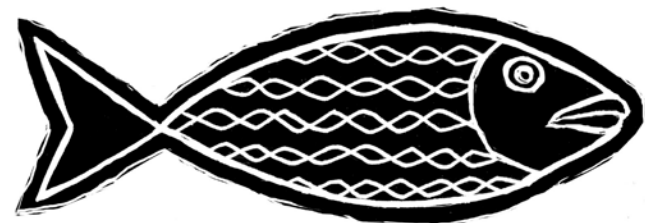


Use of Triploidy for Biocontrol of Invasive Species

Tillmann Benfey

University of New Brunswick (Canada)

**International Symposium on
Genetic Biocontrol of Invasive Fish
Minneapolis, June 21-24, 2010**



Outline

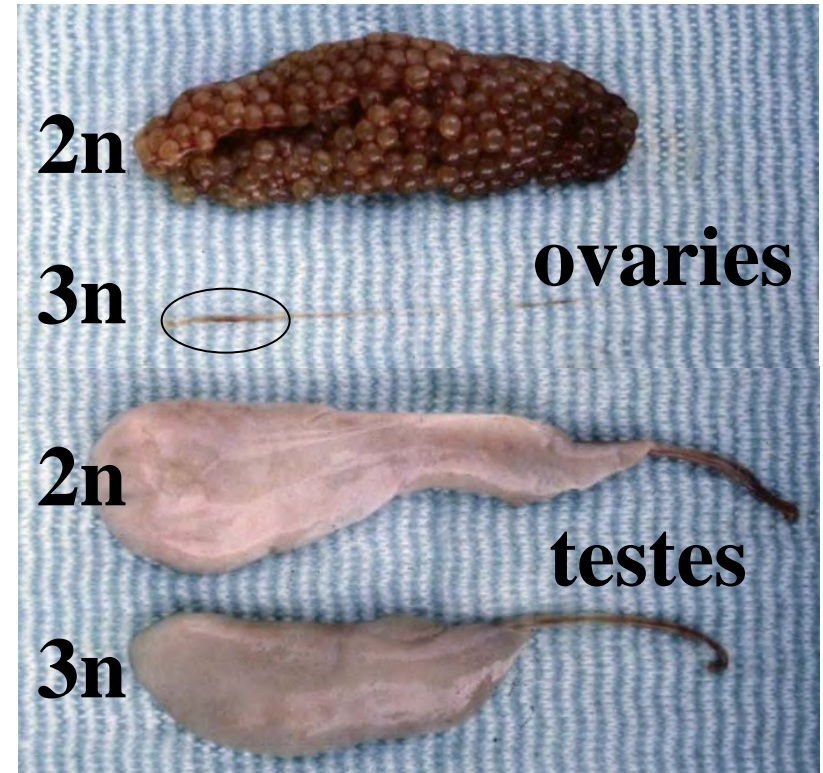
- **Brief background on triploid biology**
- **Production and identification of triploids**
- **Use of female triploids (the typical scenario)**
- **Use of male triploids (a novel application?)**
- **Questions / discussion**

Biology of Triploids

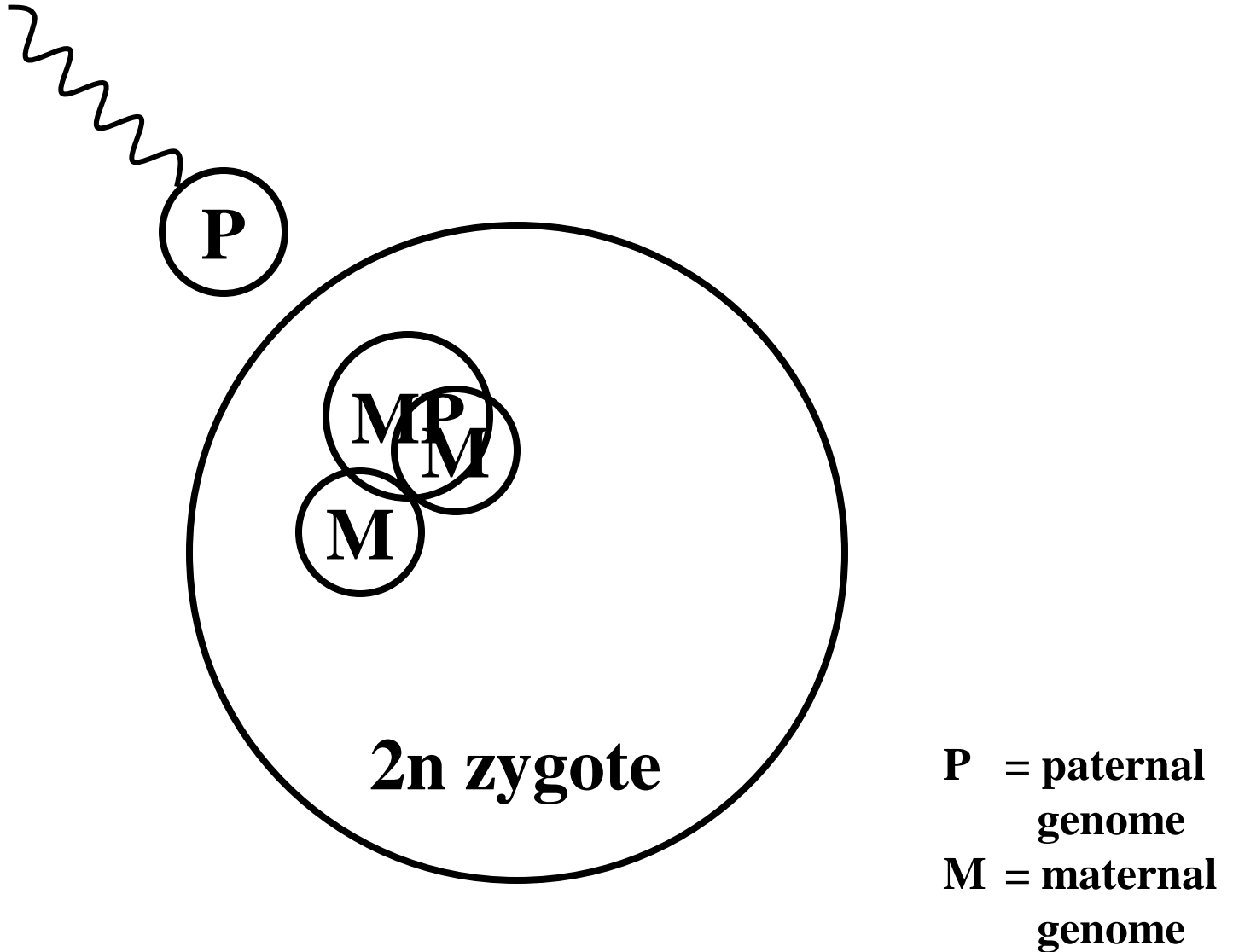
- **Three sets of homologous chromosomes**
- **Mitosis (somatic growth) unaffected**
- **Meiosis (germ cell development) disrupted**
 - **Results in reproductive sterility**
- **Used in aquaculture to ...**
 - **Prevent spawning of escaped farmed fish**
 - **Eliminate early (pre-harvest) sexual maturation**
 - **Protect investments in novel genotypes**

