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Sea lice infestation on farmed salmon: possible use of cleaner-fish as an alternative method for de-lousing.

by

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ABSTRACT

Sea lice infestation is a major problem in intensive cage culture of Atlantic salmon, and the current chemical treatment has several negative aspects. This paper describes experiments on utilizing cleaning symbiosis between wrasses and salmon as an alternative method for de-lousing in sea cages. Promising results indicate that two or three different wrasse species might be used as cleaner-fish for effective parasite control in commercial salmon farming.

INTRODUCTION

Epidemic infestation of sea lice (Lepeophtheirus salmonis) is a serious problem in intensive culture of Atlantic salmon (Salmo salar). The common solution to this problem is treatment with the chemicals Neguvon (Brandal & Egidius 1979) or Nuvan, a method that effectively delouses the salmon. However, this is a costly and laborious procedure which on many farms has to be repeated several times a year. The active ingredient in Neguvon/Nuvan (dichlorvos), can be toxic to marine life in the vicinity of the farm (Egidius & Møster 1987) and can be a health risk to farm workers if not properly used.

Lice infestation and the associated chemical treatment are major stressors to salmon. Furevik et al. (1988) showed that there is significantly decreased leaping and increased rolling activity of salmon after de-lousing. High rolling activity (surfacing) is interpreted as a secondary stress response, the primary response being release of swim bladder gas, which is succeeded by rolling to ingest air for buoyancy compensation. Other indicators of stress, particularly increased heart rate and blood cortisol levels have also been correlated with the de-lousing process, (Bjordal et al. 1988).

Efforts have been made to find simpler and less harmful ways of solving the sea lice problem, such as capture of lice based on chemo- or phototaxis or repelling the lice by sound or electric shock. So far, none of these techniques has proven to be effective. Nor has shading of cages to 70 or 40 percent of ambient light level been shown to have significant effect on lice infestation, (Huse et al. 1988).

Promising results are, however, obtained using cleaner-fish for de-lousing of farmed salmon. Bjordal (1988) found that several wrasse species were functional cleaners using Atlantic salmon as host species. Goldsinny (Ctenolabrus rupestris) and rock cook (Centrolabrus exoletus) were the most active cleaners, while female cuckoo wrasse (Labrus ossifagus) had a more modest cleaning behaviour. This paper describes further experiments in sea cages on the utilization of wrasse for de-lousing of salmon.

METHODS AND MATERIALS

Wrasse used in these experiments were caught locally by fyke nets, pots, or beach seines.

SMALL CAGE EXPERIMENTS

The experiments were conducted at the Austevoll Marine Aquaculture Station, south of Bergen, Norway. Eight (5x5 m by 4 m deep) cages with mesh size (10 x 10)mm square mesh were used.

At the start of the experiment (Aug.17,1988) 220 smolts with average weight of 84 g were stocked in each cage. The smolts had no visible lice infestation. Two cages were used as control groups, while the others were stocked with different species and numbers of wrasses. The smolt was fed to satiation with dry pelleted feed. Dead wrasse were replaced, except for rock cook which was not available beyond those originally stocked in the cages. Lice infestation and salmon and wrasse mortalities were recorded on August 30, September 29, and November 1, 1988. On the two last dates samples of all smolt groups were measured and weighed. The lice infestation level was recorded in the following categories:

Category	Number of lice per smolt.
1	0
2	1-5
3	6-10
4	11-20
5	>20

De-lousing (with Nuvan) was done when necessary, according to the judgement by the farm manager.

FULL SCALE TRIALS

This experiment was done at a commercial fish farm, Austefjordlaks A/S - at the island of Sotra, west of Bergen. The experiment included 3 adjacent standard size cages (12x12x6 m), with 20.000, 26.000 and 30.000 smolts. On September 12, 1988 500 goldsinny and 100 rock cook were placed in the middle cage with 26.000 smolts, while the two other cages were used as control groups. The smolts which had been transferred to sea cages in June were all de-loused with Nuvan two days prior to the start of the experiment. The only data recorded were the dates of de-lousing. Time of de-lousing was decided by the farm manager. The experiment was terminated on Nov. 21,1988 when the smolts were pooled into larger cages.

