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FIN CONDITION OF FISH KEPT IN AQUACULTURAL SYSTEMS

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Abstract

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Fish fins seem to be a suitable indicator of welfare state. In natural conditions there is no worsenig of fin condition. Damaged fins occur in aquacultural systems only. They are characterized by shortening size, frayed rays, disturbing of fin tissue, lesions and necrosis creation. Possible causes are aggressive behaviour of fish, inapropriately chosen size of stocking density, feeding management, diet composition, rearing system, water quality, thoughtless manipulation with fish and bacterial infections. Mostly, dorsal and pectoral fins are damaged in salmonids (not in percids). For evaluation there are all fins except adipose fin used. Lenght of fins is measured and the visual aspect is assessed. Mostly used method is "Relative fin length". Adjustment of rearing conditions, feeding ratio increasing, propriate diet composition (amino acids and minerals), rearing fish in duoculture, preventive baths in chloramine–T, prefering of ground canals and fishponds can conduce to improving of fin condition. Bad fish condition worsens swimming and it can rule the saleability of fish. Aquacultural systems do not allow natural fish farming. That is why it is necessary to assess welfare of kept fish. The fin appearance informs about condition of rearing environment.

fin erosions, welfare, aggressive behaviour, nutrition, manipulation, bacterial infection

1 INTRODUCTION

Welfare of reared animals implies a releasing of pain, fear, hunger and allows social behaviour. Huntingford and Kadri (2009) assign to fish welfare a possibility of natural life cycle. The food intake, fin condition and indirectly water quality are considered as possible welfare state indicators (Huntingford and Kadri, 2009). The welfare state is assessed by combination of body condition (condition factor), fin condition, hematocrit value, cortisol contain, lysozime, glucose in blood plasma (Turnbull *et al.*, 2005, North *et al.*, 2006), number of red blood cells and hemoglobin concentration (Montero *et al.*, 1999). Turnbull *et al.* (2005) recommend to attach glucose contain and cortisol in blood plasma to fin condition evaluation.

2 THE STATE OF FINS AND THEIR FUNCTION

Fins can be distinguished as paired and unpaired. Paired fins are pectoral (*pinnae pectorales* – P) and abdominal (*p. ventrales* – V). Unpaired fins are dorsal (*pinna dorsalis* – D), anal (*p. analis* – A) and caudal (*p. caudalis* – C). Adipose fin (*pinna adiposa*) is placed behind a caudal fin with Salmonidae and Ictaluridae (Baruš and Oliva, 1995; Spurný, 1998).

Fins are dermal structures created of bone rays lepidotrichia (Baruš and Oliva, 1995; Spurný, 1998) and collagen fin membrane (Lauder, 2006). Adipose fin does not contain bone rays (Baruš and Oliva, 1995; Spurný, 1998). Lepidotrichia are composed of 2 halves so called hemitrichia, which are detached at the base and are bonded at the end of ray. There are blood vessels and nerves running in the space between hemitrichia. Hemitrichia are connected to 4 muscles with their base. When muscles are stretched there is tilt of hemitrich on the side and it causes a ray bending. In this way the fish can adapt to current conditions (Lauder, 2006). Rays can be distinguished as unbranched spiny rays and branched soft rays (Baruš and Oliva, 1995; Spurný, 1998). With the soft rays there are branching of lepidotrichus in its half or in its last third into actinotrichia to occure (Lauder, 2006; Atta *et al.*, 2012). Number of spiny and soft fin rays is generic characteristic and it is used for fish determination. It is so called meristic characteristic (Spurný, 1998). E.g. pectoral fins with rainbow trout (*Oncorhynchus mykiss*) contain 1 spiny ray and 13–14 soft rays, dorsal fin contain 3–4 spiny rays and 10–11 soft rays (Person–Le Ruyet *et al.*, 2007). Fin membrane allows spreading and contracting the rays, and that enables fish to change surface of fins (Lauder, 2006).

