International Council for
the Exploration of the Sea

C.M. 1981/K : 29
Shellfish and Benthos
Comittee

MYTILICOLA ORIENTALIS MORI, CRASSOSTREA GIGAS THUNBERG'S PARASITE, IN THE BASIN OF MARENNES-OLERON : IMPACT ON THE CONDITION AND THE BIOCHEMICAL COMPOSITION OF OYSTERS DURING REARING.

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Abstract : Crassostrea gigas Thunberg's infestation by Mytilicola orientalis Mori in 1979 in the basin of Marennes-Oléron presents two maxima, one during spring, the other during autumn. The parasites have infested until 64 % of bred oysters.

The intensity of infestation is weak (93.5 % of oysters are infested by less than six females) and depend on the hosts' size. By this fact, significant impact appeares only in spring and in winter. A middle infestation of more than three M. orientalis females seems to induce a significant decrease of rates of carbohydrates and of glycogen.

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Résumé : L'infestation de Crassostrea gigas Thunberg par Mytilicola orientalis Mori en 1979 dans le bassin de Marennes-Oléron, présente deux maxima, l'un au printemps, l'autre en automne. Les parasites ont infesté jusqu'à 64 % des huîtres mises en élevage. L'intensité d'infestation est faible (93,5 % des huîtres sont infestées par moins de six femelles) et dépend de la taille des hôtes. De ce fait, il n'apparait d'impact significatif sur l'index de condition qu'au printemps et en hiver. Une infestation moyenne de plus de trois femelles de M. orientalis semble induire une réduction significative des taux de glucides totaux et de glycogène.

Introduction :

The endoparasitic copepod Mytilicola orientalis Mori (1935) was first described on the French Atlantic coasts in 1977 in Arcachon (Hiss, 1977). As on the American and Canadian coasts, after epizootie of 1970-1971, it's the massive introduction of the Japanese oysters, Crassostrea gigas Thunberg, which seems responsible for the Mytilicola orientalis' appearance, (Bradley and Siebert, 1978).

Opinions differ about effects induced by the presence of Mytilicolidae in the intestinal tracts of mollusks (oyster, mussel) on their condition. For some, these effects depend on the intensity of infestation (Cole and Savage, 1951 ; Andreu, 1963 ; Gee and al. , 1977), for the others, there would be no effect (Brenko, 1964 ; Dethlefsen, 1975). Likewise, in some people's opinions, Mytilicola action is made responsible for the massive mortalities of reared mollusks (Korringa, 1951 ; Hiss, 1978), whereas the others conclude to the absence of effect (Bernard, 1969 ; Katkansky and al. , 1967 ; Glude, 1975).

In parallel to a biometric and biochemical study of oyster rearing at Marennes-Oléron in I979 (Deslous-Paoli, I980), the infestation evolution of these oysters by M. orientalis has been taken into account.

We'll try, here, to examine the impact on the condition, as well as the tissues of oysters.

I Methods and materials :

The parasitism has been studied on two shares of Crassostrea gigas of different ages, the first born in I977, the second, in I978. They have been reared in elevator position since January I979 in the basin of Marennes-Oléron (fig. I) on the banc d'Agnas, at the density of 320/m^2.

Samples of 50 oysters by age groups were taken and analysed twice a month. After the determination of the weights and the volume, the intestinal tracts of oysters were opened and the parasites counted.

The parasites are classified in three groups (Chew and al., I965) :

- males and immatures : size between 2 and 5 mm ;
- females : size $\geq$ 6 mm ;
- matures females which carry sacs.

