NOTES ON SOME EURYHALINE GAMMARIDS (CRUSTACEA, AMPHIPODA) FROM THE WEST-COAST OF NORWAY

by

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ABSTRACT

Some data on the distribution in Norway and on the ecology of the euryhaline amphipods *Gammarus duebeni duebeni, G. oceanicus, G. zaddachi, G. finmarchicus* and *Chaetogammarus marinus* are presented in this paper.

Morphological differences between populations of *G. oceanicus* are briefly discussed.

I. INTRODUCTION

Relatively little is known about distribution and ecology of members of the family Gammaridae in Norway. Records concerning the biology and distribution of the genera *Gammarus, Chaetogammarus,* and *Eulimnogammarus* are found in the papers of Oldevig (1933 & 1959), Stephensen (1935-1942, with a synopsis of the then known literature), Dahl (1938, 1946 & 1952), Sexton & Spooner (1940), Sexton (1942), Schellenberg (1942), Segerstråle (1947, 1948 & 1959), Spooner (1951), Steen (1951), J. Økland (1959), K.A. Økland (1965, 1969 a & b, 1970), Brattegard (1966), Ofstad & Solem (1966), Stock & Kant (1966), Stock (1967), Solem (1969) and Vader (1969, 1971, 1972 a & b).

During a sampling trip in July 1971 along the Atlantic coast of Norway an attempt was made to obtain further information about some euryhaline species of the genera mentioned above. A survey was made in four biotopes: supralittoral rockpools, small springs in seacliffs with irregular salinity changes, small estuaries, and the intertidal zone of the fjords. For practical reasons, and because the biotopes have some common characteristics (such as a certain similarity in gammarid fauna and periodical changes in salt-content of the water) the small springs in seacliffs and small estuaries were considered together and the samples from these biotopes were pooled. Especially localities where *Gammarus duebeni duebeni* Lilljeborg, 1852, *Gammarus oceanicus* Segerstråle, 1947, *Gammarus zaddachi* Sexton, 1912, *Gammarus finmarchicus* Dahl, 1938, and *Chaetogammarus marinus* (Leach, 1815) were found, will be used in comparing the four biotopes. In the investigated biotopes these five species were most abundant. Other euryhaline gammarids, as *Gammarus salinus* Spooner, 1947, *Gammarus setosus* Dementieva, 1931, *Chaetogammarus stoerensis* (Reid, 1938) and *Eulimnogammarus obtusatus* (Dahl, 1938), together with a number of other species belonging to the Gammaridae and Talitridae, were found at several of the visited localities.

An extensive study of the limnic waterbodies and rivers in Norway was not made, since Økland (1969 a & b) reported in detail about this subject. In all inland waters, *Gammarus lacustris* Sars, 1863, is the main representative.

At some inland localities *Gammarus duebeni* is found, but in a following paper it will be shown that these localities always have a mixohaline nature, and the subspecies found there is the brackishwater form, *G. duebeni duebeni*. For further information regarding *G. duebeni* I refer to Pinkster et al. (1970) and Sutcliffe (1972).

In studying the samples it became apparent, that some taxonomic characters used in distinguishing *G. oceanicus* from other *Gammarus* species, varied in the populations examined. In a separate chapter (III) these differences will be discussed.

II. METHODS

At all 177 localities visited temperature and specific conductivity of the water was determined. From a water-sample both Cl^- and Ca^{++} contents were determined in Amsterdam.

Collected specimens have been deposited in the collection of the Zoölogisch Museum of the University of Amsterdam.

III. DIFFERENCES IN MORPHOLOGY BETWEEN *G. OCEANICUS* POPULATIONS

As pointed out in the introduction, several populations of *G. oceanicus* show characteristics deviating from the typical distinguishing characters as introduced by Segerstråle (1947) and used by Spooner (1951) and Kinne (1954). In these populations, which include ovigerous females, the males differ from the typical *G. oceanicus* in the following characters:

— The A2 flagellum is devoid of calceoli.
— The third segment of the mandible palp is ventrally armed with a row of spinules, which diminish regularly in size in proximal direction.
— Segment 1 of A1 bears on its ventral surface one thin tuft of setae and an apical tuft of setae; segment 2 bears three or four tufts of setae (including the apical tuft). The setae of the tufts on both the first and second segment of A1 are often somewhat shorter than the setae of the corresponding tufts in typical *G. oceanicus* males.

Typical *G. oceanicus* males show the following features:

— An A2 flagellum with calceoli.
— The third segment of the mandible palp is ventrally armed with a row of spinules which are mutually of a size.
— Segment 1 of A1 carries on its ventral surface two (rarely a small third) tufts of setae and an apical tuft; segment 2 has four or five tufts of setae (including the apical tuft).

Confusion thus might be caused between the atypical *G. oceanicus* and some representatives of the *G. locusta*-group (e.g., *G. inaequicauda* Stock, 1966) but can be prevented by observing certain other typical *G. oceanicus* characters:
The median palmar spine of the propodus of the

