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THE LIFE CYCLE OF THE SHRIMP (PANDALUS BOREALIS KR.) IN GREENLAND WATERS DISCUSSED IN RELATION TO THE POTENTIAL YIELD OF THE STOCKS

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INTRODUCTION

Sampling of shrimp in Greenland waters has been an important part of the research program of the Greenland Fisheries Investigations in all years since 1946. Analyses of the samples have lead to a fairly good knowledge of the general biology of the species in Greenland waters, especially regarding the life cycle including the sexual development, spawning and hatching (Horsted and Smidt, 1956). However, the analyses have normally not been connected closely with the recent discussion of the yield of the stocks. Some of the detailed analyses of samples may, however, be important background for the discussion of the potential yields, and such details are brought forward for discussion in the present paper.

MATERIAL AND METHODS

In the initial phase of the research on shrimp in Greenland waters the samples were normally sorted in several categories: juveniles, males, transitional stages (P. borealis is a protandric hermaphrodite) and females. Furthermore the females and the transitional stages were broken down in groups according to the development of the gonads and eggs: individuals without roe, those with head roe, berried (ovigerous) animals, and those where eggs recently hatched or were lost (setae on the pleopods, Berkeley, 1930). The last two categories contain no transitional individuals, whereas transitionals may be found without roe or with head roe, but transitionals and females were not broken down in more details such as Rasmussen (1953) did in his analyses of the Norwegian stocks.

After several years' analyses in the 1940-50ies the general biology seemed to be so well described that the detailed analysis of the samples was discontinued and recent work has concentrated more on measuring a great number of samples and individuals whereas the detailed sorting in categories has been confined to three groups: individuals without roe, individuals with head roe, and berried individuals.

It may be regretted now that the more detailed break down of the samples has been discontinued. Anyway, for the purpose of the present paper it has been necessary to use the older, more detailed samples, and even these ought to have been analysed in more details for this paper.

One of the important group of animals to have been considered in the paper is that category of shrimps which can be called "berried and with head roe". Such a group was, however, never established in the analyses although it existed (Horsted and Smidt, l.c. page 76). Sometimes a footnote on the sample form indicates that berried or newly hatched females also had head roe but generally head roe has been classified as such only when no eggs or setae occurred on the pleopods.

Furthermore, Horsted and Smidt (l.c.) in the earlier material classified head roe as such as soon as the green colour of the gonads was clearly visible through the carapace, whereas the various persons who sorted more recent samples used a classification where the green colour of the gonads should extent close to the posterior part of the carapace. Head roe would, therefore, occur later and relatively less abundant in more recent samples than in earlier samples. The material used by Horsted and Smidt (l.c.) was generally preserved in formalin before being analyzed whereas in recent years the material has been fresh frozen, and individuals in these samples are not very easily reckognized as developing head roe in an early stage, and many frozen and thawn individuals are not even usable for measuring the carapace.

Another difference between former and more recent material is found in the measurement of the carapace. Earlier material was measured to mm (below) from eye lobe to lateral, posterior edge of the carapace. More recent material has been measured to half-millimeter from eye lobe to dorsal, posterior edge of the carapace. Rasmussen (l.c.) also measured his material by the latter method, although to whole millimeters. Horsted and Smidt (l.c.)pages 73) gives a comparison between Rasmussen's and their method of measuring.

Time has not allowed the author to consider more than a small part of the material for the December 1976 meeting of the ICNAF Assessment Subcommittee. The analyses have, therefore, been confined to such inshore material which covers a well defined area regularly throughout the year, or which have been sampled through several years and to such offshore material which covers the more important months for this analyses (March to May).

RESULTS AND DISCUSSION

The Tunugdliarfik material.

The length of the berried (ovigerous) period varies between areas (Rasmussen, l.c., Horsted and Smidt, l.c.) but in Greenland waters it extends generally from August to April-May, a relatively long period.

The best material to illustrate the annual cycle is from the Tunugdliarfik Fjord Between Narssaq and Narssarssuaq, southern Greenland. This stock has been steadily exploited since the early 1950ies with annual catches at that time of 2-300 tons but rather less in the 1960ies and recent years. The material was sampled in the 1950ies and is given in Table 1. The periods with the most frequent sampling are illustrated on Figs. 1 and 2. Only the transitionals and females are considered here. The most easy point to start looking at the figures is probably in September-October when spawning has finished. At that time by far the major part (80% or more) of the considered group of shrimps consists of berried females, but also of individuals without roe, amongst these some with setae on the pleopods indicating that they spawned without succeeding to get berried. This corresponds with observations by Rasmussen (l.c.) in the Norwegian

material.

Throughout the winter period the level of berried females fluctuates somewhat but the general trend is a more or less pronounced decrease. This decline is due partly to some individuals loosing their eggs but especially to recruitment by transitionals to the group considered. The highest frequency of transitionals without head roe is normally found from November/December through the first 2 months of the following year (see upper part of Figs. 1 and 2). Head roe in the transitionals (and females) is not visible until late February but from March and through to spawning so to say all transitionals show this sign of maturation and their number increases considerably in March-April. Their relative number decreases in May-June, partly because they themselves gradually change the characters so much that they get classified as females (with head roe), but mainly because the eggs of the berried females hatch in April-May and after a short setae-on-the-pleopods period these animals get classified as females with head roe. Immediately before spawning starts in late July the number of head roe individuals reaches its peak, normally more than 80% of the group considered. Some females which recently hatched their eggs may, however, not develop roe for the same year's spawning and continue after hatching as females without roe. This category does, however, not seem to be a significant part of the stock in the Tunugdliarfik, but it will be combined in July-August with that category of females where spawning was unsuccessful so that in the autumn the combined non-roe group may reach a level about 20-30%. In February-March next year most, if not all, of these individuals will develop head roe and will be distinguished from the transitional head-roe individuals only by the character of the endopodite of the first pair of pleopods (Berkeley, l.c., Rasmussen, l.c.).

Length frequency diagrams of the samples show that the considered group of animals will normally have one common mode and that they will show up as only one or two age groups by the Petersen method, sometimes with a tendency to a small group of larger (older) animals (Figs. 5 and 6 show typical length frequency diagrams). However, the detailed material does allow one to state that there are at least two distinct groups distributed round the main mode of the group considered. Although they may not actually be two distinct year classes or age groups in the strict sence they could for population assessments be regarded as such. The two groups are the berried females and that part of the March-April head roe individuals which are transitional and which could be regarded as that year's recruits to the female component of the stock. They could probably consist of slow growing individuals of one year class and fast growing individuals of the following year class but could for assessment purposes be regarded as a cohort.

The material as illustrated may also lead one to judge that even if transitionals had not been separated in the head roe group there might still be a possibility to separate recruits from older animals. That part of the head-roe group which consists of older animals does namely occur in September-October as the very major part of the without-roe group, and it might, therefore, be possible to judge its strength in the following year's March-April combined head-roe group.

It is interesting to note that the relative strength of the recruiting cohort is close to the same strength as the combined groups of older age groups

to which it will recruit. This could lead to some ideas about mortality. However, in the inshore areas of West Greenland it has been clearly demonstrated that the length frequency of the population changes with depth (see Figs. 3 and 4). It is,therefore, likely that a good part of the female group emigrate (actively or by currents) from the ground to deeper grounds close to the Tunugdliarfik. In fact, at a deeper ground close to Narssaq one finds a population with a much greater inflow of larger and likely older animals than in the Tunugdliarfik (Fig. 4). It is thus likely that the relative strength of the recruits in the Tunugdliarfik material is overestimated in relation to the more widely distributed population in the area.

It should be noted that ecdyses cannot occur (without harm to the eggs) in the berried group of animals. There is, therefore, no growth in terms of changes in carapace length in the period from early August to late April. In the period April-July the major part of the previously berried females will rapidly develop new eggs. It does, therefore, seem very likely that from the time of the first spawning the growth rate is so slow that one can hardly expect to find separate age groups by the Petersen method inside a normal distribution which covers 5-6 mm. Only those relatively few females which take "a year of rest" seem to have the possibility of forming another mode in the length frequency diagrams, and such modes do occur as shown in Figs. 5 and 6. One should, however, be very careful to judge anything about mortality from the ratio between modes in the female part of the stock. Several cohorts could be accumulated around the major mode, and the various length groups will be unevenly distributed on the ground according to depth.

Furthermore, in the Tunugdliarfik it has been demonstrated that inflow of warm water in the deeper layers in winter time causes greater abundance of shrimps, especially of the larger shrimps, probably carried into the fjord from outer parts of the fjord and from adjacent offshore areas (Horsted and Smidt, l.c.). Figs. 5 and 6 show the difference in length frequencies between the summer-autumn (Fig. 5) and the winter (Fig. 6) when warm bottom water dominates and catch rate is at its highest annual level. Such migration of specific length groups will also very much limit the possibilities of using length frequency figures to estimate mortalities.

The Disko Bay material.

The material from the Disko Bay consists of a great number of samples through many years and covering various grounds in the bay. Detailed sorting has, however, been made only in the 1940-1950ies and for some few samples in the 1970ies, whereas the many samples from most recent years have been broken down in three categories mentioned on page 2. The material is generally limited to the summer months and does not allow for detailed analyses of the annual cycle, especially not for analyses of the important March-April period, when the transitionals are supposed to achieve their maximum.

Only the most recent material is computerized, and there has not been time enough to compile and tabulate the total material for the December 1976 meeting of ICNAF. Two grounds in the Disko Bay have been chosen for the analyses, viz. the ground close to the southeastern shoreline of the Disko Island (the Godhavn ground), and the ground close to Christianshåb at the southeastern part of the Disko Bay. The material from these two areas is shown in Tables 2 and 3.

