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*Cole: Amaliches Revet -
Mordall. Portucale gefist*

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Some notes on the breeding of Norway Lobster
around the Portuguese Coast

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by

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Introduction

The present paper is dealing with some of the first results from the investigations on the breeding of Norway Lobster in portuguese waters. Until now we knew practically nothing about this matter; the little information available was coming from fishermen who always have noticed that females Norway Lobsters begin to spawn in August or September.

Material and methods

Since April 1962 observations have been made from samples obtained: a) from captures of a commercial trawling boat; b) at the fishing market of Lisbon. Because of some difficulties in their acquisition neither of them were representative of the total catches or of the sex-ratio.

The carapace length was measured to the nearest millimeter and grouped into classes of 3 mm; the carapace of the males was ranged from 23 to 77 mm. and the carapace of the females from 23 to 62 mm., Length distribution of the individuals from each sample is expressed in Tables I-V. All individuals have been examined in the fresh condition and pieces of the frontal lobes of the ovaries and of the central part of the testis have been taken of and fixed in 10% formaline in Bouin's or Gilson's fluid. Twenty five eggs were measured from each ovary and several histological sections have been made from a few ones. Histological sections were also obtained from all testis. The pieces were embedding in paraffin and stained in hemalum-eosin. All individuals were found to be mature.

Development stages of the ovary

Through the macroscopical observation of the fresh ovaries and the measuring of their fixed eggs' largest diameter, we were able to classify the ovaries according with the following stages:

- I. Ovary transparent white, narrow and smooth; lateral wings conspicuous; eggs just visible to naked eye. Eggs size 0,05-0,45mm mean size 0,24 mm.
- II. Ovary opacous white, very narrow and smooth; lateral wings conspicuous. Eggs size 0,05 - 0,65 mm; mean size 0,35.

- III. Ovary yellowish white or greenish white, wide, with slight corrugations; lateral wings still visible.
Eggs length 0,05 - 0,75 mm; mean size 0,45 mm.
- IV. Ovary pale green, bright yellow or orange, wide, with marked corrugations; lateral wings hardly visible.
Eggs size 0,05 - 0,95 mm; mean size 0,55mm.
- V. Ovary green, very wide; corrugations all over the ovary die fly on the frontal lobes which are very large; no lateral wings visible. Eggs size 0,05 - 1,05mm; mean size 0,68 mm.
- VI. Ovary dark green, very wide; strong corrugations over the frontal lobes which are expanded and turned backwards; no lateral wings visible. Eggs size 0,15-2,05mm; mean size 1,09mm.

No resorbing phase or resting stage was found; all the ovaries examined showed well visible eggs to naked eye and histological sections confirm that earlier ovaries had already well developed eggs. Furthermore we were able to find one female in the act of spawning; she was already berried, but part of her ovary was still dark green with large eggs, in stage VI; the remaining of it have been passed directly into stage I and was showing small white eggs just visible to naked eye. There is evidence that the eggs of the future generation are already in maturative development when the spawning of the last generation takes place. This fast maturative development of the eggs stocks, is possibly related with the relatively high temperature of the water in portuguese coast.

We could never find in literature references to bright yellow or orange ovaries. However, these colours were rather common among the females of our material. We may think that the chromoprotein responsible for the green color of the eggs, probably the lobster's overdin, might be also accountable for the yellow and orange colors of the eggs. In fact, a solution of overdin becomes orange when heated to 65 - 70° C., in presence of neutral salts (Goodwin 1960).

Maturative development of the ovaries throughout the year

The fig.1, shows the monthly percentages of the development stages of the ovary. In June and July 1962 the bulk of ovaries was in stage VI; in August more than 50% of them were still in stage VI, but spawning had already begun, and consequently, berried females were found with thin white ovaries in stage I. In the following months stages I and II were observed in more than 50% of the females: in September the bulk of the ovaries was in stage I; in October both stages were found in about the same proportions; in November stage II was in majority and, at last, in December all the white ovaries observed belonged to stage II. Stages III and IV became evident in January 1963 and they formed a rather high percentage in February and March, together with some white ovaries in stage II. In April, the bulk of ovaries was reaching stages V and VI; in May and June stage VI was dominant. Then the ovaries became quite mature and the future spawning will certainly take place in August/September 1963.

