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Issue 2

Caligus

A newsletter on the biology and control of sea lice for researchers, aquaculture and fisheries industry, educators, consultants, and management authorities

This second issue of *Caligus* includes:

- a report on the Trondheim workshop on sea lice control on fish farms including the list of delegates,
- news of a new Internet discussion group on sea lice biology and control
- the current mailing list of persons interested in sea lice biology and control,
- a notice of an initiative in Canada to develop a lice control strategy, and
- some papers and abstracts from the workshop:
  - ⇒ Best current practice for lice control in Norway
  - ⇒ The effect of swimming depth , speed and artificial light treatment in Atlantic salmon (*Salmo salar)* culture on the infestation of the copepod *Lepeophtheirus salmonis*.
  - ⇒ Lice fighting the environmental friendly way!
- and news of the
  - ⇒ 9th International Congress of Parasitology, Japan 24-28 August 1998
  - ⇒ how fish feed companies are helping lice monitoring
  - ⇒ and a recent research reward to sea lice "fighters" in Norway
  - ⇒ 1998 international symposium on sea lice biology

Further abstracts and papers from the Trondheim workshop, and information on current research activities, will be published in future issues of *Caligus.* Issue No. 3 of *Caligus* is devoted to a bibliography of publications relevant to lice biology and/or control. In 1997, the bibliography will be developed into groups according to keywords.

This information will also be placed on the project Web site: http://www.ecoserve.ie/projects/sealice.

Some of the delegates at the sea lice biology and control workshop in Trondheim November 1997.

Photo by J. Finlay (Trouw Aquaculture)

We thank Akzo Nobel, Biomar, and the Norwegian Directorate for Nature Management and Norwegian Research Council for their sponsorship of the sea lice control workshop in Trondheim.

Internet e-mail discussion group for lice biology and control established

An e-mail discussion group has been established to enable people interested in lice biology and control to provide and request information to others in the group. All persons who have already submitted their e-mails to this project will automatically be included in the group. The group relies on people voluntarily sending and replying to messages. Sending an e-mail to <CALIGUS@ listserv.hea.ie> will send the message to all subscribers to the group. If you wish to reply to such a message consider whether it is more appropriate to send it back to everybody, or only to the individual who sent the message. The latter may avoid annoying others with irrelevant messages.

To join the group (a) send an email to <listserv@listserv.hea.ie>, (b) leave the 'subject' line blank, and (c) type in the following command in the main part of the email message: "SUBSCRIBE CALIGUS first-name surname". Do not include your email address in the message as this will be automatically recorded. To leave the list, send the message "SIGNOFF CALIGUS" to <listserv@listserv.hea.ie>.

Trondheim workshop on lice control on fish farms a success

About 50 delegates attended the workshop in Trondheim from 6 - 9 November 1997 (Table 1). The audience was a mix of researchers, government scientists, fish farmers and fish food manufacturer's from Norway, Scotland, England, Ireland, Canada and Japan. This led to discussions ranging from the longer term visions of solutions to sea lice problems on fish farms, to the immediate needs of farmers in dealing with infestations. Arising from the papers presented and discussions between participants at the workshop two documents are in preparation and will be published in *Caligus* 4:

1. A protocol for regular monitoring of lice on salmon farms so as to better apply lice control measures
2. The best current strategy for the control of lice on salmon farms.

Two presentations provided a review of current biological knowledge on lice, lice-host interactions, and host defences, with a view to developing improved control methods in the long term. The first keynote presentation was by Dr Geoff Boxshall, one of the foremost experts in copepod biology in the world, reviewed recent discoveries in copepod biology which have relevance to lice biology. Copepods have developed remarkably sophisticated techniques for tracking mates, prey, and hosts in the sea. Males can accurately detect the scent of a female in the wake of her swimming movements, and quickly follow her. Some female copepods no longer attract males after mating. Perhaps better knowledge about how lice find and choose a mate may enable the development of methods to disrupt this behaviour (e.g. trap lice, new treatments). Current studies on the interactions between lice and their host at a chemical level were described by Dr Stewart Johnson. Getting to the exact nature of such interactions will help improve a fish's defences against lice.

The more immediate issues of dealing with sea lice were introduced by speakers from industry. Subsequent keynote presentations by Pelle Kvenseth and Jim Treasurer summarised the development of the lice problem in Norway and Scotland, and how it was being handled in each country at present. David Jackson, provided a paper describing the lice management measures in place in Ireland. Following these presentations the audience broke into smaller discussion groups which discussed the merits of different lice treatment methods, and the best overall lice control strategy today. The results of these discussions will be published in *Caligus 4*.

Methods for sampling lice as part of monitoring levels on farms were outlined by Pelle Kvenseth and David Jackson, with additional input from Per Andersen, Jim Treasurer, Karin Boxaspen, and Mark Costello. These methods were discussed in some detail, demonstrated on an excursion to a fish farm, and will be published in *Caligus 4*.

Delegates at the workshop on sea lice control on fish farms, Trondheim 6-9 November 1997.

Organisation	Country	Name
Akzo Nobel	Norway	Anders Gustavson
Alpharma	Norway	Bjørn Midttun
Alpharma	Norway	Svein Alexandersen
Alpharma	Norway	Bernt Martinsen
An Bord Iascaigh Mhara	Ireland	Helen Cooper
Biologisk Institut	Norway	Thomas Shcram
Biomar	Denmark	Sølvi Skare
Pest Management Regulatory Agency	Canada	John D. Smith
University of Nottingham	England	Jim Reader
Dir. for naturforvaltning	Norway	Tone Løvold
Dunstaffnage Marine Laboratory	Scotland	Martin Sayer
EcoServe	Ireland	Mark J. Costello
EWOS AS	Norway	Egil Myhr
EWOS AS	Norway	Jon Inge Erdal
EWOS Forskningsstasjon	Norway	Christian Wallace
Fiskeridirektoratet	Norway	Vidar Baarøy
Fiskerisjefen i Trøndelag	Norway	Per Andersen
Fylkesveterinæren for Nordland	Norway	Helge Ressem
Grampian Pharmaceuticals Ltd	Norway	Leiv Aarflot
Havbrukstjenesten AS	Norway	Arnfinn Aunsmo
Havforskningsinstituttet, Austevoll	Norway	Karin Boxaspen
Hydro Seafood Fanad	Ireland	Joseph Gibbons
Hydro Seafood GSP	Scotland	W.R. Scott
Institut for fiskeri og Marinbilogi	Norway	Ernst Morten Hevrøy
Joseph Johnston & Sons	Scotland	Chris Brodie
KPMG	Norway	Kjell Maroni
KPMG	Norway	Pelle Kvenseth
Mallinckrodt Veterinary	Norway	Erik Ness
Marine Harvest McConnell	Scotland	Jim Treasurer
Marine Institute	Ireland	David Jackson
Marine Laboratory Aberdeen	Scotland	A. H. McVicar
National Research Council	Canada	Stewart Johnson
NINA	Norway	Andrea Grimnes
NTNU	Norway	Ingebrigt Uglem
Nutreco Aquaculture Research Centre	Norway	Gordon Ritchie
Statens Dyrehelsetilsyn	Norway	Inger Eidtun
The Natural History Museum in London	England	Geoff Boxshall
Trouw Aquaculture	England	Rob Sinnot
Trouw Aquaculture	England	Edward Branson
Trouw Aquaculture	England	John Finlay
University of Aberdeen	Scotland	Alan Pike
University of Tokyo	Japan	Kazuo Ogawa
Veterinary Institute Trondheim	Norway	Bård Skjelstad
Veterinærinstituttet	Norway	P.A. Heuch

