

UNIVERSIDAD DE BARCELONA

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Spawning behaviour of the Salmoninae subfamily members. A phylogenetic study



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**Spawning behaviour of the Salmoninae subfamily members.
A phylogenetic study**

**Memoria presentada por
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para optar al título de
Doctor en Biología**

V.B. del director

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Para Mari Carmen y Mafi.....

Contents

| | |
|--|------------|
| Acknowledgements | iii |
| Summary..... | vii |
| 1. General Introduction..... | 1 |
| The salmonines..... | 3 |
| Origins and Evolution | 4 |
| Spawning Behaviour | 5 |
| An overview of the Salmoninae mating system | 8 |
| A new approach to alternative male reproductive strategies and tactics... 10 | |
| Salmon and Evolutionarily Stable Strategies (ESS)..... | 14 |
| 2. Salmoninae Spawning Behaviour..... | 17 |
| Introduction..... | 19 |
| Methods..... | 21 |
| A general description of Salmoninae spawning behaviour..... | 28 |
| 3. The Role of Instincts..... | 49 |
| Introduction..... | 51 |
| Methods..... | 53 |
| Results and discussion..... | 56 |
| Two case studies: false spawnings in females and male digging..... | 60 |
| 4. Female Choice..... | 67 |
| Introduction..... | 69 |
| Methods..... | 72 |
| Results and discussion..... | 75 |

| | |
|---|------------|
| 5. Phylogeny and Spawning Behaviour..... | 85 |
| Introduction..... | 87 |
| Methods..... | 92 |
| Results..... | 128 |
| Discussion..... | 129 |
| The phylogeny of spawning behaviour..... | 132 |
| The phylogeny of life histories..... | 151 |
| Future Research..... | 158 |
| Conclusions | 161 |
| Resumen y Conclusiones/ Summary and conclusions (Español)..... | 165 |
| Literature Cited..... | 185 |

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Since I didn't do anything without the help of someone this section should be another thesis itself.

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As for the third person, she is the most important, so let me cite her at the end of this section.

In the desk

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Back to the rivers

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If I have to choose

....a single title, among the vast Salmonids literature that will be Rupert Watson's *Salmon, Trout & Charr of the world*. This splendid book sheltered by an extraordinary evolutionary perspective has been a constant source of inspiration for me.

.....a single salmon river that will be the fabulous Farrar River that runs through the mysterious Caledonian Forest in the Scottish Highlands.

....a single Salmoninae species that will be Atlantic salmon. You, the *salar*, are responsible for this long obsession.

The best

I am most thankful to my parents Manuel Esteve and Paulina Cavaller for facilitating me so much to have the life I have choose to live. I thank my sisters Marta and Laura and my brothers Jose and Víctor for their support during this long race.

Finally, during these last years I have been writing a thesis about sex. However, when today I look back at the past I realize that this dissertation has been truly about love. My wife, Mari Carmen Grisolia, has made possible for me to write this thesis. She has blindly followed me, in search of the spawning fish, to creeks, streams, and rivers along the mountains and valleys of Washington State, British Columbia and Southeast Alaska. This has double merit when one knows Mari Carmen and realizes that she doesn't like nature so much....well, in fact she does not like rivers, fish or wildlife at all.

Today I often remember the three of us; we are inside our car parked somewhere near a remote creek. I am, as always, with my eyes fixed at the color monitor plugged into the 12 volt lighter the car has. I am seeing how a coho female is probing her nest. She is breathing heavily, her movements are slow. She looks exhausted. From time to time, as the night and thermometer falls, bubbles come out of her gills. Then, Mafalda, our three years old daughter, patiently asks me. *¿Papá ya han desovado?* (Dad have they spawn yet)?

To enter the underwater camera in turbulent icy rivers, is however only a part of Mari Carmen's importance on this thesis. When I finished my 18 months visiting stay at the University of Washington my student Visa status had come to the end. This was a very stressful time for me as by that moment I still need to get data on many species. Once again, Mari Carmen saved me enrolling in the Seattle Central Community College and starting a stressful and work demanding program in Psychology that allowed me to change my immigration status from F1 (student) to F2 (espouse of a student).

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Muchas gracias

Summary

Long-term data from underwater video recordings in the wild and in semi-natural channels are used to describe and compare the reproductive behaviour of fishes in the Salmoninae subfamily. The thesis is divided into five chapters. In the first, a new division of male alternative strategies and tactics based on relative age at maturation (strategy) and on behaviour in the spawning grounds (tactic) is proposed. A variation to the evolutionarily stable strategies (ESS) model based on a growth velocity-dependent maturation threshold is suggested.

In the second chapter, methods of video recording and analyzing behaviour during spawning are introduced. The reproductive behaviour in the Salmoninae is described dividing it into different phases related to female nest selection, construction, and completion.

In the third chapter, the role of instincts during spawning, as well as the mechanisms by which they are released, are explained based on internal motivation and external stimuli. Data are used to propose *false spawnings* in females should be regarded as low intensity behaviour and that *male digging* represents two different types of displacement reaction with threatening and courting functions as ultimate causes.

In the fourth chapter, observations on different species are used to open a theoretical discussion about the role of female choice in salmonines. Particularly, the importance of Zahavi's principle among the different breeding patterns is contrasted with Fisherian runaway selection. A combination of both mechanisms is suggested. Special attention is given to male' *quivering* behaviour. Different hypotheses are proposed to explain its origin and function.

Chapter 5 uses data from underwater video recordings to construct the phylogeny of *Oncorhynchus* and *Salvelinus* based only on behavioural traits during spawning. A maximum parsimony analysis using *Thymallus*, *Hucho* and *Salmo* as outgroups is conducted (PAUP* 4.0 b10). The results agree with some minor differences our current understanding of these two genera based on morphological and molecular data. The possible evolution of several characters is discussed in detail.

Throughout the manuscript still underwater video frames are used to illustrate the explanations.