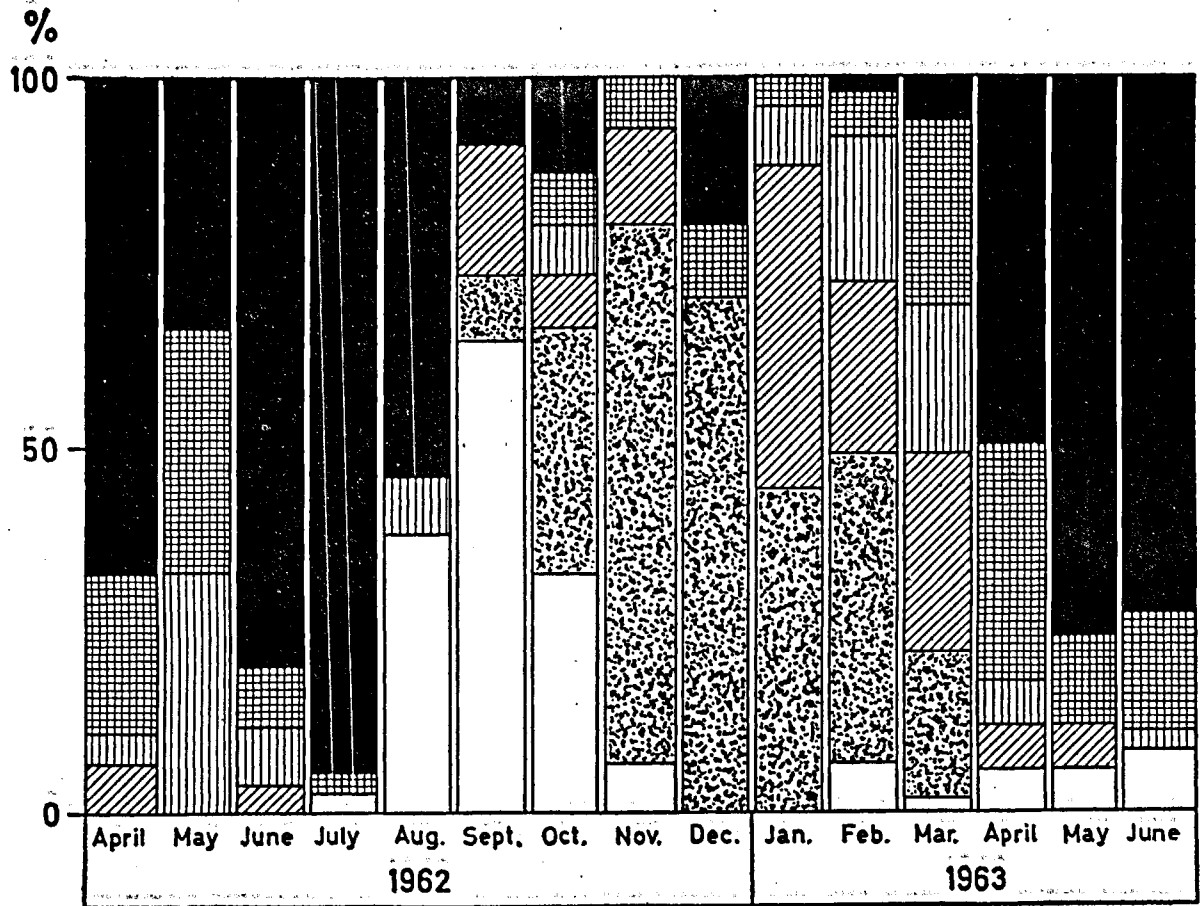
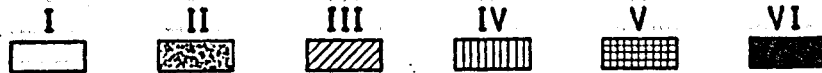


Fig.1 - Monthly percentages of the development stages of the ovaries



Development stages of the external eggs

The external eggs show a rather great variability of aspects. They are dark green just after spawning and then they become gradually lighter, through light green to olive pink; just before hatching they show a rather light pink color. Taking the length of the eggs, their color, the absence or presence of embryo and its stage of development (given by the easy measurement of the thickness of the embryo's eyes) we have tried to make up a classification of the development of the external eggs according to the following stages.