CANADIAN SEA LICE INTEGRATED MANAGEMENT STRATEGY

The Pest Management Regulatory Agency, Health Canada, in partnership with Salmon Health is undertaking a project to develop integrated management strategies for sea lice. The goal is to develop an implementable national strategy, adaptable to regional situations, which incorporates all available tools for sustainable management of this parasite.

As a first step, a working group was convened in February 1996 in Ottawa, comprising federal and provincial government officials, salmon producer groups, pesticide and drug manufacturers and researchers. Participants acknowledged that the use of long-term integrated strategies for managing sea lice is important to the sustainability of the industry and the environment in which it operates. A major issue about the development and implementation of integrated management was co-ordination of research and data collection, and communication of information to growers, consumers, and others.

A small steering group was formed to oversee the compilation and critical review of information on biology and management of sea lice, with an emphasis on products, practices and devices that can contribute to integrated management, and will develop plans for communication of this information to all parties involved.

A draft document that provides an overview of lice biology, management tools, and a proposed IPM strategy has been prepared. It is being distributed to the original working group and others who have expressed an interest in the project for comment and input. The next steps will be to refine the proposed IPM strategy, incorporating latest information on management techniques, develop the appropriate level of detail, and produce a fact sheet or brochure that will provide important details of the strategy to farmers.

For further information on this project contact:
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http://www.hc-sc.gc.ca/pmra/adlice.html

Best current practice for lice control in Norway

Per Gunnar Kvenseth
KPMG Management Consulting AS, Centre for Aquaculture and Fisheries, Trondheim

Salmon lice - the problem in Norway

The problems of lice affecting farmed Atlantic salmon has grown to a level where it is not just the primary problem of skin damage, giving osmotic problems to the salmon and entry for infections, that concerns the farmers. Even modest lice infection levels on salmon give reduced appetite and growth reductions, as do starvation periods before bath therapy. The chemical treatments are also expensive and labour intensive, and cause extra stress to the salmon. The use of chemical treatments gives in addition tissue withdrawal problems before slaughtering. All these factors add to considerable economic losses to the marine salmon farming industry.

The salmon louse (*Lepeophtheirus salmonis*) is an ectoparasitic copepod commonly found on salmonid fish in seawater, and often observed on adult salmon and sea-trout returning to spawning rivers. The life cycle consists of planktonic stages (two nauplii and one copepodid which attaches to the fish), four chalimus stages attached to the fish and thereafter free living on the fish: two pre-adult stages before the parasite reaches sexual maturity. *Lepeophtheirus salmonis* is the dominant lice species on farms in Norway. Since 1991 *Caligus elongatus* has also extended its range on farms, mainly in the northern part of the country.

The farming of salmon in net-pens in Norway has developed from few and mainly small farms in the 1970s, producing 100 tons in 1971. The salmon production in 1996 passed 300,000 tons. Today salmon farming is a more effective protein production than other intensive meat productions, both in cost and feed conversion.

Treatments against the salmon lice problem have to a large extent relied on bath treatments of the organophosphorus compounds, under trade names as: Nuvan, Neguvon, Aquaguard, Salmosan, and Azamethiphos. New methods, as hydrogen peroxide, are already in use, while others, as pyrethrum and oral treatments are being tested. Excis, also called cypermetrin (a pyrethroid) is in wide use in Norway today. All the methods involving chemical compounds have experienced some drawbacks.

The ideal method

The ideal method of lice control would be one which had a continuous effect throughout the total marine life cycle of salmon preventing levels of salmon lice from building up. The treatment should have no negative effect on the salmon, nor on the environment, and the effect should be restricted solely to the salmon lice. Such a strategy may possibly be developed using available knowledge about: salmon lice biology; farm location; salmon stocking strategy; farming practice; combined with the use of cleaner-fish (wrasse).

Background - farming technology in Norway

The dominant farming concept in Norway today is floating cages varying in size from 12m x 12 m width and 10 m deep nets, to circular cages 120 m in circumference supplied with 30 m deep nets. The dominant pen size today has an individual volume of 3,000 - 4,000 m^3.

The wild Atlantic salmon smolts enter the sea in the spring approximately 1 - 4 years after hatching, at a size of 40 gram. Traditionally this has also been the smolt size stocked to the sea-cages during the spring, from April until June. The salmon industry have gone through great changes during the last years, partly caused by the strategic use of light; to influence the time of smoltification and to reduce the growth stagnation in the sea during winter. Today there is a great variety of smolt being stocked to sea-cages; from one year old or two years smolt stocked in the spring (50 - 400 g), to autumn smolt or 0+ year smolt stocked in the fall.

Salmon lice may infect smolt heavily just few days after transfer to sea cages, and can be a constant problem as long as the temperature is above 5 ^oC.

Lice effect on farmed fish

Lice infected salmon will have reduced appetite. Norwegian fish farmers have repeatedly experienced 20 - 40 % increase in daily feeding uptake after a successful delousing, compared with the appetite during the weeks before. Reduced appetite has been noticed at infection levels of only ten mobile lice on a 3 - 4 kg salmon.