Since no continuous annual series of detailed samples exist from the Disko Bay an illustration like the one from Tunugdliarfik (Figs. 1-2) cannot be given. Instead the material has been illustrated by plotting each of the categories, irrespective of year, against the proper date. This is illustrated in Figs. 7 and 8.

Figs. 7 and 8 both indicate that the spawning period is about the same as in Tunugdliarfik, starting in July and finished at the end of August. But evidently some variation exist between years. The samples from 1948 seem to indicate a later spawning that year than normally with many head-roe animals still occurring in late August or even in the beginning of September.

Compared to the Tunugdliarfik material the Godhavn and Christianshåb material does not achieve the same high level of berried animals, but a relatively greater part of the females seem to pass the winter months without roe. Thus the potential productivity per stock unit may be relatively low in the Disko Bay although also likely to vary greatly between years. For example, in 1950 and 1952 the samples show a relatively great number of head roe transitionals which contributed to a relatively high level of berried females in the same year. Thus year-class fluctuations seem to be significant.

The most remarkable feature in Figs. 7 and 8 is probably found in the group of berried females. It will be seen that the plots for the 1940-50ies (black dots and full line) generally lies somewhat higher than those for 1963-64 and 1974-76 (open circles and broken lines). This could possibly reflect some influence from the fishery which increased considerably in the period (Fig. 3 in Res.Doc. 76/VI/16) and which may exploit the larger animals more heavily than the smaller animals, both due to actively seeking those grounds where larger animals dominate (as long as catches here are good) and due to some mesh selection. Looking at the non-roe group it could also occur that a greater part loose their eggs in recent years than formerly. However, the length frequency diagrams suggest that the increase in the non-roe group is mainly due to recruitment of smaller individuals to the considered group or to gradual decrease of the larger animals. The groups will, of course, balance to the 100% and at present no firm data are available to clearly demonstrate absolute changes in the abundance of the various length and sex groups. Further analyses, including details on possible loss of roe at spawning and of the tendency to "take a year of rest" after a year of spawning will need to be made before more firm conclusions can be drawn.

The material from the Godthåb Deep and the Sukkertoppen Deep.

The Godthåb Deep located east of the Fylla Bank (Div. 1D) and the Sukkertoppen Deep between the Fylla Bank and the Banana Bank (Div. 1C) are two offshore grounds where standard stations for trawling have been established in the annual research program of the Greenland fisheries research institute.

The total material of shrimp samples from these two grounds are presented in Tables 4 and 5 and illustrated in Figs. 9 and 10.

As said earlier in the paper the head-roe group in the material from these grounds cannot be compared to the Tunugdliarfik and Disko Bay material because of the difference in the criteria for head roe (see page 2, middle of the page). One feature does, however, occur very clearly, namely a somewhat later spawning than in the previously mentioned inshore areas. Thus berried females have not occurred in the samples until mid August, whereas in the inshore samples berried

females start to occur already in July. Hatching seems to take place at the same time as in Tunugdliarfik, probably a little earlier.

A great percentage, more than 80%, of the spawning females seems to get berried, but the percentage of berried animals declines rapidly in the first months of the year, most probably due to a recruitment by transitionals to the length groups considered. However, since transitionals were not sorted out and since the first stages of head roe were not classified as head roe it is very difficult to interprete the fluctuations in the non-roe group. Some comments are given as footnotes to Tables 4 and 5. Future samples will have to be analyzed in more details before more firm conclusions can be drawn, but the present material suggests that spawning in these grounds was rather successful, at least in 1973 and 1975, but probably less successful in 1974, when the relative abundance of berried females was low in November on both grounds, and also in the following January 1975 on the Godthåb Deep (the Sukkertoppen Deep was not sampled until April that year). The very low figure for berried females in January 1976 in the Sukkertoppen Deep is a mystery but may be caused either by a high new recruitment to the length group considered or a real decline in the number of berried females, possibly due to migration.

The samples do not at present allow any judgement about the degree to which berried females will develop roe for the next season although most length frequency diagrams will suggest that also for these offshore areas an accumulation of age groups could take place in the length groups 22-26 mm dorsal carapace length, corresponding to about 26-30 mm lateral length.

GENERAL DISCUSSION AND CONCLUSIONS

Although the length of the berried period varies somewhat between areas in Greenland it is generally of a considerable length compared to some of the other areas outside Greenland where the species occurs. In some areas, at least, the major part of berried females will develop roe for a new spawning to take place about 4 months after the eggs hatched. It is suggested that this will mean a very small annual increment in carapace length for such animals, and lead to an accumulation of some age groups around the last high mode in the length frequency diagrams. In fact, compared to frequency diagrams of most fish catches there is a very high mode amongst the oldest animals where one would expect a decrease in modes if each mode represented an age group and if recruitment was rather constant. Difference between length groups in their occurrence at various depths and the selectivity of the gear may, of course, influence the length frequency diagrams considerably, but the said character of most diagrams is noteworthy. Anyway, detailed analyses of the distribution round the modes, especially the mode in the 22-26 mm length group (carapace dorsally measured) seems to require a close study.

The commercial fishery exploits mainly that group of animals considered in this paper, viz. the transitionals and females, but also the larger males (Berenboim et al., 1976. Fuertes and Lopez Veiga, 1976). The transitionals could probably be used as a measure of each year's recruitment to this group of animals. Anyway, it should be borne in mind that the long-term yield which can be taken from the said group of animals is no more than the mean annual recruitment to the group, and a part of the recruitment will have to be saved for a spawning and a hatching, the latter not taking place until about a year

after the transitionals recruited to the said length group and to the fishery. The fact that Pandalus borealis is a protandric hermaphrodite makes the question about stock/recruitment relationship and exploitation rate very important since no spawning by females occur before they enter the exploited phase of their life, and the females are exposed to one full year's fishing mortality, at least, before they make their first contribution to the production of larvae.

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Appendix 1.

REVISED TABLES

In Tables 2 and 3 the author initially used a fixed point of carapace length to assume that all individuals without roe but larger than that size were transitionals or females. For Tables 4 and 5 the length frequency of the individual samples was taken into account when separating the groups. This has now also been done for the Disko Bay material for the years 1974-76, and the revised figures are set out in Tables 2 and 3 revised. For the Christianshåb ground further samples are added. The revisions are in most cases rather small. The revised figures are used in Figs. 7 and 8.

It will be seen that in most cases the knife-edge distinction point between the males and the transitionals plus females is at or very close to those used in the first instance for the tables.

TABLE 1. Samples of *Pandalus borealis* from Tunugdliarfik, near Narssaq, southern Greenland. ♂ indicates transitional stages, BR berried females, HR head roe visible, NR no roe, KR lost or newly hatched roe. Percentages are percentages of total ♂ + ♀ .

	Year	1947	1950	1950	1950	1950	1950	1951	1952	1953	1953	1953	1953	1953	1953	1953
1.	Day/month	7.7	2.3	16.3	29.4	4.5	10.5	6.9	23.9	8.1	11.2	9.3	7.4	21.5	11.6	22.6
2.	Total sample (nos.)	160	216	121	213	185	213	942	294	209	378	449	475	562	593	412
3.	♂ total (nos.)	33	5	14	3	5	4	0	0	24	28	63	59	32	36	16
4.	♀ total (nos.)	40	38	80	14	6	7	51	34	14	40	58	82	43	41	102
5.	♂ NR %	-	9.3	7.4	-	-	-	-	-	63.2	41.2	-	-	-	-	-
6.	♂ HR %	45.2	2.3	7.4	17.6	45.6	36.4	-	-	-	-	52.1	41.8	42.7	46.8	13.6
7.	♀ NR %	2.7	16.3	8.5	-	-	-	37.3	44.1	18.4	14.7	-	-	4.0	28.6	3.4
8.	♀ HR %	52.1	11.6	53.2	58.8	36.4	45.6	27.5	-	-	-	12.4	14.2	16.0	24.7	78.8
9.	♀ BR %	-	58.1	23.4	17.6	18.2	18.2	35.3	47.1	18.4	44.1	34.7	42.6	4.0	-	-
10.	♀ KR %	-	2.3	-	5.9	-	-	-	8.8	-	-	1.0	1.4	33.3	-	4.2

	Year	1953	1953	1953	1953	1953	1953	1953	1953	1953	1953	1953	1954	1954	1954	1954	1954
1.	Day/month	16.7	9.8	22.8	7.9	23.9	10.10	24.10	10.11	24.11	11.12	28.12	13.1	25.1	12.2	1.3	18.3
2.	Total sample (nos.)	243	225	446	541	374	438	539	476	463	409	379	343	342	420	371	502
3.	♂ total (nos.)	32	0	2	4	1	2	0	13	8	21	8	13	10	23	30	39
4.	♀ total (nos.)	56	22	57	87	72	86	60	71	77	71	93	107	104	87	99	25
5.	♂ NR %	-	-	1.7	4.4	1.4	2.3	-	15.5	9.4	22.8	7.9	10.8	8.8	20.9	23.3	-
6.	♂ HR %	36.4	-	1.7	-	-	-	-	-	-	-	-	-	-	-	-	60.9
7.	♀ NR %	4.5	45.5	20.3	20.9	26.0	29.5	18.3	45.2	28.2	39.1	20.8	12.5	10.5	3.6	8.5	1.6
8.	♀ HR %	53.4	13.6	13.6	2.2	2.7	-	-	-	-	-	-	-	1.0	1.0	2.3	7.8
9.	♀ BR %	5.7	40.9	62.7	91.4	69.9	68.2	81.7	39.3	62.4	37.0	71.3	75.0	76.3	73.6	64.3	29.7
10.	♀ KR %	-	-	-	1.1	-	-	-	-	-	1.1	-	1.7	0.4	-	1.6	-