Stages	Eggs' color	Eggs' size mm			Thickness of embryo's eyes mm		
		Min.	Max.	Mean	Min.	Max.	Mean
<u>A</u>	Dark green	1.05	1.55	1.34	no	embryo	
<u>B</u>	Dark green	1.25	1.65	1.42	0.05	0.23	0.08
<u>C</u>	Light green	1.25	1.75	1.53	0.09	0.27	0.17
<u>D</u>	Olive pink	1.35	1.85	1.62	0.09	0.32	0.23
<u>E</u>	Light pink	1.35	2.05	1.66	0.14	0.41	0.27

Development of the external eggs throughout the year

Berried females were not very common but they enable us to follow the development of their external eggs all over the year.

The number of berried females with eggs in development stages A to E is expressed, per month, in Table VI, together with the number of females bearing ovaries in development stages I to VI, also expressed per month.

As we have already mentioned before, in June/July 1962 the majority of the females had ovaries in stage VI and the spawning took place in following August/September; we may refer it as "autumn spawning" because females carry their eggs throughout autumn and winter time.

The first berried females (except one found in July) appeared just in August/September and were bearing external dark green eggs in stage A. In October we were not able to find berried females but in November they appeared again and four of them still beared external eggs in stage A; however, a single specimen was already showing eggs in stage B. In December, two berried females were found, bearing eggs in stage B. Since January 1963 stage A sharply decreases; 50% of the females were still bearing eggs in development stage B while the remaining of them were carrying eggs in stages C and D. In February all stages were found; stage B still important; stages C and D in about the same proportions as in January; and for the first time stage E was appearing, pointing out the approach of hatching. Stage A also came out in a small percentage; it probably means that there is a secondary period of spawning which shall be

referred as "spring spawning" because females will carry their eggs throughout spring and summer time. In March, stages C and D had disappeared but stage E was still found. Stages A and B from "spring spawning" were also visible. In April and May hatching had been already accomplished and the two berried females observed were carrying eggs respectively in stages A and B. In June no berried females were found.

The eggs from "autumn spawning" are carried by the females throughout autumn and winter: stage A develops slowly, extending itself since August/September to November, but the following stages are shorter, each one lasting about one month. In February/March, the eggs had reached stage E and the larvae were ready for hatching. Therefore, females are carrying external eggs over a period of 6 or 7 months.

The eggs from "spring spawning" (February/March) are carried by the females throughout spring and summer. If their development is not disturbed by the higher water temperature of this period of the year, we may think that hatching of their larvae will take place 6 or 7 months later, viz August/September.

After hatching females generally cast, and then copulation can be accomplished under the soft-shelled condition, during April/July for the "autumn spawning females" and during November/January, for the fewer "spring spawning females".

Correspondence between stages of development of the ovaries and of the external eggs.

During September, October, November and December, just after the "autumn spawning" females generally show their ovaries in stages I and II; meanwhile, berried females are carrying eggs in development stages A (September/November) and in development stage B (December). However, some females bearing ovaries in stages I and II are not berried; it probably means that they have failed to be fertilised, and consequently, the ovaries have been resorbed (which is doubtful because we could never find ovaries in resorbing phases) or the eggs have been lost just after spawning.

In January, February and March the majority of the ovaries was reaching stages III and IV; while the bulk of external eggs was passing into stages C, D and E. Hatching takes place in February/March generally before the ovaries have passed into stages V and VI. The - therefore, stages I, II, III and IV of the ovary development generally occur under berried condition; After hatching females usually cast and copulation may take place; meanwhile the ovaries are passing throughout stages V and VI, until they realize again the "autumn spawning" in August/September. The eggs of this recent spawning will be carried by females until February/March of the following year. The undermentioned table will better point out this brief explanation:

BREEDING CICLE OF "AUTOMN SPAWNING FEMALES"

External eggs from first generation							not berried females					External eggs from second generation.							
A	A	A	B	CD	CDE	DE	-	-	-	-	-	A	A	A	B	CD	CDE	DE	
I	I	I	II	II	III	III	V	V	VI	VI	VI	I	I	I	II	II	III	III	
		II		III	IV	IV					I			II		III	IV	IV	
S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	
					hatching							spaw ning						hatching	

We have some good reasons to believe that the breeding cicle of the "spring spawning females", will show an identical sequence. However, we have not sufficient data to confirm this hypothesis.

Besides, there is probably no distinction between automn and spring spawning; females spawning in early spring are perhaps advanced or retarded on the maturative development of their ovaries as compared as those spawning in early automn. That is probably the reason why berried females have been found all over the year (FIGUEIREDO, 1963).