Even 10 chalimus stages may cause heavy stress on a 50g smolt. This may be a lethal infection level when the lice reaches the preadult and adult stages. If not reduced by proper therapy, most lice infections on farmed salmon will increase until the salmon gets serious wounds. Body areas with few or no scales are most exposed to lice damage (the head). Adult lice often sit together in clusters on these areas, sucking blood and mucous. The extent of lice damage on salmon at harvest time can vary from a few lice, easy to wash away during the slaughtering and packing process, up to great price reductions (downgrading) caused by great skin-damage from massive lice attack. The yearly economic cost of lice to the Norwegian salmon farming industry is calculated to be at least 200 mill. NOK (about £20 million). This involves all costs to lice therapy, and includes reduced salmon growth.

Table 1. Delousing compounds sold in Norway 1988 - 1996. Figures are in kg or tons of active compound, and in thousands for salmon production and numbers of wrasse used.

		1988	1989	1990	1991	1992	1993	1994	1995	1996
Neguvon (Metrifonat)	Kg	3262	3300	2408	2144	1946	1779	1227	281	138
Nuvan (Diklorvos)	Kg	3210	3488	3416	3588	3115	2470	1147	395	161
Salmosan (Azamethiphos)	Kg	0	0	0	0	0	0	389	738	606
Excis (Cypermethrin)	Kg	0	0	0	0	0	0	0	0	23
Py-Sal 25 (Pyrethrum)	Kg	0	0	0	0	0	0	32	26	9
H_2O_2	ton	0	0	0	0	0	0	290	340	160
Lepsidon (Diflubenzuron)	Kg	0	0	0	0	0	0	0	0	160
Ektobann (Teflubenzuron)	Kg	0	0	0	0	0	0	0	0	610
Prod. of salmon	1,000	80	115	158	155	141	171	207	249	296
Use of wrasse	1,000	1	50	55	150	300	1000	1500	2000	3000

Preventive actions to reduce lice problems

Information - education

One of the most important actions in reducing the problems caused by salmon lice within the Norwegian aquaculture industry, has been through direct education through short training courses about salmon lice both to and provided by fish farmers, aquaculture veterinarians and aquaculture consultants. Basic knowledge about parasitology, reproduction, generation time, tolerance to different environmental parameters and sensitivity of lice to different treatments have been taught. Norwegian authorities have also focused on the importance of an integrated and co-ordinated delousing strategy in regions, so as to achieve a more successful control of salmon lice.

Location of farm

Fjords - salinity - lice tolerance

It is well known from experience that salmon farms located in Norwegian fjords dominated by a low salinity (below 15 °/₀₀ permanently or seasonally) surface current, will usually have few problems with salmon lice. Fjord locations also experience sudden disappearance of lice during spring- or fall runoff of water - heavy rain etc.. The same has been noted in rivers. Lice on wild salmon entering the river fall off within one to two weeks in fresh water. The sensitivity of the lice to low salinity was a well known therapy of delousing in the early days of salmon farming.

From laboratory experiments we know that at salinity below 10 °/₀₀ no development of eggs from lice occurs. At 15 °/₀₀ eggs will develop, but fail to produce active nauplii. At higher salinity (20 - 30 °/₀₀) active nauplii can be produced, but infective copepodids were only obtained at 30 °/₀₀ and higher. Copepodids survived less than one day in water with salinity of 10°/₀₀ or less.

Temperature

During periods with unusual high temperatures (16 - 22 °C) in the summer of 1997 the problems with sea lice on farmed fish were reduced to almost nothing in some areas. This situation continued for the western part of the country until late autumn, but the role of temperature in lice levels is unclear.

Hydrographic conditions - distance to other farms

Distance to neighbouring farms and water-currents in the surface are crucial. Farms located more than 10 km current distance from others seem to have less lice problems. Even if scientific documentation is sparse, it is repeatedly experienced that copepodids produced from adult lice on one farm, can infect salmon on adjacent farms. The distance an egg can travel, before hatching into a nauplii and developing to an infective copepodid, will depend on the sea temperature, and the speed of the water current. The main north-going current along the western coast of Norway has an average speed of 20 cm/sec (17 km/24 h). At a sea temperature of 10 °C, a nauplius could theoretically travel a distance of 210 km before attaching to a salmon. Both eddies and turbulence will disturb this picture. Backwater can also concentrate planktonic organisms as lice eggs, nauplii and copepodids and function as a reservoir of infective copepodids. The location of a fish farm is therefore critical. Land and bottom topography, salinity and dominating water current (direction and speed) will all have an influence on the lice problems.

Norwegian farms locations with uneven bottom topography have had twice as many treatments against salmon lice compared with farm locations with smooth bottom. Locations with uneven bottom topography is often surrounded by rocks and small islands. Such areas often have weak bottom current and reduced water exchange caused by eddies.

Salmon stocking strategy

Separation of year classes - fallowing

In Norway it is an established practice to stock only one generation of salmon to one site. After harvesting, the site is fallowed at least three months before restocking with smolt. Many fish farmers have experienced that new sites, far away from other farms in operation, seldom will have problems with lice before the second summer in operation. To operate such a strategy demands permission for each farm to have at least two sites.

Use of wrasse

In Norway, cleaner-fish (wrasse) have been stocked in increasing numbers in parallel with the smolt transfer to net-pens in the sea. In 1996, altogether 3 - 4 million wrasse were stocked to keep salmon lice at low levels. The use of wrasse has been very successful in Norway. The need for chemical delousing of smolt stocked together with wrasse are today rather rare. Wrasse give a continuous lice control. Goldsinny (*Ctenolabrus rupestris*) is the most numerous and common wrasse in use within salmon-farming. Rock cook and corkwing are other wrasse species being used in lice cleaning. It is important to select wrasse of a proper size to avoid escaping or gilling in the net meshes. Wrasse should be caught in a very lenient way, by fyke nets, eel traps, dipnets or wrasse pots.

Wrasse are numerous along the southern coast of Norway all the way up to Trondheim. North of Trondheim there are only small local populations of goldsinny. The district between Trondheim and Bodø is an expansive area for salmon farming. Problems with salmon lice have increased. AS Mowi have developed methods to transfer wrasse successfully by 40 hours transport on truck from the southern part of Norway all the way up to Bodø. Wrasse stocked into a salmon cage need care and attention. It is important to reduce stress and mortality among the wrasse. This is partly done by offering several hides, "wrasse-houses", for protection in each cage. It is important to introduce the wrasse early in the spring, to keep the lice infection low. During farming operations such as size grading, net changing and removing of dead salmon it is crucial to care for the wrasse.