The condition index employed outcomes from Higgins's index, (I938) :

$$I = \frac{\text{wet weight of the meat (g.)}}{\text{volume of shell cavity (ml.)}} \times I00$$

After freezing and dessication of oysters' tissues at 60° C, during 70 hours (Deslous-Paoli, I980), the proteins are analysed by the method of Lowry and al. (I95I), the carbohydrates and the glycogen by the method of Dubois and al. (I956), and the lipids, extracted and purified by the method of Bligh and Dyer (I959) are

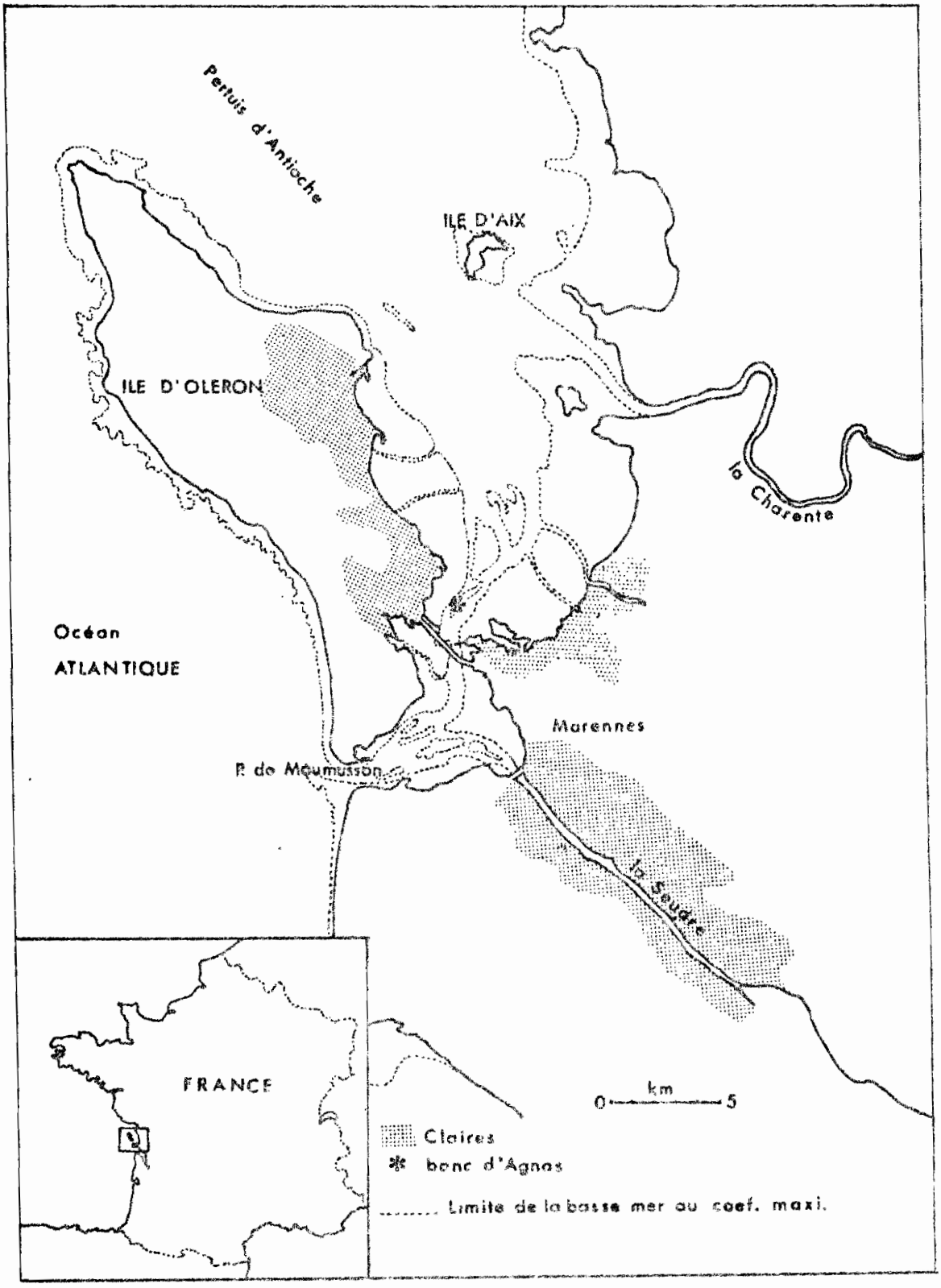

Figure 1 : Le bassin de Marennes - Oléron.

weighted.

II Results :

I- Population dynamics :

The percentage of infested oysters by Mytilicola orientalis can grow until 64 %, but seems to depend on the oysters' sizes and the season (fig. 2).

