ANNUAL REPORT 1987

OF THE PROJECT

"CULTIVATION OF CATFISH"

by

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Hisøy January 1988

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INTRODUCTION

The project started 1. April 1987. From the same date two technical Assistants, Evy Lien and Sissel Rosseland were employed in the project. Three students, Mr. Vorren, participated in the project from 21/4 to 1/5-1987 and Karl Rødland and Ania Jablanska participated from 15/6 to 26/6-1987. Cand.real. Tore Johannessen entered the project in august 1987. His main area of work initially are spawning and spawning behaviour of the catfishes. Helge Krystad has been trained in the project from 7/12-14/12-1987

Meetings

Steering group meetings were held at Flødevigen 24/4-87 and 14/12-87. Participating 24/4: T. Bodvin, Salar A/S, W. Dekker, Trouw & C.O., J. Gjøseter, SBSF, R. Hole, Skretting A/S and E. Moksness, SBSF. Participating 14/12: T. Bodvin, Salar A/S, J. Gjøseter, SBSF, P.T. Hognestad, SBSF, R. Hole, Skretting A/S, T. Johannessen, SBSF and E. Moksness, SBSF.

A planning group, R. Hole (Skretting A/S), Ø. Lie (Fiskdir. Nutrition Inst.) and E. Moksness met 9. June in Stavanger and put together a proposal on "Fóroptimalisering til Steinbit (*Anarhichas sp.*.) i oppdrett" for the Norwegian Fisheries Research Board.

T. Johannessen participated in the "NY FISK" - meeting in Bergen 14-15. September.

E. Moksness participated in the "NY FISK" - meeting in Bergen 2-3. November.

Activity

Lectures on cultivation of catfishes has been held by E. Moksness in Molde (8/10), Ås (19/10) and Haugesund 30/10).

Visiting The spawning stock at Misje A/S at Misje outside Bergen: E. Moksness (September and November), T. Johannessen (November and Desember)

Methods

The condition factor (C.F.) was calculated according to the formulae:

$C.F. = w * 100 / l^3$, where w = wet weight (g) and l = length (cm).

The %-growth was calculated according to the formulae:

%-growth = $(w_{i+1} - w_i) * 100 / w_i$, where w_i = average wet weight (g) at measurement i and w_{i+1} = average wet weight (g) at measurement i+1, used when groups are weighted every months.

At feeding the feeder gave an INDEX from 0 to 5 to indicate if the fishes were eating well or not. The highest score was 5. In the calculating of food factor (FC) an average feeding INDEX between each measurement of the fishes was calculated. This average INDEX was later used to calculate an FC based upon the INDEX.

The two food factor (FC1 and FC2) were calculated according to the formulae:

FC1 = WP * a / WW * b and FC2 = WP/WW, where WP = wet weight (g) of the wet pellets, WW = average increase in wet weight (g) of the fishes, a = dry weight/wet weight relationship of the wet pellets in that specific period and b = ~ 20 % (dry weight/wet weight relationship of the fishes).

Specific growth rate, SGR, were calculated according to the formulae:

SGR = (Ln W_{t2} - Ln W_{t1}) / (t2-t1), where W_{t1} and W_{t2} are wet weights of fishes at days t1 and t2.

Oxygen (O_2) consumption are calculated according to the formulae:
O_2 (ml/l) = O_2(in) - O_2(out)

Ammonium (NH_4; µgat/l = µM) production are calculated according to the formulae:
NH_4 (µgat/l) = NH_4(out) - NH_4(in)

Spawning behaviour

Courtship and spawning behaviour in catfish has been observed in both laboratory with single pairs of males and females and in basins with a number of fishes.

In the middle of September 21 individually tagged striped catfishes were placed in an indoor concrete basin for observation of courtship and spawning behaviour. The spawning basin covered an area of 70 m^2 and had a mean depth of about 90 cm. The room was illuminated by neon lights and the day length was kept close to outdoor day length. "Dusk" and "dawn" lasted for about 30 minutes. A video camera was mounted on a guide rail in the ceiling on which the camera could be moved back and forth. The

camera was also equipped with a pan and tilt unit, and a motorized zoom lens. All functions were controlled from a distant room where the behaviour also could be recorded on video tape. The camera could cover the hole basin. And because each fish was individually tagged, we were able to track single fishes wherever they would swim in the basin.

At first 60 soles were kept together with the catfish. They seemed, however, to be rather nervous, so after two weeks they were placed in a corner of the basin which was separated from the rest of the basin by nets and frames. The catfish was fed on wet pellets, crabs and mussels. Until the end of 1987 12 fishes had died for various reasons. Although the installed video equipment is an excellent remedy for observation of general behaviour, we concentrated on courtship and spawning behaviour since we were close to the spawning period.

Three single pairs of males and females were transferred from the spawning basin to a 4 m^3 concrete tank where they were kept under continuous video surveillance. Yet another pair was placed in an a small, natural outdoor basin where the behaviour was studied by direct observations.

The spawning behaviour in striped catfish were also observed in big indoor basin at Misje A/S, where about 100 catfishes were kept together. The basin covered an area close to 1000 m^2 and it was illuminated by natural light coming in through windows in the ceiling. The bottom of the basin was made up of coarse gravel. To increase the number of hiding places plastic barrels were distributed around the basin. Study of the behaviour was done by direct observations.

Table 2. Food components in % in the wet pellets 1987. Totally it was made 1152,658 Kg wet pellets in 1987.

Date	%-Macrell	%-Seith	%-Cod	%-Others	%-Skretting 25%	Dry/Wet
2/1	79.0				19.9	47.0
14/1	79.1				19.8	55.1
5/2	66.8			13.5 [2]	19.7	47.0
27/2	79.1				19.8	52.0
16/3	79.1				19.8	52.6
1/4	79.1				19.8	49.8
21/4 *	78.9				19.7	50.3
5/5 *	78.9				19.7	51.3
14/5	79.1				19.8	49.2
26/5	79.1				19.8	50.4
12/6 *	43.6	35.4			19.7	45.4
24/6	44.3	16.8	18.0		19.8	43.3
7/7	37.2	3.4	38.5		19.8	42.4
29/7	61.0		18.2		19.8	48.3
19/8	38.5		36.1	4.6 [3]	19.8	43.9
13/10	44.8		34.4		19.8	43.4
6/11	33.9			45.3 [3]	19.8	37.8
11/12	33.8			34.4 [3]	30.7 [1]	46.9

1) Skretting 45% bindemiddel
2) Shrimps
3) Different fish species
*) Antibiotic added as 2.4 g/kg.

Extra vitamin mixture (Skretting vitamin mixture) were added as 10g/kg and extra C-vitamin were added as 1 g/kg wet pellet.

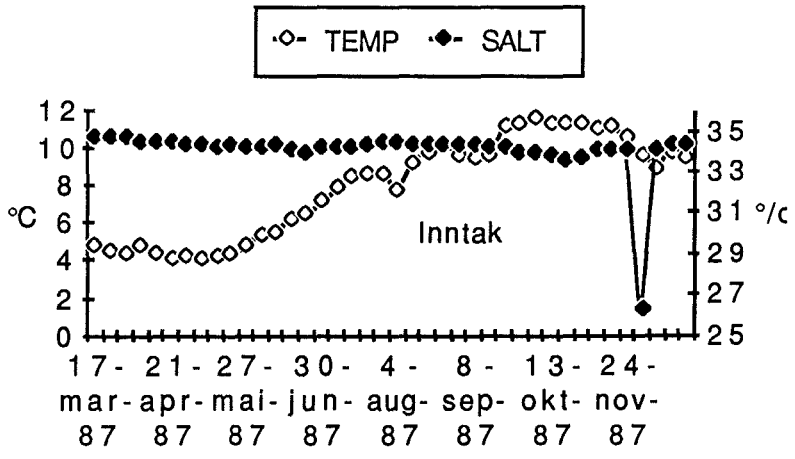

Figure 1. The temperature (°C) and salinity (°/oo) in the incoming water.

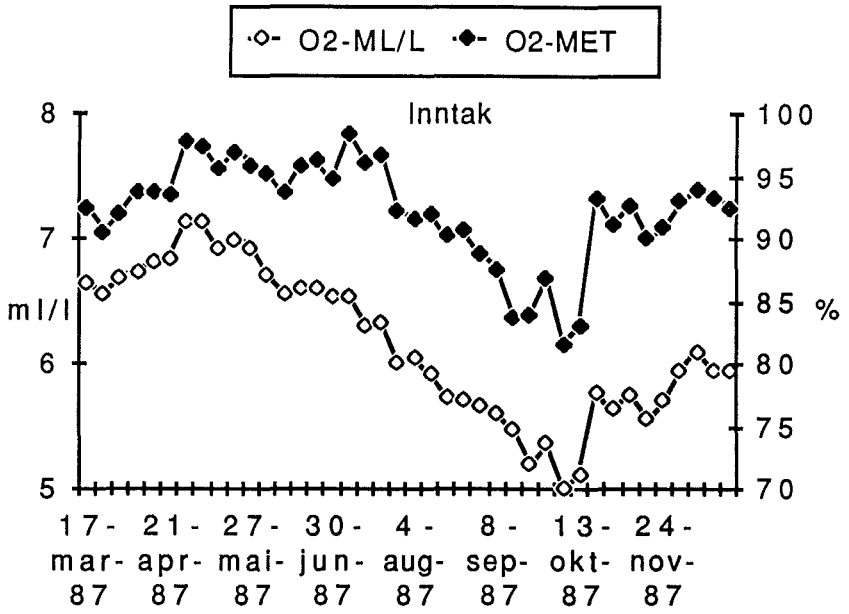

Figure 2. Oxygen content in the incoming water in ml/l and %-saturation

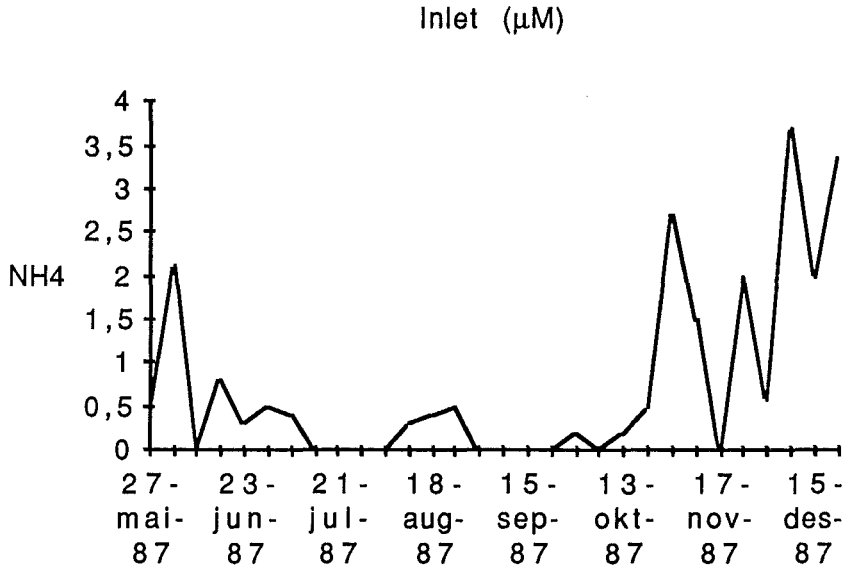

Figure 3. The ammonium consentration (µgat/l) in the incoming water.

Preliminary Results

Stripped Catfish

Collection of wild fishes 1987

Wild stripped catfish were caught locally in April and May by local fisherman.

Experimental groups

General observations

A high mortality has been observed in all groups initially due to parasites like Trichodina. Treatments with formaldehyde stopped the mortality in periods (Figure 3). Later, from September, the mortality has been caused by bacterial infection which has destroyed the heart completely killed the fish. The bacterial species is not yet known, but are under examination .

86-4

The increase in wet weight in 86-4 has been small during 1987 with a daily average wet weight increase of 1 %/day. The group has been fed wet pellets until 31/12-87. From 1/1-88 the group will be fed dry pellets. The condition factor has been stable around 0.8. The mortality observed since 1. November 1988 are expected to due to cannibalism.

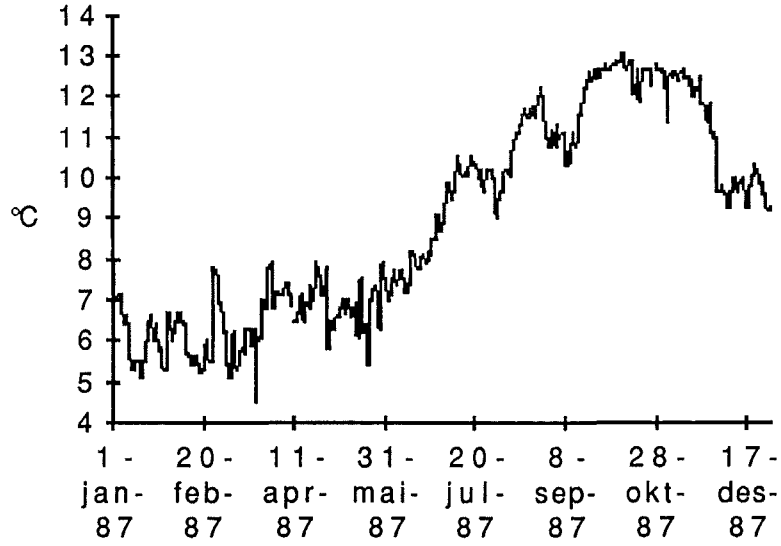

Figure 4. The observed temperature in 86-4 during 1987.

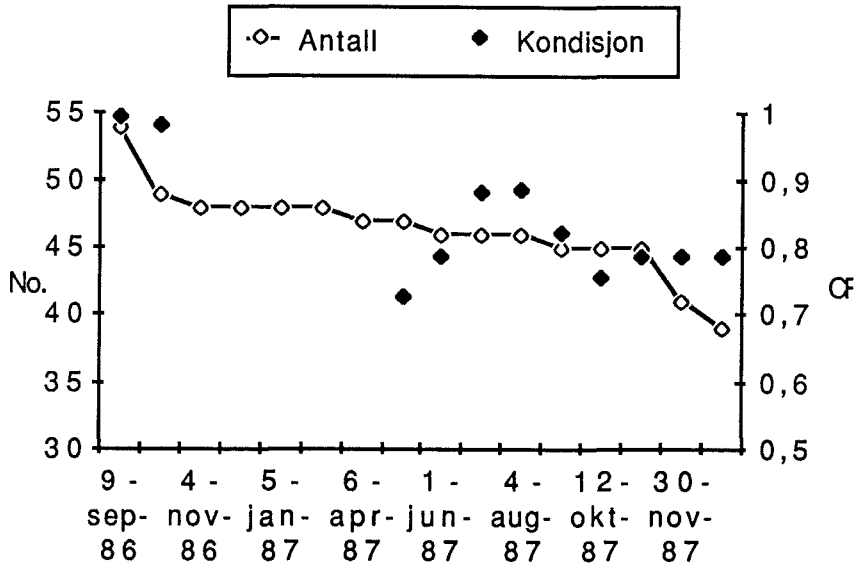

Figure 5. Observed Number of fishes and average condition factor (CF) of the fishes in 86-4.

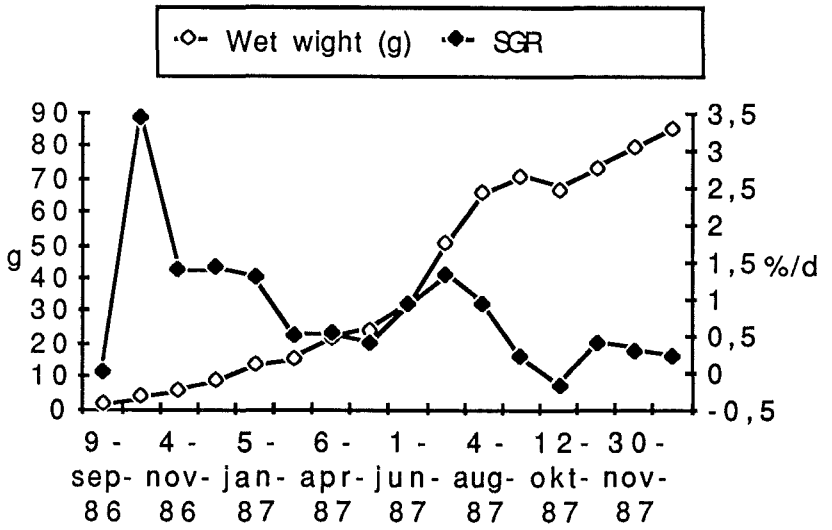

Figure 6. Average wet weight (g) and specific growth rate (%/day) of the fishes in 86-4.

87-1, -2, -4

The two group, 87-1 and 87-2, has been startfed at Flødevigen BS as reported in the Halfyear Report 1987. The mortality observed special i 87-2 have been caused by several heavy attack by the external parasite *Trichodina* sp.. The observed growth decrease in 87-1 and 87-2 and 87-4 from august 1987 might have been caused by the composition of the dry and wet pellets fed to the fishes. All three groups will be fed dry pellets from 1/1-88.