Ballan wrasse – lice eaters on big salmon - strong medicine

Hydro Seafood Mowi AS have with the project "Environmental friendly salmon farming" during the last three years, further developed the use of cleaner-fish. For salmon up to 2 kg, most of their farms in Norway uses only cleaner-fish to control salmon lice. They have also demonstrated that the biggest wrasse, ballan, efficiently can keep salmon lice under control on big salmon, 3 - 7 kg. Full scale experiments were run in 1996 with 15,000 salmon in one 15 m x 15 m by 12 m deep net-pen. Ballan reduced the number of lice from 60 to one mobile lice/salmon during a period of four weeks, confirmed by lice counting and examinations of gut contents of ballan. The grazing efficiency increased rapidly as the lice developed from chalimus to pre-adult and adult stages, and were just as efficient as chemical bath treatment. Average size of ballan were 22 - 23 cm, with a maximum of 34 cm. In periods with fouling organisms on the net (alga, blue mussel etc.) ballan were found to prefer this to salmon lice. Examinations of gut content and observations of fouling on the net-pens have confirmed that ballan wrasse and goldsinny efficiently can keep the net clean.

In parallel net-pens at the same farm site goldsinny and corkwing, alone or in mixture, showed no effective cleaning abilities on big salmon.

Farming practice

Keep nets clean

There are strong indications that heavily fouled nets (algae, seaweed, blue mussels, etc.) will increase the problems with lice. One of the theories is that the infective copepodids can rest on such substrate. In combination with the use of wrasse it is especially important to keep the nets clean. To some extent the wrasse will help in browsing fouling organisms from the nets, but it is also experienced that wrasse will prefer blue mussels to lice, and therefore be less effective in cleaning lice.

Regularly lice counting - prepared for action

Reliable surveillance is important to establish basic and regular information about the lice infections at every site, and thus be prepared to delouse at a correct time and before the lice damage on the salmon is to high. During lice counting the salmon have to be taken out of the water and anaesthetised to get reliable numbers of lice species and stages. Female lice with eggs can easily be seen on fish in the sea, but this does not give accurate information, and it may be to late to avoid skin damage or more serious damage on the salmon.

During regular counting, every week in the summer, every two week during the winter; 20 salmon are randomly sampled from each pen. After anaesthetising, salmon lice are counted and categorised in three different groups; chalimus, female lice with eggs and all others (pre-adult males and females and adult males). This control system gives the farmer several weeks of warning to be prepared before delousing is necessary. Use of anaesthetic necessitates three weeks quarantine before harvesting. Training in counting and identification of the different stages of lice were one of the main topics during the Norwegian authorities short training courses of personnel working in the salmon industry in 1993.

Removing weak fish

Weakened salmon will in many situations function as an attractant to sea lice. The lice will also continue to spread onto fish originally not weakened. Frequent removal of obvious weakened salmon, is experienced to have good preventive effect to reduce lice infections.

Treatment actions to reduce lice problems

It should be noted that all chemicals used as a treatment to reduce the lice problems within Norwegian salmon-farming, have to be prescribed by a veterinarian.

Bath treatments

The basic idea of an ectoparasite bath treatment is to transfer the fish with the parasite into a bath with the active compound dissolved, where the therapeutic dose and exposing time removes the parasite, and it has no or little negative effect on the fish itself.

(a) Treatment pen - fixed volume

For netpens containing 500 m^3 water and up to 10 tons of salmon, the fish can be transferred into a special treatment cage with fixed volume (100 m^3) held next to the salmon cage. This involves the use of a tarpaulin bag with a floating collar. The salmon are transferred to the treatment cage for as long as recommended from medical companies. The fish can be stressed during the handling and the treatment, giving increased oxygen consumption. Therefore oxygen is constantly added during the treatment, never letting the level of oxygen sink below 7-8 mg O_2/l water.

(b) Tarpaulin - flexible volume

For big pens containing 2.000 - 4.000 m^3 of water and 40 - 100 tons of salmon it is an established technique in Norway to reduce the pen volume about 60 % by lifting the pen bottom, and increase the fish density to 60 - 80 kg/m^3. The pen is than totally surrounded by a tarpaulin made of parachute- or plastic materials, and the therapeutic agent is added. Oxygen is added, never letting the level fall below 7-8 mg O_2/l water. Oxygen addition also aids the mixing of the therapeutic compound added. During such bath treatments correct estimation of enclosed water volume in the bag is difficult. A volume variation with a factor of four have been experienced on farms with standard cages, even when trained personnel and the same bag has been used through all 20 cages. Difficulties according volume estimations can partly explain incidences where the bath treatment have had little apparent effect on the lice, or caused high mortality among treated salmon.

(c) Skirt - flexible volume

For bigger pens (90 m - 120 m in circumference) containing several hundred tons of salmon it is difficult (and risky) to operate a totally closed tarpaulin. In such cases the pen volume is reduced by raising the pen bottom until a fish density of 60 - 90 kg/ m^3 and an open tarpaulin (without bottom) is mounted along the sides of the pen. This method is called the skirt method, and has the same oxygen requirements as the closed tarpaulin methods. A variation on this method is where a flexible skirt is partly closed as a purse seine net, increasing the possibility of keeping a rather fixed volume of water during the treatment time. All the mention methods can be used with the different active agents made for lice bath treatments.

Water with low salinity

Pens with lice infected salmon can be towed to a river estuary, or other low salinity areas to stay for periods from days until weeks. The method is only suitable for small scale farms placed close to low salinity areas (< 15 $^{o}/_{oo}$), and not wanting to use any of the available chemical treatments.

Hydrogen peroxide

The use of hydrogen peroxide (H_2O_2) as a delousing compound commenced in Norway in 1991. In 1992 more than 1,000 tons (50% w/w solution) of H_2O_2 was sold for delousing. Hydrogen-peroxide is a powerful oxidising agent, degrading to water and oxygen ($2 H_2O_2 \rightarrow 2 H_2O + O_2$). The presumed effect to the lice is mechanical damage to internal structure in the parasite. Great amounts of oxygen gas are released within the lice when exposed to H_2O_2. Gas bubbles can be observed inside the lice, especially within the gut. As a result of the oxygen production inside the lice, most of the parasites will float to the surface. Treated lice seems totally lifeless, but if they are transferred to clean water, more than 50% will start swimming after 3- 6 hours. H_2O_2 has a good therapeutic effect on adult and pre-adult stages, but the effect on chalimus-stages is variable (5 - 60% reduction). Hydrogen peroxide is also poisonous to the salmon, and safety margins between therapy concentration and start of mortality gets reduced as temperature reaches 14 - 16 ^oC.