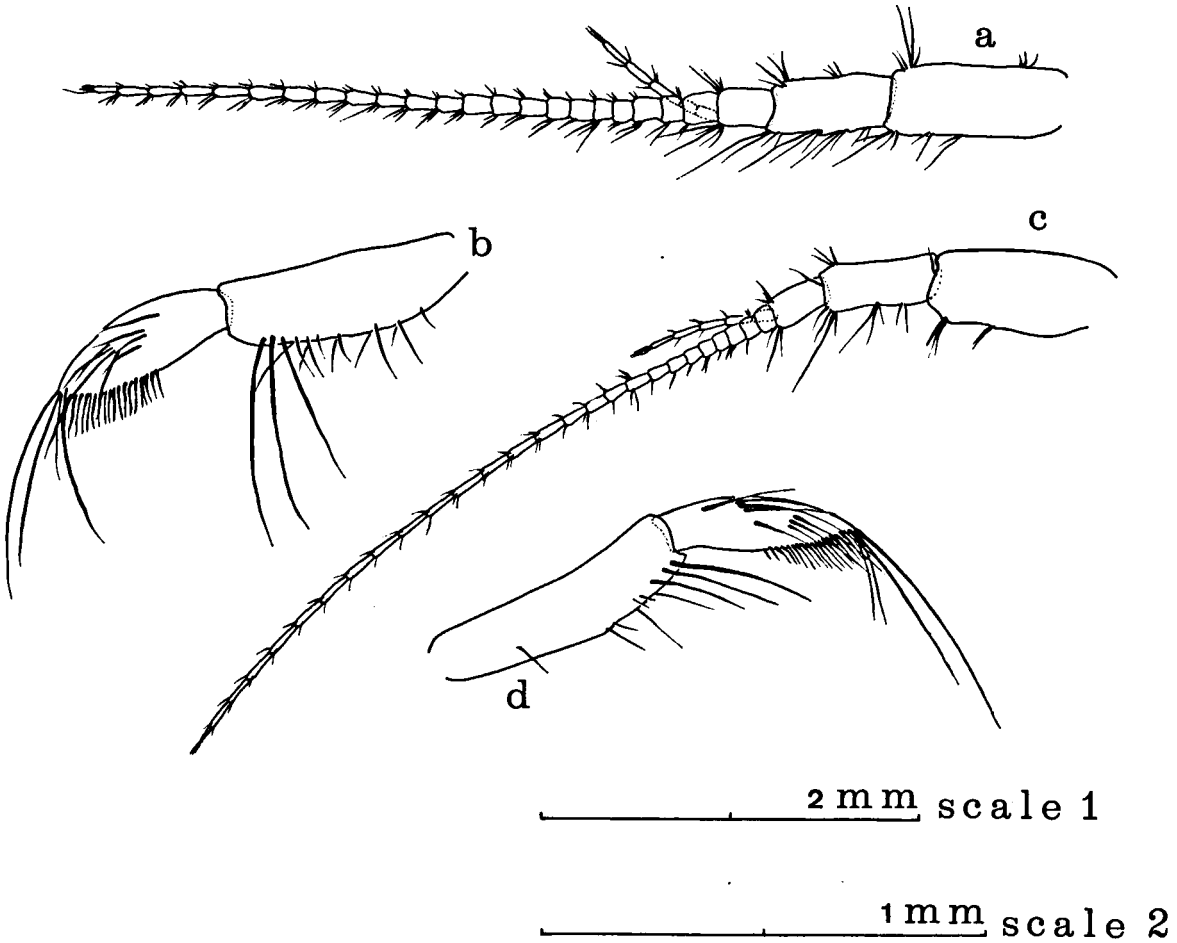

Fig. 1. *G. oceanicus:* ♂ of the typical form, from fjord at Mandal (body length 16.5 mm) and ♂ of the atypical form, from Straumfjorden at Straumfjordnes (body length 16.3 mm).
a, first antenna ♂ typical form (scale 1); b, mandible palp ♂ typical form (scale 2); c, first antenna ♂ atypical form (scale 1); d, mandible palp ♂ atypical form (scale 2).

Table I

Percentage of joint occurrence of *Gammarus*, *Chaetogammarus*, and *Eulimnogammarus* species in 3 investigated biotopes.

	G. duebeni				*G. oceanicus* all samples				*G. oceanicus* atypical form				*G. zaddachi*				*G. finmarchicus*				*Ch. marinus*			
	R	E	F	T	R	E	F	T	R	E	F	T	R	E	F	T	R	E	F	T	R	E	F	T
alone	82	54	37	62	—	40	38	33	—	—	45	36	—	31	—	24	—	100	33	33	—	—	31	28
G. duebeni					100	40	38	47	100	100	27	43	—	61	75	65	100	—	—	33	—	100	46	50
G. oceanicus	13	9	26	16									—	15	100	35	50	—	67	50	—	100	31	36
G. zaddachi	—	37	11	13	—	40	17	18													—	100	—	7
G. finmarchicus	5	—	—	2	20	—	8	9	—	—	18	14												
G. setosus	—	9	—	2									—	8	—	6								
G. salinus	—	—	4	1									—	—	25	6								
Ch. marinus	—	5	26	9	—	20	17	15	—	—	9	7	—	8	—	6								
Ch. stoerensis	—	—	7	2																	—	—	15	14
Eu. obtusatus	—	4	—	1	—	—	4	3																
total number of the samples	37	22	27	86	5	5	24	34	2	1	11	14	—	13	4	17	2	1	3	6	—	1	13	14
percentage of the samples in each biotope for each species	43	26	31		15	15	70		14	8	78		—	76	24		33	17	50		—	8	92	

R = rockpools
E = estuaries and small streams in sea-cliffs
F = fjords
T = total percentage of joint occurrence

second leg is pointed and tapering (not "flask-shaped"), the propodus of the second leg is roundish, the exopod of the third uropod has many plumose setae, and the lateral lobes of the head are of the *Lagunogammarus*-type (see Sket, 1971) which is for instance found in *G. zaddachi*, *G. oceanicus* and *G. salinus*. In fig. 1 the differences between the typical and atypical form are illustrated. The localities where the atypical form was found are indicated on the map in fig. 3.

In the southern part of Norway only specimens of the typical form were found, more to the north mixed populations and populations with the atypical form only. Neither in the biotopes inhabited by the two forms, nor in the way they live associated with other *Gammarus* species any difference was found between the two forms (cf. table I, chapter IV). However, it seems plausible to suppose that the variability mentioned above may be influenced by temperature and possibly by other factors. These factors may have a considerable effect on the development of the animals in a way we do not yet quite understand and may cause the morphological variability described.

IV. DISTRIBUTION OF THE INVESTIGATED SPECIES ALONG THE ATLANTIC COAST OF NORWAY.

The maps (figs. 2 and 3) indicate the stations at which the gammarids have been collected in Norway. Stations at which no gammarids were found are not indicated to avoid confusion. The appendix contains a list of all the localities with gammarids and some ecological data of each locality. This list includes a great number of new records of the species concerned.

In table I the joint occurence of the species as well as the frequency in each of the three biotopes investigated are summarized.

It shows, that *G. duebeni duebeni* inhabits mainly the supralittoral rockpools. Only in pseudo-supralittoral rockpools, situated in the lowest part of the black zone, at the boundary of the eulittoral and supralittoral, the species coexists with *G. oceanicus* and *G. finmarchicus*. In small estuaries and at places where springs in seacliffs reach the sea, the species lives associated with *G. zaddachi*. The substratum is mostly sand or mud with