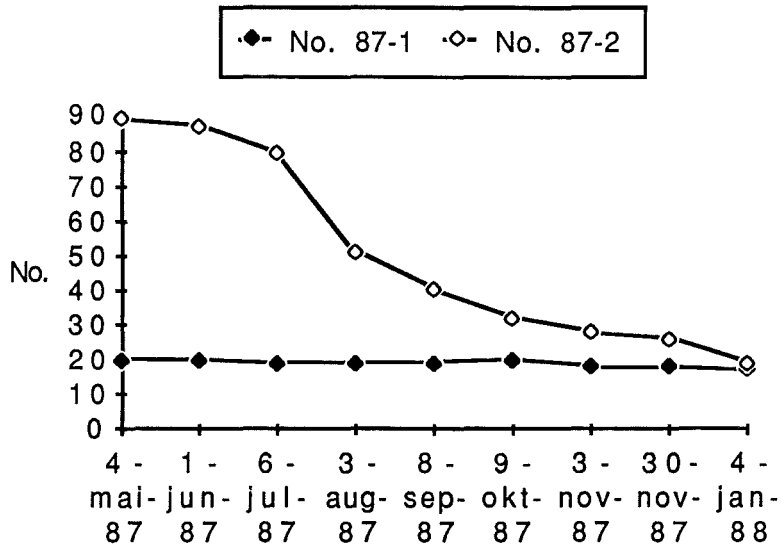

Figure 7. The number of fishes in 87-1 and -2.

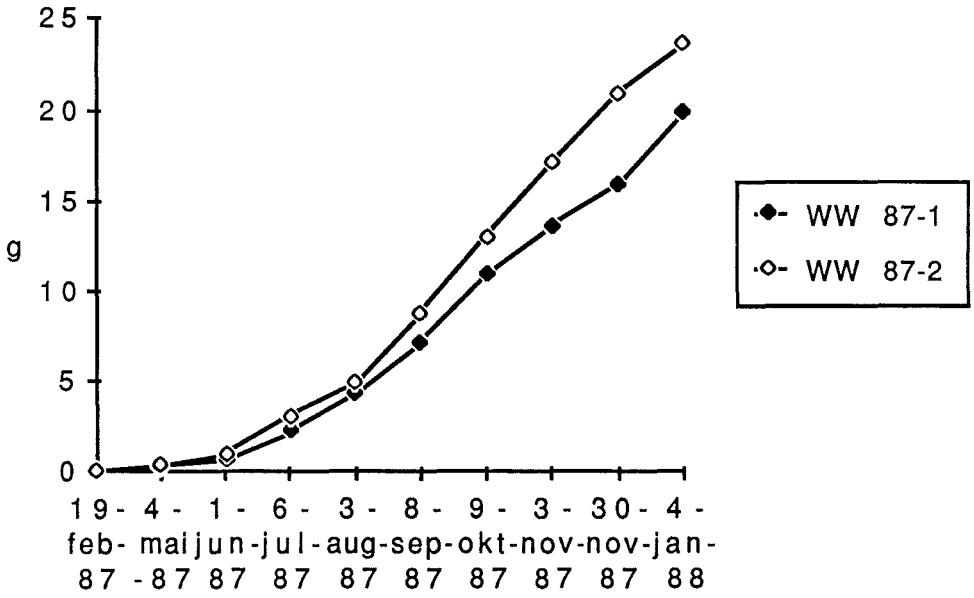

Figure 8. The wet weight (g) of the fishes in 87-1 and -2.

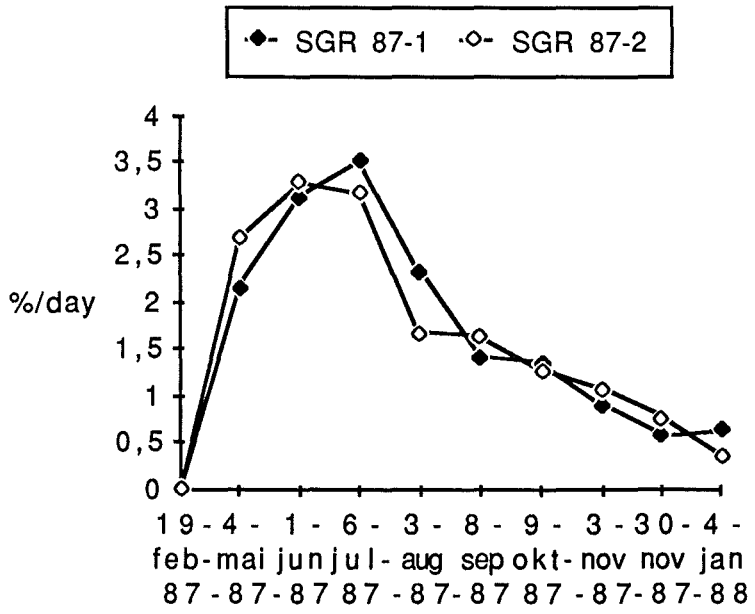

Figure 9. The specific growth rate (SGR) in group 87-1 and -2.

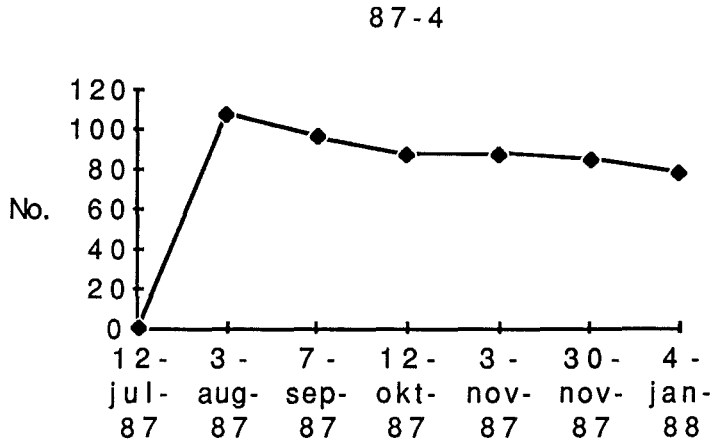

Figure 10. The number of fishes in 87-4.

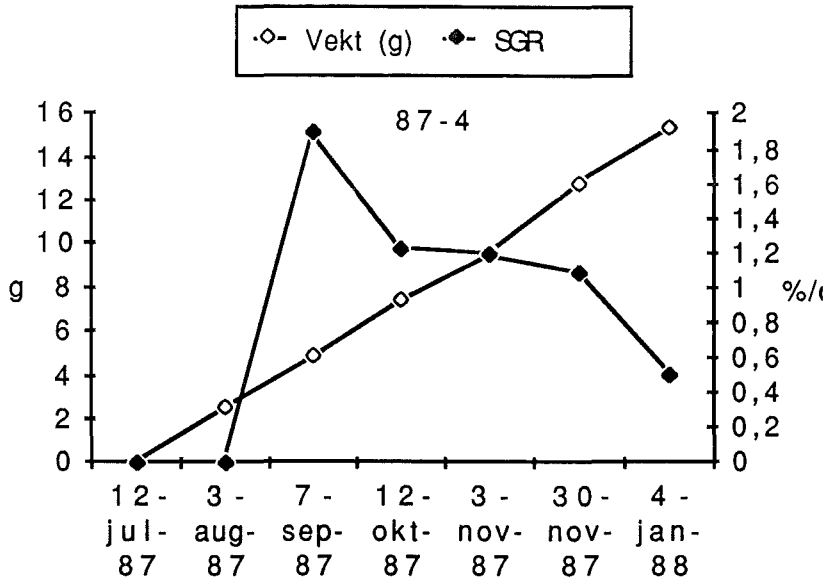

Figure 11. The wet weight (g) and the specific growth rate of the fishes in 87-4.

87-50, -60, -70, -80, -90, -95

The feeding groups, 6 in all, did not show any growth at all. The fishes suffered initially from attack of external parasites. Indeed mortality were observed, the parasites were easy to get rid of formaldehyde treatments. A later bacterial infection destroyed internal organ like the heart and caused a heavy mortality in the group.

New feeding groups will be established during spring 1988.

Table 3. The groups in this section contains fishes in half-kilos-groups, where:

85-50 = 0.5 - 1.0 kg
85-60 = 1.0 - 1.5 kg
85-70 = 1.5 - 2.0 kg
85-80 = 2.0 - 2.5 kg
85-90 = 2.5 - 3.0 kg
85-95 = 3.0 - 3.5 kg

Table 4. Data on The average wet weight and the number of fishes (N) in the different groups at the 24. august and the 8. October, with the SGR and the amount of wet pellets fed the groups in the same period. The number of fishes (N) in the groups at 1. January 1988 are also given.

Group	Wet weight (g) 1.January 24/8-87	N	8/10-87	N	SGR	Amount food 24/8 - 8/10 (g)	N
87-50	831.9	15	894.9	14	0.16	9249.4	11
87-60	1246	36	1236.5	31	- 0.02	15474.8	11
87-70	1721.4	30	1673.3	26	- 0.06	12078.1	11
87-80	2231.3	28	2194.3	23	- 0.04	14101	8
87-90	2770.1	29	2673.9	23	- 0.08	15455.7	4
87-95	3271.6	20	3187.5	19	-0.06	11448.1	6
Sum		158		136		77807.1	51

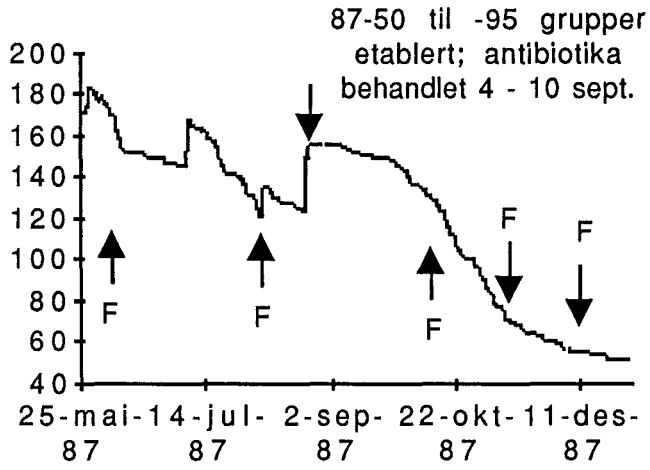

Figure 12. The total number of fishes in all the growth groups in 1987, with treatments using formaldehyde and antibiotics indicated.

Spawning groups

General observation

87-100, -110, -120

Spawning basin

Outdoor basin

A total number of 90 stripped catfishes were transferred to a 2500 m^3 outdoor basin in June. In august the basin were drained and all the fishes taken out. 17 fishes had died in this period. Shortly after the basin were refilled and 40 fishes were transferred back into the basin, while the rest of the fishes were kept in the

laboratory. The fishes were fed live blue mussels (*Mytilus edulis*) and crabs (*Carcinus maenas*).

A underwater video-system was installed in December to track the fishes. Direct and video observations indicated that the fishes stayed mainly in the deepest part of the basin. A diver went down into the basin the 22 December and observed several dead fishes and the live fishes seems to be rather nervous.

Many dead blue mussels were observed, and the mortality among these might have caused the rather bad environmental conditions observed in the basin in November/December. The followings figures illustrates the condition in the basin.

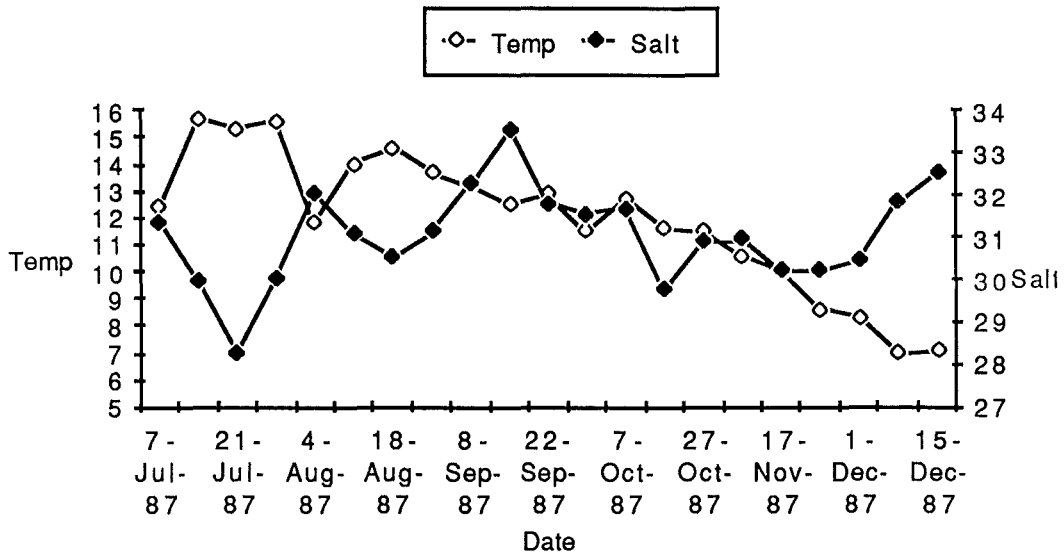

Figure 13. The temperature and the salinity in the outdoor basin.

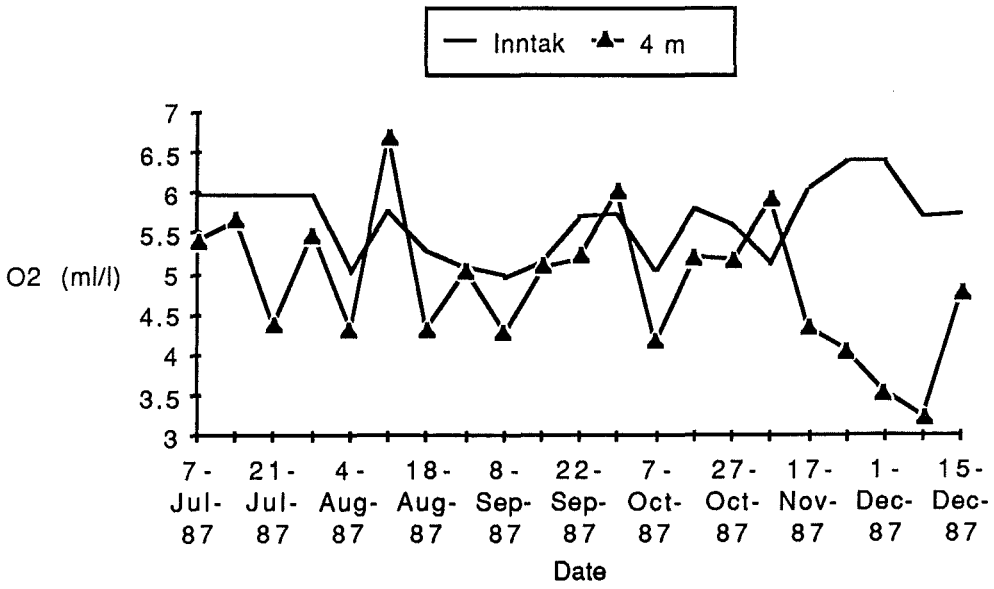

Figure 14. The oxygen content (ml/l) in the outdoor basin.

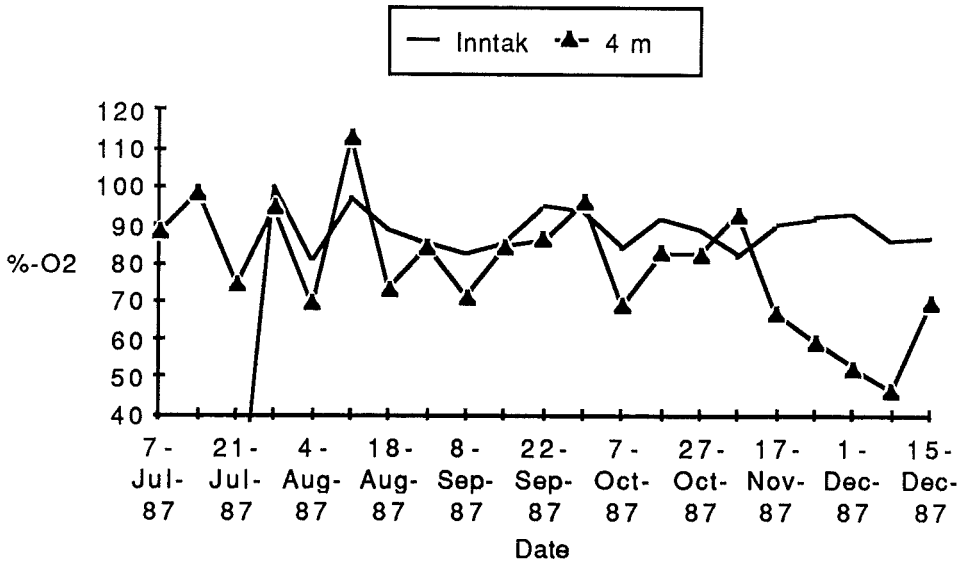

Figure 15. The oxygen saturation (%) in the outdoor basin.

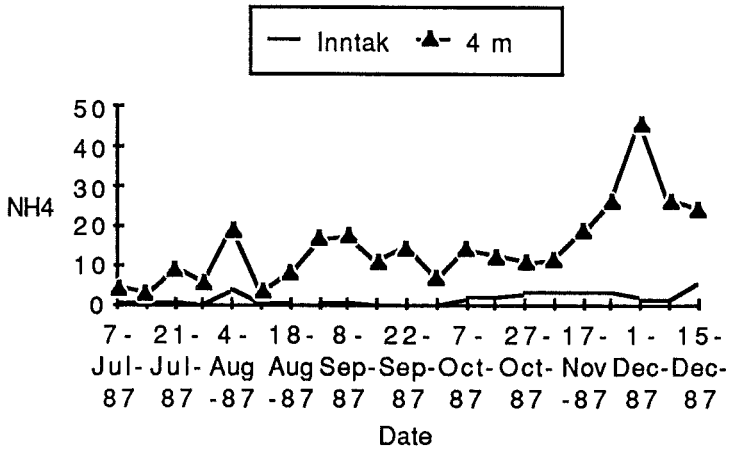

Figure 16. The ammonium (µgat/l) consentration in the outdoor basin.

Terminated groups

86-1

In the period from 18/7-86 to 2/2-87 the fishes in the group were eaten a total of 14016 g with wet pellet. 8 fishes survived to the end of the experiment, and these 8 are estimated to have eaten 10194 g of wet pellets. The estimated wet weight increase of the same 8 fishes are 3567 g. This mean that for every one kg wet weight fish there has been used 2.86 kg wet pellets.