The salmon are treated by pumping H_2O_2 into a closed tarpaulin bag surrounding the net-pen. The H_2O_2 is pumped into the pen through a perforated tube that is moved over the total pen, vertically and horizontally to get an even distribution of peroxide. Dosage of peroxide is temperature dependant. When temperatures are below 7 ^oC the treatment concentration is 1.7 - 1.8 g/litre. This is reduced to 1.3 g/litre of H_2O_2 at 14 ^oC. The actual concentration of H_2O_2 can be established by a simple field titration. To secure accurate dosing not more than ¾ of the expected consumption of H_2O_2 should be introduced before measuring the concentration. Given the concentration and the known amount of H_2O_2 added, the total bag volume may be calculated and thereby how much more H_2O_2 should be added to reach the correct treatment concentration. The extra amount of peroxide is than pumped into the pen, and the concentration is analysed again. Treatment time is 20 minutes after the last addition of peroxide. Total treatment time should never exceed 30 minutes. Oxygen addition is necessary during the whole treatment. After a hydrogen peroxide treatment, there is no withdrawal period on the salmon before harvesting and marketing.

Organophosphates

Organophosphates (OP), namely Nuvan and Salmosan (Azamethiphos) are the most common chemicals used in bath treatments against lice Norway. The most common way to run a treatment is to dissolve the OP in a closed tarpaulin bag, surrounding the pen. They act by inhibition of the enzyme acetyl-cholinesterase (AChE) in the nervous system. OP are effective against all post-chalimus stages of salmon lice, but does not remove attached chalimus stages. Some first pre-adult stages may also remain. Therefore, a second treatment is recommended and may be necessary after about three weeks to remove copepods which have passed through the chalimus stages.

Nuvan is used in concentrations from 0,5 ppm dichlorvos which is the active component, over 15 minutes at 15 ^{o}C, up to 1,5 - 2 ppm over 45 minutes at 5 ^{o}C. It is not possible to determine the concentration of dichlorvos by analysis during a treatment. Correct volume estimation is therefore crucial. Underestimation of volume can result in too high a concentration and cause salmon mortality. Overestimation of volume may give an incomplete delousing. After a dichlorvos treatment there is a 14 days withdrawal period on the salmon before harvesting. Work in both Scotland and Norway has demonstrated that some populations of *Lepeophtheirus salmonis* have developed a reduced sensitivity (resistance) to dichlorvos. These findings are not unexpected, given the dependence on the use of dichlorvos in the salmon-farming industry over a period of twenty years.

Salmosan (Azamethiphos) has a wider margin between therapeutic and mortality doses than dichlorvos. Treatment dosage is 0.1 ppm over 25 minutes, independent of temperature. After a azamethiphos treatment, there is 14 days quarantine on the salmon before slaughtering.

Table 2. Alternative compounds for treating lice.

Compound	Benefits / drawback
Nuvan	On the way out, good alternatives exist
Salmosan	Price favourable, only effective against mobile lice stages
H_2O_2	No withdrawal period required before slaughtering. Expensive, great volumes required, lice may not be killed
Py-Sal 25	Effective to all lice stages - expensive - technological problems not solved. 7 days retention time before slaughtering
Excis	Effective to all lice stages - expensive ? Treatment time 1 hour. 3 days retention time before slaughtering
Ectobann, Lepsidon	Experimental permissions. Not effective against adult lice. Should not be a first choice, only allowed in salmon’s first year at sea, 60 days retention time, expensive.

Excis - Cypermethrin

Excis is a synthetic pyrethroid that disturbs the nervous system of the lice. Cypermethrin is (rather) efficient against all lice stages, and dosed at 0.5 ml Excis / 1.000 litre of seawater. No mortality of fish is recorded with four times over the dosage. Addition of oxygen is necessary during the 1 hour treatment time. Cost of treatment, using a well-boat of 130 kg/m^3 is 0.06 NOK per kg fish treated; using a netpen + tarpauline enclosing 65 kg/m^3 it is 0.12 NOK per kg fish treated.

Pyrethrum

A delousing agent developed in Norway, Py-Sal 25 (Norsk Pyrethrum AS), is based on pyrethrum. Pyrethrum is a naturally occurring mixture of 25% pyrethrins. It is combined with a synergist, piperonylbutoxide (4%), and a paraffin oil solvent. One advantage of pyrethroids over other compounds is their effect also to reduce the number of chalimus stages (90% reduction in laboratory experiments). After a pyrethrum treatment, it is seven days withdrawal period on the salmon before slaughtering.

The use of Py-Sal 25 against salmon lice is based on the fact that the lice and the salmon have different outer protective layer. The mucous of the salmon is mainly water soluble, while the lice have a lipid layer in the outer part of cuticle. The pyrethrum compound mixed in oil will selectively penetrate the lice but not the salmon. Pyrethrum possibly affects the lice by inhibiting impulse transfer in the nerves.

Several treatment methods have been tested. The pyrethrum solution has been poured onto the surface of water in pens surrounded by a tarpaulin skirt, forming a floating layer of pyrethrum. An alternative approach is to submerge the salmon in a small reservoir of pyrethrum solution. The fish is dropped through a wide tube filled up with a 0.5 - 1 m layer of pyrethrum ending up in a net-cage. Py-Sal 25 has also been used in combination with re-vaccination, where the anaesthetising tank had a 10 cm thick surface layer of pyrethrum. Test-results have shown a delousing effect up to 96%, but none of these methods are in commercial use today.

A pyrethrum treatment method has been under development in Norway (AS Mowi, Melbu Verft AS and Norsk Pyrethrum AS). The idea is to spray the salmon with Py-Sal 25 during transportation through a grading machine, instead of being sprayed with sea water. The pyrethrum solution will be purified for lice falling off during the process and recirculated. A large scale experiment was carried out in Norway during the fall of 1996. The treatment was effective, removing about 90% of the adult and pre-adult lice. Control counts showed that 70% of the lice were mechanically removed through the fishpump (Silkstream). Even if the method is rather effective, the use of Py-Sal 25 is to high (the recirculation rate to low) and the overall cost with using the method can today not compete with traditional bath treatments.