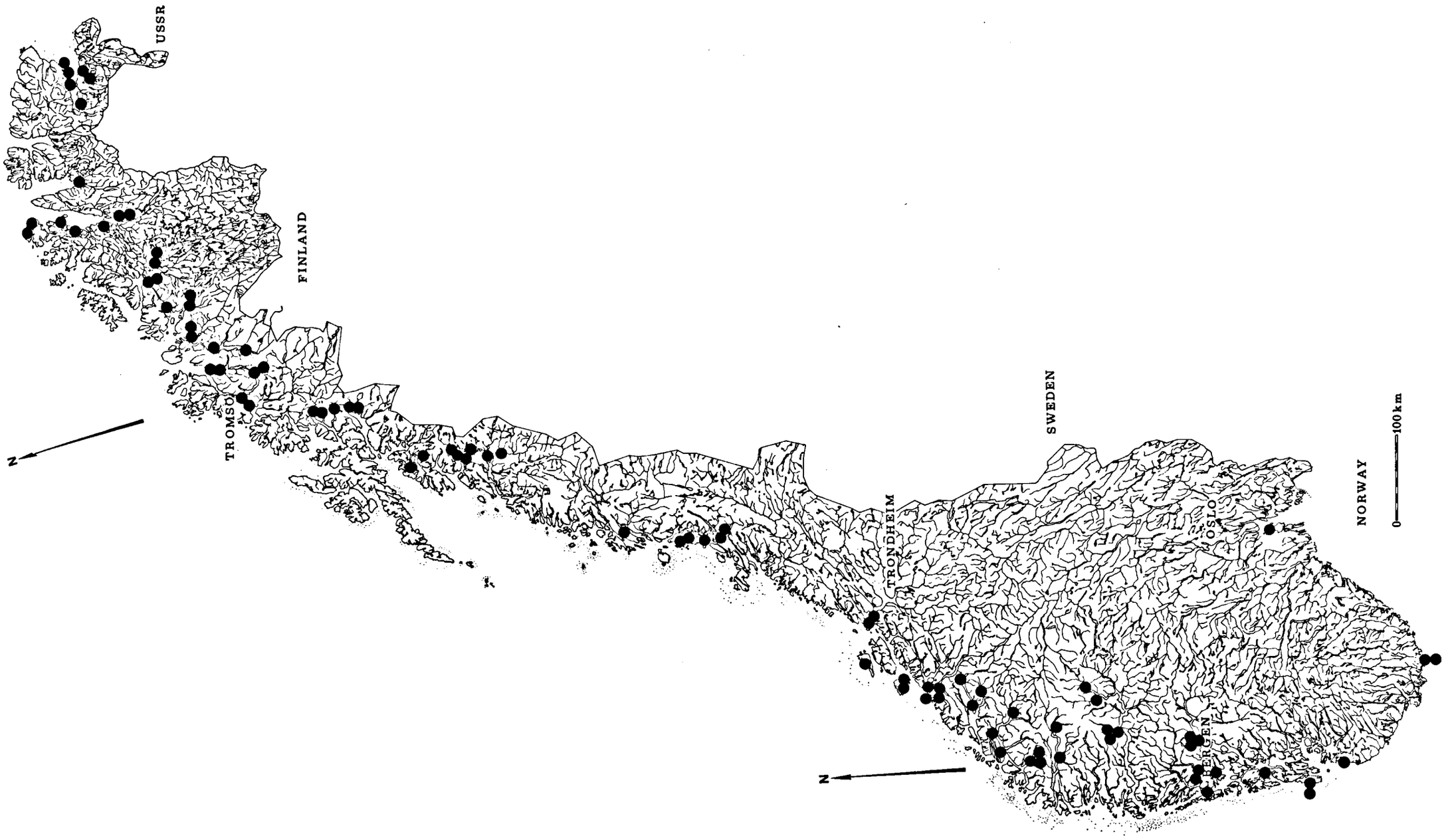

Fig. 2. Positive stations with *G. duebeni duebeni* in Norway.

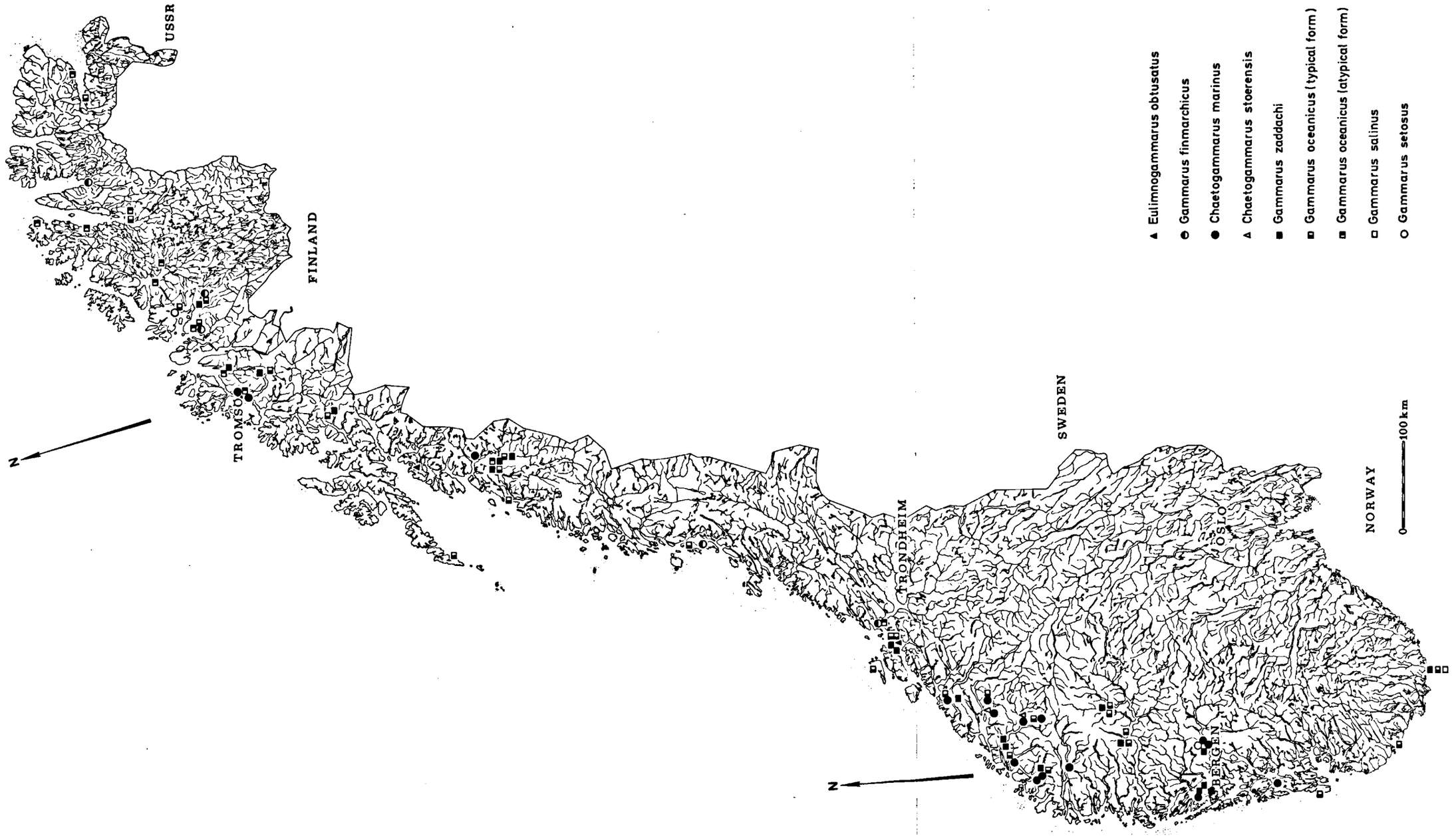

Fig. 3. Positive stations with gammarids, except *G. duebeni duebeni*, in Norway.

scattered boulders. In fjords, *G. duebeni* is practically limited to the upper algae zones with *Pelvetia* and *Ascophyllum* and is sometimes found intertidally on gravel beaches. This species lives here mainly in association with *G. oceanicus* on algae and with *Ch. marinus* under boulders.

G. oceanicus occupies chiefly the eulittoral zone of the fjords, where the species is found in fairly shallow water among stones, on *Fucus* and other algae, on a bottom of sand or pebbles. In this habitat *G. oceanicus* occurs together with *G. duebeni*, but also with *G. zaddachi* and *Ch. marinus*. The substratum in running waters, e.g. mouths of small rivers, is sand or sandy mud with an *Enteromorpha* vegetation and here the species coexists with *G. duebeni* and *G. zaddachi*. In pseudo-supralittoral rockpools *G. oceanicus* lives associated with *G. duebeni* and *G. finmarchicus*.

G. zaddachi lives mostly in running waters, and never in rockpools. In estuaries the species is associated mainly with *G. duebeni*, in fjords adjacent to estuaries it is associated with *G. duebeni* and *G. oceanicus*. In the estuaries the substratum consists of sand or mud, in the fjords, in the highest littoral zone where the species occurs, the substratum is sand or gravel.

Ch. marinus was never found in rockpools, and was encountered only once in an estuary. In the *Fucus* zone of the fjords (the main biotope of *Ch. marinus)*, the substratum on which the animals were found consists of rock or boulders. Here *G. duebeni* is a common companion of *Ch. marinus*.

From the few samples available containing *G. finmarchicus*, a certain preference of this species for the littoral zone of the fjords and pseudo-supralittoral rockpools can be discerned. The substratum on which the animal was found was rock or sand, sometimes covered with algae from the *Fucus* zone. The species occurs together with *G. duebeni* and *G. oceanicus*.

In the figs. 4A and 4B the localities at which the gammarids were caught are classified with regard to the type of biotope and the contents of Cl^- and Ca^{++}-ions of the water. Table II summarizes the minimum and maximum values of the Cl^- and Ca^{++} contents, the specific conductivity and temperature (at daytime) of the water of the biotopes from which *G. duebeni duebeni*, *G. oceanicus*, *G. zaddachi*, *G. finmarchicus* and *Ch. marinus* were collected.

Table II

Minimum and maximum values of Cl^- and Ca^{++} contents, specific conductivity and temperature of the water of the biotopes inhabited by the five species investigated in Norway.