Foodcontent:

Table 5. Components in the wet pellet fed 86-1.

Date	Days in exp.	%-Macrel	%-Seith	%-Shrimp	%-Others	%-Skretting 25%	Dry/Wet
16/7-86	65	47.3	23.7		28.4	50.1	
26/8-86	106	47.3	23.7		28.4	51.2	
30/9-86	141	44.9	25.0		29.8	49.8	
21/10-86	162	48.2		26.7 *	23.8	44.3	
9/12-86	211	79.1			19.8	49.1	
2/1-87	235	79.1			19.9	47.0	
14/1-87	247	79.1			19.8	55.1	

* 40% Blue mussels and 60% Crabs

Extra vitamin mixture were added as 7 g/kg to 10g/kg in the period from 16/7-20/10 and then 10g/kg for the rest of the experimental period. From 21/10 extra C-vitamin were added as 1 g/kg wet pellet.

Table 6. Estimated wet weight increase and amount of wet pellet eaten by the 8 stripped catfishes left in 86-1 and their feeding factor (FC).

Time period	Days in experiment	Increased wet weight	Amount of wet pellet	FC1	FC2
17/7-11/8-86	66-91	373	1023	6.9	2.74
11/8-7/10-86	91-148	359	2496	17.4	7.00
7/10-86-2/2-87	148-266	2812	9056	8.1	3.22
17/7-86-2/2-87	66-266	3544	12575	8.9	3.55

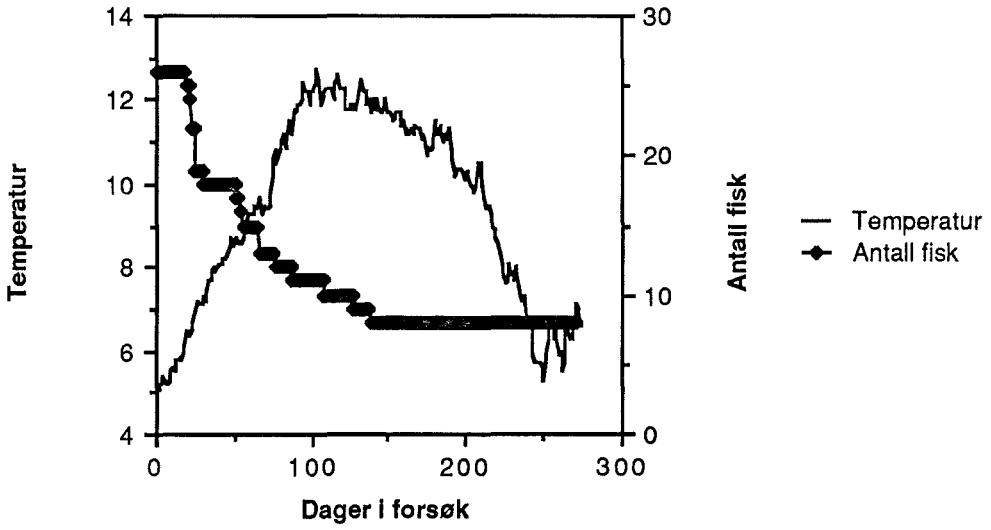

Figure 17. The number of fishes (-*-) and the recorded temperature (-) in 86-1.

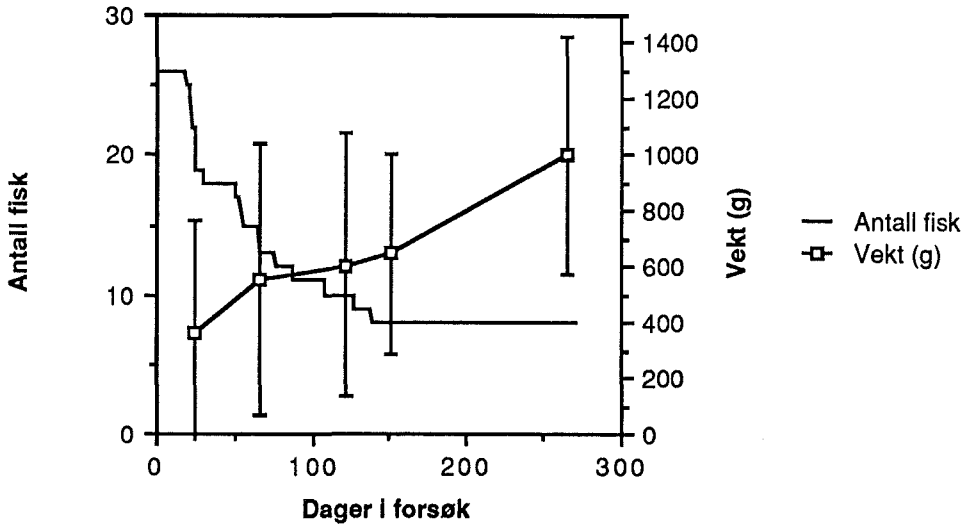

Figure 18. Average wet weight (g) with standard deviation and the number of fishes in 86-1.

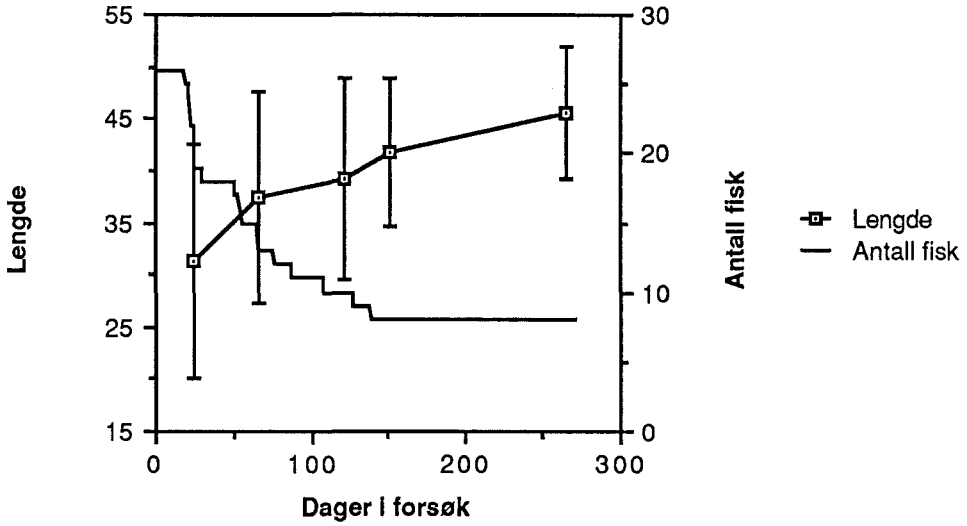

Figure 19. Average total length (cm) with standard deviation and the number of fishes in 86-1.

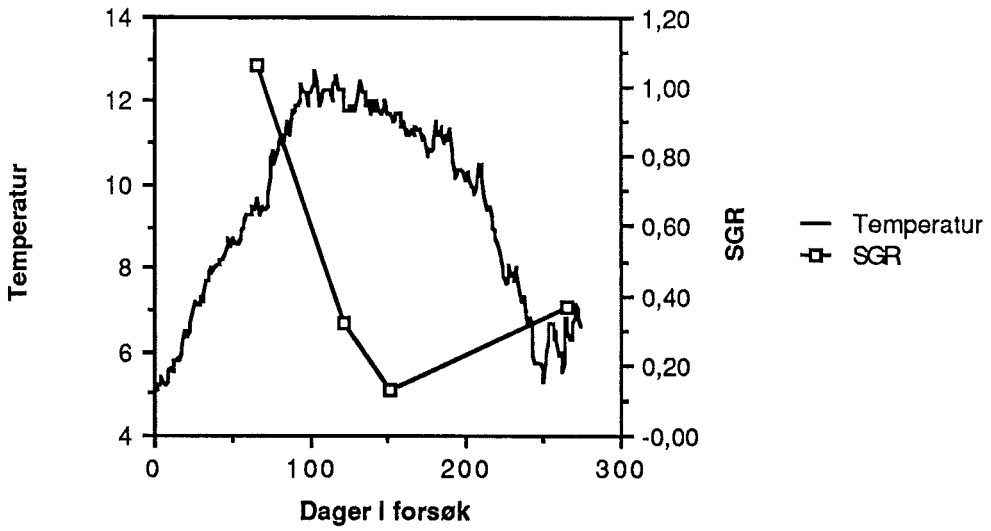

Figure 20. Calculated specific growth rate (SGR) and recorded temperature (^{o}C) in 86-1.

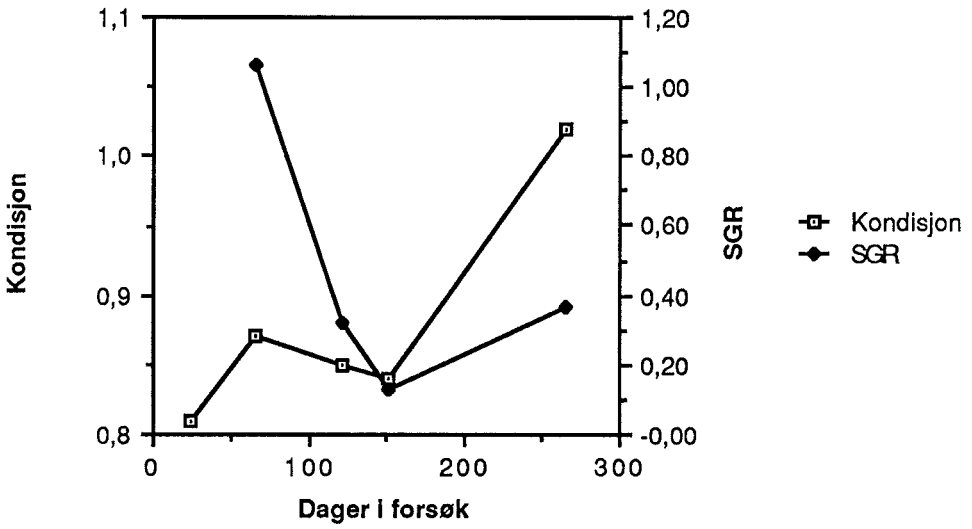

Figure 21. Calculated SGR and the average condition factor (CF) in 86-1.

Spotted Catfish

Collection of wild fishes 1987

Juvenile (N=) spotted catfishes were caught at the Finnmark coast in July by "Stallo" and "Raito". Later on 0-group surveys in the Barent Sea in August/September 5 juvenile spotted catfishes were

caught by R/V "G.O.Sars" and R/V "Eldjarn". From 10-16 September R/V "Eldjarn" collected 55 adult spotted catfishes in the Barent Sea, these were transported to SBS Flødevigen by car.

Transportation of adult Spotted Catfish

The spotted catfish were transported from Hammerfest to SBS Flødevigen in September 1987.

Equipment:

6 Gazz-bottles 70 Kg
3 Tanks (180 x 100 x 85)cm

Table 7. The total weight of spotted catfishes in each of the three transportation tanks and litre of sea-water in each tank after each water exchange.

		Litre of sea-water after different water changes			
Tank No.	Total weight (kg) of fish	1st	2end	3rd	4the
Tank 1	140.0	728	675	653	690
Tank 2	91.45	570	593	585	570
Tank 3	68.13	488	518	525	510

Table 8. Date and hrs and total hrs transportation, with changes of water and gaz indicated.

			Change	
Place	Date Hrs	Total Hrs	Water	Gazz
Hammerfest	16/9 1430	0		
Skibotn	17/9 1315	23,15	x	
Mo i Rana	18/9 1500	49		x
Hamnesberget	18/9 1630	51,30	x	
Trondhjem	19/9 0530	64,30	x	
Arendal	19/9 2150	81,50		

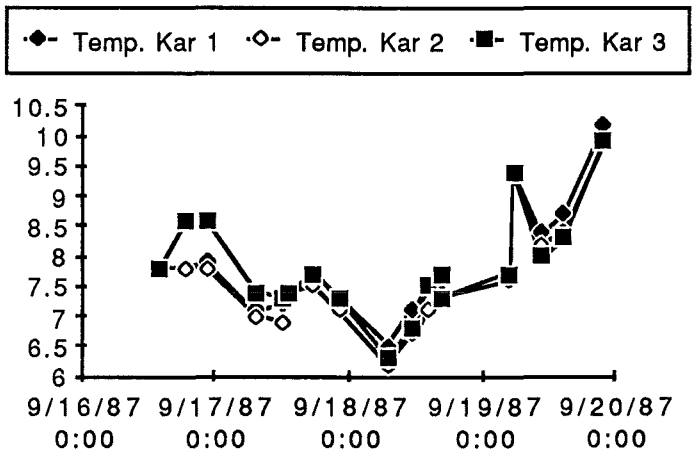

Figure 22. Temperature in the three tanks during transportation.

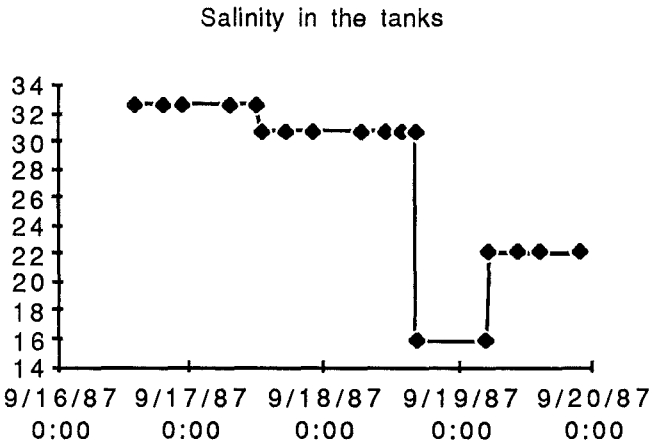

Figure 23. Salinity (°/oo) in the three tanks during transportation.

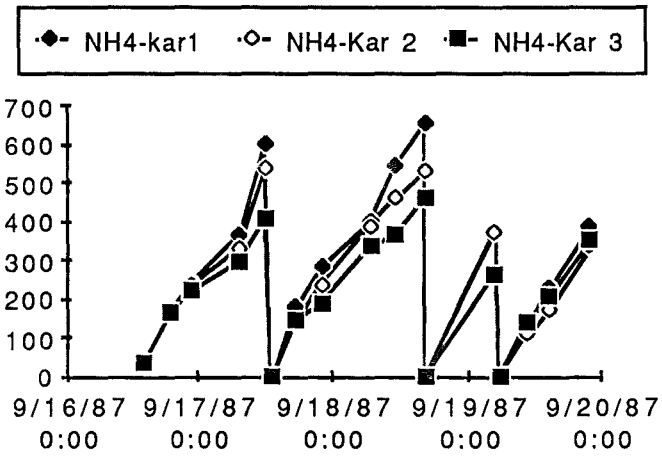

Figure 24. Ammonium (µgat/l) consentration in the three tanks during transportation.

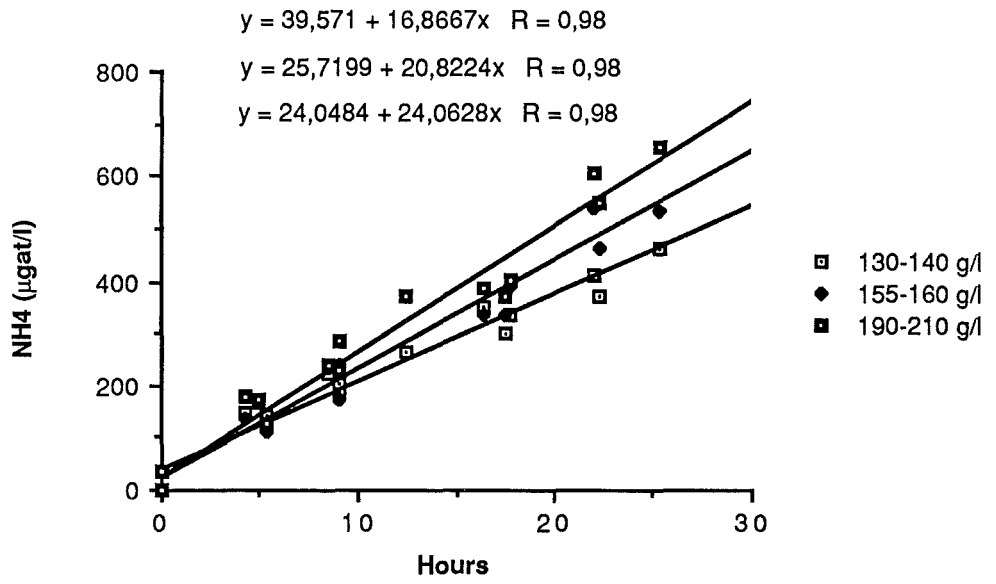

Figure 25. Ammonium (µgat/l) consentration of three weight groups of fishes (g/l) with time (hrs.) after water change.

The adult spotted wolffish let themself easily transport over a long distance and expose to a lot of stress. The fishes survived salinities down to 16 °/oo, but indeed had a strong reaction towards the salinity by Throwing up. The fishes also survived high consentration of ammonium. During the transportation the consentration of ammonium increased about 10 times in about 10 hrs. Only 5 fishes died within the first weeks after transportation.