Oral treatment

Oral treatment has the advantage of easy application in all types of fish cages, but only feeding fish will receive the treatment. Absorption by the fish may give longer quarantine time before slaughtering, than the external bath or spray treatments. Several international companies working within the field of fish feed are at the present running field trials, testing different oral treatments. In feed treatments (Ectoban and Lepsidon) have experimental permissions for field trials in Norway. These in-feed treatments in Norway are restricted not to be a first choice as a delousing strategy, and are only allowed on small fish for the first year at sea.

Delousing strategy

Accurate decisions about when and at what lice infection level it is most wise to run a delousing, is difficult. Changes in lice infection level and dominant stages over the last month gives important information. Sea temperature, salmon appetite, size and harvesting plans must also be taken into account. Bath treatments always stress the treated fish, and can cause mortality.

The basic goal when attacking the salmon lice should be to reduce the total lice infection level in a district (fjord etc.) by keeping the level of gravid female lice as low as possible, and not letting the occurrence of skin wounds on the fish decide when to delouse.

The most efficient use of OP, hydrogen peroxide or pyrethrum, will be at a time when the copepod population consists largely of pre-adults and adults but few gravid females. If the parasites can be removed at these stages it may be possible to break the cycle of generations and reduce subsequent infestations.

Single site

To achieve a good result, it is important to delouse all cages at one farm within as short a time as possible. It is also important to start the treatment upstream of the current. These practices will reduce the possibilities for re-infection of fish already treated.

Several sites

Some districts in Norway, have with encouraging results practised so-called co-ordinated delousing. Taking into account each farms placement in the waterway, dominating water current and possibilities of re-infections, all farms within the region co-ordinated their delousing activities. Lice counting was done regularly. Gravid female lice were kept at a low level, reducing the production of new lice larvae. In Flatanger (Trøndelag) the fish farmers have practised co-ordinated delousing in the winter and spring for two years, in addition to necessary treatments in the summer to avoid skin damage on the salmon. This strategy has heavily reduced the problems according salmon lice in this district, both on farmed fish and wild living salmonids (Per Andersen, pers. comm.).

The effect of swimming depth , speed and artificial light treatment in Atlantic salmon (*Salmo salar)* culture on the infestation of the copepod *Lepeophtheirus salmonis*

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Salmon louse (*Lepeophtheirus salmonis* Krøyer) infestation on cultured *Salmo salar* was studied in small netpens divided into three sections (0-4 m, 4-8 m and 8-12 m depth), with and without artificial light (24 W/m^2) distributed at the surface. Salmon without parasites were exposed for infestation in the enclosures for 7 days, and then transferred to tanks supplied with filtered seawater. After another 7 day period, the fish were controlled for lice (chalimus stages). During the exposure phase the fish were filmed and swimming speed was calculated. The experiment was repeated. The infestation was higher in groups held at 0-4 m, compared to groups held in deeper sections. In addition, the infestation was highest in the enclosure treated with artificial light. This could be due to the higher swimming speed of the fish. For this experiment, it can be concluded that position of cultured Atlantic salmon in the water column was more important than the presence of artificial light for infestation by salmon lice.

Recent advances in copepod biology of relevance in sea lice control

Geoff Boxshall
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Recent studies on the biology of sea lice were briefly reviewed with particular emphasis on work relevant to host location behaviour and mating behaviour of copepods since these areas appear, a priori, to be two of the potential weak spots in the parasite life cycle where control methods aimed at prevention rather than cure might be targeted. It was emphasised that host location is not exclusive to the infective copepodid stage since significant levels of inter-host transfer are known to occur in the field and have been demonstrated in the laboratory. The role of light as a stimulus in the infection process was commented upon and the general topic of host location and infection behaviour was identified as a continuing priority area for further research.

Two aspects of mating biology in free-living copepods were discussed in some detail since they generate insight into copepod mating processes. Both phases of mating behaviour - mate location and mate recognition - appear to be primarily chemosensorily mediated, although mechanical signals may play a supplementary role in close range mate recognition. Several papers currently in press in a theme issue of the Philosophical Transactions of the Royal Society (Edited by G.A. Boxshall) were mentioned. Using sophisticated laser illumination of free swimming swarms of copepods R.Strickler, J.Yen and their collaborators showed that male copepods are able to track females successfully through 3-dimensional space over remarkable temporal and spatial scales. This tracking behaviour has been shown to be chemosensorily mediated.

In another paper in the same issue, the interesting possibility that female copepods advertise their presence to males by providing short range hydromechanical signals was investigated. Close range mate recognition was demonstrated by T. Snell, D. Lonsdale and collaborators to be mediated by surface molecules, glycoproteins, on the body of the copepod. These provide a species-specific mate recognition system. Mating in sea lice occurs on the surface of the host fish, effectively a 2-dimensional environment with a unidirectional flow regime, and the implications of the latest research on free-living copepods to sea lice biologists were discussed.

Lice fighting the environmental friendly way!

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History

One of the first persons describing the lice on the salmon was the Norwegian priest and biologist, Erik Pontoppidan (1698 - 1764). His stated that God gave the salmon lice to the help man because the lice forced the salmon to swim up into the rivers; and thereby made the salmon easier to catch. I would guess that the salmon then, as now, found their way into the fresh river water for spawning. The lice can not take the river water for more than ten days - and will than fall off. In the “good old days” lice on a river caught salmon was a good sign; this was a salmon that had recently arrived from the sea!

Lice treatments today

Several chemical bath-treatments are today available to reduce lice infections. Compounds such as H_2O_2, Azamethiphos and Excis are in regular use. Every treatment or use of chemicals must be prescribed by a veterinary and are thereby registered. During the treatment period that lasts for 30 - 60 minutes, the net-pen containing the salmon are locked up in a big tarpaulin bag. Most bath treatments are expensive, labour intensive and some can be stressful to the salmon. Nearly all compounds are selective and only efficient against some of the lice’s life-stages. After a treatment the lice levels tend to be low, but the levels will often build up again, and treatments must be repeated. Experience has shown that even low numbers of lice will reduce the salmons appetite and growth. Several alternative methods, including a vaccine, in feed treatment and alternative chemical baths are therefore under development or being tested.

Wrasse cleaner-fish

The ideal method of lice control would be one which had a continuous effect throughout the total marine life cycle of salmon, preventing reproduction of lice and reducing the possibilities of lice levels from building up. The treatment should give no negative effect on the salmon, nor the environment, and the effect should be restricted solely to the salmon lice. The closest we come to this ideal situation today is the use of cleaner-fish, wrasse.