	Year	1954	1954	1954	1954	1954	1954	1954	1954	1955	1955	1955	1955	1955	1955	1956	1956	1956
1.	Day/month	6.4	20.4	7.5	21.5	8.6	21.6	5.7	23.8	22.8	7.9	23.9	24.10	14.11	14.12	10.1	21.2	23.3
2.	Total sample(nos.)	512	524	543	562	572	606	513	766	443	462	291	520	409	595	326	307	688
3.	♂ total (nos.)	43	20	15	6	12	8	14	0	1	0	0	0	0	6	17	2	17
4.	♀ total (nos.)	83	51	46	65	59	49	93	13	49	42	44	50	87	17	33	5	21
5.	♂ NR %	-	5.6	3.3	-	-	1.8	-	-	-	-	-	-	-	26.1	34.0	28.6	23.7
6.	♂ HR %	34.1	22.5	21.3	8.5	16.9	12.3	13.1	-	2.0	-	-	-	-	-	-	-	21.0
7.	♀ NR %	2.3	4.2	3.3	4.2	1.4	14.0	3.7	15.4	2.0	-	-	4.0	1.1	8.7	4.0	-	7.9
8.	♀ HR %	11.9	2.8	19.7	69.0	78.9	70.2	81.3	-	74.0	31.0	-	-	-	-	-	-	-
9.	♀ BR %	49.2	64.8	31.1	2.8	-	-	1.9	84.6	22.0	69.0	97.7	96.0	98.9	52.2	60.0	71.4	44.7
10.	♀ KR %	2.4	-	21.3	15.5	2.8	1.8	-	-	-	-	2.2	-	-	8.7	2.0	-	2.6

	Year	1956	1956	1956	1956	1956	1956	1956	1956	1957	1957	1957	1957	1958	1958	1958
1.	Day/month	10.4	7.5	14.6	30.6	30.7	31.8	29.9	20.10	26.1	28.2	18.3	15.11	2.1	3.3	19.7
2.	Total sample(nos.)	378	484	338	465	340	478	459	233	433	251	179	314	274	397	517
3.	♂ total (nos.)	7	4	4	1	0	1	0	0	18	9	9	8	10	21	6
4.	♀ total (nos.)	11	3	8	32	39	59	55	25	39	8	9	19	66	15	26
5.	♂ NR %	-	-	-	-	-	-	-	-	31.6	52.9	50.0	29.6	13.2	58.3	-
6.	♂ HR %	38.9	57.1	33.3	3.0	-	1.7	-	-	-	-	-	-	-	-	18.8
7.	♀ NR %	-	-	41.7	12.1	12.8	11.7	16.4	16.0	14.0	-	5.6	-	1.3	8.3	-
8.	♀ HR %	27.8	-	-	57.6	76.9	40.0	1.8	-	-	-	11.1	-	-	19.4	81.3
9.	♀ BR %	33.3	42.9	-	-	10.3	46.7	81.8	84.0	54.4	35.2	33.3	63.0	81.6	13.9	-
10.	♀ KR %	-	-	25.0	27.3	-	-	-	-	-	11.8	-	7.4	3.9	-	-

TABLE 2. Samples of Pandalus borealis from Disko Bay, trawling ground along Disko between Godhavn and Skansen. ♂ indicates transitional stages, BR berried females, HR head roe visible, NR no roe, KR lost or newly hatched roe. Percentages are percentages of total ♂ + ♀.

	Year	1948	1949	1949	1950	1950	1952	1952	1953	1953	1953	1954	1963	1964	1971	1974	1974	1974
1.	Day/month	2.9	12.7	21.8	6.6	18.7	1.7	28.7	23.7	23.7	18.8	1.8	12.8	27.7	24.7	4.8	31.8	20.9
2.	Total sample (nos.)	172	320	421	341	361	204	277	273	516	393	460	216	341	205	347	249	232
3.	♂ total (nos.)	10	2	1	16	68	39	15	6	8	7	22	6	0	1)	2)	1)	1)
4.	♀ total (nos.)	84	27	46	13	76	27	146	24	67	142	74	59	23	59	101	129	104
5.	♂ NR %	-	-	-	-	-	-	0.6	-	-	4.7	-	3)	-	1)	2)	1)	1)
6.	♂ HR %	10.6	6.9	2.1	55.2	47.2	59.1	8.7	20.2	10.7	-	22.9	9.2	-	1)	2)	1)	1)
7.	♀ NR %	-	44.8	44.7	-	17.4	15.2	36.6	16.7	28.0	38.3	2.1	63.1	39.1	54.2	54.5	65.9	77.9
8.	♀ HR %	55.3	48.3	2.1	31.0	20.8	21.2	4.3	16.7	22.6	2.7	25.0	16.9	43.5	39.0	24.8	13.2	1.9
9.	♀ BR %	31.9	-	51.1	-	14.6	4.5	45.3	46.7	38.7	54.4	40.6	10.8	17.4	6.8	20.8	20.9	20.2
10.	♀ KR %	2.1	-	-	13.8	-	-	4.3	-	-	-	9.4	-	-	1)	-	1)	1)

	Year	1974	1974	1974	1975	1975	1975	1975	1975	1976	1976
1.	Day/month	23.9	30.9	18.10	29.4	29.4	7.8	20.9	15.10	13.5	16.7
2.	Total sample (nos.)	503	548	476	750	673	749	1379	908	1457	797
3.	♂ total (nos.)	1)	1)	1)	1)	1)	1)	1)	1)	1)	1)
4.	♀ total (nos.)	126	175	129	185	221	453	346	354	228	417
5.	♂ NR %	1)	1)	1)	1)	1)	1)	1)	1)	1)	1)
6.	♂ HR %	1)	1)	1)	1)	1)	1)	1)	1)	1)	1)
7.	♀ NR %	81.7	84.6	71.3	23.8	46.6	39.7	71.7	47.2	42.1[4]	41.2
8.	♀ HR %	-	-	-	34.1	26.7	26.5	-	-	53.1	48.7
9.	♀ BR %	18.3	15.4	28.7	42.2	26.7	33.8	28.3	52.8	4.9	10.1
10.	♀ KR %	1)	1)	1)	1)	1)	1)	1)	1)	1)	1)

1) Sample broken down in 3 categories only: i) no roe ii) head roe iii) berried. All individuals of categories ii) and iii) and individuals of category i) above 26 mm(lateral) or 22 mm(dorsal) carapace length assumed to be ♀.

2) Transitionals grouped with ♀.

3) Transitionals not broken down but assumed to be with head roe.

4) Length frequency diagram indicates that most of these could be ♂.

TABLE 2, revised. Samples from the Godhavn ground, 1974-76. Samples where revisions occur are marked by x). The size above which all NR individuals are considered transitionals or females is given as carapace length dorsally (d) or laterally (l) measured.

Year	1974	1974	1974	1974	1974	1974	1975	1975	1975	1975	1975	1976	1976
Day/month	4.8	31.8	20.9	23.9	30.9	18.10	29.4	29.4	7.8	20.9	15.10	13.5	16.7
Total nos.	347	249	232	503	548	476	673	750	749	1379	908	1457	797
♂ + ♀ nos.	131	130	104	93	175	129	271	231	453	293	354	228	417
♂ + ♀ NR %	54.5	66.2	77.9	75.3	84.6	71.3	58.3	39.0	39.7	66.6	47.2	42.1	41.2
♂ + ♀ HR %	24.8	13.1	1.9	-	-	-	19.9	27.3	26.5	-	-	53.1	48.7
♀ BR %	20.8	20.8	20.2	24.7	15.4	28.7	21.8	33.8	33.8	33.4	52.8	4.9	10.1
mm carapace	26 l	26 l	26 l	27 l	22 d	22 d	21 d	21 d	22 d	23 d	22 d	22 d	22 d
Reference	Sandgr.	4971	4986	Alut	Kinga-puk	Hans H.	Elisa-beth	Anda P.	5101	5129	5141	5195	5262
Footnotes		x)		x)			x) 1)	x) 1)		x)		2)	

1) The NR group is likely to contain recruiting transitionals.

2) The NR group may contain some large males.

TABLE 3. Samples of Pandalus borealis from Disko Bay, ground off Christianshåb. ♂ indicates transitional stages, BR berried females, HR head roe visible, NR no roe, KR lost or newly hatched roe. Percentages are percentages of total ♂ + ♀.

