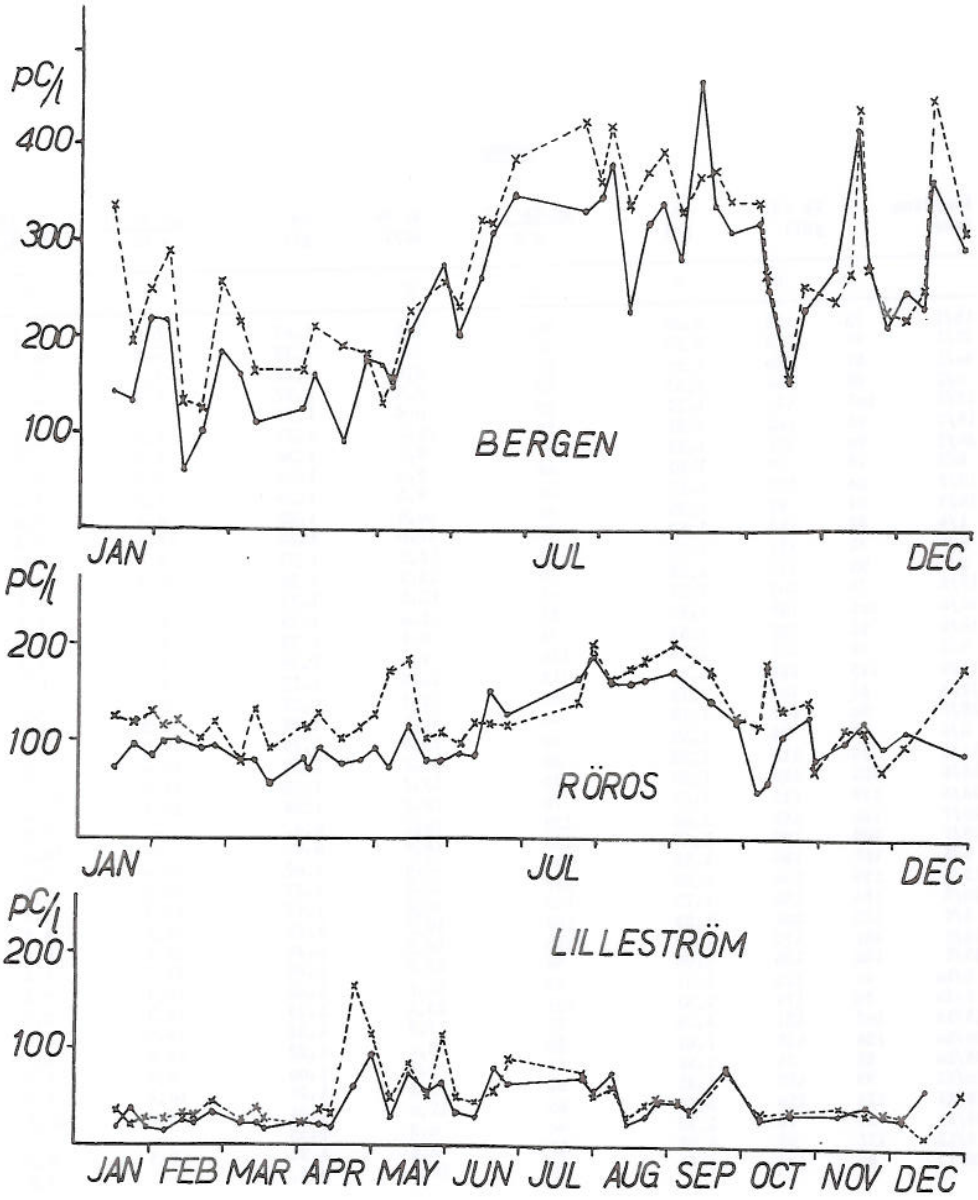

FIG. 3.1 Cs 137 IN MILK 1959

---x--- Gammaspectrometric