The use of wrasse, as an scientific experiment in Norway, started with the small scale use of cleaner-fish in tanks and small net-cages at the Institute of Marine Research at Austevoll in 1987. However, years before this fish farmers had used small ballan wrasse to pick lice from their farmed salmon. The Norwegian newspaper: “FISKAREN - The fisherman” had an article 27th of September 1976 about this. The use of wrasse in the Norwegian salmon farming industry have increased steadily from a total use of 1,000 fish in 1988 up to an estimated use of 2.5 - 3 million fish in 1996 (Table 1). Scottish salmon farmers started experiments using wrasse in 1989. Jim Treasurer at Marine Harvest McConnell estimates the Scottish use to be in the range of 150,000 wrasse used each year from 1994 on.

Table 1. The use of wrasse in Norway since 1987.

	Numbers in 1000s	Number of farm sites using wrasse
1987	experiments	0
1988	1	1
1989	50	20
1990	55	22
1991	150	28
1992	300	67
1993	1000	137
1994	1500	170
1995	2000	300
1996	3000	400
1997	3500	400

Studies by KPMG - Centre for Aquaculture and Fisheries in Trondheim show that the use of wrasse reduces the need for delousing chemicals by about 35% in Norway. In addition, companies using wrasse in the fight against lice increased their yearly net income with Nok 1 per kg salmon produced, compared with others using conventional chemical methods to control lice.

To prevent over fishing of the valuable natural stocks of wrasse along the Norwegian coast, the Institute of Marine Research in Bergen, has started a three year project mapping the wrasse stocks. Wrasse fishermen have not reported reductions in the stocks of wrasse beyond the local variations. We have also started breeding experiments with wrasse. In 1992 and 1993 Hydro Seafood AS, Norway and Golden Sea Produce Ltd. in Scotland produced about

5,000 goldsinny each year, at experiments run at Hunterston - Scotland. The research was financially supported by the Norwegian Fisheries Research Council. There is no farming of cleaner-fish at present, but at least we have some experience with the technology. In addition we have now started experiments in Norway to culture ballan wrasse.

Wrasse biology

Wrasse live in shallow water along the Norwegian coast, with the densest populations in the southern parts of the country. North of Trondheim the coast is sparsely populated with wrasse, mostly goldsinny. The commercial distribution of wrasse stops at about 65 ^{o} North. This have given business opportunities to catch wrasse in the south, where there are no fish farms, and transport them to fish farms at Møre, Trøndelag and Nordland. About 800,000 wrasse were transferred in 1996. The wrasse are less active during winter with water temperatures lower than 7 ^{o}C, both in nature and in the cages. This means that feeding slows down, and at 3 ^{o}C most wrasse will hide in crevice, holes etc. and turn into a torpid stage. Wrasse will not thrive in the net-pens during the winter. Winter storage over a six months period has been successful in land-based tanks, as well as in submersible cages in the sea with a survival rate close to 100 %.

Wrasse used on small salmon

Estimates show that about 50% of all farms in Norway in 1996 stocked wrasse with their smolts. Usual stocking density are 2 - 5 % wrasse. Wrasse are stocked into the cages as early in the season as possible. Usually the local catches of wrasse start mid May in western Norway, some weeks later farther north. Wrasse need care and attention. Wrasse are provided hides (houses) placed at different places in the net-pens. One of the big advantages with the use of wrasse in lice control is the continuity of the cleaning. Cleaning efficiency improves as the lice develop and increase in size. Given the opportunity wrasse will start eating the biggest lice first, this means female lice with eggs. This is a good strategy, reducing the lice that causes the greatest damage and in addition reducing the lice reproduction potential. We have experience that 600 wrasse have controlled lice in pens with 10,000 salmon from smolt to 10 months ahead, while the rest of the pens with bigger salmon without wrasse had to be deloused five times.

A proportion of goldsinny in western Norway carry the bacterial disease *Aeromonas salmonicida.* The bacteria do not give disease among salmon, but infects goldsinny and give stress-induced pathogenicity of the disease.

Ballan wrasse - lice eaters on big salmon - strong medicine

Through my project “Environmental friendly salmonfarming” during the last three years, the use of cleaner-fish has been further developed. For salmon up to 2 kg, most farms with lice problems in Norway used cleaner-fish as a first choice to control salmon lice.

We have also demonstrated that the bigger cleaner-fish, ballan wrasse, can efficiently keep salmon lice under control on big 3 - 7 kg salmon. Full scale experiments were run in 1996 with 15,000 salmon in one 15 m x 15 m - 12 m deep net-pen. Ballan reduced the number of lice from 60 to one mobile lice per salmon during a period of four weeks, confirmed by lice counting and examinations of gut contents of ballan. The grazing efficiency increased rapidly as the lice developed from chalimus to pre-adult- and adult stages, and were just as efficient as chemical bath treatment. The average size of ballan were 22 - 23 cm, with a maximum of 34 cm. In periods with fouling organisms on the net (alga, blue mussel etc.) ballan were found to prefer this to salmon lice. Examination of gut contents and observations of fouling on the net-pens have confirmed that ballan wrasse and goldsinny can efficiently keep the net clean. In parallel net-pens at the same farm, goldsinny and corkwing, alone or in mixture, showed no cleaning abilities on big salmon.

Biographic note on Per Gunnar Kvenseth (45). Pelle comes from Hydro Seafood AS in Bergen where he has been working the last five years as project leader responsible for development and integration of methods for environmental friendly fish farming, especially by use of cleaner-fish wrasse to control salmon lice and net fouling. He is also one out of three main authors of: “Environment book for fish farming”. Earlier (1990 - 1992) his work within Hydro Seafood / Mowi AS was co-ordinating projects with farming halibut and turbot, both research and commercial production in Norway, Scotland and Spain. In 1986 Per Gunnar was one of the founders and project leaders within the fish farming firm Lagoon Management & Construction AS (LMC) for commercial production of turbot, cod and halibut. Before LMC Per Gunnar was working as a research fellow at the Institute of Marine Research Aquaculture Station at Austevoll, main work was fry production and on growing of cod and halibut. Per Gunnar was educated at the University of Bergen, Cand. Real. degree in 1982.

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9th International Congress of Parasitology, Japan 24-28 August 1998

This large (over 1000 delegates expected) meeting will have several symposia of interest to fish parasitologists, although the direct relevance of papers will not be known until papers have been submitted (deadline is 31 January 1998). Of the about 50 symposia, those on 'Control of parasitic diseases of cultured fish', 'Application of fish parasites to fisheries and other sciences', 'Biochemical aspects of parasitism', 'Development of new drugs', and a range of symposia of molecular biology and immunology may be relevant to sea lice control. Although it is well known that Japan is expensive compared to most other countries, the registration fee at about £200 is not unreasonable. There are travel awards available to young scientists.