Indeed, though we find parasites in the six-month old oysters, it's only in the 15-month old that we notice an augmentation of infested percentage in the population. In the oldest oysters, the infestation presents a maxima during spring, which, after a summer fall, reappears in autumn before a winter stage.

However, the infestation intensity, or middle number of parasites per infested host (fig. 2), showing a maxima only in autumn, involves a most important infestation during this period for the two oyster groups.

The M. orientalis population structure (fig. 3) shows a spring augmentation of mature females number, and a decrease of immature females. The phenomena is reversed at the end of autumn. The females seem mature during all the year. The males and immature number rises in autumn until an important stage during winter.

2- Influence of the parasitism on the condition index :

A significant difference appears between the middle condition index of the infested oysters and that of the non-infested oysters, during spring and winter, for those, born in 1977 (table I).

Though, we must point out that, during all the studied year, taking only the female parasites into consideration (the bigger),

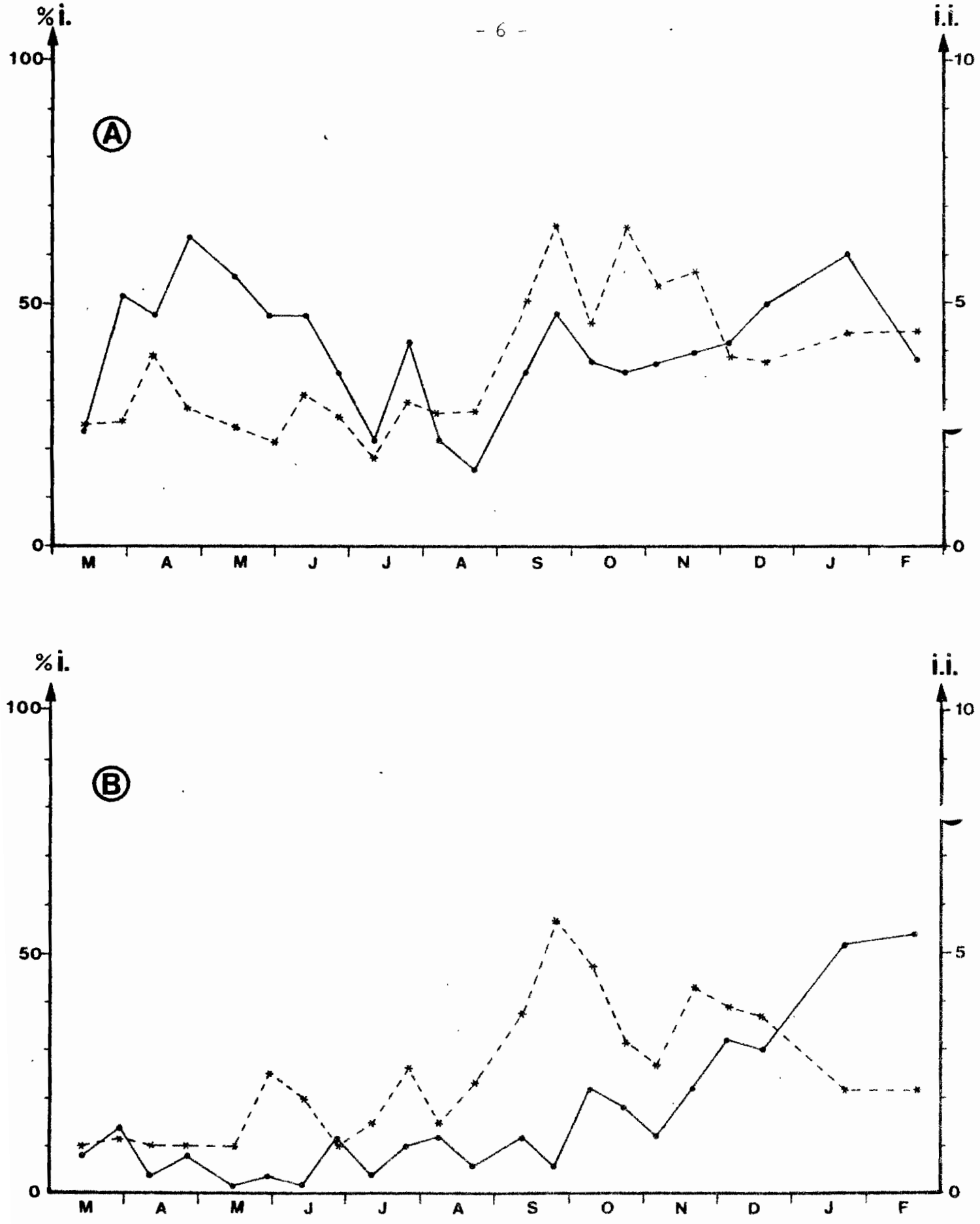

Figure 2 : Variations of percentage (⟶) and of the infestation intensity (⟶) during 1980 for Crassostrea gigas :

A- born in July 1977

B- born in July 1978.