Experimental groups

87-5

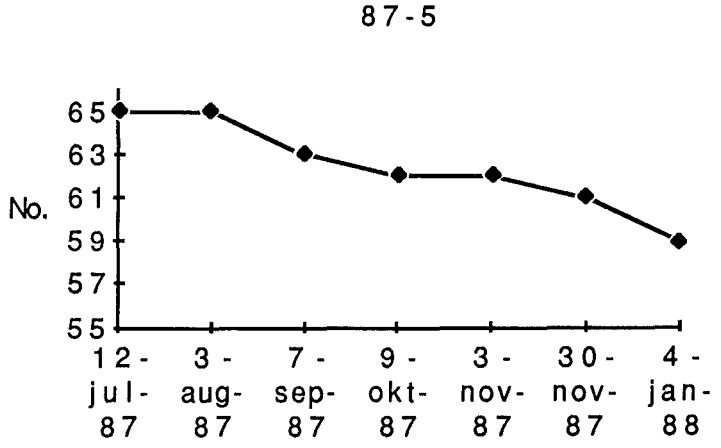

Figure 26. The reduction in number of larvae in 87-5.

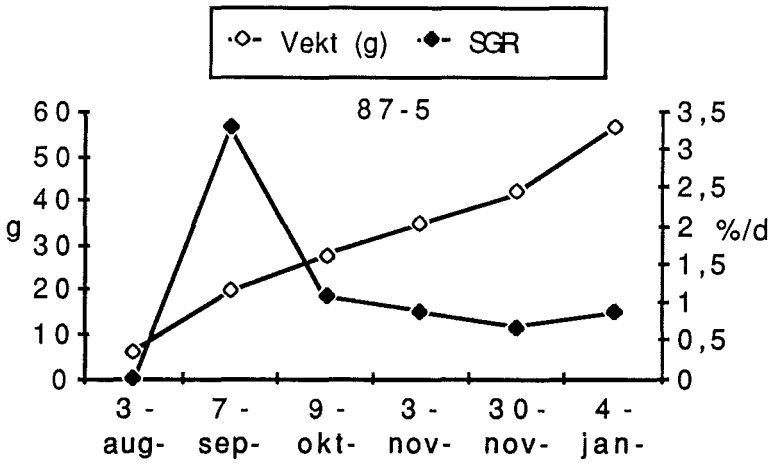

Figure 27. The average wet weight (g) and specific growth rate (%/day) of the 87-5 group.

Spawning groups

General observation

From the arrivals at SBS Flødevigen and up to 31/12-87 5 of the 55 fishes has died. The 5 fishes died shortly after the arrivals to SBSF. The fishes has been fed the same wet pellets as the other fishes. All wounds on the skin of the fishes seems to have been healed.

87-200, -210, -220

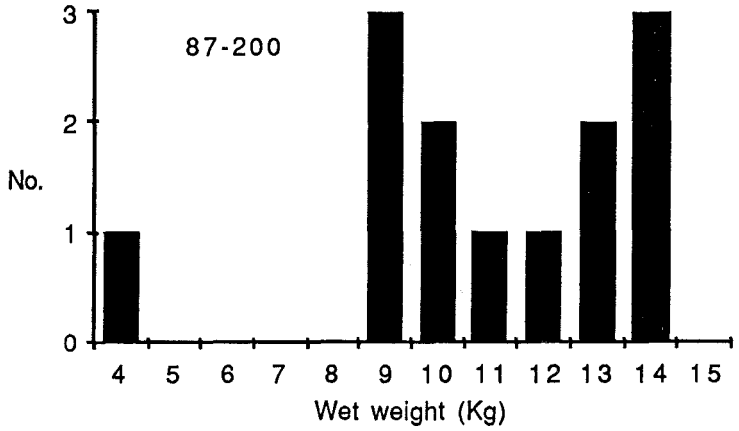

Figure 28. Wet weight (Kg) distribution in 87-200

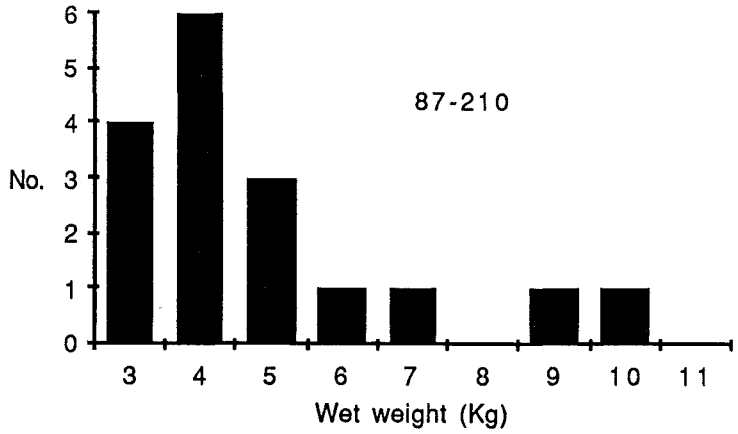

Figure 29. Wet weight (kg) distribution in 87-210.

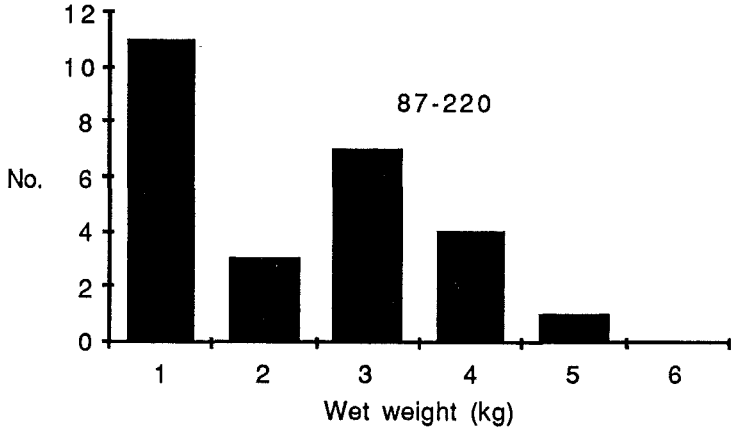

Figure 30. Wet weight (Kg) distribution in 87-220.

Terminated groups

85-3 and 86-3

Has been reported in the Halfyear report 1987.

Spawning behaviour

Observations

Most of the observed behaviour has been recorded on video tape. However, it has not yet been analysed in detail. The conclusions we have drawn from the observations must therefore be considered to be preliminary.

The catfish in the spawning basin split into two equally sized groups. In each group the fish was lying close together. In the beginning of October two females were observed to be quite "active" around two different males. The females placed themselves close to and upon the males, and every now and then rubbed themselves to the males. This was interpreted as being some sort of courting behaviour. It has not been observed in males. In the literature it has been suggested that a catfish will stay with the same partner for the rest of its life. Our observations, however, indicate that this is not true. A number of times we have observed that after a male that a female had been courting died, the female soon after started to court another male. Some females, however, were not observed to court at all.

An interesting observation that we did in the spawning basin was that after a pair seemed to had been established, all other fishes "moved away" form the area where the pair was lying. But frequently different males would swim up to the pair and lie there for a couple of minutes. Afterwards the "intruding" male would swim away again. No physical aggression was observed during these events, and the general impression is that there is little or no physical aggression between catfishes. Although there was no physical aggression, it seemed to be clear that the fishes communicated in one or another way. Except for this behaviour, males have not been seen to court females.

Beside females courting males, a number of other behaviour patterns have been observed that is believed to have something to do with courting and spawning. Males have been observed to lie over on the side and bend and twist intensively. This behaviour last for 10 to 20 minutes, and it does not seem to depend on females being close to the male. After a pair has been established, we have observed that both males and females now and then will jerk heavily. One maturing female has been observed to dig by sucking gravel into its mouth and spit it out again.

So fare we have had no successful spawning. At Misje we counted between 15 and 20 maturing females in the beginning of December. Until the end of 1987 a number of the females had spawned, but only once the eggs were found. 5 catfishes was observed to eat on them. Some of the eggs were saved, but they were not fertilized. On female was observed to spawn. It was bending and twisting its body heavily, and now and then the hole body shivered. Slime was observed to come out of the female. The female was stripped, and the eggs mixed with milt from three males. The eggs were not fertilized.

Preliminary conclusions are that tanks with single pairs are the best facility for natural spawning in catfish. Although we have not had successful spawning so fare, the spawning season is not yet over, so there is still hope.

Observation on changes in oxygen and ammonium

To monitor the water quality samples for analyzing oxygen and ammonium content in the tanks were taken ones a week. During a period of 9 days samples were taken more frequently.

Intensive observations

Table 9. Temperature, amount of fish and the tank volume for the larvae groups. The 87-1 and -2 were fed dry pellets, while 87-4 and -5 were fed wet pellets.

Group	Temperature °C	Amount fish (kg)	Tank Volume (l)
87-1	11.7 - 12.1	0.2174	213
87-2	11.7 - 12.1	0.4174	213 - 229
87-4	11.7 - 12.1	0.6511 - 0.6525	203
87-5	11.8 - 12.3	1.7621	182 - 208

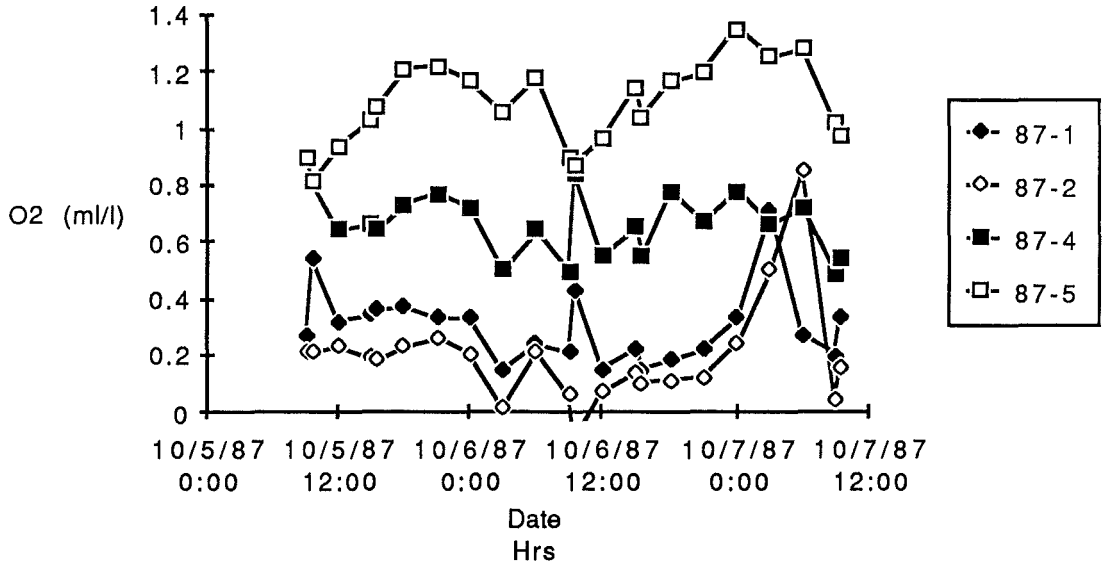

Figure 31. Consumption of oxygen (O_2), by the larvae over a 48 hrs period. The fishes were fed 2 times every day.

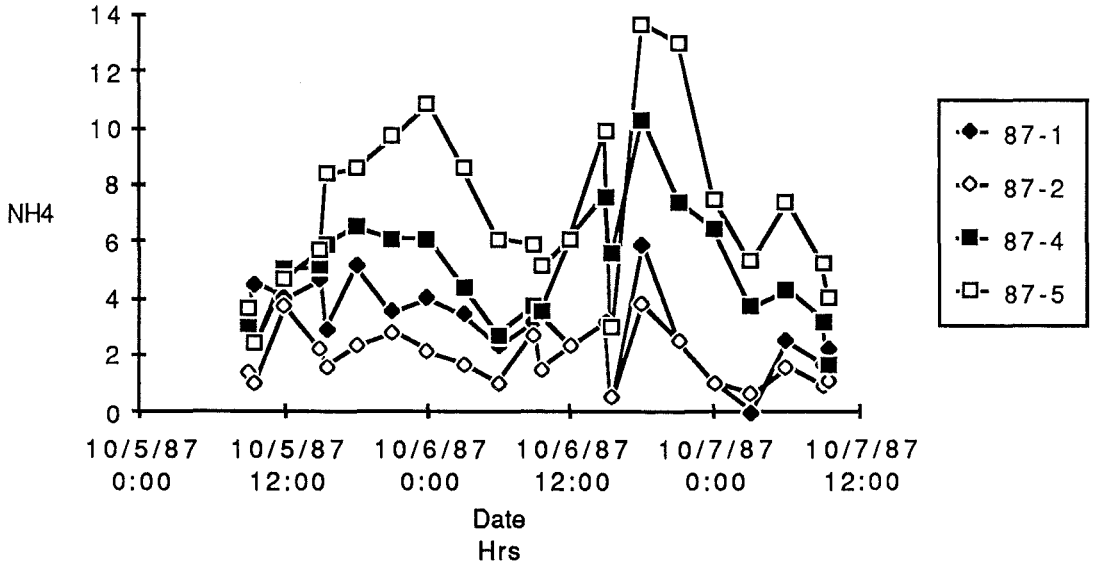

Figure 32. Consentration of ammonium (µgat/l) in the larvae groups during a 48 hrs. period. The larvae were fed 2 times a day.

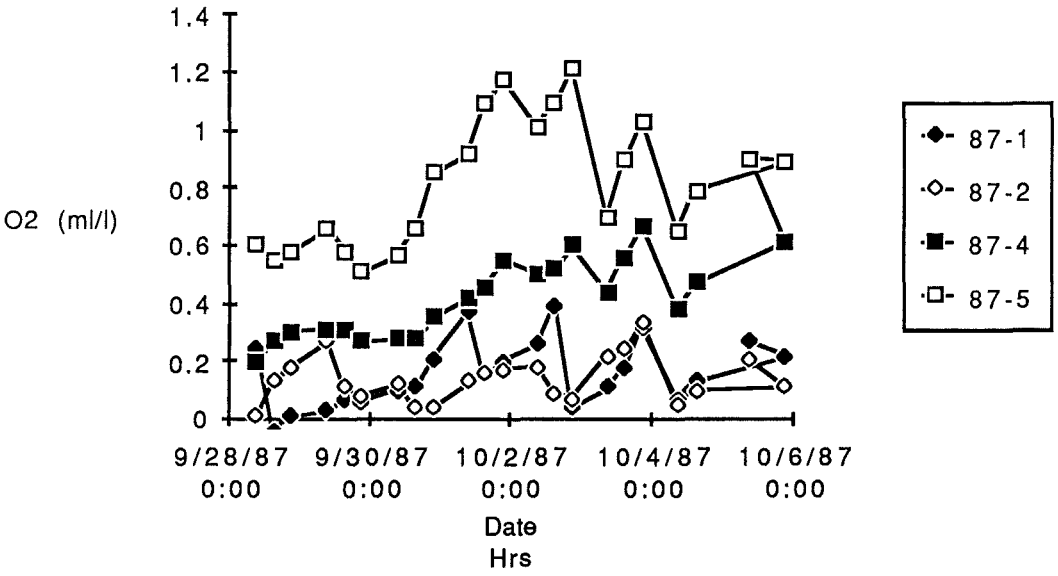

Figure 33. Consumption of oxygen (O_2), by the larvae over a week period. The fishes were fed 2 times every day.

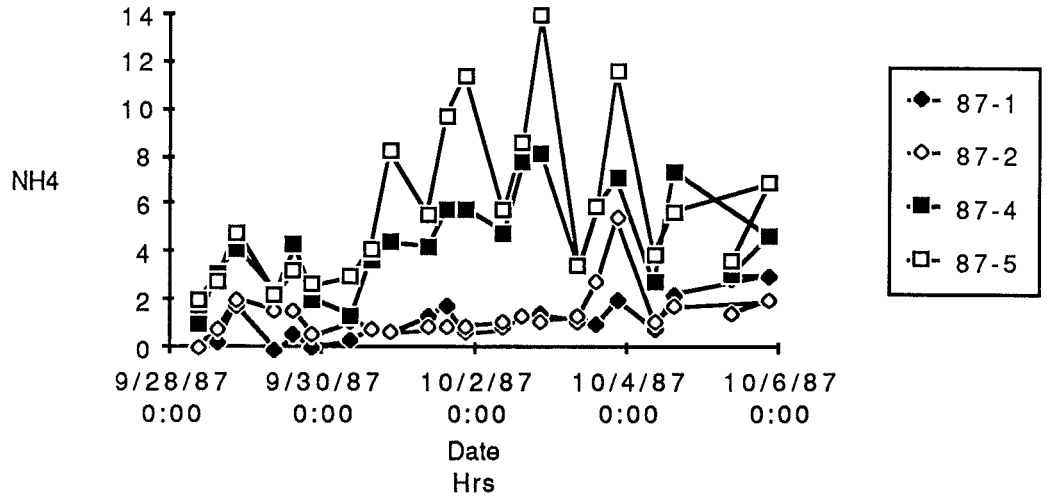

Figure 34. Consentration of ammonium (µgat/l) in the larvae groups during a week period. The larvae were fed 2 times a day.

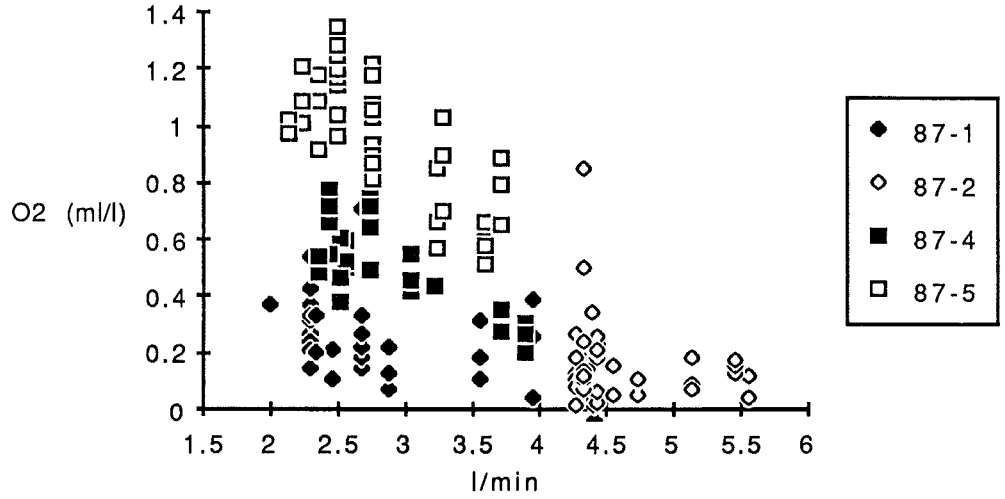

Figure 35. Differences in oxygen content (ml/l) (o_{2in} - O_{2out}) in the larvae groups with different water exchange.