		Cl^- in mg/l		Ca^{++} in mg/l		Spec. conductivity in μS		temperature in °C	
		min.	max.	min.	max.	min.	max.	min.	max.
G. duebeni	R	15	20000	<5	376	170	36230	8.6	28.6
	E	4	17000	<5	228	45	34500	7.4	18.4
	F	18	17900	<5	376	85	33300	9.8	18.6
G. oceanicus	R	4600	16100	84	276	11060	36040	9.0	14.1
	E	5	12700	<5	302	45	23970	8.3	21.0
	F	18	17900	14	385	85	35250	9.8	18.2
G. zaddachi	R	—	—	—	—	—	—	—	—
	E	5	69	<5	17	45	395	8.3	17.8
	F	18	6100	14	118	85	15820	13.4	17.0
G. finmarchicus	R	11600	12100	257	261	24890	25310	12.0	14.1
	E	2450*		63*		7200*		10.4*	
	F	10900	17000	204	357	23960	33520	10.8	12.4
Ch. marinus	R	—	—	—	—	—	—	—	—
	E	5*		<5*		45*		13.2*	
	F	2000	17500	38	367	5850	33300	10.4	22.4

* = only one sample available
R = rockpools
E = estuaries and small streams in sea-cliffs
F = fjords

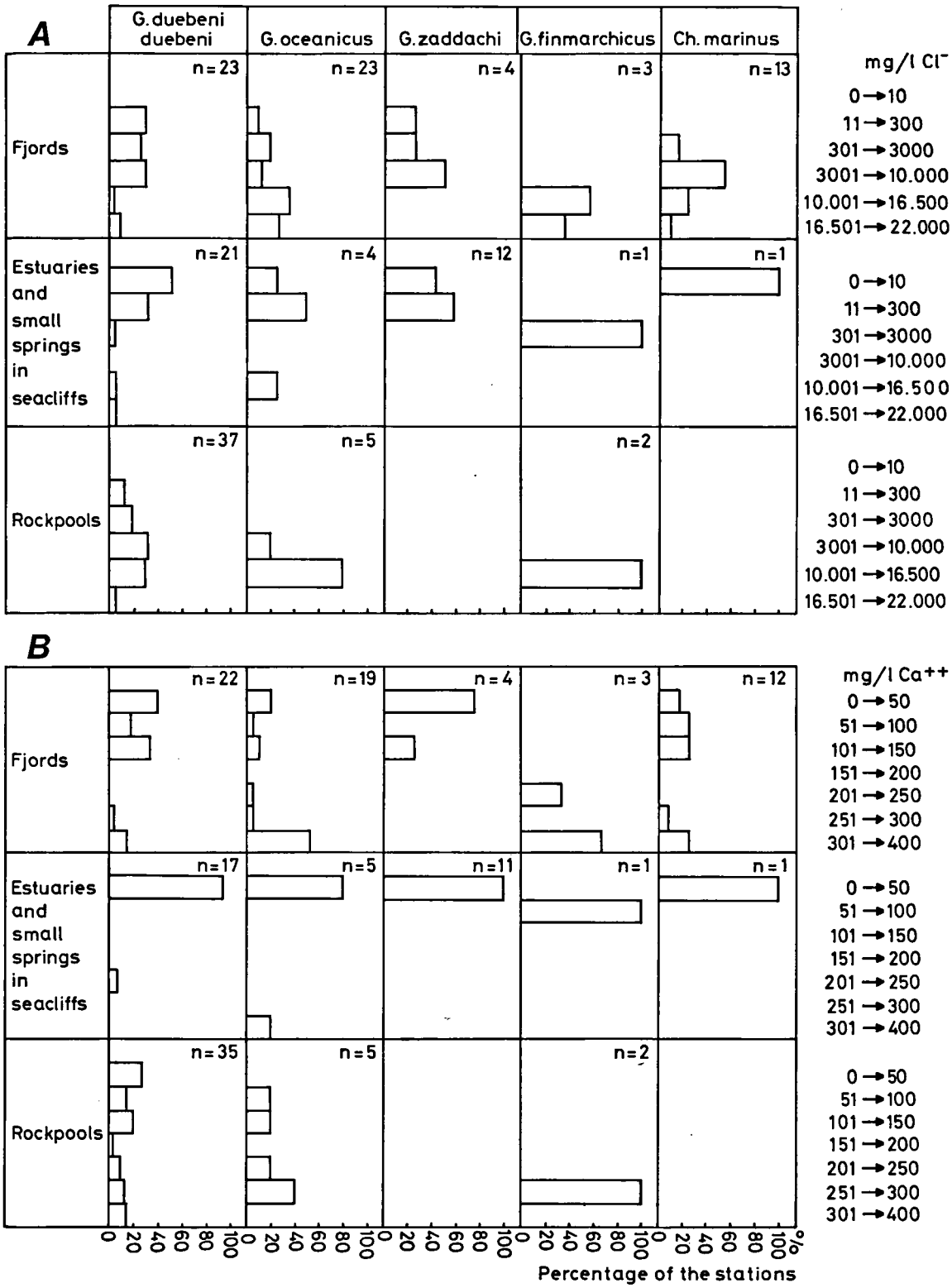

Fig. 4A. Localities with the species investigated classified with regard to the Cl^- content of the water and the type of biotope.

Fig. 4B. Localities with the five species investigated classified with regard to the Ca^{++} content of the water and the type of biotope. (n = number of stations).

V.DISCUSSION

The facts and figures presented in chapter IV about physical and chemical environment characters, and the substratum on which the investigated species occur, agree fairly well with the scattered facts known from other publications, which, however, are mainly concerned with localities outside Norway, while in this paper a systematic investigation is made on the variability of these environmental parameters in relation to the investigated species in Norway.

Habitat selection of the species mentioned in this paper is discussed earlier in a more general way by Steen (1951), Brattegard (1966) and Meadows & Campbell (1972).

Specifically it can be said, that the observations about habitat (including Cl^- content of the water) of *G. duebeni duebeni* are in agreement with the findings of Kinne (1953a, 1954), Hynes (1954), Sutcliffe (1967, 1971) and Pinkster et al. (1970).

Up to now *G. oceanicus* had never been found at very low salinities. According to Serventy (1935), Segerstråle (1947, 1959), and Steele & Steele (1972) this species is limited to waters with a salinity of more than 2.5 ‰, which corresponds with about 1500 mg/1 Cl^-. According to Steen (1951) the species is found at salinities down to 1‰ (corresponding with a Cl^- content of about 600 mg/l). In seven of the present records of *G. oceanicus* in Norway the chlorinity of the water was less then 600 mg/l (see appendix). A much lower minimum salinity must therefore be assumed for this species. This can be explained by the low temperature in northern areas, because Kinne (1952, 1953b) has provided experimental evidence that low temperatures favour survival of *Gammarus* at low salinities.

The data presented concerning *G. zaddachi* are in complete agreement with those known from the literature (Sexton 1912, Segestråle 1947, Kinne 1954, Stock, Nijssen & Kant 1966, Dennert et al. 1969).

G. finmarchicus is found in Norway exclusively in mixohaline waters of rockpools and in the tidal belt of fjords. Neither on the Cl^- and Ca^{++} contents of the water, nor about the other environmental factors discussed here, exact observations are known. Dahl (1938, 1946), Sexton & Spooner (1940) and Brattegard (1966) mention the lower half of the littoral zone as the typical biotope for this species.