Paired fins influence the angle of ascending, descending in the water column and for the maintaining balance (Harris, 1938; Baruš and Oliva, 1995; Spurný, 1998; Drucker and Lauder, 2003). Pectoral fins are used for changing direction (Baruš and Oliva, 1995) and together with spreading of caudal fin it is used for braking (Drucker and Lauder, 2003). Alternating movement of pectoral fins secures the body maintaining on the spot in the water column (Drucker and Lauder, 2003). With some sea species pectoral fins can be missing or modified (flying fish, climbing fish). Abdominal fins can be placed in abdominal (e.g. Salmoniformes, Cypriniformes), pectoral (e.g. Perciformes) or jugular (Gadidae) position. Some species are missing abdominal fins e.g. Anguilliformes (Spurný, 1998).

Dorsal and anal fins serve to movement regulation (Baruš and Oliva, 1995, Spurný, 1998) and its stabilisation (Lauder and Drucker, 2004). Size of the dorsal fin varies according to species e.g. common carp (*Cyprinus carpio carpio*) vs. European catfish (*Silurus glanis*). Northern pike (*Esox lucius*) has dorsal fin moved towards caudal direction. With some representatives of Perciformes there is dorsal fin on two parts devided. Some sea fish species are distinguished by higher number of dorsal fins or by fin hem which includes the dorsal fin. Size and shape of anal fin depend on species. It can be part of the fin hem or devided on more parts (e.g. cods), Spurný (1998). Caudal fin jointly with body and tail musculature constitue the main muscoskeletal system of fish (Spurný, 1998). According to inner and outer symmetry in the caudal fin structure heterocercal (Acipenseridae), homocercal (Cyprinidae) and difycercal (Angullidae) fins can be distinguished (Baruš and Oliva, 1995; Spurný, 1998).

Movement of fish is realised by horizontal undulation of body and caudal fin (Baruš and Oliva, 1995; Spurný, 1998; Lauder and Drucker, 2004; Lauder, 2006). The movement starts with head and follows up to tail. With some fish species the movement is reduced only on caudal peduncle e.g. common carp. Fish without caudal fin has to make effort about 40% of energy more for movement and its movement is not fluent (Spurný, 1998).

3 CAUSES OF FIN DAMAGES

Worsened condition of fins is distinguished by shortening of fins, fryed rays (Latremouille, 2003), disruption of fin tissue, lesions and necroses creation (Turnbull *et al.*, 1998). Length of fin depends on the size of fish, stocking density and on rearing conditions (Wagner *et al.*, 1996a; Person–Le Ruyet *et al.*, 2008). There are probably no fin damages in natural conditions (Turnbull *et al.*, 1996; Hoyle *et al.*, 2007; Stejskal *et al.*, 2011). Fin erosion occurs only in the intensively reared fish (Bosakowski and Wagner, 1994; Ellis *et al.*, 2008). Worsened fin condition influences swimming abilities and surviving of reared fish in natural conditions (Bosakowski and Wagner, 1995). Fin erosions are caused by abrasion against tank surface and by physical contact with other fish, especially when feeding (Person–Le Ruyet *et al.*, 2007; Turnbull *et al.*, 2008; Adams *et al.*, 2011), by inapropriate diet composition, feeding management, (Latremouille, 2003; Noble *et al.*, 2008), thoughtless manipulation (Svobodová *et al.*, 2007) and bacterial infections (Ellis *et al.*, 2002; Latremouille, 2003). A certain influence on fin condition has a stocking density, water quality (Person–Le Ruyet *et al.*, 2008) and type of rearing facility (Moring, 1982; Turnbull *et al.*, 1998). Process of fin damaging proceeds from margins till fin base (Person–Le Ruyet *et al.*, 2007). Mostly damaged fins are dorsal and pectoral in salmonids (Turnbull *et al.*, 1998; Rasmussen *et al.*, 2007), subsequently anal, caudal and abdominal (Bosakowski and Wagner, 1994). With European perch (*Perca fluviatilis*) there were paired fins – pectoral and abdominal in rearing facility mostly affected. Size reduction of pectoral, second caudal, abdominal and anal was observed compare to fish from natural conditions (Stejskal *et al.*, 2011). Fish are able to heal damaged fin. Regenerated fin has the same shape and size as original fin, but number of rays varies and ray branching is situated higher then at original fin (Atta *et al.*, 2012).