1. Year	1947	1948	1948	1948	1948	1948	1948	1949	1949	1950	1950	1950	1950	1950	1952	1953	1953
Day/month	28.9	29.6	14.7	19.8	27.8	28.8	31.8	8.7	27.8	22.7	22.7	1.8	15.8	1.9	26.6	3.7	29.7
2. Total sample (nos.)	324	546	353	390	760	357	571	323	810	335	357	114	168	161	162	212	544
3. ♂ total (nos.)	0	44	18	24	11	11	3	3	13	32	18	3	1	1	32	11	23
4. ♀ total (nos.)	26	49	214	91	57	87	38	41	165	69	62	25	26	32	42	94	61
5. ♂ NR %	-	2)	2)	-	-	-	4.9	6.8	4.5	3.0	1.3	3.6	3.7	3.0	5.4	5.7	27.4
6. ♂ HR %	-	2)	2)	20.9	16.2	11.1	2.4	-	2.8	28.7	21.3	7.1	-	-	37.8	4.8	
7. ♀ NR %	26.9	2)	2)	9.6	8.8	8.1	9.8	25.0	50.6	10.9	16.3	21.4	25.9	12.1	21.6	53.3	31.0
8. ♀ HR %	-	2)	2)	60.0	25.0	43.4	24.4	68.2	3.4	27.7	27.5	10.7	14.8	6.1	24.3	16.2	9.5
9. ♀ BR %	73.1	2)	2)	9.6	47.1	28.3	58.5	-	38.8	28.7	28.8	57.1	55.6	72.7	10.8	18.1	32.1
10. ♀ KR %	-	2)	2)	-	-	8.1	-	-	-	1.0	5.0	-	3.7	6.1	-	1.9	-

1. Year	1953	1953	1953	1954	1954	1974	1974	1974	1974	1975	1976
Day/month	31.7	10.9	22.9	3.6	8.8	1.8	12.8	24.10	24.10	22.10	25.8
2. Total sample (nos.)	180	207	187	114	252	501 1)	535 1)	591 1)	546 1)	1397 1)	847 1)
3. ♂ total (nos.)	3	7	4	25	3						
4. ♀ total %	59	81	42	55	64	138 1)	132 1)	141 1)	164 1)	194 1)	268 1)
5. ♂ NR %	1.6	4.5	8.7	-	-	1)	1)	1)	1)	1)	1)
6. ♂ HR %	3.2	3.4	-	31.3	4.5						
7. ♀ NR %	25.8	50.0	41.3	52.5	34.3	49.3	57.8	58.9	59.8	44.8	57.1
8. ♀ HR %	17.7	13.6	-	16.3	29.9	29.0	14.4	-	-	-	0.7
9. ♀ BR %	50.0	28.4	50.0	-	31.3	21.7 1)	28.0 1)	41.1 1)	40.2 1)	55.2 1)	42.2 1)
10. ♀ KR %	1.6	-	-	-	-						

1) Sample broken down in 3 categories only: i)no roe ii)head roe iii)berried. All individuals of categories ii) and iii) and individuals of category i) above 26 mm (lateral) or 22 mm(dorsal) carapace length assumed to be ♀.

2) No detailed break down of transitionals and females

TABLE 3, revised. Samples from the Christianshåb ground, 1974-76. Samples where revisions occur are marked by x). The size above which all NR individuals are considered transitionals or females is given as carapace length dorsally (d) or laterally (l) measured.

Year	1974	1974	1974	1974	1974	1975	1975	1975	1975	1976	1976
Day/month	1.8	12.8	22.9	24.10	24.10	23.7	17.9	22.10	23.10	19.5	25.8
Total nos.	501	535	246	546	591	817	1075	1397	976	889	847
♂ + ♀ nos.	138	132	75	164	122	212	216	180	290	313	251
♂ + ♀ NR %	49.3	57.8	64.0	59.8	52.5	40.6	54.6	40.6	40.7	7.6	54.2
♂ + ♀ HR %	29.0	14.4	-	-	-	44.8	-	-	-	90.4	0.8
♂ + ♀ BR	21.7	28.0	36.0	40.2	47.5	14.6	45.4	59.4	59.3	1.9	45.0
mm carapace	26 l	26 l	26 l	26 l	27 l	22 d	23 d	23 d	23 d	22 d	22.5 d
Reference	Kuluk	Beathe O.	4988	Hans Ole	Hans Chr.	5081	5122	Rasmus A.	5151	5201	Kuluk
Footnotes			1)		x)	1)	1)	x)	1)	1)	x)

1) These samples are not included in the original Table 3.

TABLE 4. Samples of Pandalus borealis from the Godthåb Deep. Div. 1D. In this table the length frequency diagrams has been to judge the likely number of individuals without roe which may belong to the transitionals or females, and the size above which animals are regarded as belonging to this category is given in the table. Percentages are percentage of total transitionals (♂) plus females (♀). NR= no roe. HR= head roe. BR= berried females. d= dorsal measure, L= lateral measure of carapace.

1.	Year	1970	1970	1971	1971	1971	1971	1972	1972	1973	1973	1973	1973	1974	1974	1974
	Day/month	5.6	24.7	17.1	13.5	18.8	19.8	26.5	13.7	6.2	17.4	22.6	23.10	8.1	21.1	11.6
2.	Total sample (nos.)	403	250	160	209	353	317	225	390	129	147	164	228	170	177	275
3.	Total ♂ + ♀ (nos.)	110	53	130	200	137	101	136	201	92	95	116	92	90	63	99
4.	♂ + ♀ NR %	68.2	35.8	10.0	92.0	44.5	42.6	34.6	46.3	41.3	26.3	13.8	31.5	16.7	27.0	19.2
5.	♂ + ♀ HR %	31.8	64.2	-	-	51.8	53.5	65.4	53.7	-	6.3	86.2	-	-	-	90.9
6.	♀ BR %	-	-	90.0	8.0	3.6	4.0	-	-	58.7	67.4	-	68.5	83.3	73.0	-
7.	Size above which NR-individuals are considered ♂ or ♀(mm)	-	24L	24L	25L	25L	25L	25L	25L	25L	26L	26L	26L	27L	27L	26L
8.	Reference no. and footnotes.	4376	4422	4512	4530 4)	4582	4582	4626	4669	4718 5)	4738	4754	4865	4876	4877	4913

1.	Year	1974	1974	1975	1975	1975	1975	1975	1975	1976	1976
	Day/month	13.7	27.11	9.1	24.4	18.6	19.8	7.10	10.11	20.1	8.6
2.	Total sample (nos.)	270	217	226	549	804	406	578	684	541	723
3.	Total ♂ + ♀ (nos.)	195	92	122	149	122	149	273	219	292	288
4.	♂ + ♀ NR %	11.8	63.0	76.2	36.9	32.0	32.9	19.0	24.2	10.3	62.5
5.	♂ + ♀ HR %	88.2	-	-	4.0	68.0	63.1	0.7	-	-	37.5
6.	♀ BR %	-	37.0	23.8	59.1	-	4.0	80.2	75.8	89.7	-
7.	Size above which NR-individuals are considered ♂ or ♀(mm)	26L	24L	23L	27L	22.5d	22.5d	23d	23d	22.5d	22d
8.	Reference no. and footnotes	4943	5002 3)	5016 1)	5031 1)	5043 2)	5110 2)	5134	5158	5176 1)	5209

1) The NR group is likely to be composed mainly of transitionals which have or will develop head roe.
2) The NR group may include relatively many large males.
3) The NR group likely to be composed of animals which are in the first transitional stages.
4) The NR group includes many with recently hatched eggs.
5) The record show 58.7 % HR, but should presumably read BR.

TABLE 5. Samples of Pandalus borealis from the Sukkertoppen Deep, ICNAF Div. 1C. In this table the length frequency diagrams has been to judge the likely number of individuals without roe which may belong to the transitionals or females, and the size above which animals are regarded as belonging to this category is given in the table. Percentages are percentage of total transitionals (♂) plus females (♀). NR= no roe. HR= head roe. BR= berried females. d= dorsal measure. L= lateral measure of carapace.

1.	Year	1970	1971	1971	1972	1972	1973	1973	1973	1974	1974	1975	1975	1976	1976	1976
	Day/month	1.6	28.5	20.8	14.4	14.6	13.2	12.3	28.6	18.6	4.12	21.4	24.6	14.1	30.4	9.6
2.	Total sample (nos.)	341	171	226	189	151	144	121	242	265	117	122	478	591	595	460
3.	Total ♂+♀ (nos.)	288	150	182	125	133	116	111	217	208	50	86	257	338	279	335
4.	♂ + ♀ NR %	99.7	100.0	17.6	80.8	36.8	44.0	54.1	48.8	24.0	54.0	98.8	10.5	95.0	88.9	32.8
5.	♂ + ♀ HR %	0.3	-	82.4	-	63.2	-	-	51.2	76.0	-	-	89.5	-	1.8	67.2
6.	♀ BR %	-	-	-	19.2	-	56.0	45.9	-	-	46.0	1.9	-	5.0	9.3	-
7.	Size above which NR-individuals are considered ♂ or ♀(mm)	-	25L	26L	26L	26L	26L	25L	25L	25L	26L	26L	24d	22d	22.5d	23.5d
8.	Reference no. and foot notes	4375	4532 2)	4583	4621 1)3)	4637	4719	4726 1)	4759	4916 1)	5003	5030	5047	5175 1)	5187 1)	5215

1) The NR group is likely to be composed mainly of transitionals which have or will develop head roe.

2) Most of those without roe have recently hatched the eggs (setae on the pleopods).

3) The NR group contains some which recently hatched the eggs.

4) The NR group may contain some large males.