In one case *Ch. marinus* is found in an estuary with an extreme low salinity at low tide. Jones (1948) notes the occurrence of *Ch. marinus* in estuaries in Britain, but fails to give minimum values of the salinity at ebbtide. At hightide the chlorinity of the water is 5500 mg/1 Cl^-. Robelus (1970, unpublished) gives as minimum value at which he found *Ch. marinus* in small streams in the cliffs of the French Channel coast, a Cl^- content of 74 mg/1. In the intertidal belt in the Netherlands, Den Hartog (1964) and Vlasblom & Bolier (1971) found populations at a minimum chlorinity of 7000 mg/1 Cl^-.

From the data presented it can be concluded, that *G. oceanicus* and *Ch. marinus* occur at a wider salinity range than was known from the literature. No distinction can be made between the typical and atypical form of *G. oceanicus* with regard to the environmental factors discussed above. Joint occurrence of two or more of the investigated species is possible in all biotopes studied (see table I). When the conditions become suboptimal for some of the species, the numbers of associated species drop. Finally, in the most extreme biotope, the supralittoral rockpools, in 82 % of the positive stations the only species found is *G. duebeni duebeni*.

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APPENDIX

LIST OF LOCALITIES WHERE GAMMARIDS WERE COLLECTED

G. duebeni was found at the stations: 1-5, 8-14, 17-19, 21-24, 26-30, 32, 34-43, 47, 48, 50, 54-57, 59-62, 65-70, 72-74, 76-79, 81, 83-90, 92-94, 97, 98, 100-106, 108-112, 115-117.

G. oceanicus was found at the stations: 2, 6, 7, 18, 22, 25, 27, 31, 33, 37, 44, 47, 50, 51, 53, 59, 63, 64, 75, 77, 80, 84, 87, 89, 91, 93, 95, 97, 99, 101, 104, 107, 109, 113, 114, 118.

G. zaddachi was found at the stations: 2, 10, 12, 18, 22, 27, 30, 45, 46, 52, 53, 61, 64, 76, 82, 86, 92, 96.

G. finmarchicus was found at the stations: 50, 58, 71, 91, 93, 110.

G. setosus was found at the stations 12 and 94.

G. salinus was found at station 2.

Ch. stoerensis was found at the stations 39 and 40.

Ch. marinus was found at the stations: 13-16, 20, 26, 27, 31, 33, 37, 39, 40, 44, 84.

Eul. obtusatus was found at the stations 51 and 94.

LIST OF STATIONS

Prov. Vestfold:

1 — Ditch near Borrevann, pos.: 59°25'30"N, 10°25'50"E, 29-VIII-1958, brackish water (to the taste).

Prov. Vest-Agder:

2 — Fjord at camping Mandal, Mandal, pos.: 58°01'N, 7°26'30"E, 1-VII-1971, temp. 16.2°C, Cl-6100 mg/l, Ca++118 mg/l, spec. conductivity 15820 µS.

3 — Rockpools near fjord at camping Mandal, pos.: 58°01'N, 7°26'30"E, 1-VII-1971, temp. 24.5°C, Cl-105 mg/l, spec. conductivity 420 µS.

Prov. Rogaland:

4 — Rockpool at sea at Tananger, pos.: 58°56'20"N, 5°34'E, 2-VII-1971, temp. 17.0°C, Ca++241 mg/l, spec. conductivity 31640 µS.

5 — Rockpool at Syrafjorden, Ferringstadhamn, pos.: 59°13'40"N, 5°10'E, 2-VII-1971, temp. 16.0°C, Cl-8100 mg/l, Ca++118 mg/l, spec. conductivity 18460 µS.

6 — Söndregåpet, Hestnes, pos.: 58°26'N, 6°01'E, 1-VII-1971, temp. 13.8°C, Cl-10500 mg/l, spec. conductivity 21700 µS.

7 — Mouth river at Ferkingstadhamn, pos.: 59°13'40"N, 5°10'30"E, 2-VII-1971, temp. 21.0°C, Cl-167 mg/l, Ca++14 mg/l.

Prov. Hordaland:

8 — Rockpool at Bömlafjorden, Valevåg, pos.: 59°42'N, 5°29'E, 2-VII-1971, temp. 22.6°C, Cl-20000 mg/l, Ca++376 mg/l, spec. conductivity 36230 µS.

9 — Mouth cliffstream in side-branch of Kobbaleiafjord, Kolltveit, pos.: 60°20'40"N, 5°03'E, 4-VII-1971, temp. 18.4°C, Cl-14 mg/l, Ca++<5 mg/l, spec. conductivity 70 µS.

10 — River under road 560, between Ytre Arna and Arna, pos.: 60°27'N, 5°27'30"E, 5-VII-1971, temp. 14.8°C, Cl-69 mg/l, spec. conductivity 395 µS.

11 — Sörfjord, Ytre Arna, pos.: 60°27'N, 5°27'30"E, 5-VII-1971, sand beach, no watersample.

12 — Mouth of river at Ytre Samlafjorden, South of Øystese, pos.: 60°23'N, 6°12'E, 5-VII-1971, temp. 11.8°C, Cl-8 mg/l, Ca++<5 mg/l, spec. conductivity 150 µS.

13 — Ytre Samlafjorden, 100 m E. of river, Øystese, pos.: 60°23'N, 6°12'E, 5-VII-1971, temp. 17.8°C, Cl-5200 mg/l, Ca++102 mg/l, spec. conductivity 13500 µS.

14 — Ytre Samlafjorden, 10 m E. of river, Øystese, pos.: 60°23'N, 6°12'E, 5-VII-1971, temp. 15.9°C, Cl-3600 mg/l, Ca++70 mg/l, spec. conductivity 8610 µS.

15 — Fjord S. of Salhus, pos.: 60°29'20"N, 5°10'15"E, 4-VII-1971, temp. 19.0°C, Cl-5100 mg/l, Ca++86 mg/l, spec. conductivity 11230 µS.

16 — Fjord, W. of the road at Röd, Förde, pos.: 59°35'20"N, 5°25'30"E, 2-VII-1971, temp. 22.4°C, Cl-15500 mg/l, Ca++286 mg/l, spec. conductivity 29830 µS.

Prov. Sogn og Fjordane:

17 — Mouth brook at N.W. point of Vetlefjorden, Svaeren, pos.: 61°17'N, 6°31'E, 6-VII-1971, temp. 10.4°C, Cl-8 mg/l, Ca++15 mg/l, spec. conductivity 72 µS.

18 — Vetlefjorden, Svaeren, pos.: 61°17'N, 6°31'E, 6-VII-1971, temp. 17.0°C, Cl-18 mg/l, Ca++20 mg/l, spec. conductivity 85 µS.

19 — Rockpool at Utfjorden, Anda, pos.: 61°52'N, 6°0.5'30"E, 6-VII-1971, temp. 15.4°C, Cl-2250 mg/l, Ca++61 mg/l, spec. conductivity 6210 µS.

20 — Utfjorden/Gloppenfjorden, Anda, pos.: 61°50'N, 6°05'30"E, 6-VII-1971, temp. 15.2°C, Cl-2000 mg/l, Ca++48 mg/l, spec. conductivity 5850 µS.

21 — Lusterfjord near Skjolden, pos.: 61°29'20"N, 7°36'E, 3-VI-1970, temp. 11.2°C, Cl-4440 mg/l.

22 — Gaupnefjord near the mouth of the Jostedalselva, pos.: 61°24'N, 7°17'20"E, 4-VI-1970, temp. 15.3°C, Cl-580 mg/l.

23 — Vetlefjorden near Svearen, pos.: 61°17'N, 6°32'E, 6-VI-1970, temp. 8.8°C, Cl-230 mg/l.