3.1 Aggressive behaviour

Aggressive behaviour of fish expresses at attacks against other individuals (Ellis *et al.*, 2002) and is distinguished by pursuit, bitting, threatening and fight between individuals (Stringer and Hoar, 1955). Bitting between individuals can indicate an implementation of social hierarchy (Moutou *et al.*, 1998). Mainly it happen in the time of serving feed (Maclean *et al.*, 2000; Linnér and Brännäs, 2001; Ellis *et al.*, 2002; Stejskal *et al.*, 2011), when dominant fish restrain access to food to inferior fish (Ellis *et al.*, 2002). Dominant fish are mostly huge individuals (Lemm *et al.*, 1988; Maclean *et al.*, 2000). On the contrary, subordinate fish are smaller individuals and with reduced growth rate (Moutou *et al.*, 1998). There is an increase of probability of fin damage with dominance of individuals because these individuals are fighting for food with Atlantic salmon (*Salmo salar*). On the contrary, smaller subordinate fish intake less feed, they are growing slowly and reduce the risk of conflict with dominant individuals and fin damage (Maclean *et al.*, 2000). The dorsal fin becomes damaged most frequently in salmonids (Bosakowski and Wagner, 1995; Maclean *et al.*, 2000). Flood *et al.* (2012) observed by camera that the most attacks of big rainbow trout individuals were heading towards caudal fin area of smaller individuals. Turnbull *et al.* (1998) observed attacks of Atlantic salmon, which headed mostly towards dorsal and caudal fins but mostly damaged were dorsal and pectoral fins. With European perch there are erosions mostly on pectoral fins (Stejskal *et al.*, 2011). Occurrence of aggressive behaviour between individuals is influenced by the age of fish. Non–adult fish showed higher frequency of attacking and slower fin regeneration than adult fish (Mork *et al.*, 1989). Decreasing light intensity, water temperature and following food intake decrease an aggressive behaviour (Stringer and Hoar, 1955; Maclean *et al.*, 2000).

3.2 The influence of stocking density

Salmonids are kept in high densities and in the same age categories. The reason is modifying of their behaviour from territorial to flock and limitation of aggression (Turnbull *et al.*, 2008). The risk of conflict increases when feeding (Grand and Dill, 1999). Most of publications are focused on Salmonids rearing, mainly rainbow trout. High stocking density over 500 fish m^{-3} limits an access of food to some individuals, it reduce fish apetite, influences fish growth (Boujard *et al.*, 2002) and limits individual area among individuals (Person–Le Ruyet *et al.*, 2008). Lower stocking density (10 kg.m^{-3}) creates a social structure with dominant individuals inside of the flock and increase of size heterogenity (North *et al.*, 2006). Rasmussen *et al.* (2007) observed higher frequency of attacks among individuals at low stocking density (45 kg.m^{-3}) than at high stocking density (124 kg.m^{-3}). Other subordinate fish have mostly damaged dorsal fins caused by high ranking individuals and a damage level of dorsal fins can be used as social hierarchy indicator inside the flock (Moutou *et al.*, 1998). Rasmussen *et al.* (2007) reported that anal fin is in better condition at low stocking density (up to 41 kg.m^{-3}). Fin erosions increase with stocking density. E.g. North *et al.* (2006) found out that longer fins are more present in stock of 10 kg.m^{-3} than in high stocking density 40–80 kg.m^{-3}. Similar results were found by Person–Le Ruyet *et al.* (2008) in stock of 24.8 kg.m^{-3}. On the contrary, Soderberg and Krise (1987) had not observed any influence of stocking density on fin condition of lake trout (*Salvelinus namaycush*). Wagner *et al.* (1996a) observed a different fin lenght depending on age and stocking density with fry of rainbow trout. They recommended an optimal stock size of 44 fish m^{-3}, which do not influence growth and condition of fins.