Contact: Dr Somei Kojima, Secretary General 9th ICoPa, c/o Simul International Inc., 13-9 Araki-cho, Shinjuku-ku, Tokyo 160, Japan; tel. +81-3-3226 2822; fax +81-3-3226-2824. Email icopa9@hgc.ims.u-tokyo.ac.jp.

Feed companies aid lice monitoring

Both Ewos Aqua AS and Skretting (Nutreco) have produced laminated colour guides to the identification of all stages of salmon lice on salmon. The actual life size of chalimus, pre-adult and adult lice stages are shown and accompanied by photographs. Graphs indicate the growth of lice at different temperatures so the timing of treatments can be planned. The A4 sized cards are only in Norwegian at present but perhaps they will be translated into English for the Scottish, Irish and Canadian farmers?

Research reward to sea lice fighters

The EWOS research reward of NOK 25 000 was this year given to research director Åsmund Bjordal, Institute of Marine Research, and senior consultant Per Gunnar Kvenseth, KPMG, for their future oriented research on biological fighting of salmon lice. By using wrasse they have found an environmentally friendly and effective way of using natures own method in reducing the problems with sealice within Norwegian salmon farming.

The announcement of this years winners was on Thursday 14 August in a ceremony during the biggest international fish farming exhibition, Aqua Nor 97 in Trondheim. This years research reward committee was led by Professor Helge Reinhertsen, University of Trondheim, together with the last price winner, development leader in EWOS Karl-Erik Slinning, and deputy leader in EWOS Jon Inge Erdal. The rules for the EWOS research reward state that it is a scientific reward which aims to stimulate practical research within Norwegian aquaculture. The prize is given to the scientist or group of scientists that have done excellent work to stimulate a useful development within aquaculture.

In their reasons for this years reward the research reward committee have said that the two scientists have developed in an innovative and systematic way to utilise natures own potential for biological parasite fighting. They have been especially clever to communicate their results in such a way that the knowledge immediately could be used by the fish farmers. The use of wrasse has helped to improve the production conditions within the farms and has strongly improved the environmental image of the whole business of farming salmon.

ACKNOWLEDGEMENT

This newsletter is funded under the European Union FAIR (aquaculture) research programme as part of a project entitled 'Biology and management in the control of lice on fish farms' (contract number CT96-1615). The project is a 'Concerted Action' and so does not involve new research but rather facilitates the communication of information related to the control of lice on fish farms. This is being achieved through providing a World Wide Web site and e-mail network, hosting of meetings (workshops and conferences), establishment of a list of researchers, farmers and authorities interested in lice control, producing a computerised bibliography, and publishing the bibliography, newsletter, and proceedings of meetings.

The project is co-ordinated by Dr Mark J. Costello (EcoServe, Dublin) in partnership with Dr Geoffrey A. Boxshall (Natural History Museum, London), Mr Kjell Maroni (KPMG, Lauvnes), Mr Per Gunnar Kvenseth (Norsk Hydro a/s), and Dr Carmel Mothersill (Dublin Institute of Technology). Enquires about the project should be sent to: mcostello@ecoserve.ie; Dr M. J. Costello, Ecological Consultancy Services Ltd, 7 Glenmalure Park, Rialto, Dublin 8, Ireland; or any of the project's partners.

1998 INTERNATIONAL WORKSHOP ON SEA LICE BIOLOGY

Recent advances in the study of the biology of Sea Lice will be the subject of a THREE DAY WORKSHOP to be held in Amsterdam from 22nd to 24th JULY 1998.

Following the very successful formula of the first Sea Lice workshop held in Paris in 1992, the AMSTERDAM workshop will take place during the Fourth World and Third European Crustacean Congresses - hosted by the University of Amsterdam. The dates of the main congress are 20th to 24th July. This will enable Sea Lice workshop participants to experience sea lice research within its wider context, to interact with the top crustacean specialists world-wide, and to hear about research in important related topics - such as shellfish aquaculture and fisheries. The proceedings will be peer-reviewed and published after the meeting.

The Crustacean Congress has plenary sessions each morning so contributed sessions will take place in the afternoons. The sea lice sessions will be held from Wednesday 22nd to Friday 24th of July.

SEA LICE WORKSHOP SESSIONS

Wednesday 22nd July pm:	Sea Lice and Fish Parasitic Crustacea
Thursday 23rd July pm:	Sea Lice Biology
Friday 24th July am:	Plenary session
	Sea Lice Workshop Speaker: Mr Gordon Rae, Scottish Salmon Growers Association
Friday 24th July pm:	Sea Lice Biology

There will also be Poster Sessions during the period 22nd to 24th - poster papers are encouraged.

REGISTRATION:
Please register as soon as possible if you have not already done so. Address all correspondence concerning registration to:
Conference Office, Universiteit van Amsterdam, Spui 21, 1012 WX Amsterdam, The Netherlands.
Tel: +31-20-525-4791; Fax: +31-20-525-4799

ABSTRACTS
We have sufficient time for 20 oral presentations plus as many posters as you would care to submit. If you want to present a paper please obtain the abstract form direct from the organisers in Amsterdam at:

4th International Crustacean Congress,
Universiteit van Amsterdam, c/o ISP, Postbus 94766, 1090 GT Amsterdam, The Netherlands.
Tel: +31-20-525-6635 or 6435 or 5422; Fax: +31-20-525-5402; Email to: zijl@bio.uva.nl; or schram@bio.uva.nl.

The general deadline for submission of abstracts is:- 1st December 1997 please try to make it. The organisers have made a special concession because of the timing of our workshop in Trondheim - we have three extra weeks for abstract submission: NOTE ..... NEW DEADLINE

Your abstracts must be postmarked....20th DECEMBER 1997 at the latest.
GET THEM OFF BEFORE CHRISTMAS - SO YOU CAN RELAX AND ENJOY THE HOLIDAY!!

QUESTIONS
The Sea Lice workshop will be organised by Geoff Boxshall on behalf of the partners in the EU Concerted Action on "Lice Control in Fish Farms" under the FAIR programme.

If you have any questions or problems concerning the Amsterdam meeting please contact:
E-mail: G.Boxshall@nhm.ac.uk; Fax: +44-171-938-9158