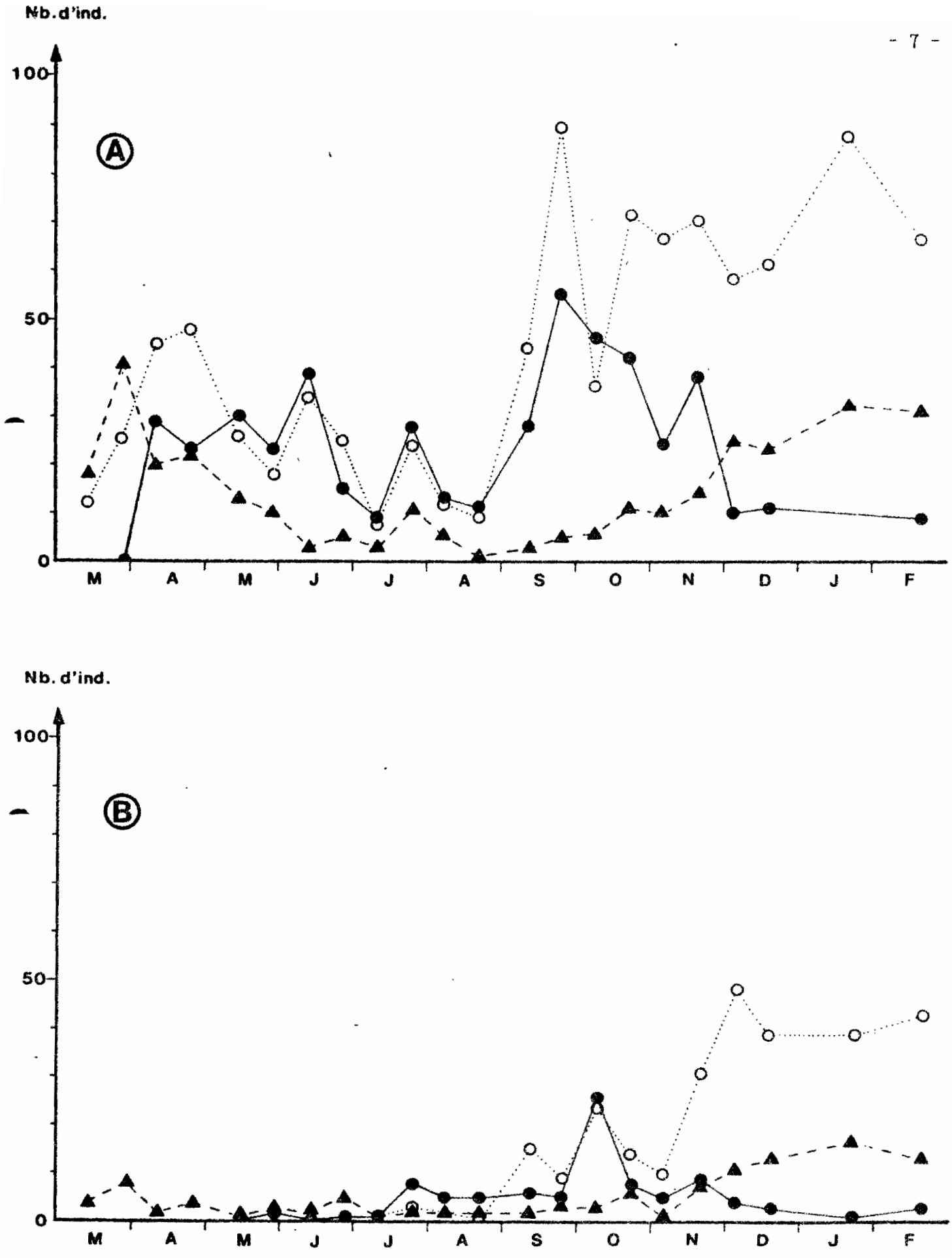

Figure 3 : Evolution of the number of mature females (●——●), of immatures females (▲- - -▲) and of males and immatures (o····o) of Mytilicola orientalis in a sample of 50 oysters :

A - born in July 1977
B - born in July 1978

Table I : Influence of the presence of Mytilicola orientalis on the oysters condition index. Statistic comparison between the averages of n individuals.

date	infested oysters			non-infested oysters			d / S_d	signif.
	index	s	n	index	s	n		
13- 3	2,2	0,9	12	2,9	0,7	38	2,61	P= 0,02
28- 3	3,0	0,9	26	3,1	1,1	24	0,39	-
11- 4	3,4	1,5	24	4,5	1,0	26	2,97	P= 0,01
25- 4	4,9	1,3	32	6,0	1,6	18	2,68	P= 0,02
14- 5	9,6	2,0	28	10,3	2,7	22	1,05	-
28- 5	9,7	2,8	24	11,2	2,4	26	1,98	-
12- 6	8,8	2,3	24	10,3	1,9	26	2,51	P= 0,02
26- 6	12,0	2,2	18	11,9	2,3	32	0,10	-
10- 7	13,7	4,7	11	15,5	4,5	39	1,16	-
24- 7	11,0	2,2	21	11,0	1,8	29	0,03	-
7- 8	9,5	3,1	11	10,5	2,0	39	1,26	-
21- 8	6,2	2,2	8	6,7	3,0	42	0,44	-
11- 9	4,6	1,1	16	5,2	1,6	34	1,38	-
24- 9	5,0	1,2	24	5,3	1,0	26	0,75	-
8-10	4,4	1,1	19	4,6	0,9	31	0,61	-
22-10	4,3	0,9	18	4,2	0,8	32	0,12	-
5-11	4,7	1,0	19	4,5	0,8	31	0,60	-
20-11	4,2	0,9	20	4,3	1,4	30	0,34	-
4-12	3,6	1,2	21	3,8	1,6	29	0,33	-
18-12	3,4	1,1	25	4,9	1,2	25	2,15	P= 0,05
21- 1	3,4	0,9	30	3,6	0,6	20	0,58	-
19- 2	3,5	1,0	24	4,2	1,1	26	2,51	P= 0,02

s : standard deviation

n : nb. of oysters.

93.5 % of the infested oysters, are infested by five females or less (table 2).

Table 2 : Infested oysters percentage, infested by Mytilicola orientalis' females.

Number of females	I	2	3	4	5	7	>7
percentage	40,9	24,8	I5,0	7,9	4,9	4,5	2

The little number of parasited oysters born in I978, and the weak intensity of infestation, make the analyse impossible.

3- Influence of the parasitism on the oysters biochemical composition :

For the I977-born oysters (annexe I), during the year, there's no significant difference between infested oysters and non-infested, for all the biochemical constituants of the tissues.

But, as previously, we must notice that 87.8 % of the oysters infested by females, are parasited by three Mytilicola or less (table 3).

However, if the annual middle is made, according to the female parasites number found in the intestinal tract of the I977-born oysters, it appears, that the presence of more than three Mytilicola induces a significant decrease of the carbohydrates and of the glycogen, in keeping with the infested oysters by only one female (table 3).