3.3 Feeding management and diet composition

An appropriate feeding management can improve a condition of fins (Person–Le Ruyet *et al.*, 2007). Small feeding ratio can give a rise to social hierarchy and fin condition worsening. E.g. feeding ratio up to 0.5% of fish stock weight can cause an occurrence of large fin erosions at subordinate and dominant fish. Establishing of social hierarchy can be prevented by the increasing of feeding ratio (Moutou *et al.*, 1998). Mostly damaged is dorsal (Noble *et al.*, 2008; Suzuki *et al.*, 2008) and caudal fin (Moutou *et al.*, 1998). Condition improving of these fins can induce a feeding ratio over 0.5% of stock weight. While serving a feed once a day, the aggression of fish increases due to long time without nutrition (Moutou *et al.*, 1998). Contrary Rasmussen *et al.* (2007) found that there is a recovery of left pectoral fin at feeding once a day comparing to feeding 3 times a day. The reason of pectoral fin recovery is lesser risk of bitting from other fish. Using of self feeders enables food providing during the whole day and resulted in lower presence of dorsal fin erosions (Suzuki *et al.*, 2008). Wagner *et al.* (1996b) recommends 1 self feeder per 5.5 m of 1.2 m wide rearing raceway. There is no improvement of fin condition and state of health using of more self feeders in raceway. Self feeder can improve caudal and abdominal fin condition compare to hand feeding several times a day (Wagner *et al.*, 1996b). The frequence of feeding has no influence on dorsal fin condition. Better condition comes at high stocking density over 54 kg.m^{-3} (Rasmussen *et al.*, 2007).

Inappropriate composition of diet causes worsening of fin condition (Lemm *et al.*, 1988; Barrows and Lellis, 1999). Lack of essential amino acids in diet with rainbow trout (lysin, arginin, histidin, isoleucin, threonin, valin and tryptophan) affected fin condition, mainly caudal fin. Especially lysin presented in diet in amount of 6.1% is served as prevention of fin erosions (Ketola, 1982; 1983). With channel catfish (*Ictalurus punctatus*) there are caudal fin deformation caused by a lack of C vitamin (Mazik *et al.*, 1987) and with tilapia (*Oreochromis karongae*) there are fin erosion with bleedings caused (Nsonga *et al.*, 2009). With barramundi (*Lates calcarifer*) there were deformations of fin rays and swimming malfunctions find out (Phromkunthong *et al.*, 1997). The lack of A vitamin in feed for Nile tilapia (*Oreochromis niloticus*) causes bleedings on fins, on contrary A vitamin surplus causes caudal fin necroses (Saleh *et al.*, 1995). Panthotenic acid deficit caused grievous fin erosions with blue tilapia *(Tilapia aurea*) (Roem *et al.*, 1991). Fish oil in diet has no influence on fin condition improvement (Lock *et al.*, 2011). Krill meal improves dorsal fin condition of rainbow trout, length of the fin was similar to length at natural populations. On the contrary, anchovy meal worsened fin condition by erosion, darkening and necroses presence. One possible explanation of krill meal effect is that it contents higher amount of minerals (calcium, iron, copper, magnesium, sodium and strontium), (Barrows and Lellis, 1999). Total fish diet composition can have substantial influence on fin condition (Latremouille, 2003). Barrows and Lellis (1999) reported that proteins and minerals (particularly sodium, magnesium and copper) are important for better fin condition.

3.4 Rearing system

Design of rearing system influenced a condition of fins, particularly in pectoral fins which are damaged by abrasion against tank surface (Turnbull *et al.*, 1998). Reared fry of cutthroat trout (*Oncorhynchus clarki*) in concrete raceways suffers with erosions of pectoral, dorsal and caudal fins. With rainbow trout reared in same conditions was observed a worsened condition of right pectoral fins, both abdominal fins, dorsal, caudal and anal fins (Bosakowski and Wagner, 1995). Rainbow trout reared in recirculation systems have smaller size of pectoral and dorsal fins compare to fish reared in flow through systems. This is probably caused by higher water velocity inside the tank. Caudal fin is usually damaged in both systems regardless a fish stock size (D'orbcastel *et al.*, 2009). There were observed erosions of fins and ray splitting with chinook salmon (*Oncorhynchus tschawytscha*) reared in net cages. Most frequently affected by bleeding presence are dorsal and caudal fins. Intensified frequency of injuries was observed from late summer to half of autumn. Recommended stocking density in cage systems is up to 20 kg.m^{-3} (Moring, 1982).