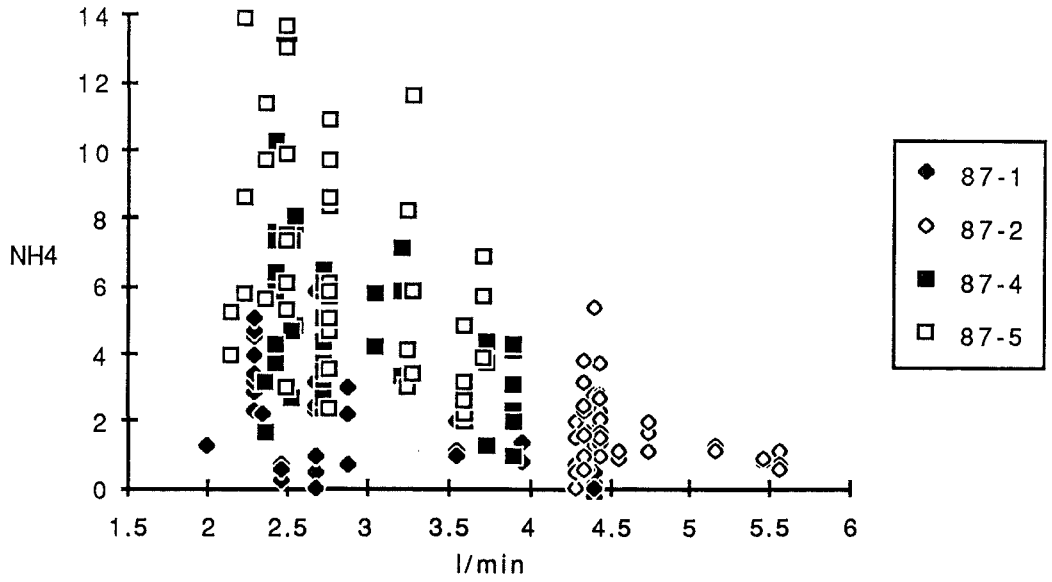

Figure 36. Differences in ammonium concentration (µgat/l) (NH_{4out} - NH_{4in}) in the larvae groups with different water exchange.

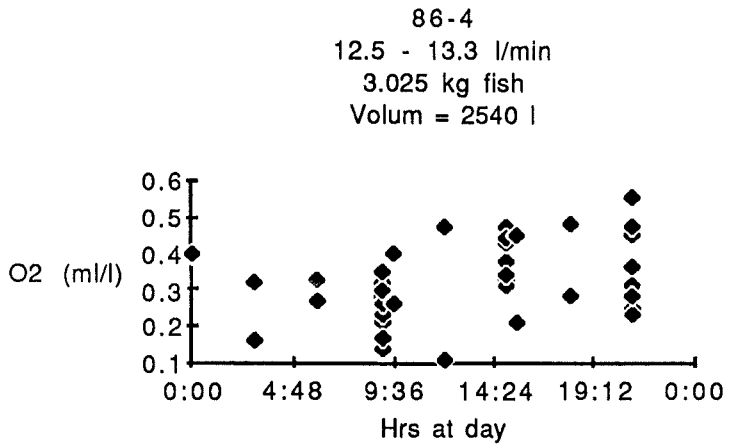

Figure 37. Changes in oxygen (ml/l) in the juvenile group 86-4. The group were fed 2 a day. Observations during a 9 day period.

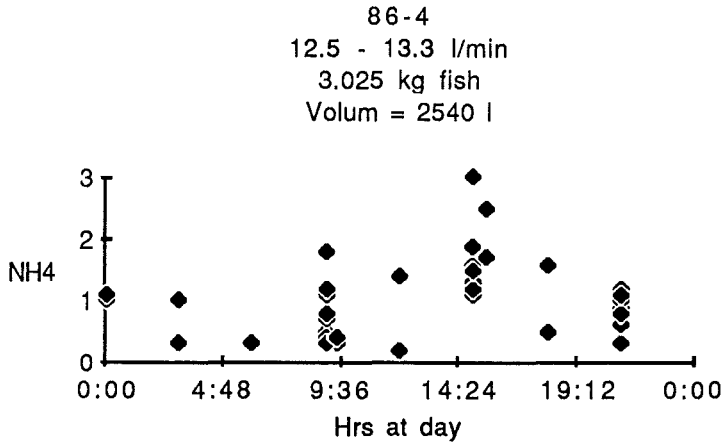

Figure 38. Changes in ammonium (µgat/l) within 24 hrs. (observations from 28/9 - 7/10) in the juvenile group 86-4. The group were fed 2 a day.

Table 10. Temperature, wet weight of fish (Kg), tank volume in the growth group of young striped catfish.

Group	Temperature oC	fish (kg)	Tank Volume (l)
87-50	12.1 - 12.2	12.528 - 13.371	2440
87-60	12.3 - 12.7	38.332 - 40.725	2560
87-70	12.2 - 12.7	43.505 - 45.003	2560
87-80	12.3 - 12.7	50.469 - 56.853	2560
87-90	11.9 - 12.1	61.499 - 66.016	2440
87-95	11.8 - 12.1	60.563 - 63.592	2480

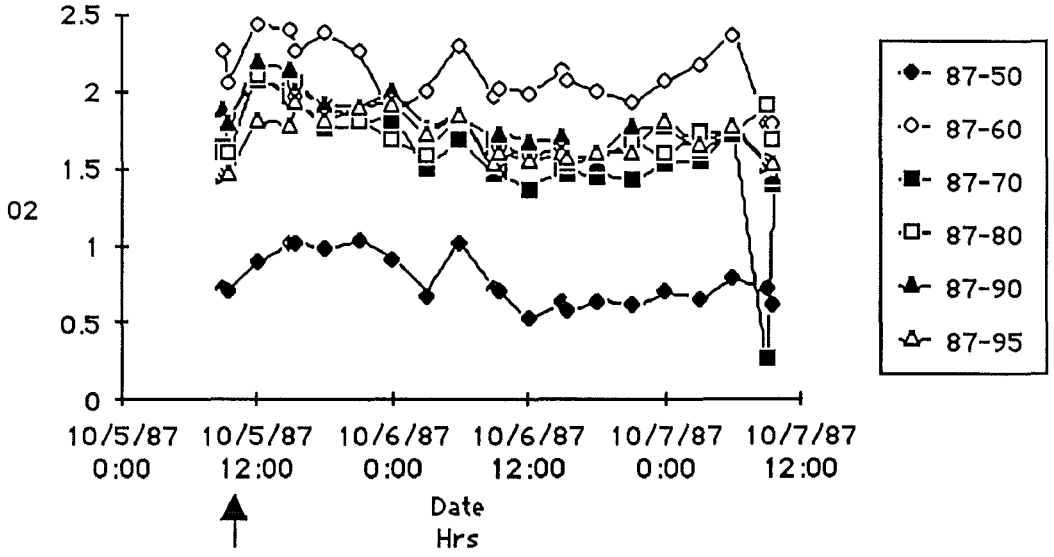

Figure 39. Oxygen (ml/l) consumption in the growth groups over a 48 hrs. period. Arrow indicate feeding time.

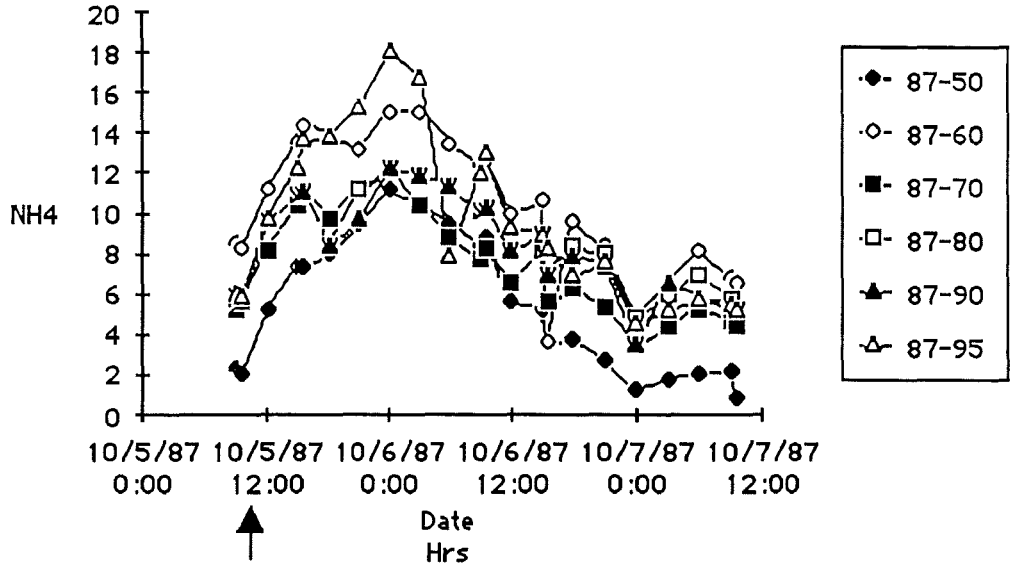

Figure 40. Ammonium (µgat/l) production in the growth groups over a 48 hrs. period. Arrow indicate feeding time.

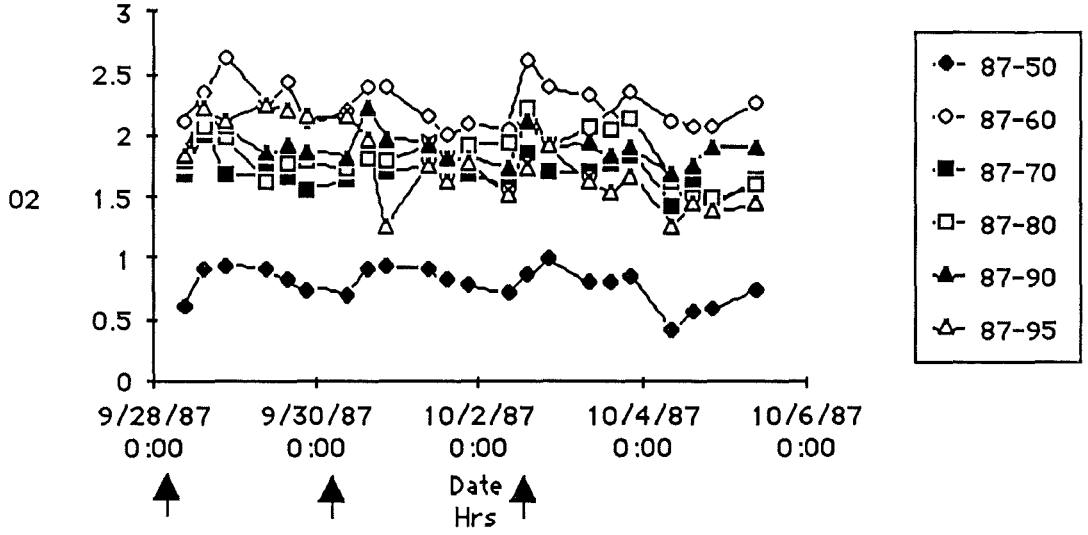

Figure 41. Oxygen (ml/l) consumption in the growth groups over a week period. Arrows indicate feeding time.

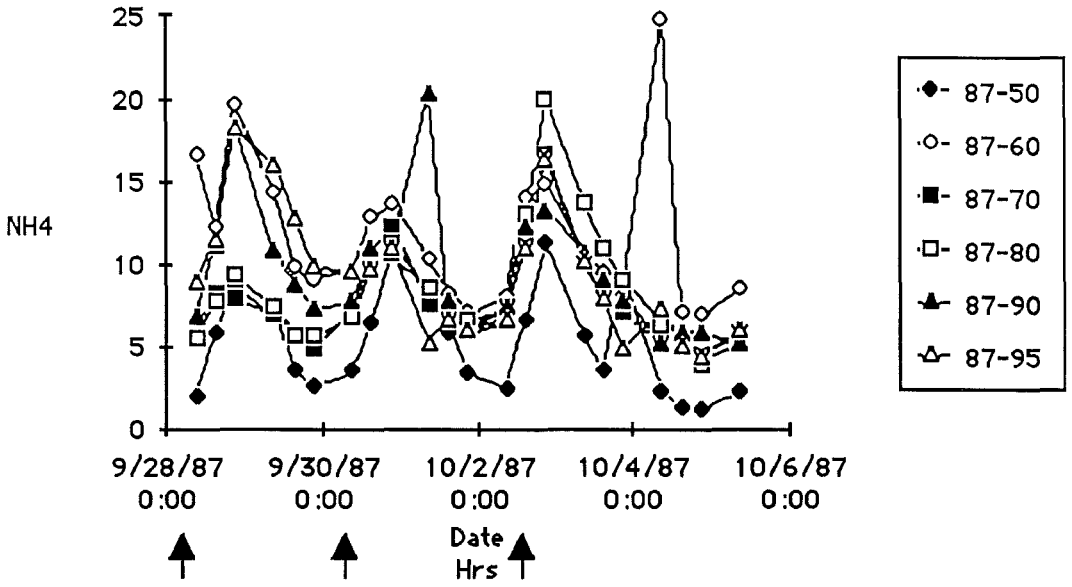

Figure 42. Ammonium (µgat/l) production in the growth groups over a week period. Arrows indicate feeding time.

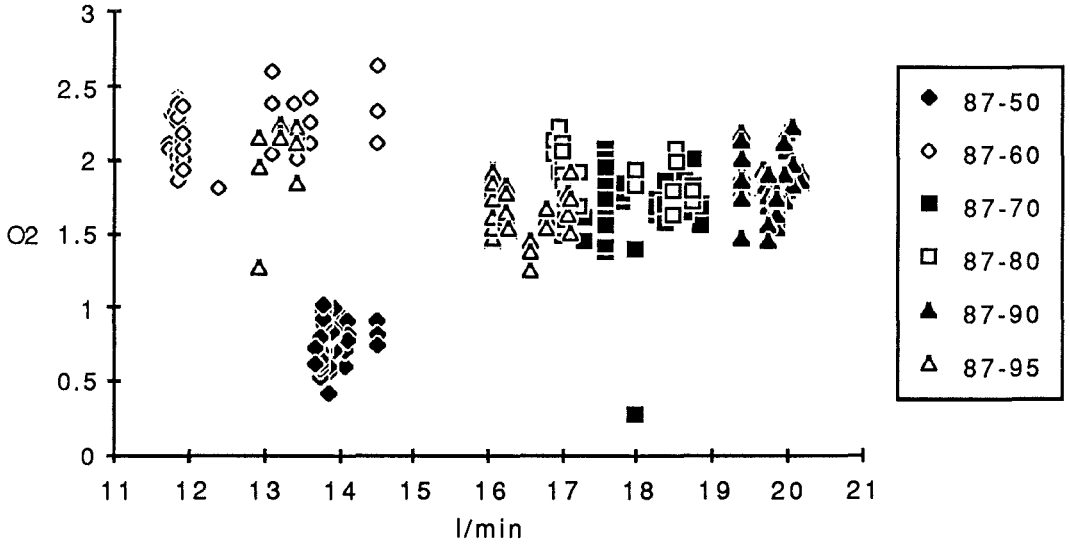

Figure 43. Oxygen (ml/l) consumption in the growth groups with different water exchange (l/min).

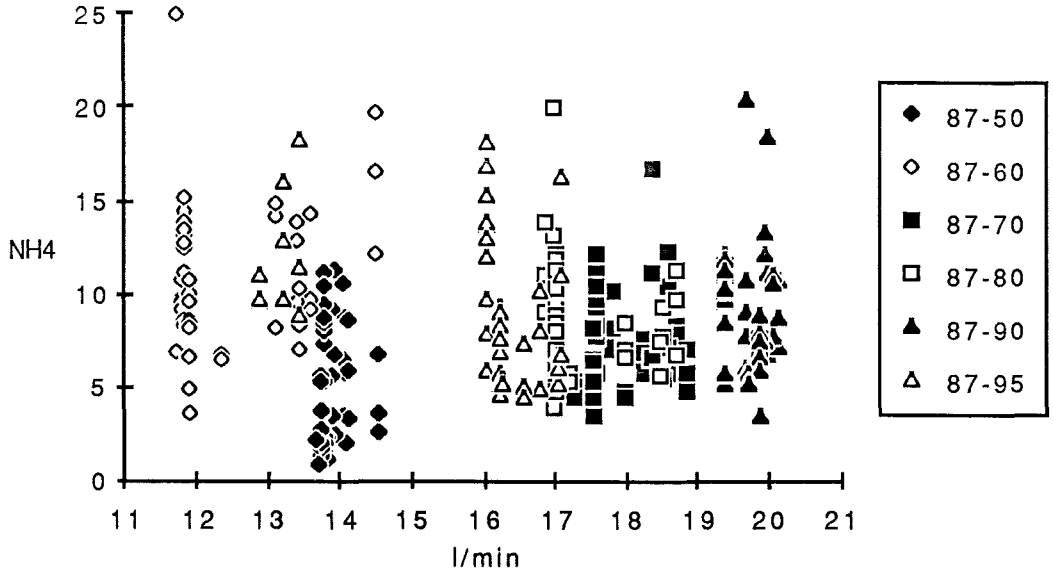

Figure 44. Ammonium (µgat/l) production in the growth groups with different water exchange (l/min).