RESULTS

SMALL CAGE EXPERIMENTS

Lice infestation

Lice infestation level, expressed as the average category value is given in Table 1. A heavy lice infestation occurred shortly after the start of the experiment. Control group I and both groups with cuckoo wrasse had to be de-loused by Nuvan after two weeks. Control group II suffered from high mortality and was significantly weakened due to the lice infestation and was therefore taken out of the experiment. Control group I needed two more chemical de-lousings, and a new control group II required one de-lousing by early November. During the same period the lice infestation level was constantly low to moderate in the goldsinny and/or rock cook groups. Also the cuckoo wrasse groups needed no further de-lousing by chemicals.

Mortalities of smolts and wrasses

The mortalities of smolts and wrasses are given in Table 2. Smolt mortality was very high in both control groups and also in the cuckoo wrasse groups (52-70%), while the smolt mortalities in the remaining wrasse groups were low to moderate (0-16%). Wrasse mortality was high in the 50 rock cook group, while the mortalities in the other groups were low.

Growth of smolt

Growth data of the different smolt groups (except control group II) are given in Table 3. Control group I showed the poorest growth, the cuckoo wrasse groups intermediate, while the highest average weights were noted in the 50 goldsinny, 50 rock cook and 15 goldsinny/15 rock cook groups.

FULL SCALE TRIALS

During the experimental period only a few smolts were observed with lice infestation in the wrasse cage. The control group with 20.000 smolts suffered repeated lice attacks, and de-lousing with Nurvan was done 3 times during the period (Sept.19, Oct.10 and Nov.14, 1988), while the second control group was de-loused once, (Nov.14).

DISCUSSION

Based on earlier findings on cleaning symbiosis between wrasses and lice infested salmon (Bjordal 1988), the experiments described in this paper clearly indicate that wrasses can be used as cleaner-fish for salmon in sea cage culture. Even under intensive lice attacks, smolts in cages that were stocked with goldsinny and/or rock cook had only slight lice infestation. The cuckoo wrasse also showed good cleaning abilities but with somewhat lower effectiveness compared with the other two species. Smolt mortality showed a fairly good correlation with lice infestation, with the highest mortalities in the control and cuckoo wrasse groups. However, these results were obtained in small cage experiments, and may not apply to a full scale operation. Wrasse mortality was high only in the cage with 50 rock cook, (90%). Bjordal (1988) observed that rock cook generally showed more aggressive behavior than goldsinny, and intraspecific aggression combined with relatively high stocking density might explain the high mortality. The low mortality of rock cook in the combined group with goldsinny support this hypothesis, although the existing material does not allow any conclusion on this point.

The smolt growth data should also be interpreted with care. Although the growth of the goldsinny and rock cook groups was superior to the control and cuckoo wrasse groups, the difference in growth might have been caused by other factors such as different densities due to different mortality rates or an effect of intestinal parasites that were found in some of the groups. However, there is reason to expect better growth of fish with low lice infestation compared with fish that are stressed by repeated lice attacks followed by chemical treatment.

The experiment conducted at the commercial fish farm was the first trial of this method in a full scale operation. Promising results were obtained at a much lower wrasse-to-smolt ratio (1:50) than in the small cage experiments. The group with 50 rock cook, however, ended up at a somewhat similar ratio (5 wrasse to 220 smolts), as there was no replacement of dead wrasse in this group. Effective cleaning might, therefore, be obtained at a 1:50 wrasse/smolt ratio. However, further investigations are needed to establish optimal ratios between wrasse and smolts.

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Table 1. Small cage experiment, 1988. Lice infestation levels (according to category values given in text) and de-lousings (DL).

Date	C-I	C-II*	25CW	50CW	25G	50G	50RC	15/15	Comments
Aug 17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	Exp. Start
Aug 30	4.80	5.00	4.70	4.50	2.30	1.90	1.20	1.20	
Aug 31	DL		-	-	-	-	-	-	
Sep 1	-		DL	DL	-	-	-	-	
Sep 29	3.66		2.26	1.94	1.22	1.06	1.02	1.04	
Oct 5	DL	1.00	-	-	-	-	-	-	
Nov 1	3.52	3.28	1.68	1.28	1.36	1.30	1.06	1.02	
Nov 4	DL	DL	-	-	-	-	-	-	

C=Control, CW=cucko wrasse, G=Goldsinny, RC=Rock cook, 15/15=15G + 15RC
*Due to high mortality caused by severe lice infestation, the C-II control group was taken out of the experiment on Aug 30th. A new group of 200 smolt was stocked in the cage on October 5th.