3.5 Water quality

Stocking density influence a quality of water in tanks. Worsened water quality limits welfare and food intake, causes physiological stress, gill and fin damages and increases sensitivity to diseases (Ellis *et al.*, 2002). Length and condition of pectoral and dorsal fins depend on water quality (Person–Le Ruyet *et al.*, 2008; D'orbcastel *et al.*, 2009). Person–Le Ruyet *et al.* (2008) reported that dorsal and pectoral fins are in better condition in lower stocking density (up to 25 kg.m^{-3}) and water quality equivalent to 6 mg.l^{-1} O_2 at the outflow and total concentration of ammonia (T–AN) 0,6 mg.l^{-1} (0,002 mg.l^{-1} NH_3 at pH 7,0 and temperature 9 °C).

3.6 Manipulation with fish

Inapropriate manipulation can cause injuring or stress of fish (Conte, 2004; Huntingford *et al.*, 2006). Damaged fins belongs to indicators of inappropriate manipulation (Fawc, 1996). Injured fins are insertion site for various pathogens. Wherefore it is allways necessary to handle fish with care and used instruments have to be allways wet (Svobodová *et al.*, 2007). Fishing with netting can cause injuries to fish (Conte, 2004). Most frequently, fish are damaged by knot nets, mainly pectoral and caudal fins show the highest level of damages (Barthel *et al.*, 2003). Fawc (1996) and Conte (2004) recommend using of fish pumps. Turbine fish pump damages fins more than vakuum fish pump (Grizzle *et al.*, 1992).

3.7 Bacterial infections

Damaged fins can be colonized by bacteria (Schneider and Nicholson, 1980), e.g. *Aeromonas, Pseudomonas, Vibrio, Dermocystidium, Flexibacter* (Latremouille, 2003) which inflict lesions. These structures occur on the margins of fins. They are accompanied by thicken tissue and frayed rays. Lesions can be the cause of whole fin loosing. Thicken tissue around lesion is the response of cells on inflamination by enlarging of its volume. Bacteria causing this disease were found only on the uncovered fins and not on lesions. During the treatment affected cells gradually peels off (Turnbull *et al.*, 1996). Changes induced by bacteria on the surface of fins influence even internal body of organism e.g. decreases hematocrit, hemoglobin, total protein in plasma, number of immature erythrocytes and neutrophilus (Khan *et al.*, 1981). Factors influencing the colonization of bacteria on fins are frequency and rate of tissue damage, water temperature (Turnbull *et al.*, 1998) and fish stock size (Mazur *et al.*, 1993; Bebak–Williams *et al.*, 2002). Schneider and Nicholson (1980) found that there is an increasing frequency of bacterial infection occurrance according to decreasing temperature. There is higher risk of bacterial disease of fins in high stocking density (Mazur *et al.*, 1993; Bebak–Williams *et al.*, 2002).

4 METHODS OF FIN CONDITION EVALUATION

Fin condition is evaluated by combination of length and fin profile (Bosakowski and Wagner, 1994; Person–Le Ruyet *et al.*, 2007, Ellis *et al.*, 2009). Evaluation has to be carried out always by the same person (Maclean *et al.*, 2000; Rasmussen *et al.*, 2007). When comparing it is necessary to compare perfect non–damaged fins as control with disrupted, i.e. to compare fins of fish from natural populations with fish from reared systems or fish from low density fish stocks (Latremouille, 2003).

Most frequently used method for evaluation is "Fin Index" or "Relative Fin Length", Ellis *et al.* (2009). This method was for the first time described by Kindschi (1987) with the former designation as "Fin Factor". It is formulation of percent which presents ratio of fin length to body length of fish. The length of longest ray is measured at fins and this distance is called "fin length". It can be measured manually using a calliper (Ellis *et al.*, 2009) or by taking a picture and measure by computer software (Stejskal *et al.*, 2011). This length is placed then into fin index equation:

$$\text{Fin Index} = 100 \times (\text{fin length} \times SL^{-1}).$$

SL is a standard body length, formerly a total body length was used (Ellis *et al.*, 2009). With increasing fish length there is also a fin growth occuring (Bosakowski and Wagner, 1994; Stejskal *et al.*, 2011). All of fins with rays are measured, except adipose fin in Salmoniformes, which has no rays and there are no evidence of damaging or erosions on this fin (Bosakowski and Wagner, 1994). Evaluation by this method is accurate, however, requires more time than other methods (Latremouille, 2003).