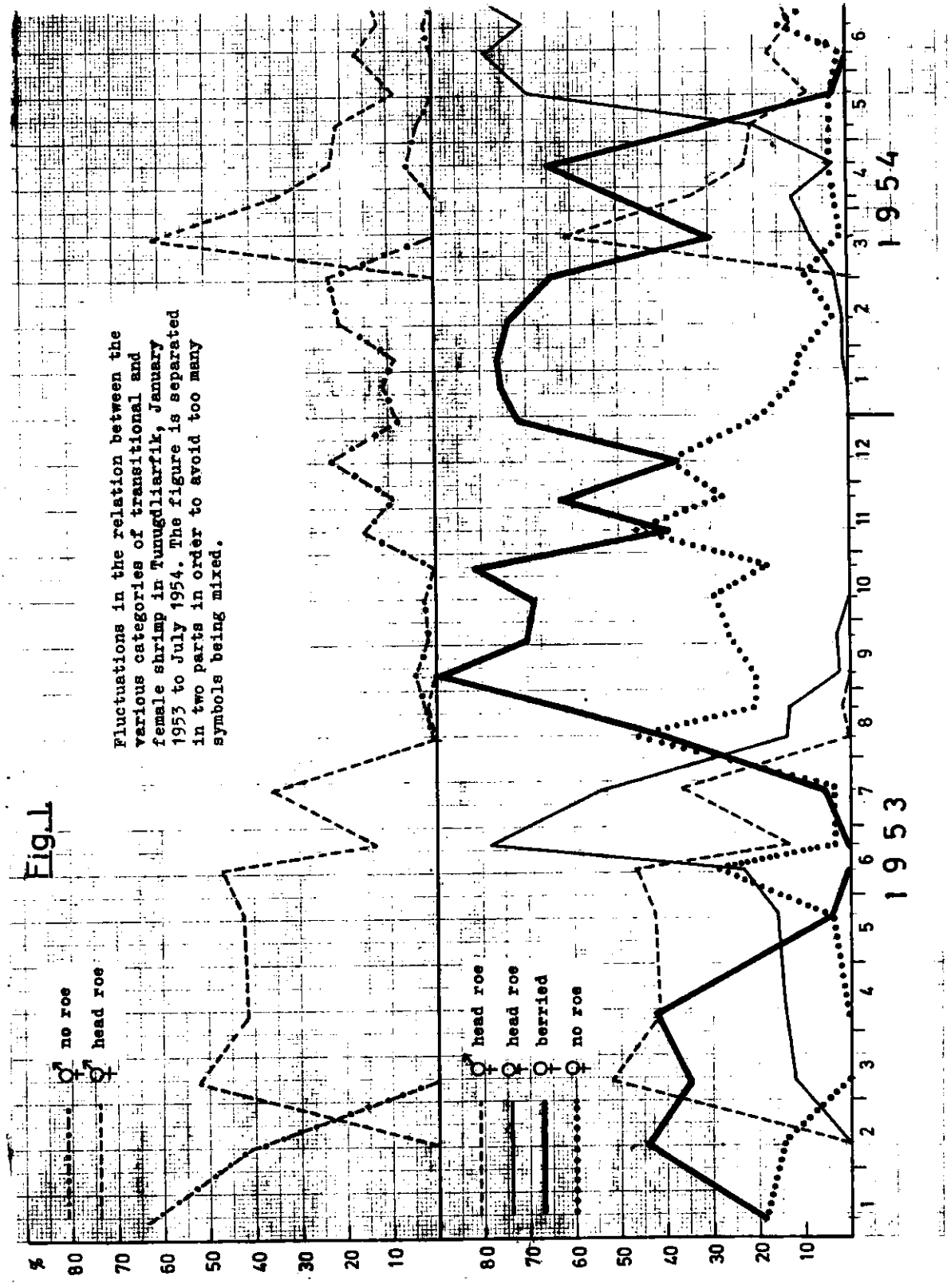
Fig.1
Fluctuations in the relation between the various categories of transitional and female shrimp in Tunugdliarfik, January 1953 to July 1954. The figure is separated in two parts in order to avoid too many symbols being mixed.
♂ no roe
♂ head roe
♀ head roe
♀ head roe
♀ berried
♀ no roe
%
1953
1954

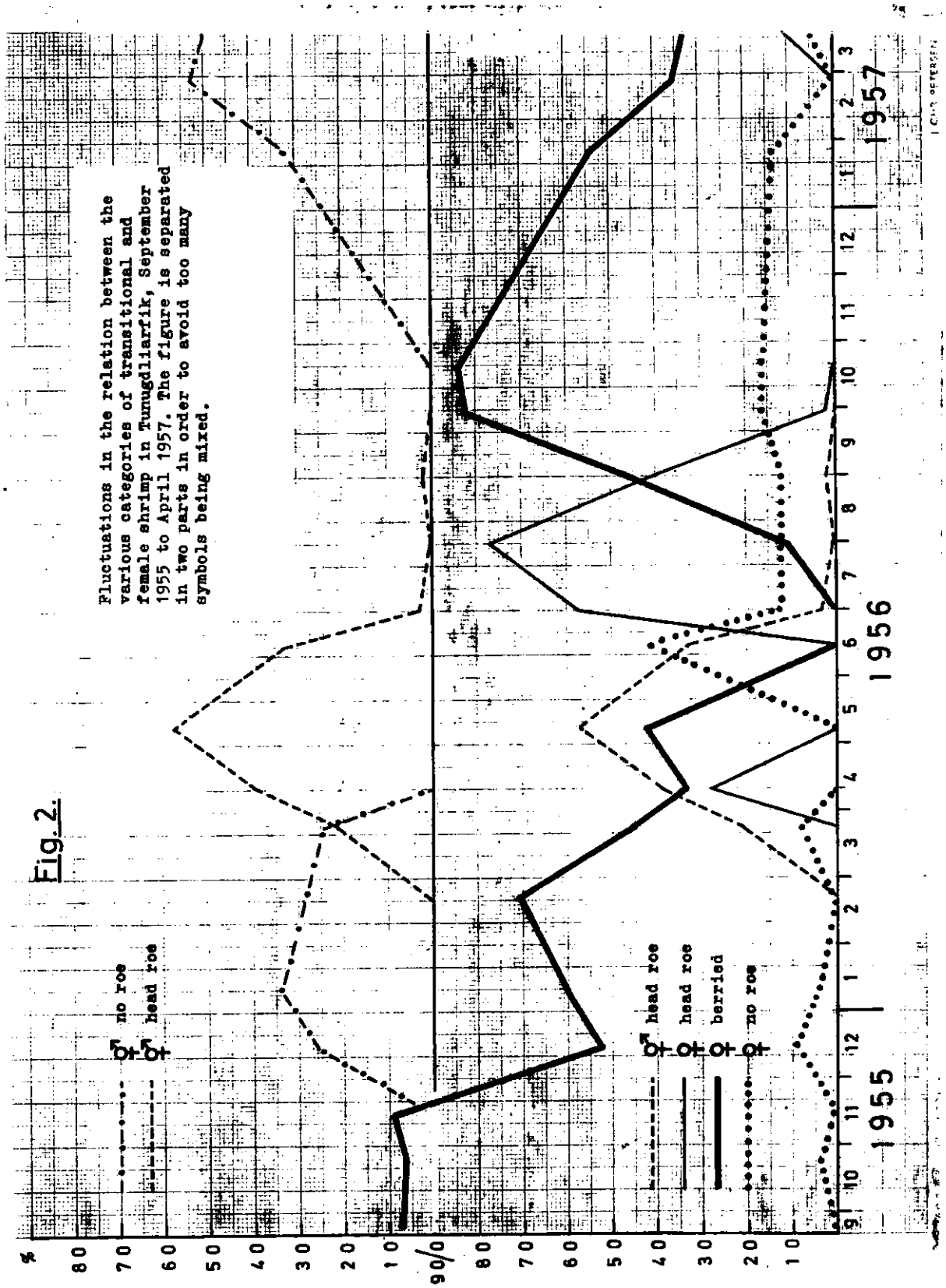
Fig.2.
Fluctuations in the relation between the various categories of transitional and female shrimp in Tunugdliarfik, September 1955 to April 1957. The figure is separated in two parts in order to avoid too many symbols being mixed.
no roe
head roe
head roe
head roe
berried
no roe
1955
1956
1957
%