Table 2. Small cage experiments, 1988. Mortality of smolts and wrasses, given as total number of original fish remaining. S-smolts, W-wrasses (Explanation of other abbreviation, see Table 1) %M-percent mortality during the experiment.

	C-I		C-II		25CW		50CW		25G		50G		50RC		15/15	
Date	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
Aug 17	220	-	220	-	220	25	220	50	220	25	220	50	220	50	220	30
Aug 30	217	-	138	-	213	24	211	47	205	25	213	50	220	26	219	29*
Sep 29	79	-	-	-	68	23	105	46	185	25	207	49	220	18	217	29
Nov 1	75	-	-	-	67	23	105	46	184	24	206	48	220	5	217	29
% M	66		-		70	8	52	8	16	4	6	4	0	90	1	3

*one dead rock cook.

Table 3. Small cage experiment, 1988. Growth data of the different smolt groups given as mean weights with the range in parentheses. n=50 for all groups. Weight at start of experiment (Aug 17th): 84 g, range 35-155 g, n=138 of total 1760 smolts.

Date	C-I	25CW	50CW	25G	50G	50RC	15/15
Sep 29	125 (70-210)	124 (65-190)	131 (75-200)	158 (85-270)	154 (90-245)	152 (70-280)	157 (80-275)
Nov 1	220 (110-240)	252 (110-460)	253 (90-420)	276 (100-480)	290 (130-470)	292 (80-520)	297 (140-490)
% Increase	162	200	201	229	245	248	254

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Salmon farmers put 'cleaner fish' on the payroll

Stephanie Pain

A SMALL orange fish may soon take on the job of the cleaner at salmon farms around the coast of Britain. The fish will not only help to keep salmon healthy but it might also help to clean up the industry's image as a polluter of coastal waters.

The gold sinny wrasse, *Ctenolabrus rupestris*, is one of several species of wrasse that offer an alternative to pesticides as a means of removing sea lice from salmon in fish farms. Sea lice, a type of crustacean parasite, are a serious problem for salmon farmers. Fish kept at close quarters in sea cages are prone to the parasite, which can cause extensive damage to the skin. Sometimes the parasites penetrate the brain and kill the fish.

Fish farmers control the parasite by dosing the cages with an organophosphorous pesticide, dichlorvos, which is sold under the name Nuvan. Regular treatments, every three to four weeks, are necessary because the parasites reproduce rapidly.

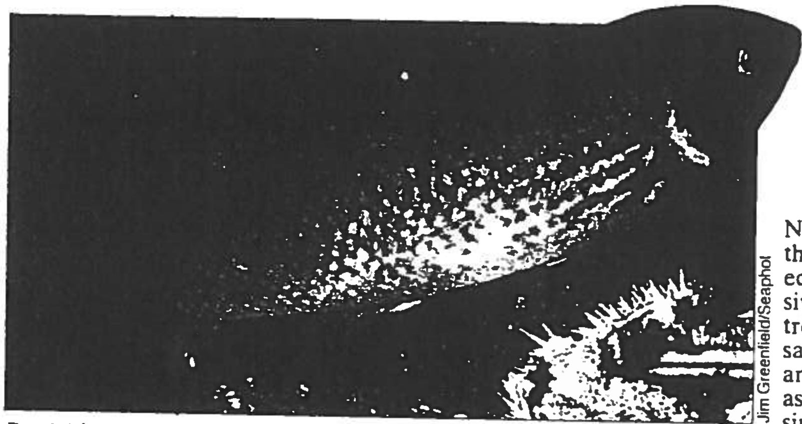
But Nuvan does not stay in sea cages for long, and it is a serious threat to other marine organisms in the vicinity. Results of a recent study suggest that it is the cause of the sudden upsurge in the incidence of cataracts among wild fish (*New Scientist*, Science, 26 August). The industry is now looking for alternative ways to control sea lice.

This month, trials began with the gold sinny wrasse, a fish that is about 12 centimetres long. The wrasse will pi[...] external parasites from other fis[...] fish, which generally live inshore ar[...] kelp beds, are not specifically [...] fish". They would not normally co[...] contact with salmon, which spend [...] their lives in the open sea.

However, says Peter Smith of t[...] Fish Industry Authority's Marine Fa[...] Unit at Ardtoe in Argyll, "they are inquisitive and will eat anything, eve[...] happens to be attached to another fish[...] gold sinny wrasse is as likely to re[...] parasites from a salmon as from other fish it more normally associates with, if the two are together in a cage.