—●— Radiochemical

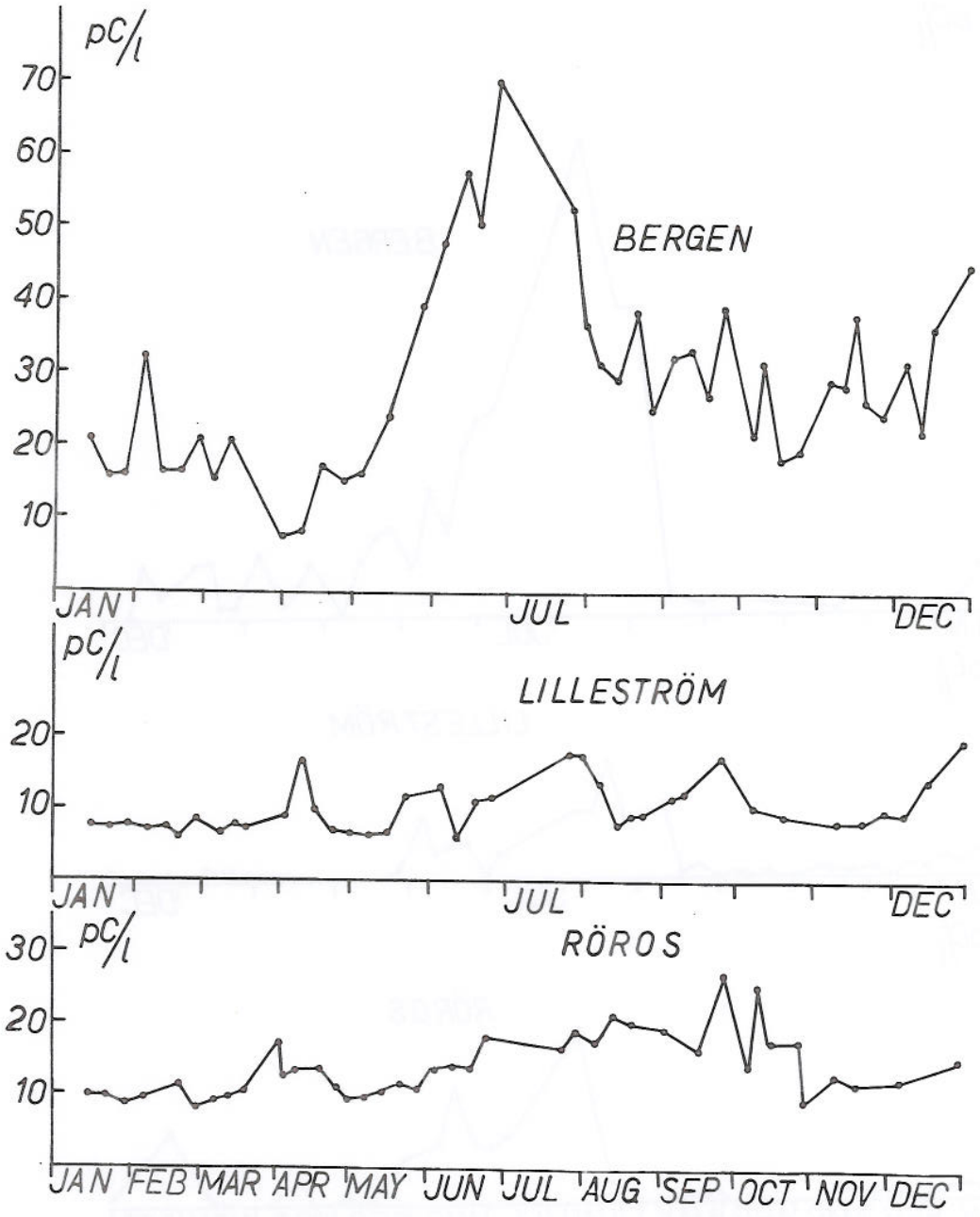

FIG. 3.2 Sr 90 IN MILK 1959.