Table 11. Temperature, amount of fish and tank volume for 3 spawning stock groups of striped catfish.

Group	Temperature oC	Amount fish (kg)	Tank Volume (l)
87-110	11.8 - 12.1	35.497	2480
87-120	11.7 - 12.0	35.551 - 39.661	2280
87-130	11.7 - 12.0	32.153	2560

Table 12. The amount of wet pellets eaten by the 3 spawning group in the examined period 28/9 - 7/10, both totally and per kg. fish in the tanks.

Group	Total eaten (g)	Eaten/kg fish (g)
87-110	2195.1	66.2
87-120	922.7	24.3
87-130	2170.7	61.4

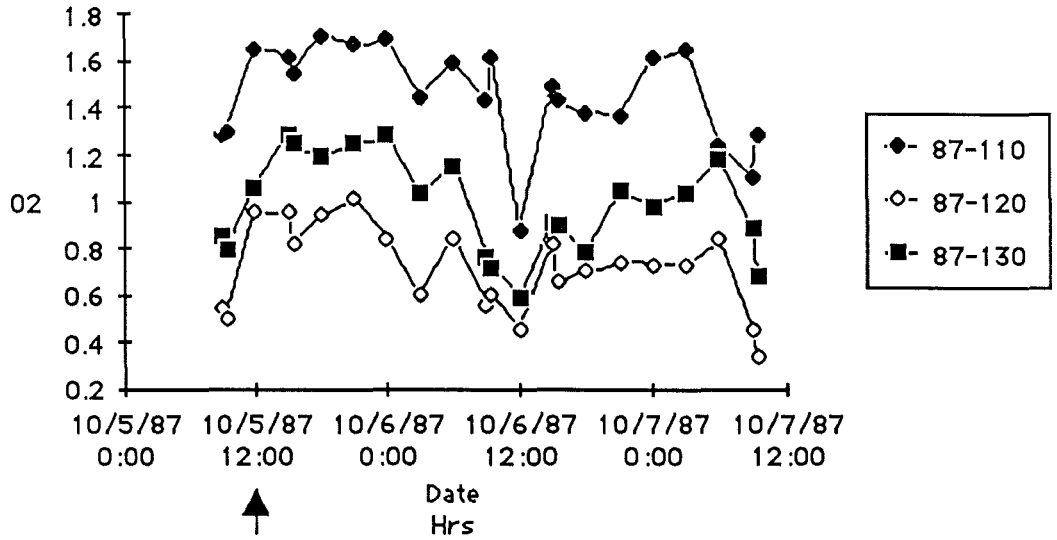

Figure 45. Oxygen (ml/l) consumption in the spawning group in a 48 hrs period. Arrow indicate feeding.

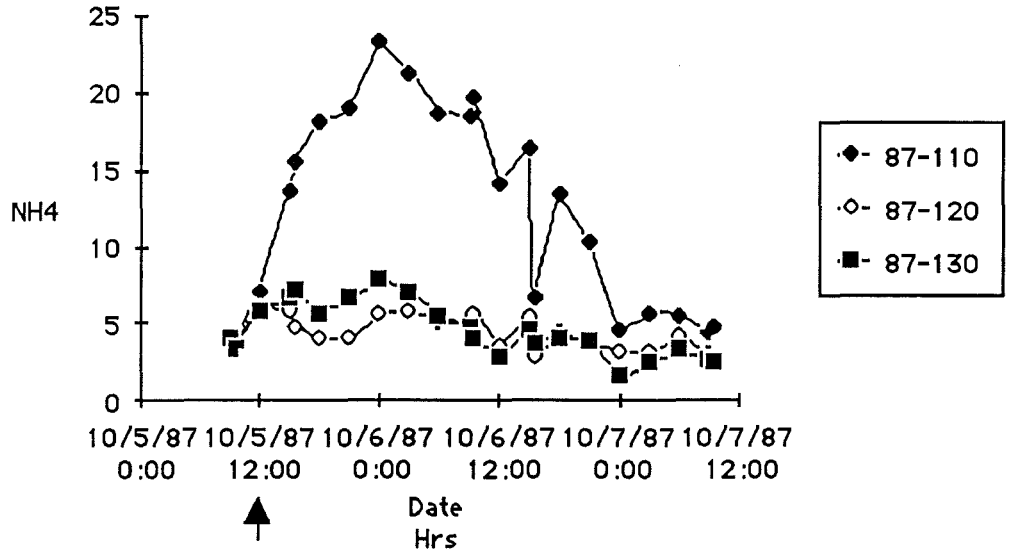

Figure 46. Ammonium (µgat/l) production in the spawning group in a 48 hrs period. Arrow indicate feeding.

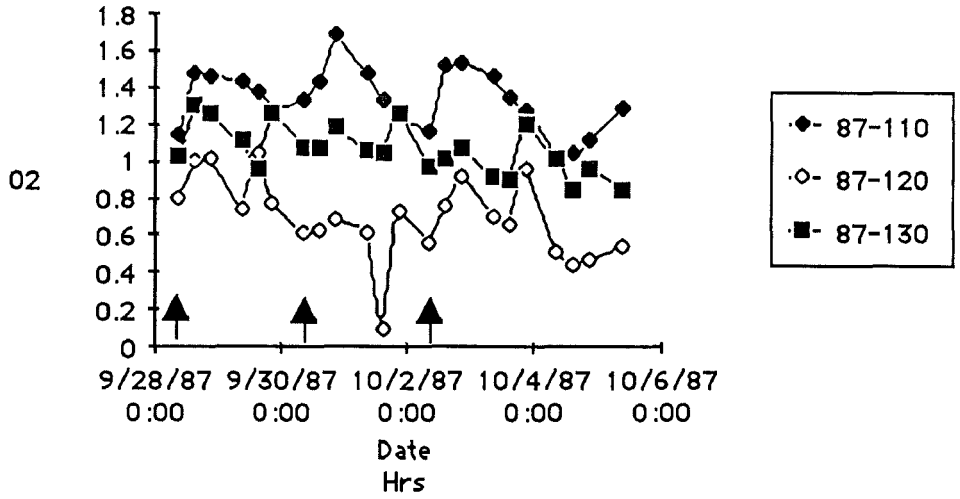

Figure 47. Oxygen (ml/l) consumption in the spawning group over a week period. Arrow indicate feeding.

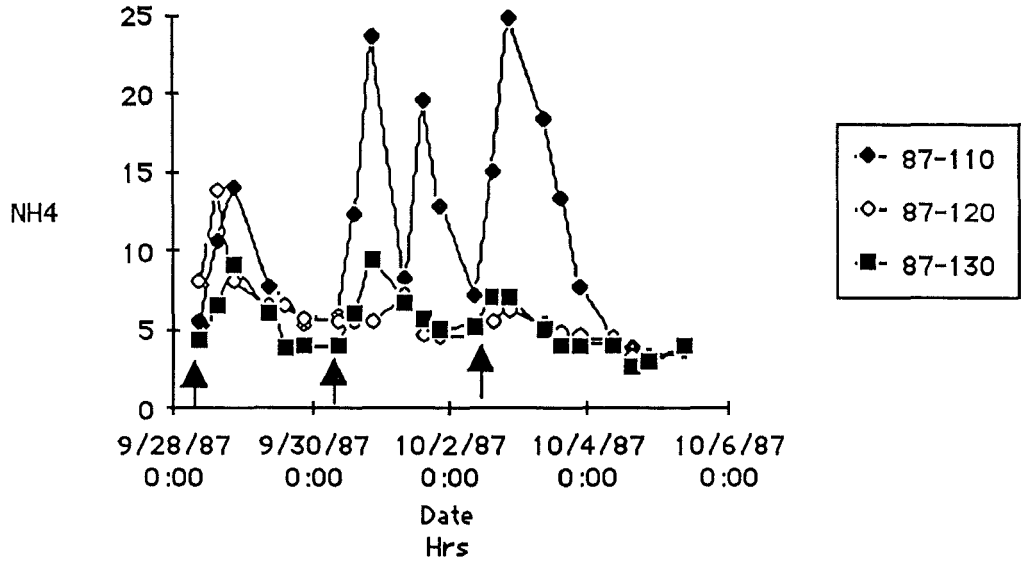

Figure 48. Ammonium (µgat/l) production in the spawning group over a week period. Arrow indicate feeding.

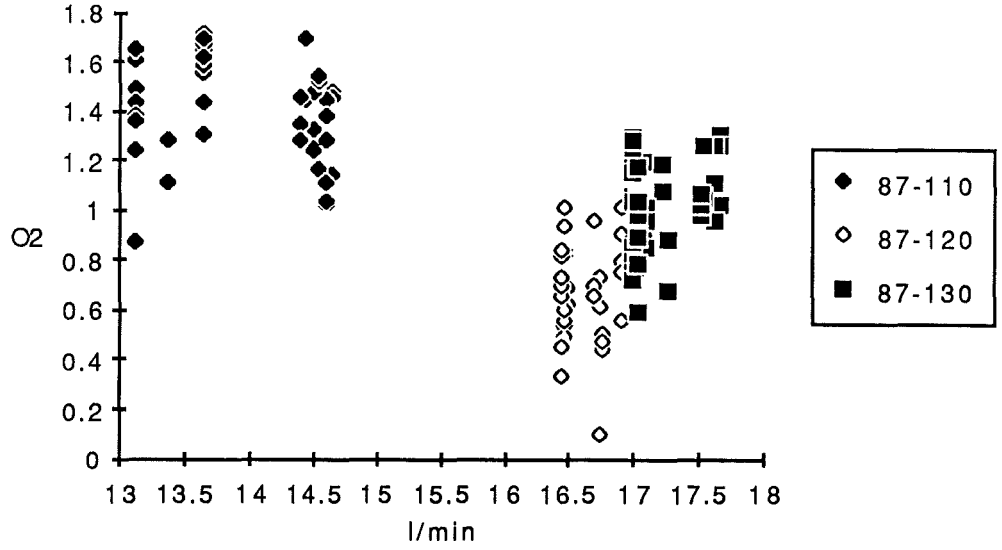

Figure 49. The observed oxygen consumption (ml/l) in the spawning groups against the water exchange (l/min).

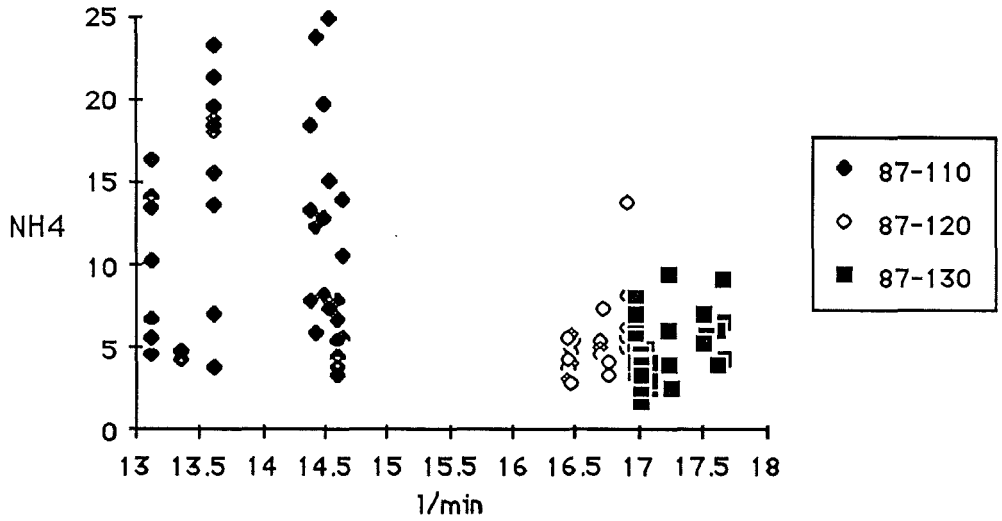

Figure 50. The observed ammonium (µgat/l) production in the spawning groups against the water exchange (l/min).

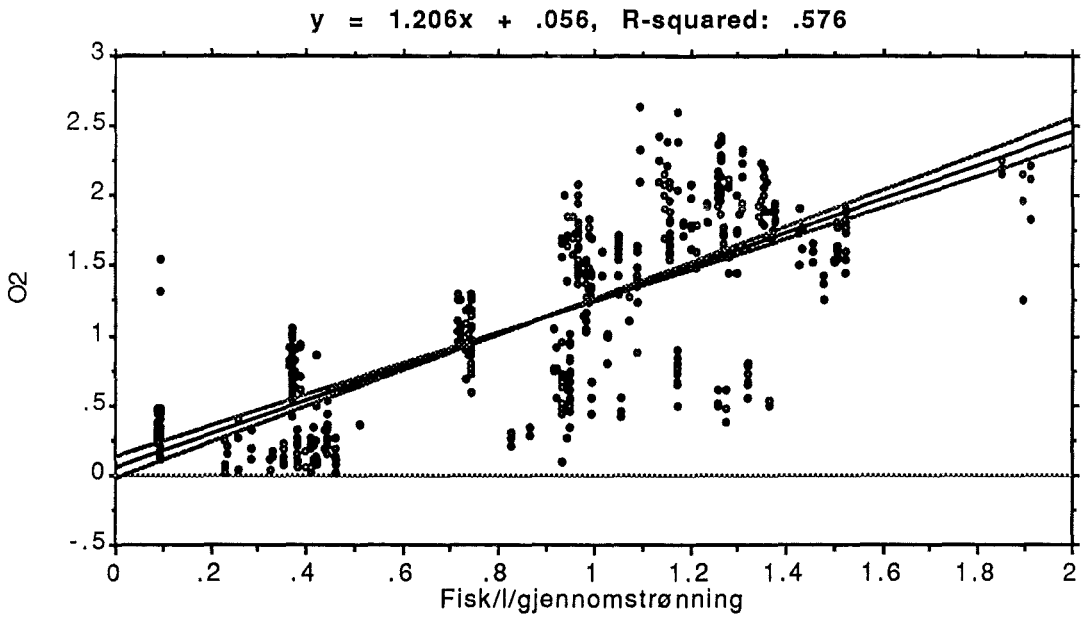

Figure 51. Oxygen (ml/l) consumption towards gram fish per volume (litre) and water exchange (l/min). All groups indicated.

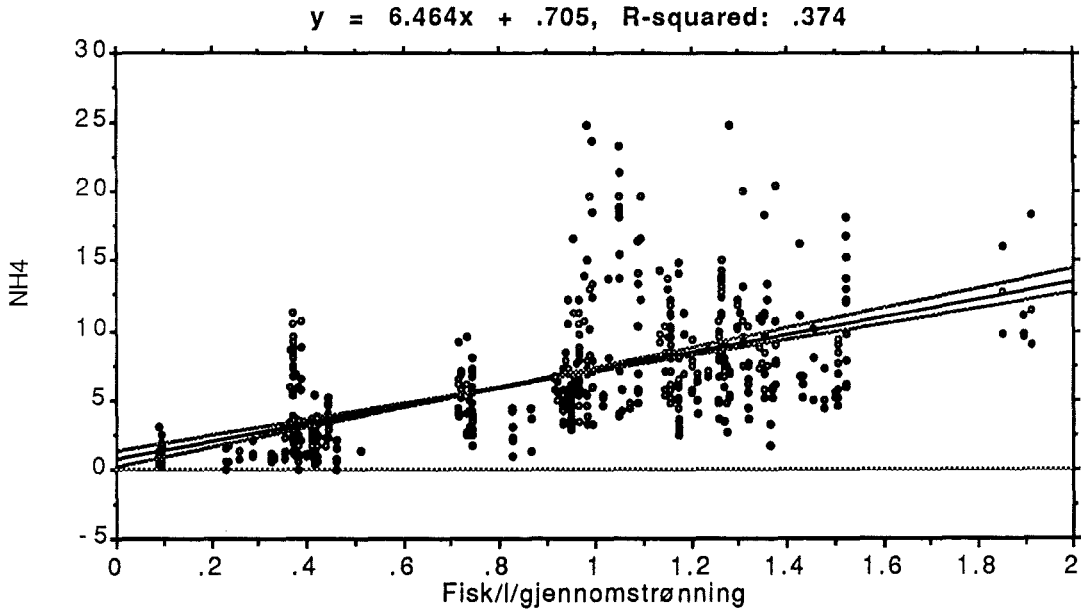

Figure 52. Ammonium (µgat/l) production towards gram fish per volume (litre) and water exchange (l/min). All groups indicated.

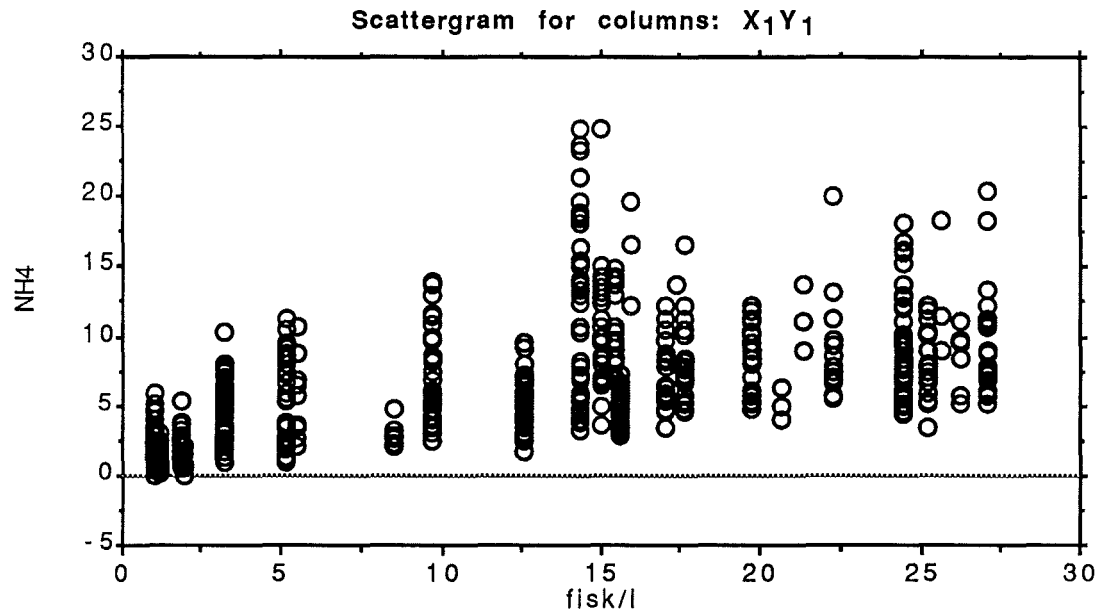

Figure 53. Ammonium (µgat/l) production towards gram fish per volume (litre). All groups indicated.