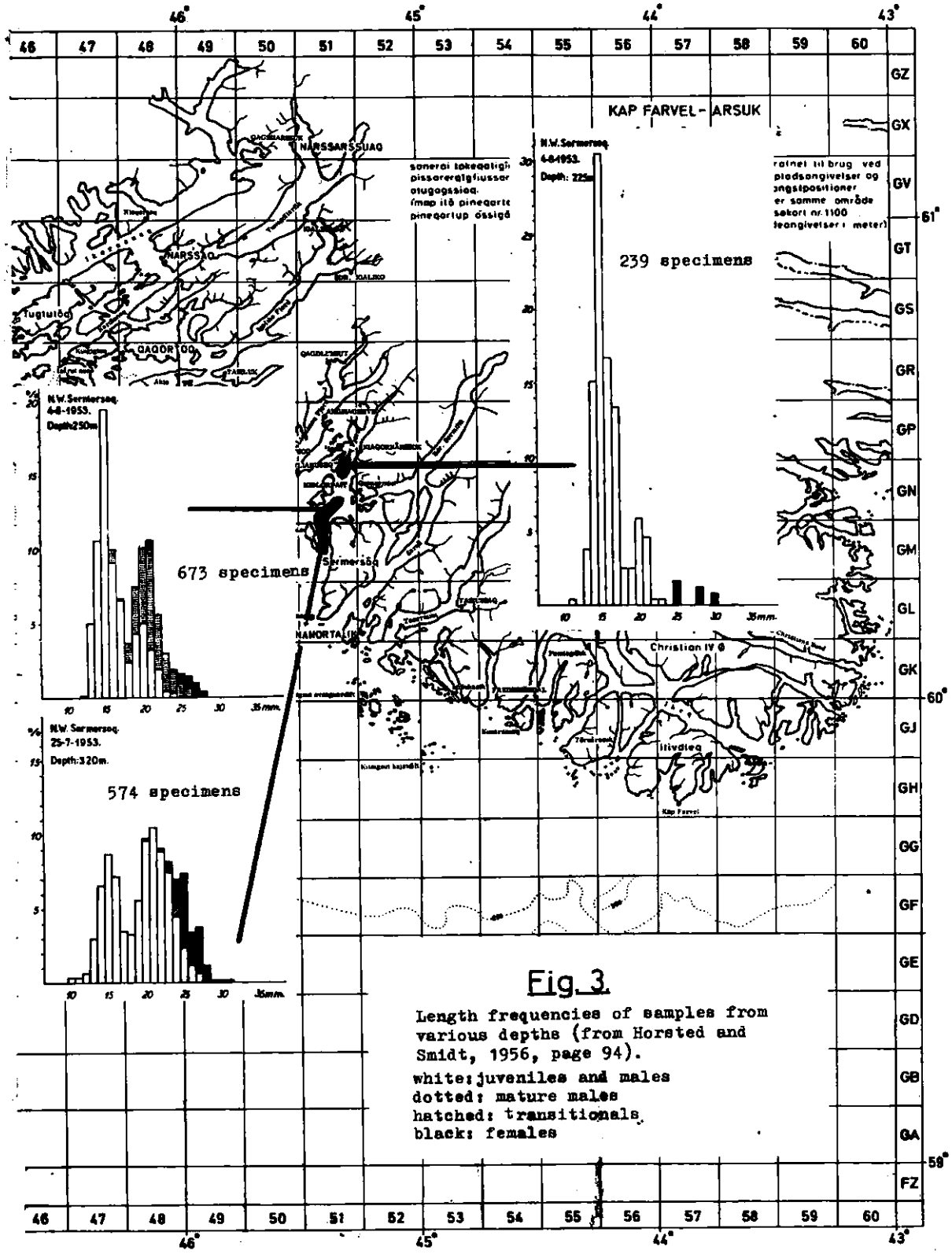

Fig. 3.

Length frequencies of samples from various depths (from Horsted and Smidt, 1956, page 94).

white: juveniles and males
dotted: mature males
hatched: transitionals
black: females

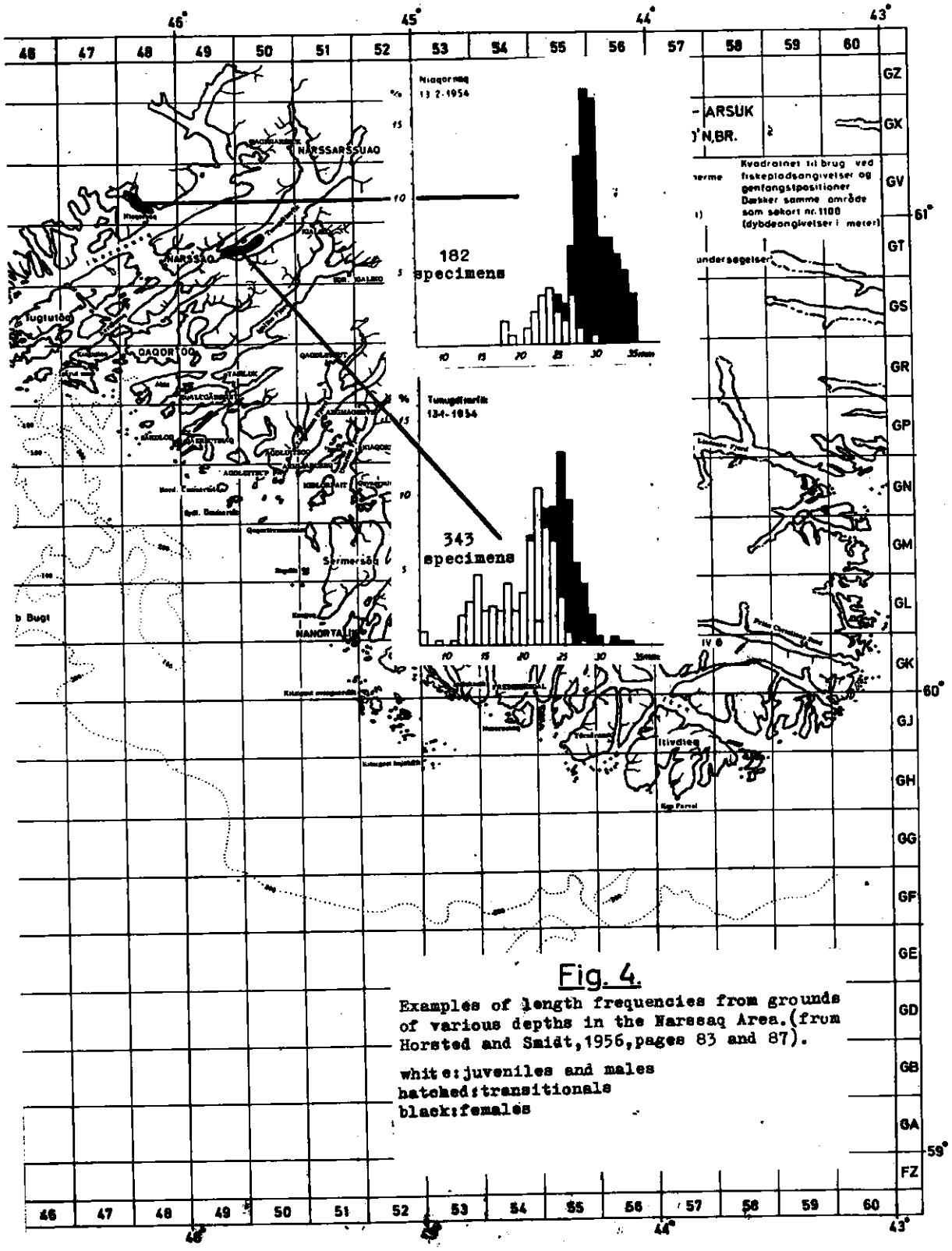

Fig. 4.

Examples of length frequencies from grounds of various depths in the Narssaq Area.(from Horsted and Smidt,1956,pages 83 and 87).

white:juveniles and males
hatched:transitionals
black:females

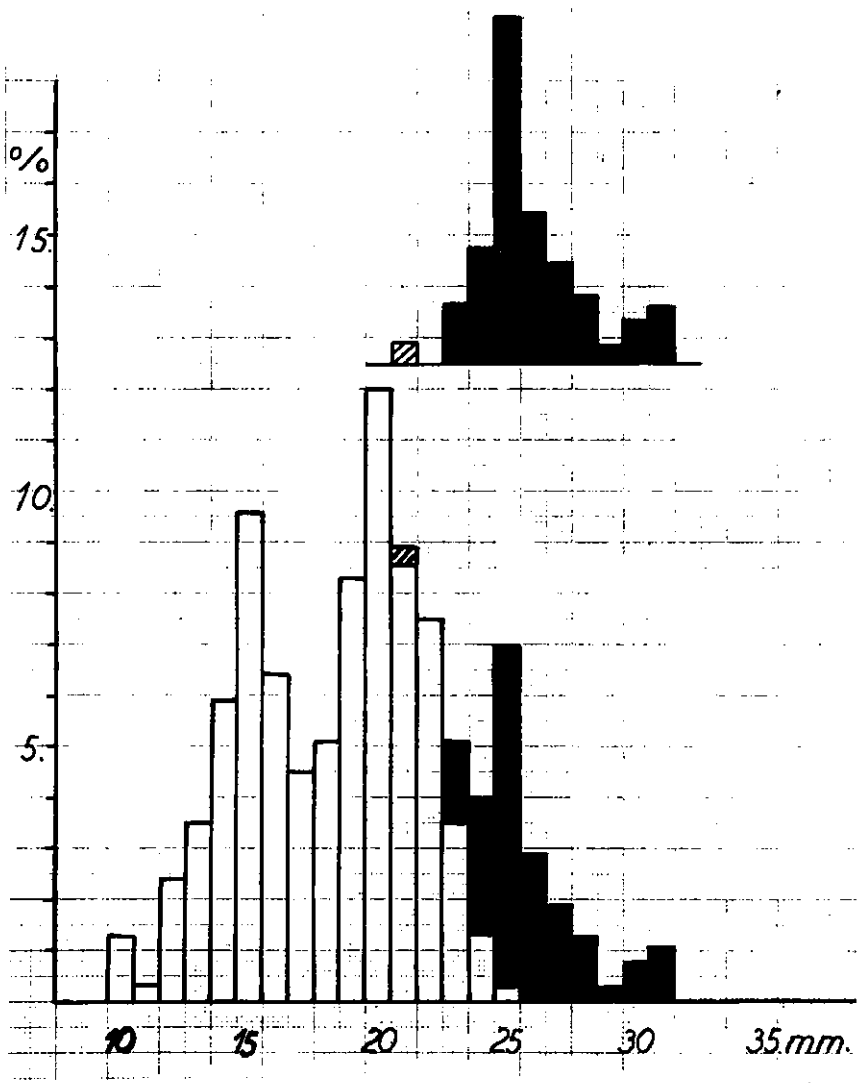

Fig. 5. Length frequencies of shrimps from Tunugdliarfik, 23 September 1953. Transitionals and females shown separately in the upper part of the figure. White - juveniles and males; hatched - transitionals; black - females. Total: 374 specimens.