Sometimes the maturative development of the ovary proved to be very fast; in fact, four females have been found with ovaries in stage V, bearing external eggs in stages B, C, D and E. The last one was found in February, just before hatching, while her nearly mature green ovary was showing that spawning would certainly take place in a delay of about four months, viz in May. This fact suggest that Norway Lobsters females from portuguese waters are some times able to spawn twice in the same year.

Maturative development of testis

Macroscopical observations of the testis have been also undertaken but we soon realized that they furnished no elements to make up a classification of their maturative development. In consequence, we have tried a microscopical examination through the study of several histological sections obtained all over the year. Presently we are still working on them, but some provisory conclusions can be pointed out:

1. Histological sections always revealed mature testis although there was no possibility of separating them into different stages of development.

2. There is evidence that the spermatogenesis may be accomplished all over the year, but two main periods are to be regarded concerning its intensity: a) one period of great activity, extending from November to August, which is characterised by a great number of germ cells in all phases of their maturative process;

b) other period comprising only September and October in which most lobes of the testis are seen in a quite evident desorganisation, but in a few ones, we can state germ cells in full activity.

This evidence suggests that males are generally fertile all over the year, with a decreasing intensity in September/October, just after the mainly period of spawning.

Summary

In this paper, we intend to make up classifications of the maturative development of the ovaries and of the external eggs in Norway Lobster. Accordingly, these maturative processes have been followed throughout the year; the bulk of the ovaries were found to pass from first stage of development, in August/September, to maturity, in August/September of the following year; then spawning takes place and external eggs are carried by the females over a period of about 6 or 7 months, until hatching in February/March of the following year. Briefly, from the early maturities of the ovaries until the hatching of the larvae, a delay of about one year and an half is to be expected. Males have been found to be fertile all over the year with a decreasing intensity of their fertility in September/October just after the bulk of females have accomplished their spawning.

R E F E R E N C E S

- FIGUEIREDO, M.J., 1963 Note sur la composition des Stocks de Langoustines (NEPHROPS NORVEGICUS (L)) de la côte portugaise; Contribution N° 43 du Comité de Mollusques et Crustacés du Conseil International pour l'Exploration de la Mer.
- GOODWIN, T.W., 1960. The physiology of Crustacea. Vol.I (Metabolism and Growth) Chapter 3, p.101. Academy Press, New York and London, 1960.

TABLE I - 1962

Sample Date	1 17 Apr.		2 9 May		3 23 May		4 11 June		5 22 June		6 27 June	
Class	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm												
23	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
29	1	-	-	-	1	-	-	-	-	1	-	-
32	5	1	-	-	1	-	-	-	2	-	-	-
35	3	8	2	1	3	7	-	2	3	4	-	-
38	2	3	-	-	1	5	-	-	-	2	-	-
41	4	3	2	8	1	3	-	4	1	3	-	-
44	8	7	3	7	1	2	-	1	-	-	-	2
47	6	5	1	1	-	1	1	-	-	-	3	5
50	3	-	-	-	-	-	-	-	-	-	1	-
53	-	-	-	-	-	-	1	-	-	-	1	-
56	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	1	-
65	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	-	-	-	-	-	-	-	-
Total	32	27	8	17	8	18	2	7	6	10	6	7
♂ber.♀	0		0		0		0		0		0	

TABLE II - 1962

Sample Date	7 6 July		8 11 July		9 26 July		10 27 July		11 10 Aug.		12 .27 Aug.		13 .11 Sept.		14 .19 Sept.	
Class	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm																
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
32	-	-	-	-	-	-	-	-	1	2	-	-	-	-	1	-
35	-	-	-	-	-	-	1	-	2	-	-	-	3	2	1	1
38	2	1	-	-	1	-	1	-	5	5	-	-	1	3	1	1
41	1	2	1	2	1	4	1	2	-	2	-	1	4	-	-	1
44	5	3	-	3	6	4	4	1	-	-	1	1	4	1	2	1
47	3	2	2	2	5	1	2	7	-	-	-	2	-	-	-	-
50	2	1	3	-	2	-	2	-	-	-	-	1	1	-	2	-
53	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	13	9	6	7	17	9	11	10	8	9	2	5	13	7	7	4
♂ber.♀	0		0		11.1		0		0		40.0		57.1		50.0	