Another possibility is a comparison of non–damaged fins with disruptions and classify them according to size of missing tissue to various erosion grades, e.g. Person–Le Ruyet and Le Bayon (2009) distinguish erosion to 5 grades. Hoyle *et al.* (2007) chose 6 grades of erosion where the first grade was without any signs of erosion. These fish origin from natural condition and were used as a pattern for reared fish. The photographic key for using at rearing facilities.

Person–Le Ruyet *et al.* (2007) evaluated condition of fins of rainbow trout according to position of last untouched ray and to this the grade of erosion was matched (Fig. 1).

There were 5 grades of erosion applied on pectoral and caudal fins classified. Grade 0 at pectoral fin meant no erosion in the area of first and third untouched ray. Grade 1 was up to sixth ray, grade 2 was up to ninth ray, grade 3 was up to twelveth ray and grade 4 was up to fourteenth ray or meant no fin. Grade 0 at caudal fin meant no erosion in the area between spiny rays and first soft rays. This fin rays were counted from caudal part. Grade 1 was up to eighth ray, grade 2 up to fifth ray, grade up to first ray and grade 4 meant that all rays are affected or there is whole fin missing.

Another possibility of fin condition is using of HCP (Health/Condition Profile) fin index. The fin condition is distinguished in three grades according to the size of missing tissue. Non–damaged fins are evaluated by grade 0, minor disturbance of fin tissue are evaluated as grade 1, large disruptions of fin areevaluated as grade 2. Subsequently, each fish marks of each fin are added up and result is a total evaluation of individual's fins (Bosakowski and Wagner, 1995).

Moutou *et al.* (1998) evaluated fin condition according to missing tissue. They distinguished four grades of damaging: no damage, light damage (up to 30% of fin tissue missing), heavy damage (30–70% tissue missing) and very heavy damage (more than 70% of tissue or the whole fin missing). From each group of fish individuals were divided into these catogories and total fin damages (I_D) were counted for each group.

$$I_D = N^{-1}\sum_{i=0}^{3} nD_i\ ,$$

where n is a number of fish in group with the same grade of damage, N is the number of fish in group.

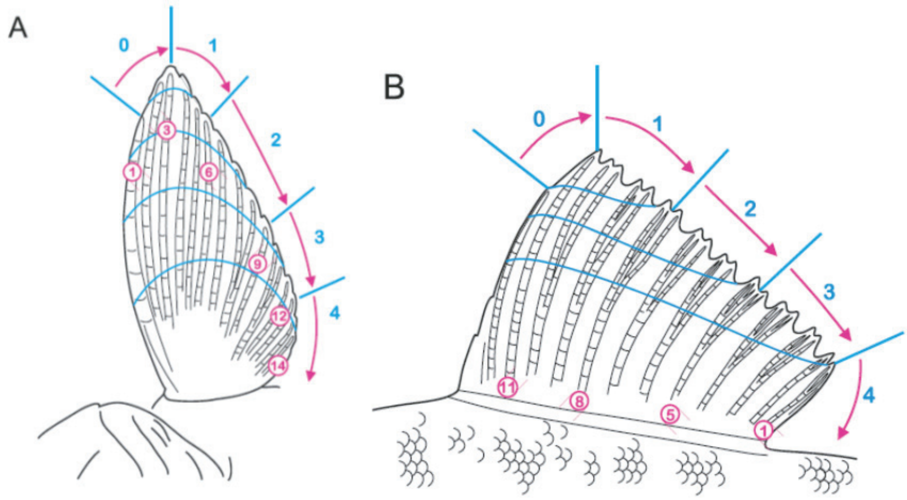
Dorsal fin was evaluated by Maclean *et al.* (2000) according to 3 criteria: a fin size, a grade of splitting and a thickening during healing (Fig. 2).