24 — Innvikfjorden, 10 km from Olden, pos.: 61°51'30"N, 6°48'E, 7-VI-1970, temp. 11.4°C, Cl-130 mg/l, Ca++<5 mg/l.

25 — Sognefjord at Hella, pos.: 61°13'N, 6°36'E, 6-VI-1970, temp. 19.0°C, Cl-7800 mg/l, Ca++134 mg/l.

Prov. Möre og Romsdal:

26 — Killspollen, Straumshamn, pos.: 62°04'N, 6°03'E, 6-VII-1971, temp. 14.1°C, Cl-6800 mg/l, Ca++133 mg/l, spec. conductivity 17280 µS.

27 — Rivermouth E. of South-point Killspollen, Straumshamn, pos.: 62°03'N, 6°03'E, 6-VII-1971, temp. 13.2°C, Cl-5 mg/l, Ca++<5 mg/l, spec. conductivity 45 µS.

28 — 10 m E. of mouth river, Killspollen, Straumshamn, pos.: 62°03'N, 6°03'E, 6-VII-1971, temp. 13.4°C, Cl-2800 mg/l, Ca++59 mg/l, spec. conductivity 8010 µS.

29 — Rockpool at Storfjorden, Solevåg, pos.: 62°25'N, 6°20'E, 7-VII-1971, temp. 16.2°C, Cl-65 mg/l, Ca++<5 mg/l, spec. conductivity 270 µS.

30 — River running into Storfjorden, Tyssa, pos.: 62°29'30"N, 6°44'E, 7-VII-1971, temp. 15.7°C, Cl-58 mg/l, Ca++17 mg/l, spec. conductivity 240 µS.

31 — Storfjorden, Solevåg, pos.: 62°25'N, 6°20'E, 7-VII-1971, temp. 14.4°C, Cl-3490 mg/l, Ca++322 mg/l, spec. conductivity 30800 µS.

32 — Mouth of river W. of Isfjorden near Brevik, pos.: 62°35'N, 7°45'E, 8-VII-1971, temp. 17.3°C, Cl-400 mg/l, Ca++20 mg/l, spec. conductivity 1260 µS.

33 — Isfjorden near Tokle, Andalsnes, pos.: 62°35'N, 7°45'E, 8-VII-1971, temp. 18.2°C, Cl-14800 mg/l.

34 — Rockpool at Langfjorden, Sölsnes, pos.: 62°40'15"N, 7°27'40"E, 8-VII-1971, temp. 28.6°C, Cl-15 mg/l, Ca++17 mg/l, spec. conductivity 170 µS.

35 — Pseudo-supralittoral rockpool at Kristiansund, pos.: 63°07'30"N, 7°43'E, 8-VII-1971, temp. 17.4°C, Cl-34 mg/l, Ca++22 mg/l, spec. conductivity 240 µS.

36 — Rockpool at Kristiansund, pos.: 63°07'30"N, 7°43'E, 8-VII-1971, temp. 18.0°C, Cl-23 mg/l, Ca++<5 mg/l, spec. conductivity 117 µS.

37 — Freifjorden, Kvitnes, pos.: 63°01'N, 7°47'E, 8-VII-1971, temp. 15.0°C, Cl-15100 mg/l, Ca++346 mg/l, spec. conductivity 30600 µS.

38 — Rockpool at Freifjorden, Kvitnes, pos.: 63°01'N, 7°47'E, 8-VII-1971, temp. 23.0°C, Cl-10500 mg/l, spec. conductivity 22500 µS.

39 — Norddalsfjord at Eisdal, pos.: 62°16'N, 7°11'E, 9-VI-1970, temp. 12.0°C, Cl-5600 mg/l, Ca++75 mg/l.

40 — Rödvenfjord at Rödven, pos.: 62°38'20"N, 7°30' E, 9-VI-1970, temp. 19.4°C, Cl-7000 mg/l, Ca++ 111 mg/l.

41 — Tingvollfjorden at Eidsöra, pos.: 62°48'30"N, 8°11'30"E, 10-VI-1970, temp. 14.0°C, Cl-2700 mg/l, Ca++38 mg/l.

42 — Fjord at Skjölberg, island Smöla, pos.: 63°20'30" N, 8°02'E, 9-VII-1971, temp. 18.2°C, Cl-30 mg/l, Ca++13 mg/l, spec. conductivity 190 µS.

43 — Mouth brook near Skjölberg, pos.: 63°20'30"N, 8°02'E, 9-VII-1971, temp. 18.4°C, Cl-4 mg/l, Ca++13 mg/l, spec. conductivity 160 µS.

44 — Geirangerfjord at Geiranger, pos.: 62°06'10"N, 7°12'30"E, 8-VI-1970, temp. 10.2°C, Cl-2430 mg/l, Ca++38 mg/l.

45 — Mouth and outer marches river near Tyssa, pos.: 62°29'30"N, 6°44'E, 7-VII-1971, temp. 15.7°C, Cl-750 mg/l, Ca++22 mg/l, spec. conductivity 2475 µS.

46 — River running into Batnfjorden, 1 km W. of Batnfjordsöra, pos.: 62°55'N, 7°40'30"E, 8-VII-1971, temp. 17.8°C, Cl-31 mg/l, Ca++15 mg/l, spec. conductivity 160 µS.

Prov. Sör-Trondelag:

47 — Fröyhavet Fjord, Tuvnes, pos.: 63°44'30"N, 8°39' E, 10-VII-1971, temp. 14.8°C, Cl-39 mg/l, spec. conductivity 220 µS.

48 — Storvatnet, Musdal, pos.: 63°35'30"N, 9°38'5"E, 11-VII-1971, temp. 14.0°C, Cl-70 mg/l, Ca++47 mg/l, spec. conductivity 1190 µS.

49 — Rockpool at Stjörnfjorden, Mölnbukt, pos.: 63° 37'30"N, 9°39'E, 11-VII-1971, temp. 14.0°C, Cl-5000 mg/l, Ca++109 mg/l, spec. conductivity 11340 µS.

50 — Stjörnfjorden at Mölnbukt, pos.: 63°37'30"N, 9°39'E, 11-VII-1971, temp. 11.0°C, Cl-17000 mg/l, Ca++357 mg/l, spec. conductivity 33520 µS.

51 — Hemnefjorden near ferry, Sunde, pos.: 63°29'30" N, 9°10'E, 10-VII-1971, temp. 12.0°C, Cl-17000 mg/l, Ca++341 mg/l, spec. conductivity 34350 µS.

52 — Rivulet near Hemnefjorden, Sunde, pos. 63°29' 30"N, 9°10'E, 10-VII-1971, temp. 16.4°C, Cl-20 mg/l, Ca++<5 mg/l, spec. conductivity 100 µS.

53 — Rivermouth near ferry at Hemnefjorden, Sunde, pos.: 63°29'30"N, 9°10'E, 10-VII-1971, temp. 16.5°C, Ca++28 mg/l, spec. conductivity 2490 µS.

Prov. Nordland:

54 — Kolbotn, Arsandöy, pos.: 65°04'N, 12°11'E, 13-VII-1971, temp. 10.4°C, Cl-17900 mg/l, Ca++296 mg/l, spec. conductivity 27250 µS.

55 — Pseudo-supralittoral rockpool at Sörfjorden, Möllebogen, pos.: 65°03'30"N, 12°04'E, 13-VII-1971, temp. 12.0°C, Cl-9200 mg/l, Ca++137 mg/l, spec. conductivity 18900 µS.