TABLE III - 1962

Sample Date	15		16		17		18		19		20		21		22	
	16 Oct.		23 Oct.		3 Nov.		13 Nov.		24 Nov.		29 Nov.		4 Dec.		13 Dec.	
Class	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm.																
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
26	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1
29	2	3	-	-	1	-	3	3	-	-	-	-	-	-	3	3
32	7	3	-	-	3	4	5	4	-	-	1	1	-	-	3	-
35	12	4	-	-	7	1	9	1	-	-	-	1	-	-	3	2
38	19	4	-	-	8	-	10	-	-	-	-	-	1	-	3	-
41	10	2	-	-	3	-	4	-	-	-	-	-	1	-	1	-
44	1	-	-	-	-	-	1	-	4	-	1	-	4	1	-	-
47	-	-	-	-	-	-	1	-	2	-	-	-	4	-	1	2
50	-	-	-	-	-	-	-	-	3	-	-	-	-	-	2	-
53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-
68	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
71	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	51	17	4	-	22	5	33	8	10	-	3	2	10	1	20	9
%ber.♀	0		-		0		37.5		-		100.0		100.0		11.1	

TABLE IV - 1963

Sample Date	23		24		25		26		27		28		29		30		31	
	15 Jan.		22 Jan.		3 Feb.		8 Feb.		18 Feb.		7 Mar.		19 Mar.		29 Mar.		29 Mar.	
Class	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm.																		
23	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
29	4	3	-	-	-	1	-	4	1	-	-	1	-	-	-	-	-	1
32	2	4	-	3	-	-	-	13	2	-	-	4	1	-	-	2	3	3
35	4	3	1	3	-	-	-	12	2	-	-	3	1	-	-	3	3	4
38	1	-	-	3	-	1	1	12	4	-	1	9	4	-	-	2	3	3
41	2	-	-	1	-	3	1	5	5	-	-	3	2	-	1	1	3	2
44	3	1	-	1	1	6	-	2	-	-	-	2	2	-	-	2	3	2
47	1	-	-	1	-	4	-	-	-	-	-	-	-	-	-	2	4	-
50	-	-	1	1	-	1	-	-	-	-	-	-	-	-	2	2	4	-
53	1	-	1	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
56	-	-	1	-	-	3	-	-	-	-	-	-	2	-	1	-	-	-
59	-	-	2	-	2	-	-	-	-	-	-	-	1	-	1	-	-	-
62	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	19	12	6	14	5	20	2	49	14	-	1	22	13	-	7	14	23	15
%ber.♀	33.3		50.0		65.0		46.9		-		9.1		-		28.6		0	

TABLE V - 1963

Sample Date	32 15 Apr.		33 22 Apr.		34 4 May		35 7 May		36 4 June		37 12 June		38 20 June	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
mm.														
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	1	-	-	-	-	-	-	2	1	10	-	1	-
35	-	2	2	-	-	-	3	-	1	4	6	1	1	-
38	-	5	3	-	-	5	7	-	2	4	1	2	1	-
41	-	3	7	-	-	8	5	-	2	-	1	2	2	-
44	-	4	3	-	-	4	1	-	1	1	1	-	2	-
47	-	2	1	-	-	-	-	-	-	-	-	2	2	-
50	-	-	-	-	-	-	-	-	-	-	-	1	-	-
53	-	1	-	-	-	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	2	-	-	2	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	1	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	18	16	-	-	17	16	-	3	8	10	19	10	10
%Ber.♀		5.6	-		5.9	-			0		0			0

TABLE VI

NUMBER PER MONTH OF DEVELOPMENT STAGES OF OVARIES (I to VI)
AND OF EXTERNAL EGGS (A to E)

	I	II	III	IV	V	VI	A	B	C	D	E
1962											
April	-	-	2	1	6	18	-	-	-	-	-
May	-	-	-	6	6	6	-	-	-	-	-
June	-	-	1	2	2	19	-	-	-	-	-
July	1	-	-	-	1	28	1	-	-	-	-
Aug.	5	-	-	1	-	7	2	-	-	-	-
Sept.	7	1	2	-	-	1	6	-	-	-	-
Oct.	5	5	1	1	1	2	-	-	-	-	-
Nov.	1	11	2	-	1	-	4	1	-	-	-
Dec.	-	7	-	-	1	2	-	2	-	-	-
1963											
Jan.	-	10	10	2	1	-	-	5	2	3	-
Feb.	5	29	16	14	4	1	4	9	7	11	3
March	1	10	14	10	13	3	1	2	-	-	2
April	1	-	1	1	6	9	1	-	-	-	-
May	1	-	1	-	2	13	-	1	-	-	-
June	3	-	-	1	6	27	-	-	-	-	-