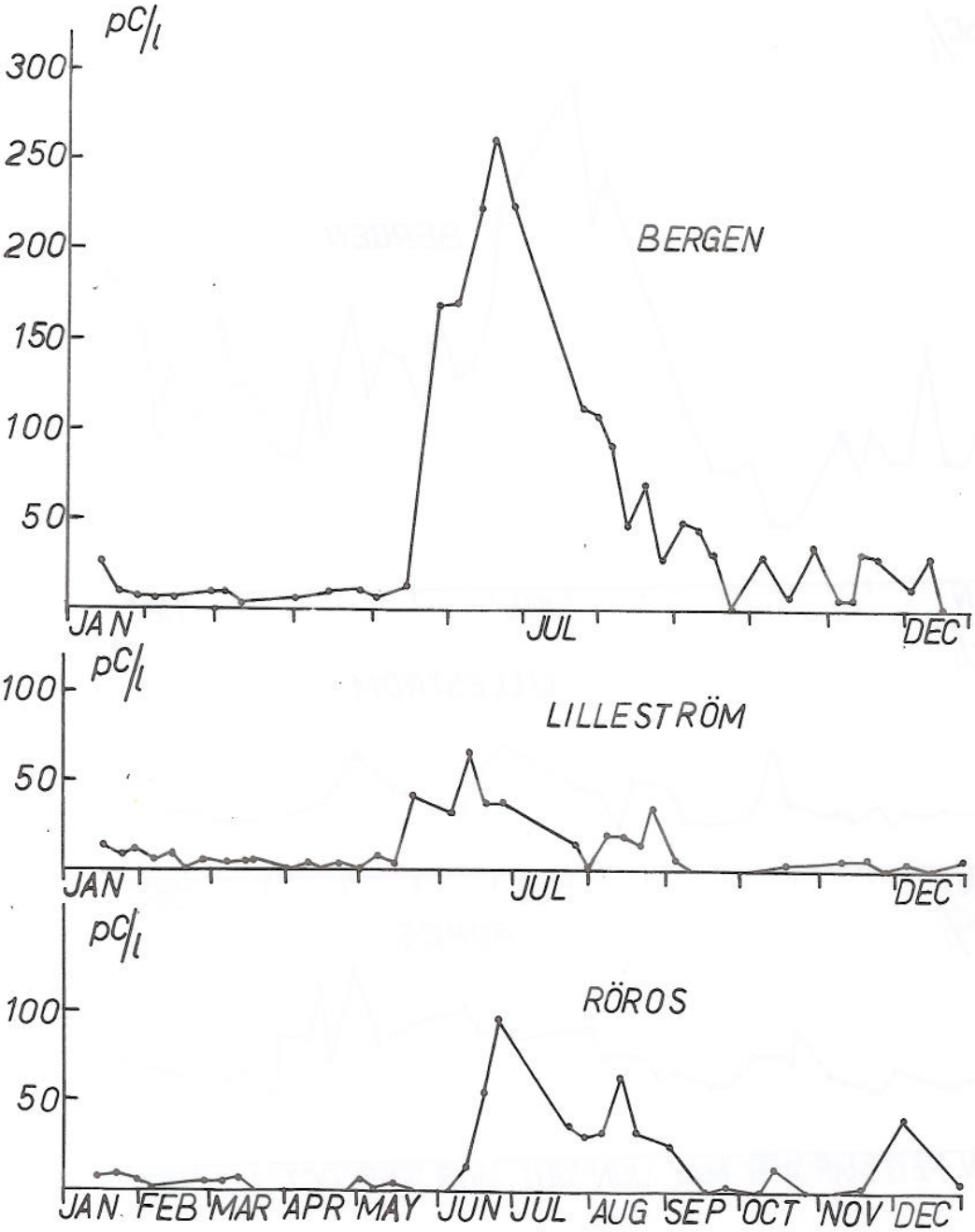

FIG.3.3 Sr 89 IN MILK 1959

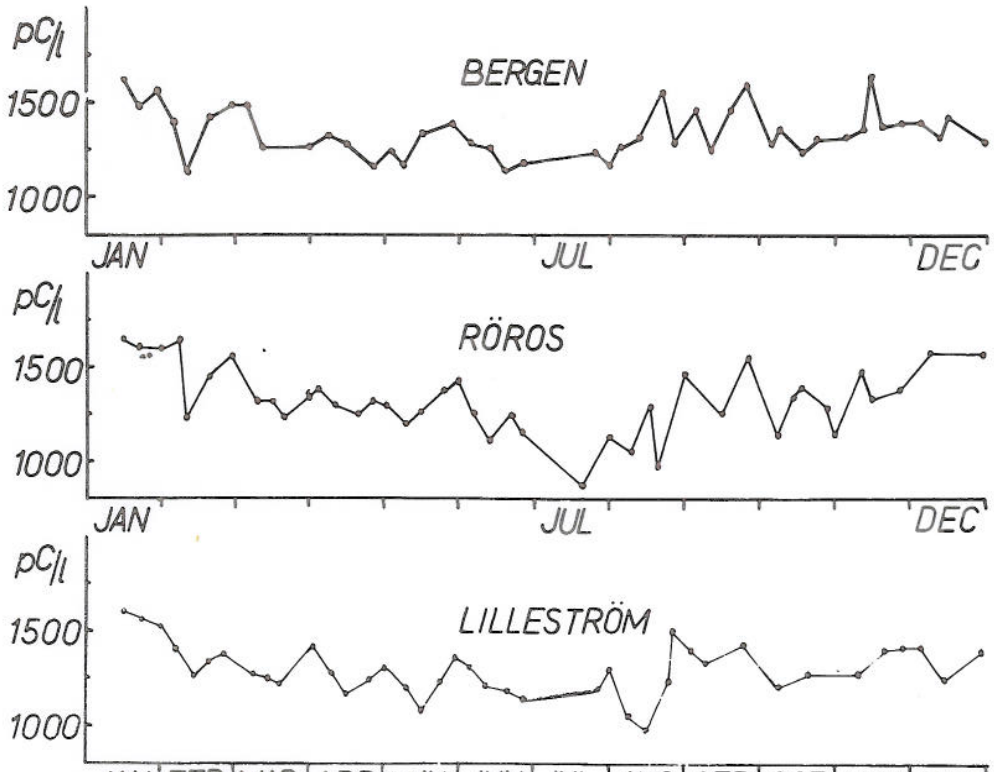