Last year, in Norway, Asmund Bjordal tried out several species of wrasse. After some small-sc[...] n tanks, he tried a lar[...] 500 wrasse in a sea [...] lmon. The salmon [...] nt with Nuvan, [...] had to be treated [...] ce under control. [...] encouraged the [...] carry out some [...] s are now under [...] ough the winter. [...] by the Shetland [...] iation is near Ler[...] where 100 wrasse are [...] with 5000 of this year's salmon smolts. The other, in Loch Sunart, on the west coast of Scotland, involves 70 wrasse in a cage with 3000 older salmon weighing about 2 kilograms each. If the results are as good as Bjordal's, the fish farmers want to extend the trials through the summer, when sea lice are especially damaging.

Cleaner fish are an attractive alternative to Nuvan, and not just because they are more acceptable ecologically. Nuvan is expensive. "It can cost £100 a year to treat one cage with pesticide," said Smith, "so reusable wrasse are sensible financially as well as ecologically." The gold sinny wrasse may soon be proving its worth in the waters of Scotland. □



Jim Greenfield/Seaphot

Pesticide substitute: the gold sinny wrasse can kill the parasites that plague salmon in fish farms

Neurons do not live by nerve growth factor alone

SOME types of nerve cells, or neurons, need a special protein, known as nerve growth factor (NGF), in order to survive. Researchers have suspected for years that other types of neuron in the brain need similar factors. Now Yves-Alain Barde and his colleagues at the Max Planck Institute for Psychiatry at Martinsried in West Germany have found a second factor. The substance, which they call brain derived neurotrophic factor (BDNF), is very closely related to NGF (*Nature*, vol 341, page 149).

In the embryo, neurons grow extensions known as axons, which make contacts with target neurons. The target cells produce minute amounts of growth factor and scientists such as Barde believe that the axons have to compete to obtain enough growth factor for their parent cells to survive. This may be the mechanism that limits the number of neurons that control a single target cell in the adult.

Scientists believe that adult animals need the growth factors in order to maintain neurons in a healthy state. Researchers have used NGF in rats to "rescue" neurons which might otherwise have died through damage or old age. Several research groups are hopeful that NGF may one day be useful for treating degenerative diseases of the brain, such as Alzheimer's disease.

Last year, Barde and his colleagues isolated BDNF from pigs' brains. They showed that the substance is required by neurons in the central nervous system—for instance, those that carry signals from the retina to the brain. These particular cells do not respond to NGF and, in their turn, those that do respond to NGF are not influenced by BDNF. Other nerve cells, meanwhile, respond to neither of these factors.

Now Barde, together with Joachim Leibrock and others, have determined the sequence of amino acids that make up the BDNF molecule. When the researchers compared the sequence of BDNF with NGF, they found many similarities; they think that the two molecules have much the same shape. The selective actions of the two proteins are probably determined by the way they fit into their specific receptor molecules on the membranes of the cells whose behaviour they influence.

Scientists now know of many families of proteins with closely related structures. Once researchers have worked out the sequences of one or two members of a family, they can then use these to identify other relatives. Barde and his colleagues believe that their knowledge of BDNF's sequence may open the way to discovering yet more nerve growth factors. □

Trees may fare badly as Britain warms

THE SITKA spruce, commonest of the trees in Britain's forestry plantations, grows best in cooler, moist regions and reacts badly to heat and aridity. So says Paul Jarvis of the University of Edinburgh, who believes that the sitka spruce is not, therefore, a good choice for growing in Britain. In a decade or so, when the general warming of the Earth due to the greenhouse effect makes hot dry summers a common feature of the British climate, the sitka spruce may be badly affected.

Trees, such as the sitka spruce, will also face other problems as the Earth warms up. Climatologists predict that winds will get stronger and there will be more storms. Already, more than half of the forested trees in Britain are felled before they reach maturity to minimise the risk of wind damage. According to Eric Grace, another researcher at the University of Edinburgh, "a small increase in average wind speed could have a devastating effect on the economics of forestry."

An occasional powerful storm, such as the one that struck southeast England in October 1987, can fell more than a million cubic metres of timber. If such events were to happen more often, the effect on all Britain's forests would be disastrous.

Some scientists speculate, meanwhile, that insect pests will be a greater threat to trees when the climate is warmer. Forest fires may also become more common. □