Table 3 : Middle biochemical composition of C. gigas, according to the M. orientalis females number found in the intestinal tract.

females nb of M. orientalis	nb analysed oysters	%	% prot. (s)	% carb. (s)	% gly. (s)	% lip. (s)
I	46	5I,I	43,I (5,6)	5,I6 (2,I5)	3,50 (2,39)	II,I (4,2)
2	20	22,2	45,I (5,4)	5,57 (I,76)	2,52 (I,85)	9,7 (2,4)
3	I3	I4,5	43,9 (6,2)	3,92 (2,63)	2,45 (2,46)	9,7 (3,I)
≥ 4	II	I2,2	46,0 (3,9)	3,II*** (2,79)	2,02** (2,62)	I2,0 (5,4)

Significant level at : ** 99,8 %, *** 99,9 %.
(S) : standard deviation.

III Discution :

If in England, only an activity peak in Summer has been described for Mytilicola intestinalis Steuer (Williams, I969), it's the same as for M. orientalis (Chew and al. , I964 ; Bernard, I969 ; Bradley and Siebert, I978). In parallel, Andreu (I963), in the Mediterranean sea, doesn't record a seasonal variation in the middle number of M. intestinalis per host. As Sparks (I962) for M. orientalis, and Davey and al. (I978) for M. intestinalis, we would opt for an intermediary position. Indeed, two infested periods are shown, the first in Spring, the second Autumn.

It seems then, that, in spite of the mature females presence during all the year, (Grainger, I95I ; Bradley and Siebert, I978), M.

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orientalis reproduces twice a year in the basin of Marennes-Oléron. The second reproduction, giving a greatest number of individuals than the first as Davey and al. (1978) have recorded, induces a more important infested intensity in Autumn.

The infestation during this period, entailing an augmentation of the infested hosts and an augmentation of the parasites number per host, is especially the fact of immatures which will slowly progress during Winter (Grainger, 1951).

The infested intensity is weak as 93.5 % of infested oysters are infested by five Mytilicola females and less. Meanwhile, the copepods middle number per infested oysters, varies between 1 and 6.6, as Hiss (1978) has recorded in the basin of Arcachon.

As Katkansky and al. (1967) and Hiss (1977), we notice that the juveniles are infested too, but less. Indeed, less than one year-old oysters ($L = 40.9 \pm 3.3$ mm) rarely contain more than one or two parasites. The infested intensity increases as soon as September, when the oysters grow to the middle size of 73.4 ± 3.7 mm, whereas, the oysters population is more infested only from November on. But, if the infestation intensity is the same, regardless of the age, the infestation percentage of the two populations is different. So, there is a limit to the parasitism extension, according to the hosts age, possibly related with a weak percentage of meeting between the two sexes of the parasite in the young oysters.

Though, we must notice that, the increase of the infestation intensity in the two groups of oysters, appears just after the oysters' reproduction. Therefore, the infestation intensity, as well as the infestation propagation, is likely to depend on the induced physiological perturbations, in the oysters by internal stresses (egg-laying) or external stresses (food lack) (Bayne and al. , 1978).

Katkansky and al. (1967) think that, five M. orientalis are necessary at least to provoke an effect on the condition ; Korringa (1951) thinks that there is no effect when the mussels are infested

by less than three M. intestinalis. As a matter of fact, it's difficult to conclude to an action of parasite on the oysters condition in the case of minor infestation.

As Katkansky and al. (I967) suggest, for the lengthwise growth, at identical age, the smallest oysters, then, perhaps the most fragile, are the more likely to be infested.

Indeed, we observe significant difference between the middle condition of infested and non-infested oysters, just at the end of the winter and at the beginning of the spring. During this period, the oysters are weak because of the small proportion of available food in the basin of Marennes-Oléron, in comparison with the amount of inorganic substances (Heral and al. , I980). The oysters, in best condition are, maybe, more likely to reject the parasites, as Sparks (I962) points out, because M. orientalis isn't able to stay by itself in the C. gigas' intestinal tract, for a long period.

Seasonal variations of the biochemical constitution exist, but monthly differences between the infested oysters component and those of the non-infested oysters aren't really significant.

The greatest part of the biochemical variations of C. gigas tissues, is induced by the gonads development (Deslous-Paoli, I980). Mann, (I956) proves that the infested mussels by Mytilicola, show a I0 to 20 % loss of their gonads, in comparison with non-infested mussels. Williams (I969) finds significant differences, between infested oysters and non-infested oysters, for the lipids and the carbohydrats, after the reproduction.