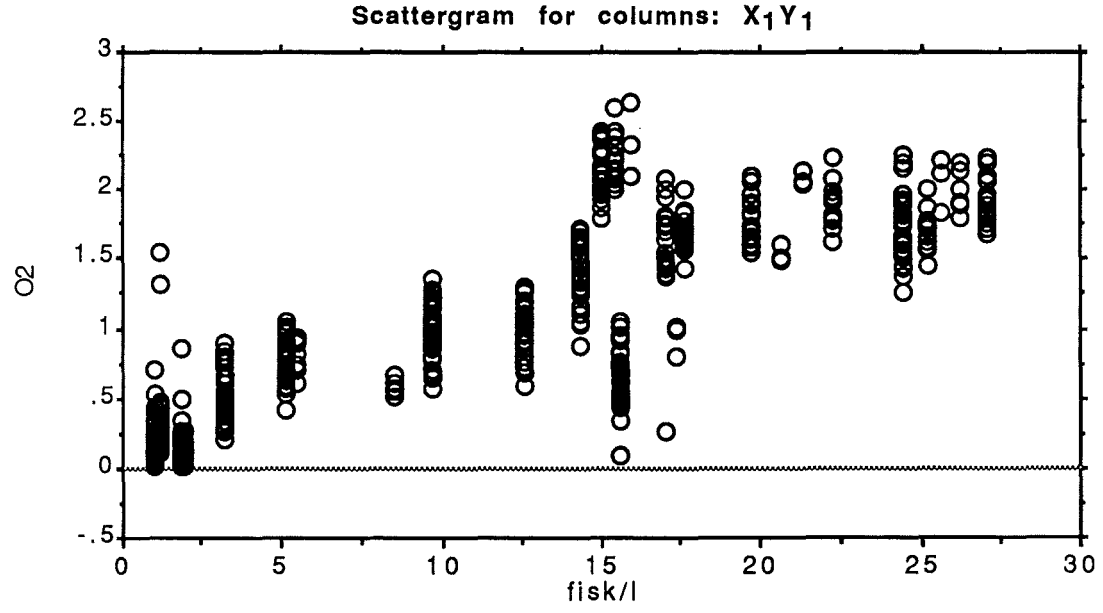

Figure 54. Oxygen (ml/l) consumption towards gram fish per volume (litre). All groups indicated.

Conclusions:

1. There is a relationship between O_2-consumption and amount of fish.

2. The oxygen consumption is approx. 0.9 ml/l using 13 kg stripped catfish at 14 l/min.

Kg fish	l/min	ml/l (O_2)	O_2/Kg
~ 13	~ 14	~ 0.9	0.07
~ 40	12 - 14	~ 2.4	0.06

3. Production of ammonium (NH_4; µgat/l) increase heavily after feeding time in all the experimental groups. In the growth groups (87-50 to -95) the ammonium consentration increased from 2 till 3 times what observed values inbetween feeding times. Extreme increases were as high as five times the normal consentration.

		NH_4		NH_4/Kg	
Kg fish	l/min	low	high	low	high
~ 13	~ 14	~ 2.5	~ 11	0.19	0.85
~ 40	12 - 14	~ 7	~ 15	0.18	0.38

Long run observations

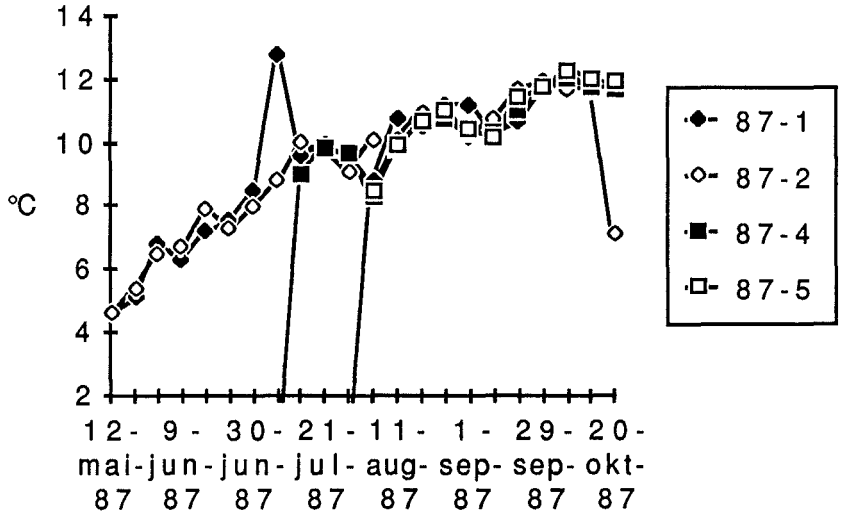

Figure 55. The temperature (°C) in the larvae group.

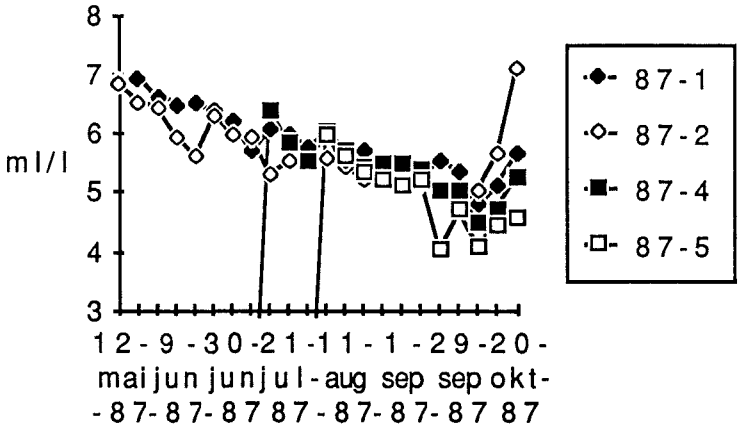

Figure 56. The observed oxygen content (ml/l) in the larvae group.

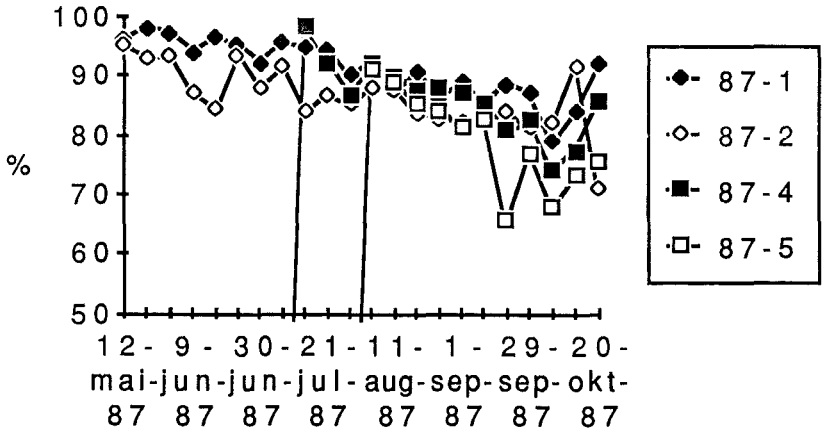

Figure 57. The observed oxygen consentration in %-saturation in the larvae group.

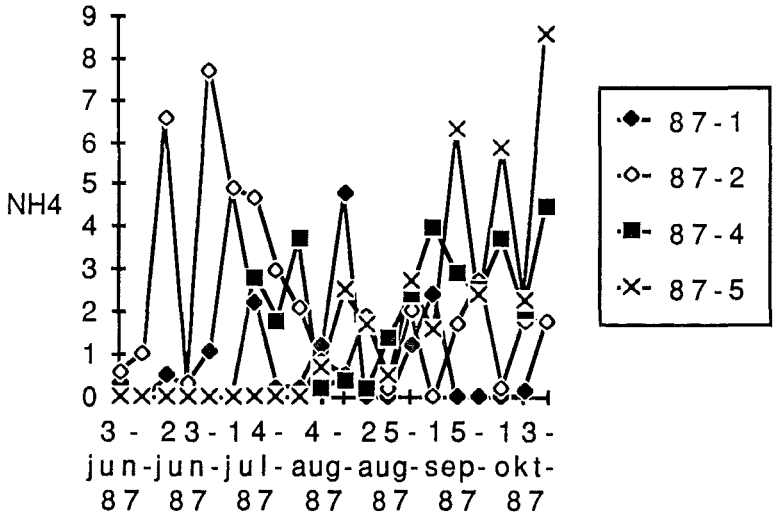

Figure 58. The observed ammonium (µgat/l) in the larvae group.

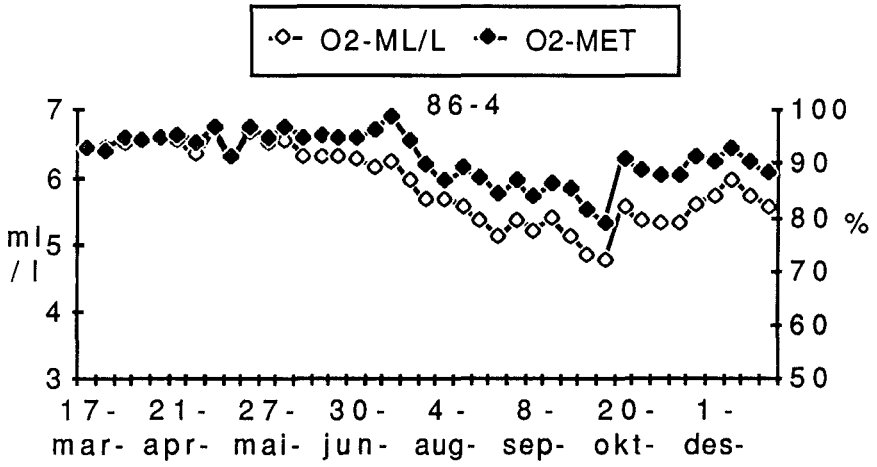

Figure 59. The oxygen content in the 86-4 group in ml/l and %-saturation.

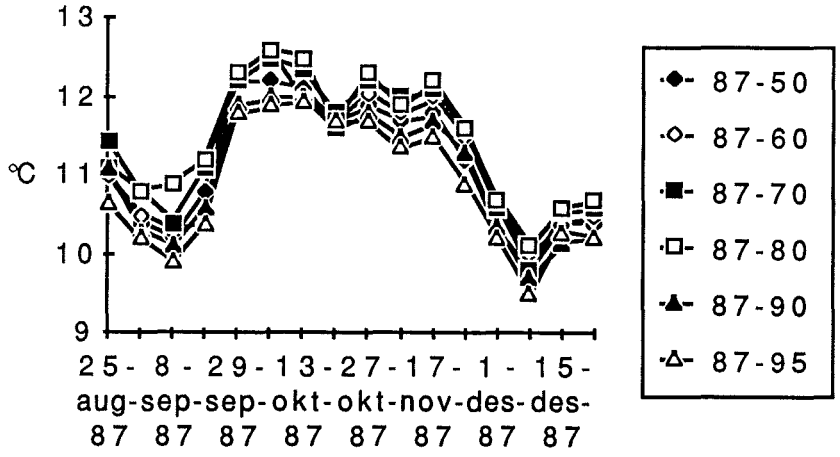

Figure 60. The temperature in the growth groups.

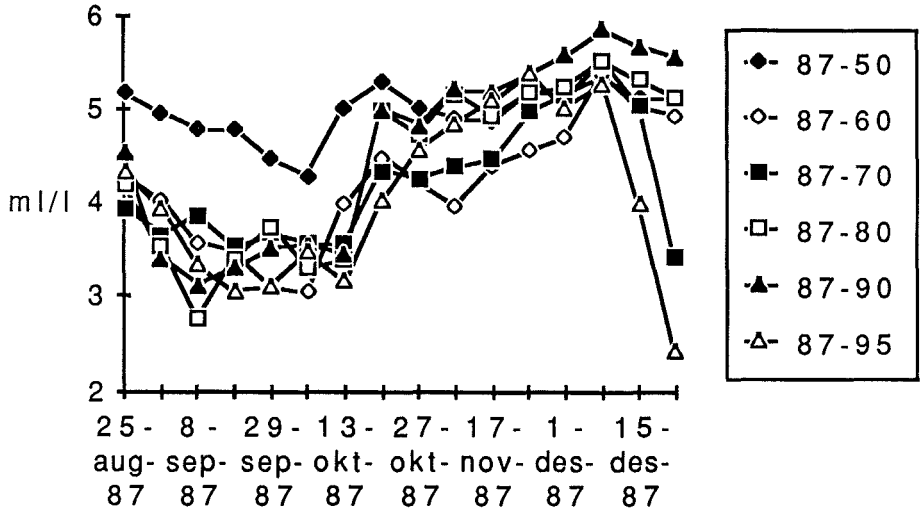

Figure 61. The oxygen content (ml/l) in the growth groups.

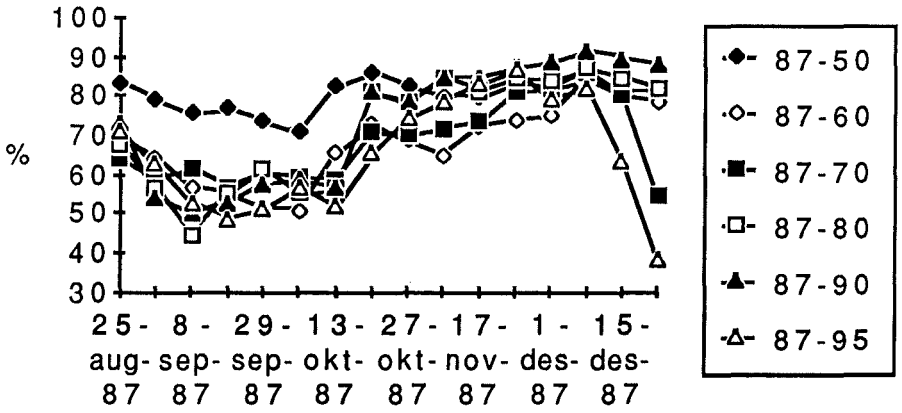

Figure 62. The oxygen saturation (%) in the growth groups.

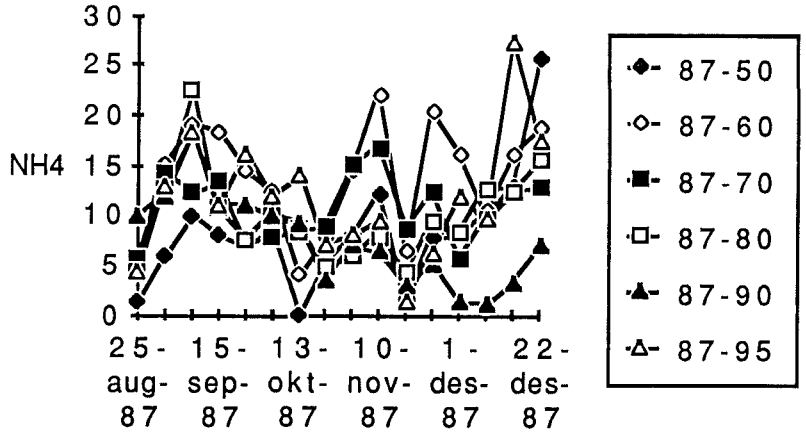

Figure 63. The ammonium consentration (µgat/l) in the growth groups.

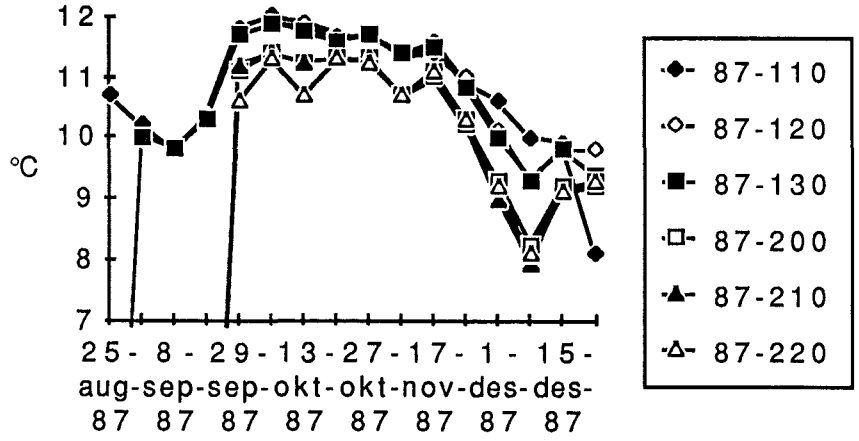

Figure 64. The temperature observed in the spawning groups.