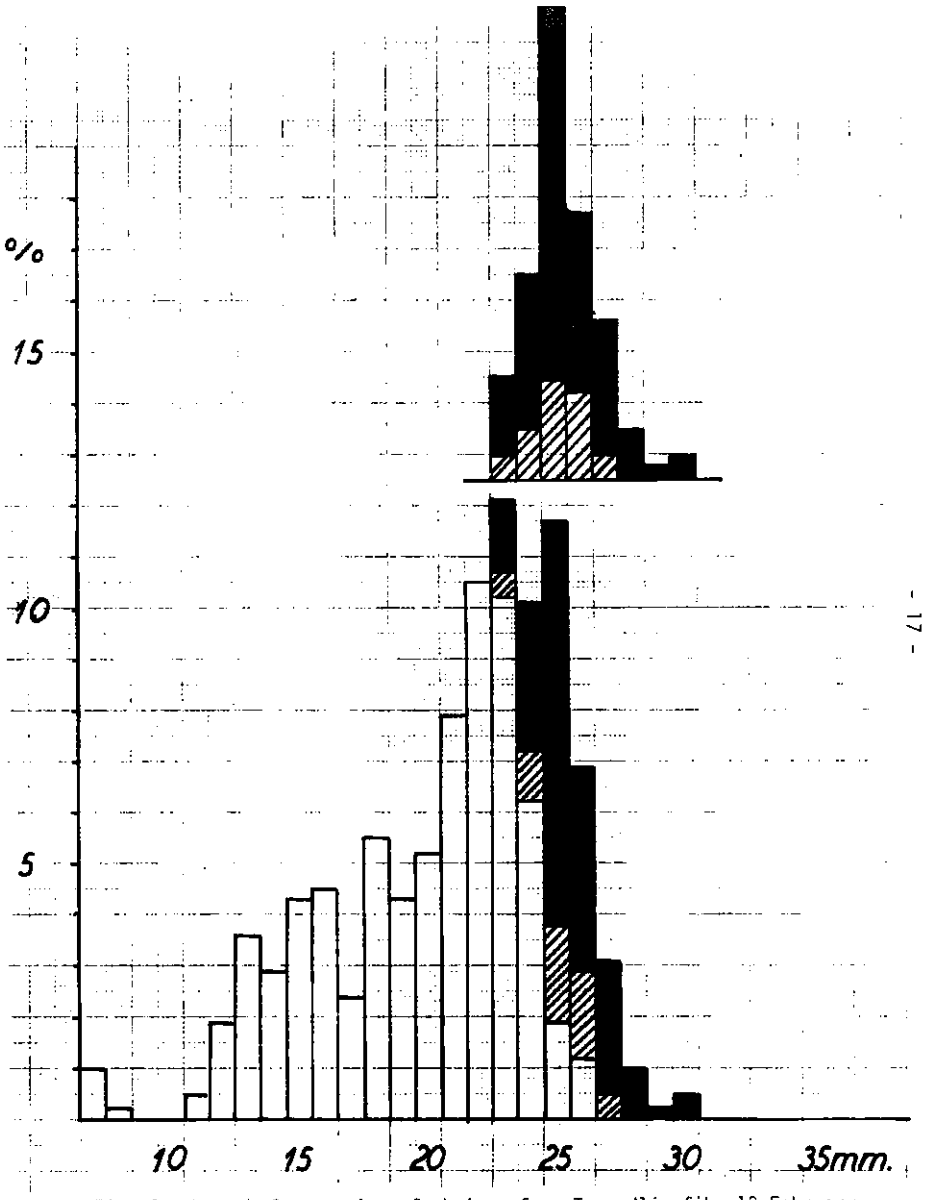

Fig. 6. Length frequencies of shrimps from Tunugdliarfik, 12 February 1954. Transitionals and females shown separately in the upper part of the figure. Symbols - see Fig. 5. Total: 420 specimens.

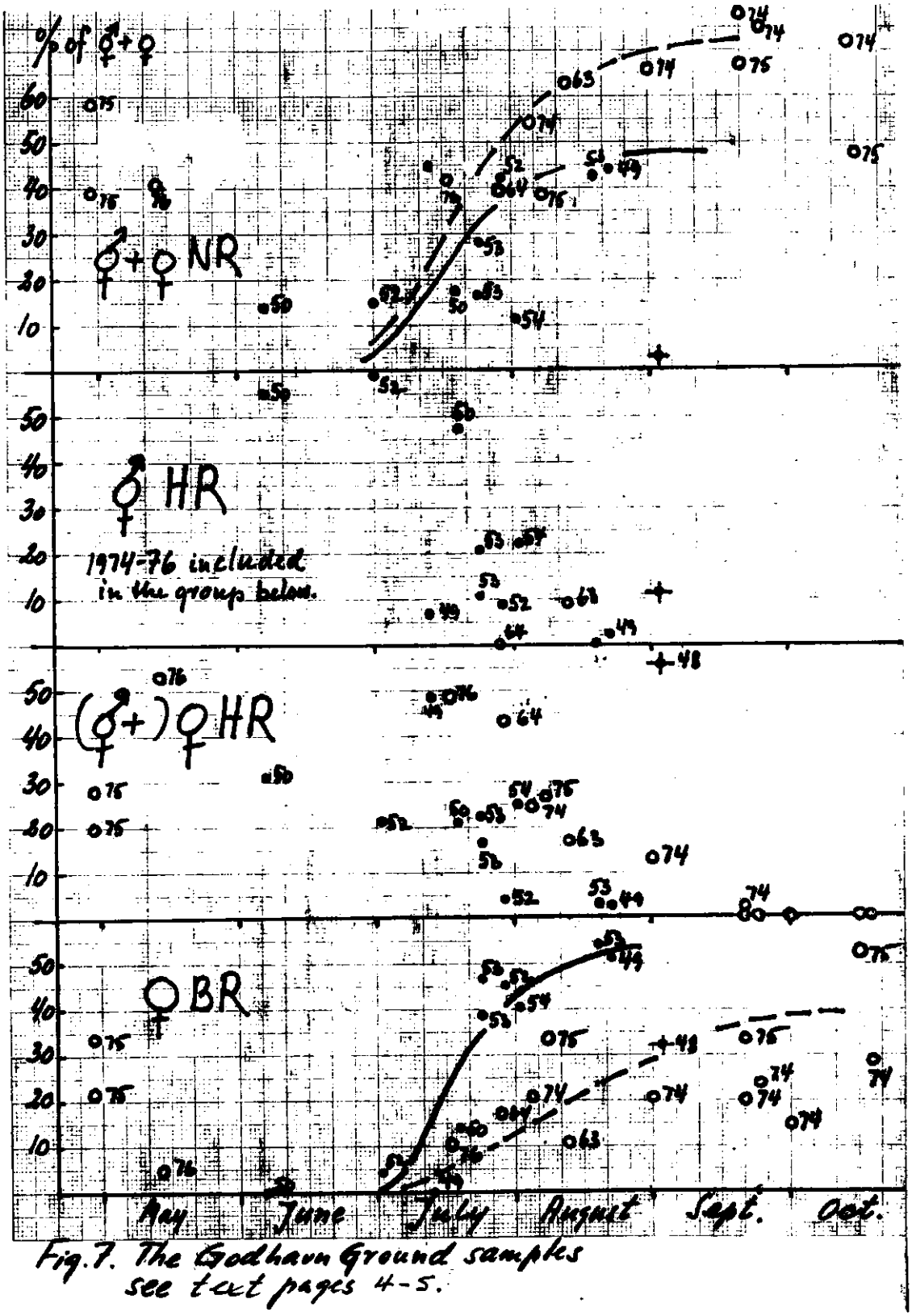

Fig. 7. The Godhavn Ground samples
see text pages 4-5.