56 — Rockpool at Holm, pos.: 65°10'30"N, 12°07'E, 13-VII-1971, temp. 12.0°C, Cl-218 mg/l, Ca++8 mg/l, spec. conductivity 730 µS.

57 — Creek running into Torgfjorden, Berg, pos.: 65° 23'N, 12°16'30"E, 13-VII-1971, temp. 9.8°C, Cl-160 mg/l, Ca++33 mg/l, spec. conductivity 800 µS.

58 — Torgfjorden, Berg, pos.: 65°23'N, 12°16'30"E, 13-VII-1971, temp. 10.8°C, Cl-15700 mg/l, Ca++ 361 mg/l, spec. conductivity 30740 µS.

59 — Rockpool at Harmfjorden, near camping Brönnöysund, pos.: 65°26'30"N, 12°12'E, 14-VII-1971, temp. 13.2°C, Cl-16100 mg/l, Ca++276 mg/l, spec. conductivity 36040 µS.

60 — Rockpool at Fjord at Leinesodden, pos.: 66°02' N, 12°41'E, 14-VII-1971, temp. 18.5°C, Cl-3800 mg/l, Ca++80 mg/l, spec. conductivity 8790 µS.

61 — Mouth Saksenkivelka at Saltdalsfjorden, Saltdal, pos.: 67°06'30"N, 15°27'E, 15-VII-1971, temp. 9.5°C, Cl-66 mg/l, Ca++<5 mg/l, spec. conductivity 250 µS.

62 — Rockpool at Nedrevatnet, Fauske, pos.: 67°15'N, 15°26'30"E, 15-VII-1971, temp. 13.4°C, Cl-1150 mg/l, Ca++27 mg/l, spec. conductivity 3960 µS.

63 — Saltdalsfjorden at Saltdal, pos.: 67°06'30"N, 15° 27'E, 15-VII-1971, temp. 12.6°C, Cl-840 mg/l, Ca++14 mg/l, spec. conductivity 2550 µS.

64 — Fjord Fauske Vika, Fauske, pos.: 67°15'N, 15° 27'30"E, 15-VII-1971, temp. 13.4°C, Cl-680 mg/l, Ca++14 mg/l, spec. conductivity 2170 µS.

65 — Törrfjorden, Vlegården, pos.: 67°22'N, 15°37'E, 15-VII-1971, temp. 12.4°C, Cl-51 mg/l, Ca++<5 mg/l, spec. conductivity 200 µS.

66 — Leirfjorden, Sommarset, pos.: 67°32'N, 15°36'E, 15-VII-1971, temp. 13.3°C, Cl-3800 mg/l, Ca++ 54 mg/l, spec. conductivity 10110 µS.

67 — Cliffbrook N. of Kalviktunnel, Sommarset, pos.: 67°32'N, 15°36'E, 15-VII-1971, temp. 9.0°C, Cl-2 mg/l, Ca++<5 mg/l, spec. conductivity 49 µS.

68 — Rockpool at Leirfjorden, Sommarset, pos.: 67° 32'N, 15°32'E, 15-VII-1971, temp. 17.0°C, Cl-4900 mg/l, Ca++112 mg/l, spec. conductivity 12660 µS.

69 — Sagfjorden, Tömmerneset, pos.: 67°55'30"N, 15° 53'E, 15-VII-1971, temp. 14.2°C, Cl-194 mg/l, Ca++9 mg/l, spec. conductivity 660 µS.

70 — Rockpool at Presteidfjorden, Hammaröy, pos.: 68°05'30"N, 15°37'30"E, 15-VII-1971, temp. 13.9° C, Cl-2150 mg/l, Ca++61 mg/l, spec. conductivity 5850 µS.

71 — Rivulet on temporary dry marsh, Presteidfjorden, Hammaröy, pos.: 68°05'30"N, 15°37'30"E, 15-VII-1971, temp. 10.4°C, Cl-2450 mg/l, Ca++63 mg/l, spec. conductivity 7200 µS.

72 — Rockpool at Rombaken, Fossetua, pos.: 68°27' N, 17°31'30"E, 16-VII-1971, temp. 18.4°C, Cl-7200 mg/l, Ca++143 mg/l, spec. conductivity 17300 µS.

73 — Cliffstream running into Rombaken, Fossetua, pos.: 68°27'N, 17°31'30"E, 16-VII-1971, temp. 8.2°C, Cl-4 mg/l, Ca++<5 mg/l, spec. conductivity 76 µS.

74 — Rombakenfjorden, Fossetua, pos.: 68°27'N, 17° 31'30"E, 16-VII-1971, temp. 9.1°C, Cl-630 mg/l, Ca++26 mg/l, spec. conductivity 2250 µS.

75 — Fjord near Reine, Lofoten, pos.: 67°56'N, 13° 16'20"E, 18-VIII-1939 (no further details known).

Prov. Troms:

76 — Gratangsbotn at Rivermouth, Fjordbotn, pos.: 68°40'N, 17°24'E, 16-VII-1971, temp. 12.0°C, Cl-12 mg/l, Ca++13 mg/l, spec. conductivity 112 µS.

77 — Sagfjorden, Ottera, pos.: 68°51'30"N, 17°48'E, 17-VII-1971, temp. 10.4°C, Cl-2600 mg/l, Ca++83 mg/l, spec. conductivity 6930 µS.

78 — Rockpool at Sagfjorden, Ottera, pos.: 68°51'30" N, 17°48'E, 17-VII-1971, temp. 12.4°C, Cl-1290

mg/l, Ca^{++}48 mg/l, spec. conductivity 3780 µS.

79 — Rivulet running into Balsfjorden, Kvitberg, pos.: 69°15'30"N, 19°27'E, 17-VII-1971, temp. 9.7°C, Cl^-6 mg/l, Ca^{++}<5 mg/l, spec. conductivity 73 µS.

80 — Balsfjorden, Kvitberg, pos.: 69°15'30"N, 19°27'E, 17-VII-1971, temp. 11.4°C, Cl^-13500 mg/l, Ca^{++}315 mg/l, spec. conductivity 28350 µS.

81 — Rockpool at Balsfjorden, Laksvatn, pos.: 69°22'30"N, 19°21'E, 17-VII-1971, temp. 13.7°C, Cl^-4600 mg/l, Ca^{++}104 mg/l, spec. conductivity 12150 µS.

82 — River from lake to Balsfjorden, Ytre Laksvatn, pos.: 69°23'N, 19°22'E, 17-VII-1971, temp. 10.4°C, Cl^-9 mg/l, Ca^{++}<5 mg/l, spec. conductivity 64 µS.

83 — Rockpool at Tromsöysundet, camping Tromsö, pos.: 69°37'30"N, 18°54'E, 17-VII-1971, temp. 13.6°C, Cl^-13900 mg/l, Ca^{++}304 mg/l, spec. conductivity 31050 µS.

84 — Tromsöysundet, camping Tromsö, pos.: 69°37'30"N, 18°54'E, 17-VII-1971, temp. 10.4°C, Cl^-17500 mg/l, Ca^{++} 367 mg/l, spec. conductivity 33300 µS.

85 — Cliffstream running into Lyngen, Rasteby, pos.: 69°24'N, 20°09'E, 17-VII-1971, temp. 8.5°C, Cl^-3 mg/l, Ca^{++}<5 mg/l, spec. conductivity 96 µS.

86 — Jaegervatnet 500 m from the fjord, pos.: 69°44'N, 19°49'E, 19-VII-1971, temp. 10.0°C, Cl^-6 mg/l, spec. conductivity 53 µS.

87 — Mouth Jaegervatnet, pos.: 69°44'N, 19°49'E, 19-VII-1971, temp. 10.0°C, Cl^-26 mg/l, Ca^{++}<5 mg/l, spec. conductivity 77 µS.