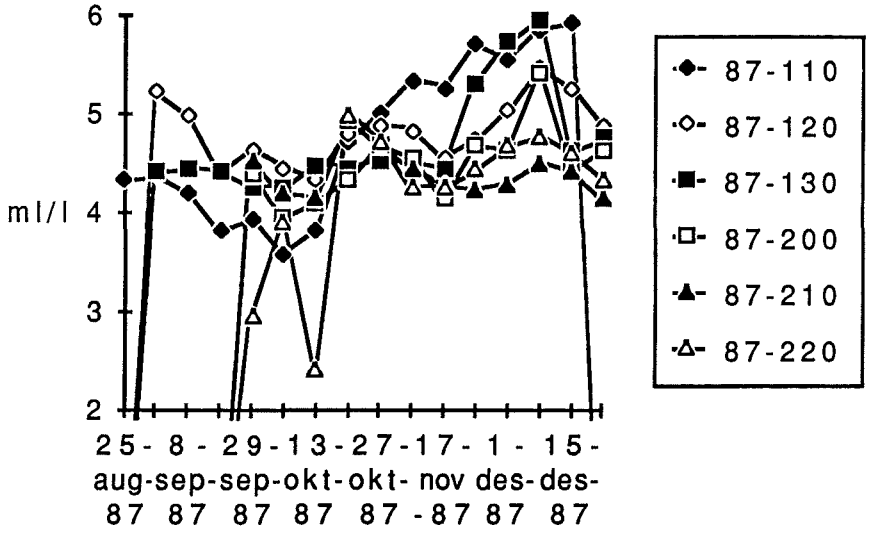

Figure 65. The oxygen content (ml/l) in the spawning groups.

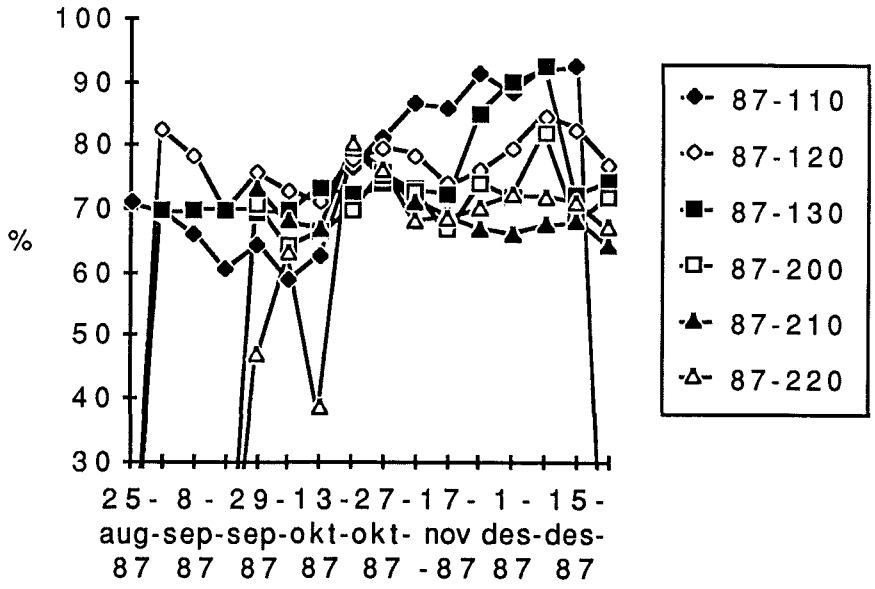

Figure 66. The oxygen saturation (%) in the spawning groups.

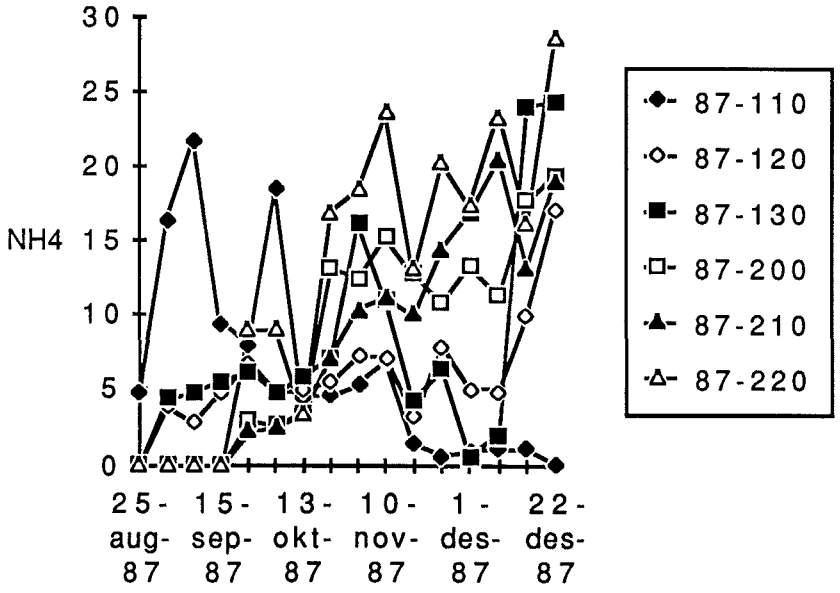

Figure 67. The ammonium consentration (µgat/l) in the spawning groups.

Chemical analysis

Øyvind Lie at the Institute of Nutrition, Bergen, has conducted the analysis listed below. These results will later be discussed and used in connection with the new feeding project.

On fish

SAMPLES FROM THE STRIPED CATFISH

	Dato: 10.06.87								Dato: 08.10.87		
Fish:	1	2	3	4	5	6	7	8	1	2	3
Filet											
Tørrstoff	25.0	22.5	21.1	22.4	14.7	21.7	22.9	25.4	21.0	39.0	22.8
Protein	17.9	17.3	15.9	16.8	11.8	16.7	18.8	18.7	14.7	12.6	15.6
Fett	4.3	2.2	2.0	3.2	1.3	2.8	1.0	3.9	4.6	24.0	5.3
Aske	0.7	0.8	0.8	0.6	0.5	0.7	0.8	0.8	0.9	0.7	1.0
Liver											
Tørrstoff	45.6	42.3	38.8	39.3	32.7	43.5	26.8	34.8	30.1	41.3	34.6
Protein	9.9	11.6	11.6	11.6	14.3	10.4	13.7	14.2	10.6	10.5	10.7
Fett	30.8	23.7	24.5	20.1	13.0	27.5	9.8	14.5	11.0	25.9	16.7
Aske	0.4	0.6	0.5	0.5	0.7	0.5	-	0.6	0.9	0.9	1.0

FETTSYRESAMMENSETNING AV FILET FRA STEINBIT

	10.06.87								08.10.87		
Fisk	1	2	3	4	5	6	7	8	1	2	3
14:0	1.7	2.4	1.2	1.8	1.4	1.5	1.0	2.1	4.1	5.0	4.6
16:0	12.1	11.6	15.5	13.6	14.1	13.9	16.3	12.8	11.6	11.3	12.2
16:1	9.7	8.0	5.6	8.3	6.5	6.9	5.7	12.3	6.5	8.4	7.4
18:0	2.2	2.7	4.1	2.7	3.6	3.0	4.1	2.9	1.7	1.4	1.6
18:1w9	21.5	15.1	14.3	18.1	13.4	16.6	11.3	14.8	18.8	19.4	18.5
18:1w7	5.9	5.8	5.1	6.1	5.3	5.6	5.1	7.7	4.1	4.6	4.2
18:2	1.0	1.8	1.1	1.4	0.9	1.2	1.1	1.5	3.4	3.3	3.5
18:3	0.5	1.0	0.2	0.7	0.3	0.7	0.5	0.5	1.5	1.8	1.6
18:4	0.5	2.3	0.2	0.8	0.4	0.6	0.5	0.8	3.3	4.0	3.5
20:1w11	1.1	2.0	0.8	1.0	3.2	0.9	0.7	1.5	0.9	1.2	0.9
20:1w9	2.2	3.2	1.3	2.2	2.3	1.8	1.0	1.7	5.4	5.0	5.8
20:1w7	0.9	0.7	0.8	1.1	1.0	1.0	1.1	1.6	0.0	0.5	0.3
20:4w6	2.5	5.2	8.7	4.3	7.5	5.6	10.1	6.9	0.9	2.0	1.1
20:4w3	0.5	0.8	0.6	0.6	0.3	0.6	0.5	0.3	1.2	1.4	1.3
20:5	11.3	11.9	16.0	12.2	13.1	14.3	15.5	11.1	8.6	8.0	7.7
22:1	0.7	2.1	0.3	0.7	0.5	0.5		0.3	4.6	4.4	5.5
22:5	1.8	1.9	2.9	2.1	1.9	2.3	3.6	2.0	1.5	1.4	1.5
22:6	16.5	14.7	16.5	15.7	16.4	17.5	15.8	6.7	17.8	12.2	15.4
24:1									0.3	0.3	0.3
SUM	92.7	93.2	95.3	93.3	92.1	94.4	93.9	87.5	96.1	95.5	96.6
DIV	7.3	6.9	4.7	6.7	7.9	5.6	6.2	12.5	3.9	4.5	3.4
ΣS	16.0	16.7	20.8	18.1	19.1	18.4	21.4	17.9	17.4	17.7	18.4
ΣM	42.1	36.9	28.2	37.5	32.3	33.2	24.9	39.9	40.4	43.8	42.8
ΣP	33.6	37.8	45.2	36.4	39.8	41.5	46.6	28.3	34.9	30.8	32.0

FETTSYRESAMMENSETNING AV LEVER FRA STEINBIT

	10.06.87								08.10.87		
Fisk	1	2	3	4	5	6	7	8	1	2	3
14:0	1.9	1.5	1.4	1.0	0.9	1.1	1.3	1.3	1.5	1.4	1.6

16:0	14.7	10.5	14.1	11.0	11.3	13.9	15.3	11.4	9.4	8.7	9.9
16:1	14.3	7.2	13.2	10.3	9.7	11.4	10.0	15.4	4.7	6.3	7.2
18:0	2.5	2.6	2.3	2.0	2.4	2.5	3.7	2.0	2.3	1.9	1.7
18:1w9	36.4	24.3	31.2	28.1	24.4	33.0	21.3	22.0	29.3	33.1	26.1
18:1w7	7.7	5.9	8.5	6.5	7.3	7.3	8.1	9.3	5.9	5.9	5.5
18:2	0.5	2.0	0.8	1.2	0.6	0.8	0.9	1.1	2.6	2.4	3.0
18:3		1.0	0.3	0.4		0.2	0.2	0.3	0.6	0.7	0.7
18:4		1.9	0.2	0.4				0.2	0.7	0.6	0.6
20:1w11		1.0	0.3	0.4	1.3	0.3	0.2	0.3	1.1	0.8	1.0
20:1w9	1.1	3.3	1.0	1.8	2.1	1.3	0.8	0.9	5.0	3.6	4.0
20:1w7	0.3	0.3	0.4	0.3	1.3	0.4	0.6	0.5	0.3	0.0	0.0
20:4w6	1.3	2.6	3.6	2.8	5.2	2.6	7.9	7.3	1.7	1.4	1.3
20:4w3	0.2	1.3	0.4	0.6		0.4	0.3	0.3	1.0	1.7	1.5
20:5	6.3	11.6	9.1	11.7	12.6	9.4	14.9	13.0	10.5	9.7	10.4
22:1		1.9		0.8	1.7				2.0	1.4	2.2
22:5	1.2	1.8	1.8	1.9	1.0	1.6	2.4	2.0	1.9	2.1	2.5
22:6	7.9	14.4	7.4	14.9	5.6	10.2	7.6	4.8	12.3	14.6	15.8
24:1						0.2			0.0	0.0	0.0
SUM	96.3	95.2	95.8	96.0	87.3	96.6	95.5	92.1	92.6	96.3	95.0
DIV	3.7	4.8	4.2	4.0	12.7	3.4	4.5	7.9	7.4	3.7	5.0
ΣS	19.1	14.5	17.8	14.0	14.5	17.5	20.3	14.7	13.1	12.0	13.2
ΣM	59.8	44.0	54.5	48.2	47.8	54.0	41.0	48.4	48.2	51.1	46.1
ΣP	16.9	34.6	22.8	32.6	24.5	24.4	33.3	27.9	28.7	30.8	32.8

On food

RÅANALYSER AV FOR

	Dato: 16.06.87		Dato: 08.10.87				
				24/6	7/7	20/7	13/10
For:	1	2	1	2	3	4	5
Tørrstoff	44.7	50.7	45.3	43.8	42.5	47.7	43.5
Fett	11.9	16.7	11.3	10.8	9.0	16.9	10.2
Protein	19.9	20.4	20.3	20.8	21.1	20.1	20.1
Aske	1.3	1.2	4.1	3.4	3.2	3.4	4.0

FETTSYRESAMMENSETNING AV FORPRØVER

	Dato: 10.06.87		Dato: 08.10.87				
For:	1	2	1	2	3	4	5
14:0	6.1	6.6	6.3	6.0	6.1	6.4	6.2
16:0	15.3	14.8	14.3	14.5	14.5	14.1	14.7
16:1	3.9	4.0	3.9	3.6	3.8	3.9	3.9
18:0	3.0	2.7	2.4	2.5	2.4	2.2	2.5
18:1w9	12.0	9.9	10.1	10.2	10.5	10.0	10.7
18:1w7	3.6	2.6	2.5	2.8	2.5	2.6	2.7
18:2	3.1	2.8	3.3	3.3	3.8	2.6	3.5
18:3	1.7	1.8	1.7	1.6	1.7	1.7	1.7
18:4	3.8	4.5	4.5	4.0	4.2	4.6	4.2
20:1w11	0.7	0.0	0.8	0.8	0.7	0.7	0.7
20:1w9	7.1	8.9	7.5	7.4	7.5	7.6	7.1
20:1w7	0.4	0.0	0.3	0.3	0.3	0.4	0.3
20:4w6	0.4	0.7	0.6	0.7	0.7	0.5	0.6
20:4w3	1.0	1.2	1.2	1.1	1.1	1.2	1.1
20:5	7.5	6.4	7.0	7.4	7.2	7.2	7.0
22:1	11.9	13.8	13.1	13.1	12.9	13.3	12.5
22:5	1.2	1.1	1.2	1.3	1.2	1.2	1.2
22:6	13.9	13.0	14.3	14.3	14.4	13.6	14.3
24:1	0.7	0.7	0.9	0.9	0.9	0.9	0.9
SUM	97.2	95.2	95.7	95.7	96.4	94.6	96.0
DIV	2.9	4.8	4.3	4.3	3.6	5.4	4.0
ΣS	24.4	24.0	22.9	23.0	23.0	22.8	23.5
ΣM	40.2	39.8	39.0	39.1	39.1	39.3	38.9
ΣP	29.4	28.6	30.5	30.4	30.5	29.8	30.2

Reports, Newspaper-article,radio-program etc.

Agderposten 2/2-87. Flødevigen nye oppdrettsfisk

Agderposten 9/3-87. Steinbit hos gynekologen

A-Magasinet Nr. 3/87: side 20. Nye husdyr i havbruket

Fedrelandsvennen 29/4-87. Steinbit -ny, lovende oppdrettsfisk: Selges ikke på trynefaktoren.

Fiskaren 29/4-87. "Er jeg gravid doktor ?" Med fru Steinbit til gynekologen.

Lillesandposten 30/4-87. Forskningsstasjon vil ha levende steinbit

Nordisk Aquakulture Nr. 1/87: 12-13. Nye marine arter: Stygg som steinbit.

NTB-reportasje (Mars/April). Steinbiten - den nye oppdrettsfisken (Publ. i en rekke av landets aviser. bl.a. Nordlys, Sunnmøreposten, Fedrelandsvennen, Vårt Land, Tiden)

Varden 11/3-87. Kragerø-steinbiten får sin "brudesuite"

NRK radio P1 "Kolumbus", 30 min. Kl. 1920 27/5-87.

National Fisherman, West Coast Focus 1987, Vol. 68, Nr. 6: 4-7. Norway's farmed halibut and cod are coming.

Gjøseter, J. and E. Moksness 1987. Some preliminary observations on catfish (*Anarhichas lupus* L. and *A. minor* Olafsen) in captivity. ICES CM 1987/F:32. 1-12.

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Moksness, E. 1987. Oppdrett av steinbit. Seminar om marin fisk. 8/10-87 i Molde. 4 sider

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Anon. 1986. Preliminary report of the international 0-group fish survey in the Barent Sea and adjacent waters in August-

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Anon. 1987. Preliminary report of the international 0-group fish survey in the Barent Sea and adjacent waters in August-September 1987. ICES CM 1987/G:38 : 1-27.

Moksness, E. og J. Gjøseter 1987. Årsrapport 1986 på prosjektet "Oppdrett av Steinbit" til BPNorge A/S

Moksness, E. og J. Gjøseter 1987. Halvårsrapport 1987 på prosjektet "Kultivering av Steinbit" til BPNorge A/S

Ackowledgement

We like to thank the following persons for there help during 1987:

B. Berland, Zoological Laboratorium, Bergen, for help in problems with parasitts.
E. Egidius, Dept. of Aquaculture, Inst. of Marine Research, Bergen, for help with bacterial problems.
A. Reinert, Inst. of Marine Research, Torshavn, Faroe Island, for delivering newly hatched larvae in spring 1987.
H. Bjørke, Institute of Marine Research, Bergen, for help with collecting catfish larvae in July 1987.
A. Hylen, Institute of Marine Research, Bergen, for help in collecting catfish juveniles in August/september.
Ø. Lie, Institute of Nutrition, Bergen, for chemical analyzes.
The crew on the following ships: "Eldjarn", "G.O.Sars", "Raito", "Stallo".

We also like the thank the following Thechnical Assistans at Flødevigen BS:
Inger Henriksen
Terje Jåvold
Kristian Kristiansen
Evy Lien
Kate Lønnhaug
Øystein Paulsen
Sissel Rosseland

Pluss all those we have forgotten to thank.