FIG. 3.4 K 40 IN MILK 1959

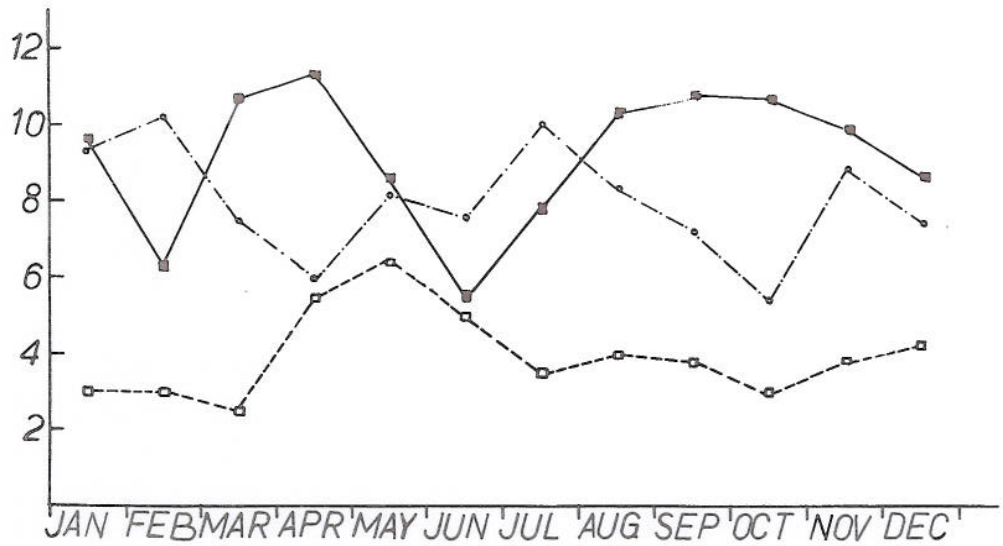

FIG. 3.5 RATIO Cs 137/Sr 90 IN MILK 1959.