88 — Cliffstream at Lyngen, Lyngmoen, pos.: 69°40'N, 20°29'30"E, 19-VII-1971, temp. 7.4°C, Cl^-10 mg/l, Ca^{++}<5 mg/l, spec. conductivity 68 µS.

89 — Rockpool at Straumfjorden, pos.: 69°51'N, 21°13'E, 19-VII-1971, temp. 13.3°C, Cl^-11400 mg/l, Ca^{++}239 mg/l, spec. conductivity 23970 µS.

90 — Cliffstream running into Straumfjorden, Straumfjordnes, pos.: 69°51'N, 21°13'E, 19-VII-1971, temp. 10.2°C, Cl^-4 mg/l, Ca^{++}<5 mg/l, spec. conductivity 79 µS.

91 — Straumfjorden at Straumfjordnes, pos.: 69°51'N, 21°13'E, 19-VII-1971, temp. 12.4°C, Cl^-10900 mg/l, Ca^{++}204 mg/l, spec. conductivity 23960 µS.

92 — Mouth Navetkjokka in Straumen, Navet, pos.: 69°47'N, 21°56'E, 19-VII-1971, temp. 8.3°C, spec. conductivity 230 µS.

93 — Rockpool at Straumen, Kjaekan, pos.: 69°46'30"N, 22°05'E, 19-VII-1971, temp. 14.1°C, Cl^-11600 mg/l, Ca^{++}257 mg/l, spec. conductivity 25310 µS.

94 — Little stream on tidal marsh S. of Alteidelva, Alteidet, pos.: 70°01'30"N, 22°05'E, 19-VII-1971, temp. 7.4°C, Cl^-10 mg/l, Ca^{++}<5 mg/l, spec. conductivity 80 µS.

95 — Mouth river, S. of Alteidelva, Aldeidet, pos.: 70°01'30"N, 20°05'E, 19-VII-1971, temp. 8.3°C, Cl^-12700 mg/l, Ca^{++}302 mg/l, spec. conductivity 23970 µS.

96 — Mouth of the Malselva, Nordstrand, pos.: 69°16'30"N, 18°30'30"E, 17-VII-1971, temp. 11.6°C, Cl^-27 mg/l, Ca^{++}17 mg/l, spec. conductivity 170 µS.

Prov. Finmark:

97 — Rockpool at Altafjorden, Inestoften, pos.: 70°08'30"N, 22°59'30"E, 19-VII-1971, temp. 11.0°C, Cl^-14800 mg/l, Ca^{++}133 mg/l, spec. conductivity 28120 µS.

98 — Beach of Altafjorden, under boulders, Inestoften, pos.: 70°08'30"N, 22°59'30"E, 19-VII-1971, no water sample.

99 — Altafjorden at Inestoften, pos.: 70°08'30"N, 22°59'30"E, 19-VII-1971, temp. 10.6°C, Cl^-16200 mg/l, spec. conductivity 28930 µS.

100 — Rockpool at Altafjorden, Rafsbotn, pos.: 70°N, 23°29'30"E, 21-VII-1971, temp. 19.4°C, Cl^-390 mg/l, Ca^{++}328 mg/l, spec. conductivity 1310 µS.

101 — Altafjorden, Rafsbotn, pos.: 70°N, 23°29'30"E, 21-VII-1971, temp. 14.2°C, spec. conductivity 11530 µS.

102 — Rockpool at Porsangen, Repvåg, pos.: 70°45'N, 25°41'E, 21-VII-1971, temp. 10.4°C, Cl^-4500 mg/l, spec. conductivity 640 µS.

103 — Rockpool at Nordkapp, pos.: 71°09'30"N, 25°48'30"E, 22-VII-1971, temp. 9.6°C, Cl^-7400 mg/l, Ca^{++}96 mg/l, spec. conductivity 11530 µS.

104 — Rockpool at Risfjorden, Skarsvåg, pos.: 71°06'30"N, 25°49'30"E, 22-VII-1971, temp. 9.0°C, Cl^-4600 mg/l, Ca^{++}84 mg/l, spec. conductivity 11060 µS.

105 — Two rockpools at Porsangen, Nordmanset, pos.: 70°06'N, 26°16'E, 22-VII-1971, temp. 8.6°C, Cl^-20 mg/l, Ca^{++}<5 mg/l, spec. conductivity 110 µS.

106 — Cliffstream at Porsangen, Ytre Gåradak, pos.: 70°15'30"N, 25°02'E, 22-VII-1971, temp. 10.6°C, Cl^-10600 mg/l, Ca^{++}228 mg/l, spec. conductivity 23960 µS.

107 — Porsangen, Nordmanset, pos.: 70°06'N, 20°16'E, 22-VII-1971, temp. 11.2°C, Cl^-16900 mg/l, Ca^{++}316 mg/l, spec. conductivity 32270 µS.

108 — Rockpools at Austerbotn, Stråskogen, pos.: 70°04'N, 25°09'E, 22-VII-1971, temp. 16.0°C, Cl^-7700 mg/l, Ca^{++}198 mg/l, spec. conductivity 18080 µS.

109 — Austerbotn, Stråskogen, pos.: 70°04'N, 25°09'E, 22-VII-1971, temp. 11.5°C, Cl^-14100 mg/l, Ca^{++}327 mg/l, spec. conductivity 31350 µS.

110 — Rockpool at Laksefjorden, Landersfjorden, pos.: 70°25'30"N, 26°43'30"E, 22-VII-1971, temp. 12.0°C, Cl^-12100 mg/l, Ca^{++}261 mg/l, spec. conductivity 24890 µS.

111 — Two rockpools at Munkfjorden, Munknes, pos.: 69°42'N, 29°37'E, 23-VII-1971, temp. 16.2°C, Cl^-10000 mg/l, Ca^{++}204 mg/l, spec. conductivity 23050 µS.

112 — Cliffstream at Munkfjorden, Munknes, pos.: 69°42'N, 29°37'E, 23-VII-1971, temp. 11.2°C, Cl^-17000 mg/l.

113 — Langfjorden at Straumdalen, pos.: 69°42'30"N, 29°57'E, 23-VII-1971, temp. 12.4°C, Cl^-11700 mg/l, Ca^{++}261 mg/l, spec. conductivity 24400 µS.

114 — Veinesbukta at Grasbakken, pos.: 70°05'N, 28°47'E, 23-VII-1971, temp. 9.8°C, Cl^-17900 mg/l, Ca^{++}335 mg/l, spec. conductivity 34430 µS.

115 — Rockpool at Veinesbukta, Grasbakken, pos.: 70°05'N, 28°47'E, 23-VII-1971, temp. 12.8°C, Cl^-14000 mg/l, Ca^{++}341 mg/l, spec. conductivity 32540 µS.

116 — Rockpool at Verangerfjorden, Saltfjern, pos.: 70°03'30"N, 30°E, 24-VII-1971, temp. 17.0°C, Cl^-

14900 mg/l, Ca^{++}322 mg/l, spec. conductivity 28930 μS.

117 — Rockpool at Verangerfjorden, Saltfjern, pos.: 70° 03'30"N, 30°E, 24-VII-1971, temp. 18.4°C, Cl^- 17600 mg/l, Ca^{++}312 mg/l, spec. conductivity 35330 μS.

118 — Verangerfjorden at Saltfjern, pos.: 70°03'30"N, 30°E, 24-VII-1971, temp. 15.4°C, Cl^-17700 mg/l, Ca^{++}385 mg/l, spec. conductivity 35250 μS.

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