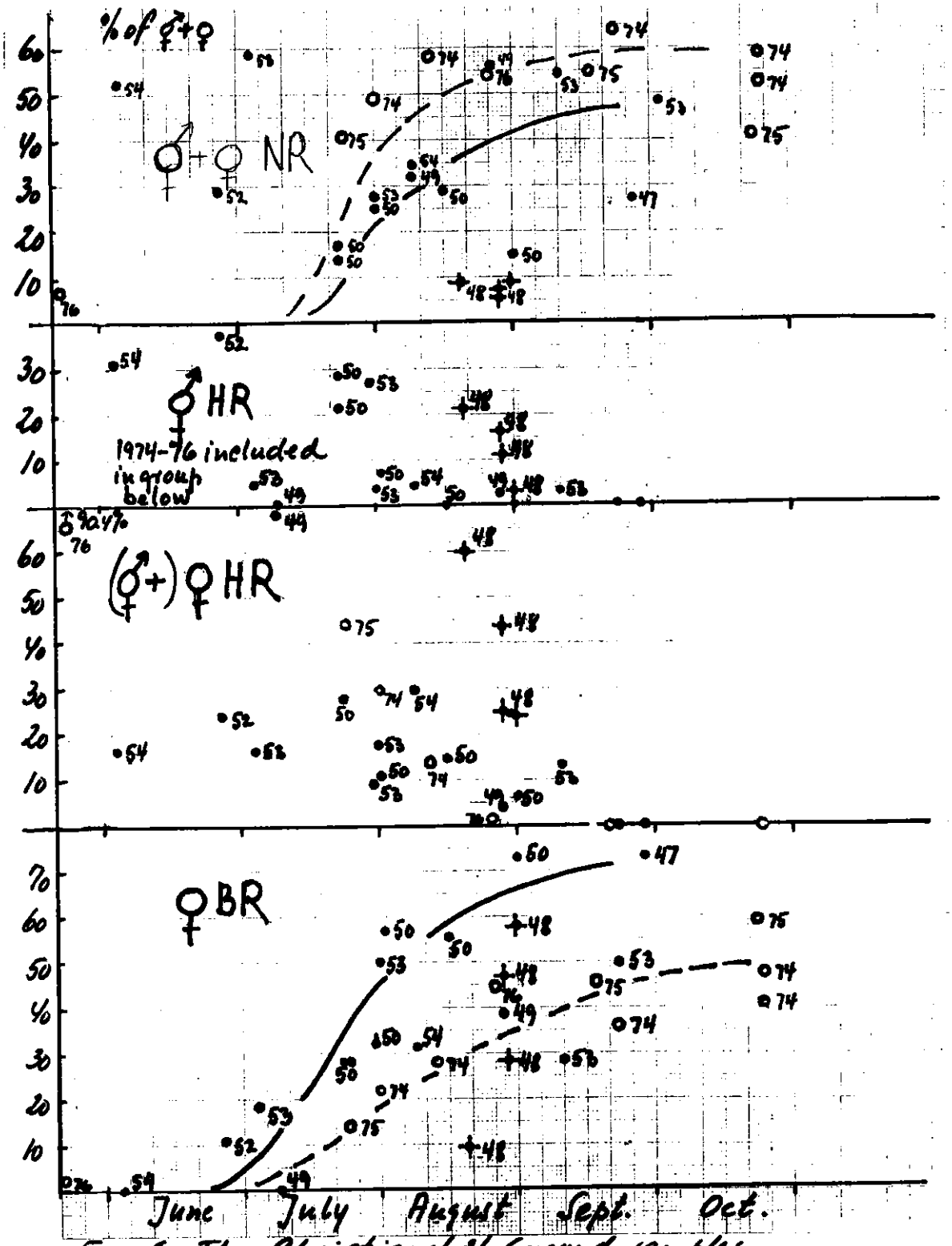

Fig. 8. The Christianshåb Ground samples
see text pages 4-5.

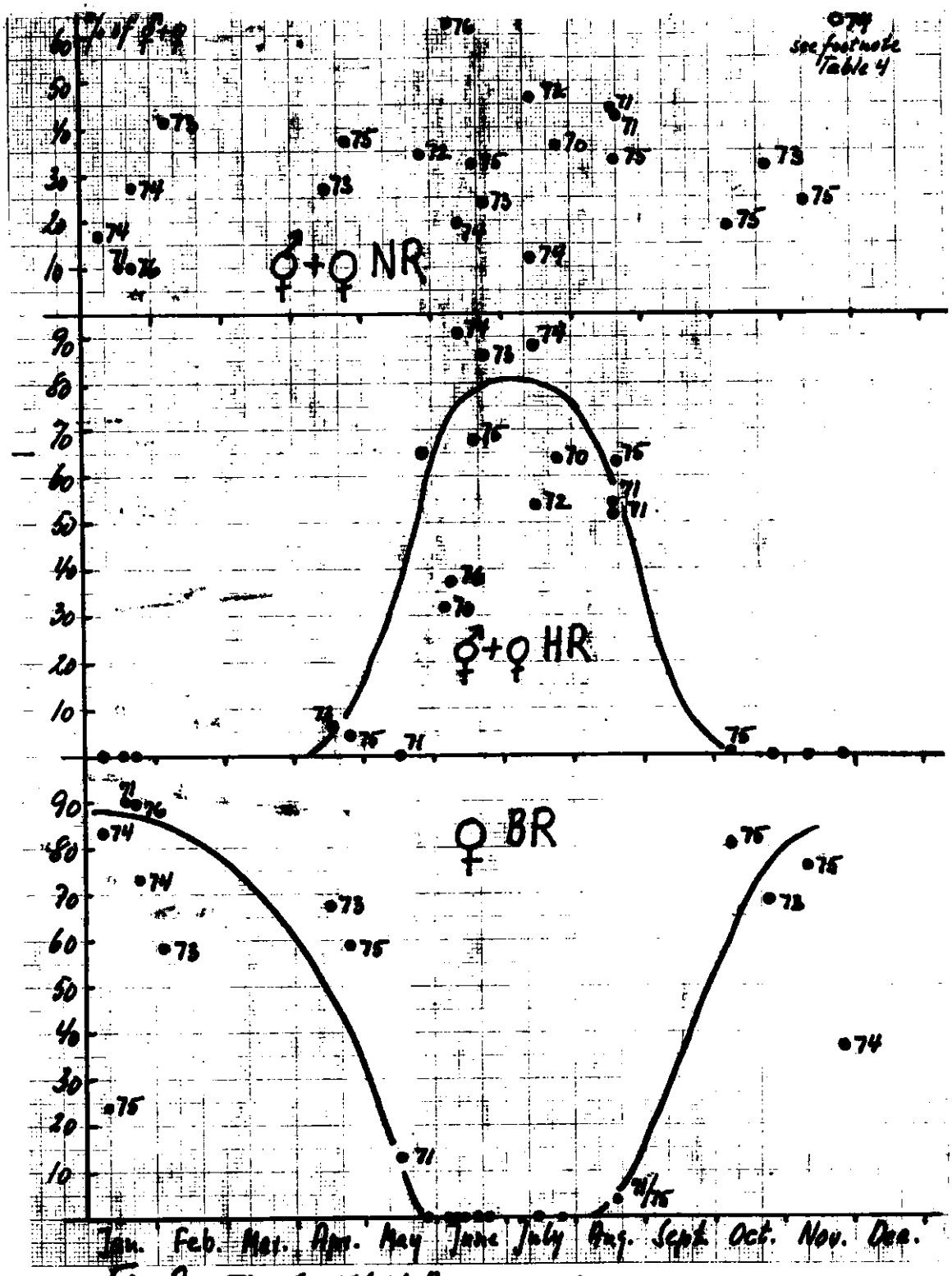

Fig. 9. The Godthåb Deep samples

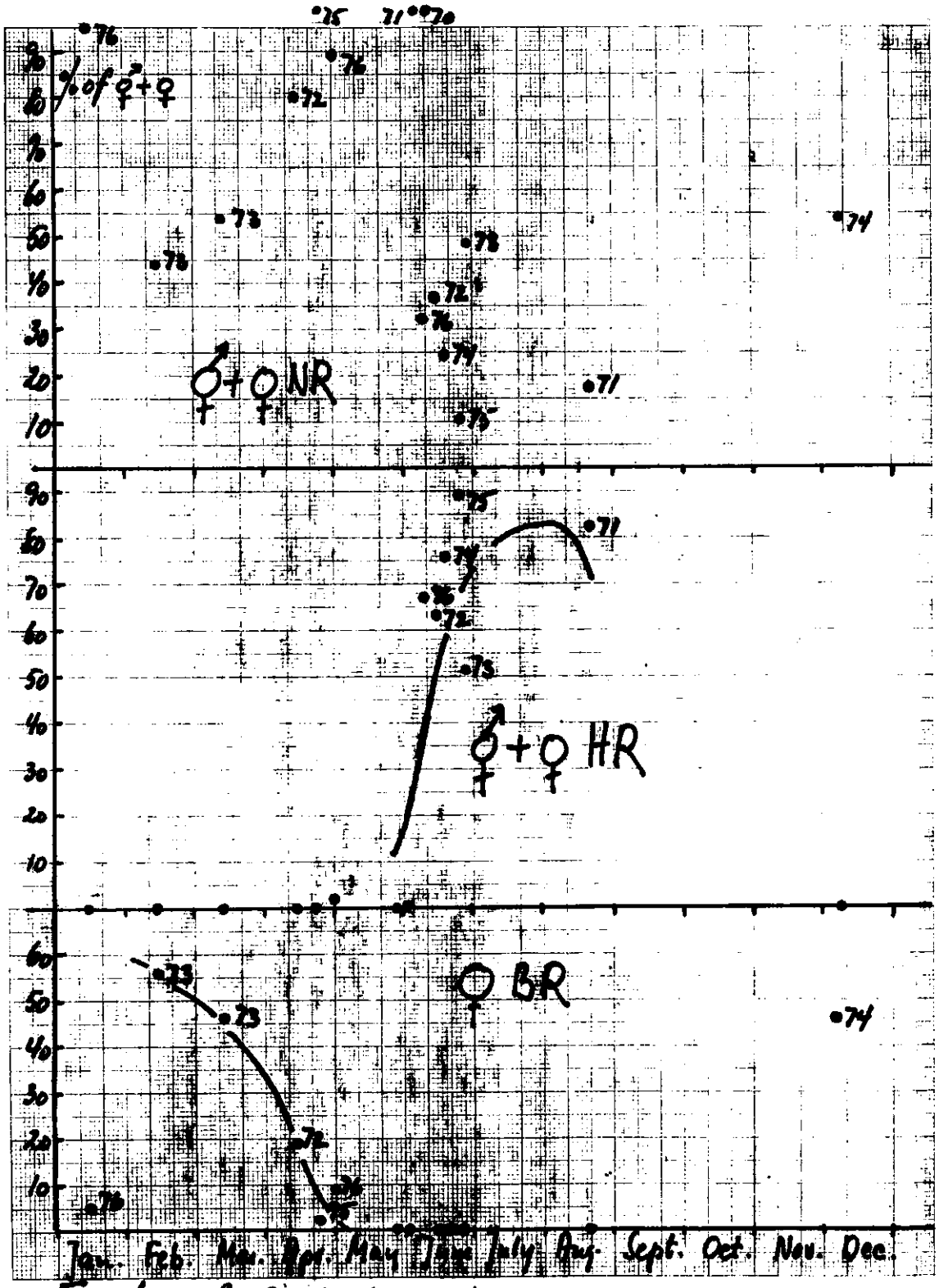

Fig. 10. The Sickler toppen Deep samples.