Rasmussen *et al.* (2007) evaluated fins visually and classified them into four grades:

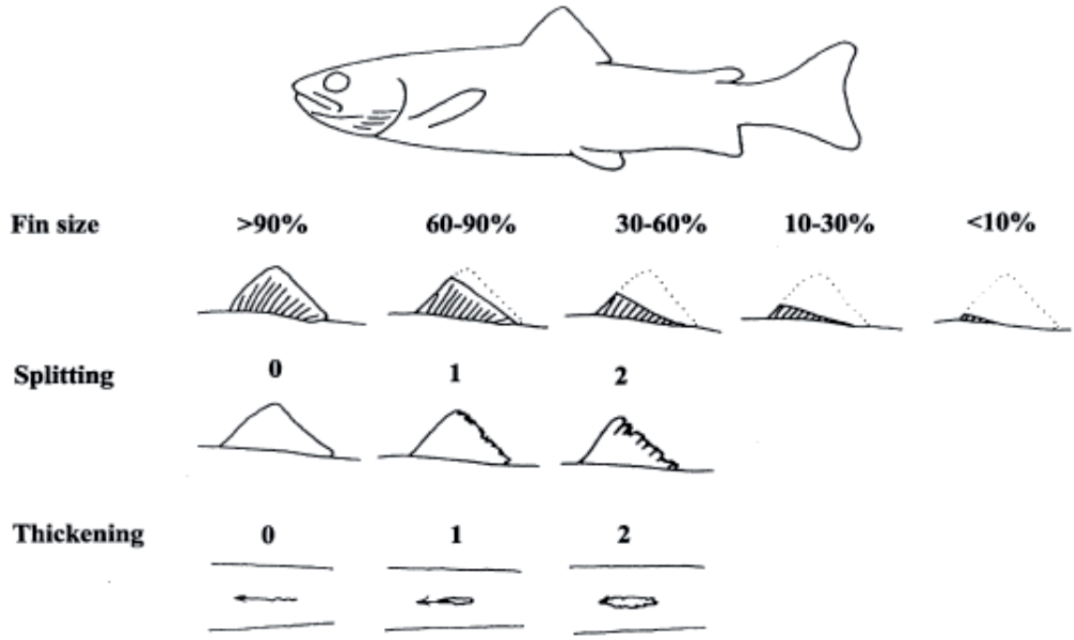
1. Grade – the whole front dorsal ray or its part is without pigmentation, pectoral, abdominal, anal and caudal fins have a white colouring in minor rate.
2. Grade – small part of front dorsal ray is missing, pectoral and abdominal fins are missing up to 25% of tissue, at anal and caudal fins 10% of tissue is missing also with occasional presence of blood spots.
3. Grade – large part of front dorsal ray is missing, 25–50% of pectoral and abdominal fin is missing with occasional presence of blood spots, 10–25% of anal and caudal fin tissue is missing.
4. Grade – lowered caudal fin with occasional presence of blood spots, more then 50% of pectoral and anal fin tissue is missing, anal and caudal fin shows more than 25% damaging.

5 POSSIBILITIES OF FIN CONDITION IMPROVEMENT IN REARING FACILITIES

For improvement of fin condition an adding of synthetic imitations of sea algaes with sale name "AquaMats" can be helpful. It provides refuge for



1: *The evaluation of fin condition according to Person–Le Ruyet et al. (2007)*



2: *The evaluation of fin condition according to Maclean et al. (2000)*

water plants and animals (mainly water invertebrates: Amphipods, Ostracods, Copepods and water insect) that can serve to fish as a supplementary food and improve a condition of fish by that. This possibility was studied by Arndt *et al.* (2002) who proved a temporary improvement of fin condition in halfway through the experiment, mainly the fin length. Only left pectoral fin was longer at the end of experiment, other fins evened with controls. Positive influence of synthetic algaes on fin condition is phased out in accordance to fish growth and increasing stocking density. Appropriate way of feeding can reduced mutual attacking between individuals, improve a pectoral and dorsal fin condition (Person–Le Ruyet *et al.*, 2007). Increasing of daily feeding ratio over 0,5% of stock weight has a positive influnce on fin condition (Moutou *et al.*, 1998). Suitable diet composition has beneficial effect on fin condition. The effect of krill meal was proven, proteins and minerals, mainly sodium, magnesium and copper are important (Barrows and Lellis, 1999). Computer–controlled feeding systems tracking a fish behaviour can improve a dorsal fin condition and welfare of fish (Noble *et al.*, 2007). Covering of the concrete bottom with cobble substrates or sand can help to improve a fin condition (Bosakowski and Wagner, 1995; Latremouille, 2003). However, under intensive conditions of these improvement unfeasible because it would mean a worsening of water qaulity in tanks. With Atlantic salmon it is recommended to add a bigger individual to smaller fish for suppresion of aggression and increase by that the growth of smaller individuals (Adams *et al.*, 2000). Contrary, this effect was not confirmed with rainbow trout, all the more, it resulted in increased aggression of big individual against smaller ones (Flood *et al.*, 2012). Duoculture of Atlantic salmon with Arctic char (*Salvelinus alpinus alpinus*) decreases intraspecific aggression and improves a condition of caudal fin with Atlantic salmon (Holm, 1989). On the contrary, duoculture of Atlantic salmon with brown trout (*Salmo trutta*) had negative influence on fin condition with Atlantic salmon, which has become a target of attacking of brown trout individuals (Jobling *et al.*, 1998). Chloramin–T in concentrations smaller then 10 $mg.l^{-1}$ can be used as preventive measure against bacterial infection of fins (Powell *et al.*, 1994).

