

## SOCIAL HIERARCHIES IN FISH

The social behaviour of a many fish species living in groups is characterised by the development of a dominance hierarchy. The development of dominance hierarchies involves aggressive behaviour and may be related to stress. Aggressive displays tend to be non-damaging and avoid harm to other fish. Dominance hierarchies influence choice of position in the stream and feeding opportunities in both the wild and cultured environments. Dominance may therefore lead to greater access to resources and to increased growth. Aggression consists of threat displays and overtly aggressive acts. The specific behaviours associated with aggressive acts in salmonid fish include:

Behaviour	Description
Fin display	Aggressors have fully raised dorsal fins which serves as a threat display.
Charge	A direct but slow approach towards another individual. The charging fish usually have extended fins.
Chase	A succession of at least two attacks towards the same fleeing individual.
Bite	Or nip, aimed at a closely located individual.

Hierarchies benefit dominant individuals by:

- preferential access to resources such as food, territories and mates.
- becoming larger quicker due to a higher food intake (Dominant individuals are not always the biggest animals in a group, but a larger size may result from being dominant).
- reaching sexual maturity quicker and demonstrating increased fitness.

In contrast, submissive fish typically exhibit avoidance of dominant fish, are less willing to move around and show very little aggressive behaviour. Subordinate individuals may be subjected to more attacks, exhibit stress and do not feed well.

By videoing or watching a group of animals for a period of time, you can observe and take a note of their behaviour. By counting the number of aggressive acts given by each individual, or by recording feeding success an idea of the dominance hierarchy can be achieved in the following ways:

Dominance Index (DI)	Mean Share of Meal (MSM)
<p>This is calculated for each fish in the from its individual contribution to aggression within the group as a whole:</p> $DI = A_i / A_T \times 100$ <p><math>A_i</math> = aggressive acts by an individual <math>A_T</math> = total aggressive acts of the group</p> <p>This gives each individual in the group a percentage of the total aggression expressed. The individual with the highest percentage will be the dominant, and the individual with the lowest percentage will be the submissive.</p>	<p>Another expression of DI for an individual based solely on its own behaviours:</p> $DI = A_G / (A_G + A_R)$ <p><math>A_G</math> = aggression given by individual <math>A_R</math> = aggression received by individual</p> <p>The individual with the number closest to 1 will be the most dominant, and the individual with the number furthest from 1 will be the most submissive.</p>
	<p>To calculate this value the number of pellets each individual eats is compared with the total number of pellets eaten by the whole group.</p> $MSM = P_i / P_T \times 100$ <p><math>P_i</math> = no. of pellets eaten by an individual <math>P_T</math> = total pellets eaten by the group</p> <p>The fish with the highest MSM percentage will be dominant, and the fish with the lowest will be the most submissive.</p>

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To demonstrate and observe social behaviours, 4 rainbow trout were put into a tank and acclimated to the tank and feeding conditions for 2 weeks. Below is a table of the mean number of aggressive acts for the each individual fish, observed by 4 students in a series of observation sessions.

Observation of Aggression				
	Individual Fish			
	#1	#2	#3	#4
Charge	3.50	6.50	5.50	0.00
Flee	7.30	1.80	2.00	6.00
Nip Given	0.00	0.50	0.50	0.50
Nip Received	0.25	0.00	0.25	0.50

Observation of Feeding				
	Individual Fish			
	#1	#2	#3	#4
Pellets Eaten	9	22	19	1
MSM (%)	18	43	27	2

1. Using the Dominance Index and the data given, complete the table below and calculate Dominance Index for each fish, using both methods:

Dominance Index				
	Individual Fish			
	#1	#2	#3	#4
Aggression given ( $A_I$ or $A_G$ )				
Aggression received ( $A_R$ )				
TOTAL Aggression of group ( $A_T$ )				
DI ( $A_I / A_T \times 100$ )				
TOTAL Aggression per individual ( $A_G + A_R$ )				
DI ( $A_G / (A_G + A_R)$ )				

2. Use the data to construct the dominance hierarchy for these fish, in order of most dominant, downwards to most submissive:

- a) MSM: \_\_\_\_\_
- b) DI ( $A_I / A_T \times 100$ ): \_\_\_\_\_
- c) DI ( $A_G / (A_G + A_R)$ ): \_\_\_\_\_

3. Comment on what the hierarchies you determined suggest about the three methods used:

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