These differences could be due, either to a slowest answer of the oyster's behaviour, or to a slowest recovery after the end of the period of reproduction. The absence of difference that we obtain, may be owed to a weak intensity of infestation (87.8 % of analysed oysters are parasited by three females Mytilicola and less), but also, to the small number of analysed oysters per sample. Nevertheless, it seems that the presence of Mytilicola in adequate quantity, (> to three females), can induce a decrease of the carbohydrates, and particularly of the glycogen.

This seems to be the result of a nutritional effect. Actually sufficient the presence of Mytilicola in quantity in the intestinal tract of mollusks, can entail a break of the intestinal transit, and an alimentary spoliation (Hiss, I978). This spoliation induces a decrease of the energetic reserves, constituted mainly by glycogen. (Deslous-Paoli and Heral, I980).

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Annexe 1 : twice a month average of the percent of the biochemical components of the infested and non-infested oysters by *M. orientalis*

	PARASITED OYSTERS									NON-PARASITED OYSTERS								
Date	n	Proteins		Lipids		Carbohydrates		Glycogen		n	Proteins		Lipids		Carbohydrates		Glycogen	
		average	s	average	s	average	s	average	s		average	s	average	s	average	s	average	s
28-3	12	43,1	1,7	8,6	0,9	2,92	1,14	0,63	0,38	12	42,6	1,9	8,6	1,6	2,18	1,10	0,46	0,38
11-4	12	44,4	2,3	9,5	2,1	3,63	1,67	2,70	1,49	12	44,3	2,0	9,6	0,3	4,04	1,74	3,24	1,90
25-4	14	42,3	3,5	8,4	1,0	5,34	0,99	3,23	1,02	11	40,2	1,8	8,2	1,1	5,02	1,43	2,67	0,60
14-5	10	37,6	1,9	10,2	1,7	6,31	1,40	2,71	1,52	10	39,4	2,9	10,9	0,7	5,69	1,25	2,82	1,46
28-5	10	41,4	2,0	12,5	1,8	3,98	1,02	1,78	1,25	10	43,8	2,6	10,3	0,9	3,28	1,13	1,03	0,77
12-6	9	55,9	4,0	13,8	2,3	3,50	0,91	3,01	1,12	9	55,6	3,4	10,9	3,1	3,58	0,48	2,87	1,09
26-6	6	54,1	3,7	12,9	4,2	5,65	1,22	4,93	0,88	6	47,5	4,2	13,2	4,3	5,72	1,41	4,89	2,03
10-7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24-7	5	43,5	1,4	16,5	5,6	7,03	1,47	4,95	1,70	5	42,7	1,9	13,8	5,6	6,76	2,52	4,93	2,74
7-8	3	44,4	1,9	14,8	4,9	7,33	2,14	5,40	2,23	3	43,9	2,1	14,8	3,6	7,23	3,23	5,22	3,21
21-8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8-10	6	44,8	1,5	7,2	0,6	4,70	3,54	3,13	3,29	4	45,0	3,0	7,6	0,7	6,08	2,91	4,31	2,91
22-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5-11	5	44,7	2,0	10,3	1,6	7,59	1,54	4,69	2,48	5	43,4	1,9	11,1	2,6	8,18	3,32	7,31	3,59
20-11	5	41,5	3,3	8,7	0,5	8,06	4,61	6,46	4,98	5	42,2	2,3	9,2	2,5	7,51	3,80	5,46	4,57
4-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18-12	4	45,7	2,0	7,7	0,6	3,26	2,39	1,24	1,48	6	46,8	2,3	7,8	1,3	3,87	2,62	1,75	1,93
21-1	7	44,0	2,6	9,1	2,4	2,44	2,76	1,19	2,28	3	44,6	3,0	8,0	0,6	4,61	2,37	2,20	2,13
19-2	6	43,3	2,9	11,4	2,6	4,75	3,94	3,29	3,83	4	42,9	2,0	9,9	1,2	6,95	3,31	5,12	3,22

n : number of analysed oysters

s : standard deviation