Latremouille (2003) summarized preventive measures for fin condition improvement: feeding fish ad libitum, increasing of water flow in rearing tanks, cross–flow water current in rearing tanks, rearing of fish in duoculture (limitation of intraspecies aggression), cover the bottom of rearing raceways with sand, cobble substrates, took priority of ground canals over concrete and use larger fishponds. As well as, addition of amino acids and minerals, mainly copper to fish diet.

6 CONCLUSIONS

Condition of fin indicates a bad welfare and wrong management of rearing (Person–Le Ruyet *et al.*, 2007). Aquacultural systems disable natural life cycle to fish, this is the reason why there can't be sufficient welfare in this facilities (Huntingford and Kadri, 2009). An appearance of fins can also decide about saleability of live fish (Hoyle *et al.*, 2007; Stejskal *et al.*, 2011). Damaged fins can disturb a swimming ability of fish (Stejskal *et al.*, 2011). So, fin appearance can be considered as important indicator of environmental conditions.

7 SUMMARY

Fin condition serves as indicator of welfare state. It is convenient to observe a glucose content and cortisol in blood plasma in addition to fin condition. Fins consist of bony fin rays and colagenous fin membrane. Erosions or fin damages are a worsened condition of fins distinguished by smaller size of fins, frayed rays, disturbed fin tissue, erosions and necroses creation. In natural conditions there are no fin erosions, these occure only at reared fish. The causes of worsened fin condition are aggressive behaviour among individuals, inappropriate fish stock size, the way of feeding management, diet composition, type of rearing system, water quality, thoughtless handling with fish and bacterial infections. Dorsal and pectoral fins are most frequently damaged. Aggressive behaviour between individuals is connected with social hierarchy creation, mainly when feeding. High stocking density turns territorial behaviour into flock, it limits aggressive behaviour but increases a risk of clash between individuals. Low stocking density implies social hierarchy at dominant individuals, subordinate fish have damaged dorsal fin. Longer fins are present more in lower than in high stocking density. Low feeding ratio up to 0.5% of stock weight worsens fin condition. Self feeders improve a condition of fins. Unsuitable diet composition worsens condition of fins. Sufficient amount of essential amino acids, vitamins and minerals have a positive influence on fin appearance. Damages of pectoral fins against tank surface occur in rearing systems. Fish in recirculation facilities have smaller pectoral and dorsal fins than in flow through system. In net systems damages of caudal and dorsal fins most frequently occur. Water quality influences the length of fins, condition of pectoral and dorsal fins. Thoughtless manipulation damages fins. Used tools have to be allways wet. Fish fins are not so much damaged by fish pumps. Damaged fins are the cause of bacterial infection origin. Fin condition is evaluated by combination of length and fin profile. Most frequently used method for fin evaluation is the “Fin index”. Modification of rearing facility, increasing of feeding ratio, appropriate diet composition (amino acids and minerals), rearing fish in duocultures, preventive baths in chloramine–T, prefering ground canals and fishponds can contribute to improvement of fin condition. Bad condition of fins worsenes a swimming of fish and can rule the saleability of fish. Aquacultural systems do not allow natural behaviour of fish, that is why it is necessary to evaluate a welfare of reared fish. The appearance of fin informes about condition of rearing facility.

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