Biology of Triploids

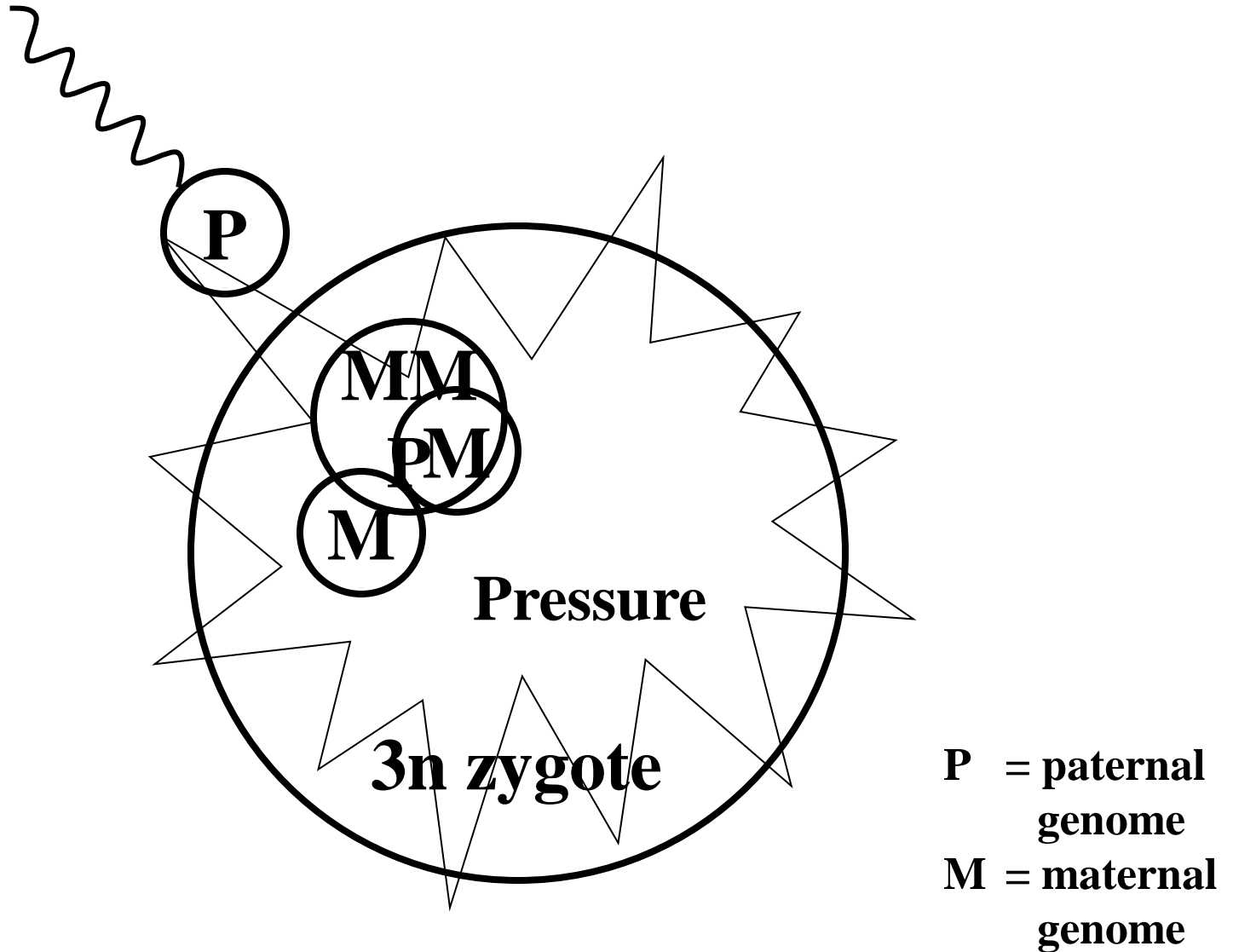
- Sex-specific effects on gonadal development
- Affects ...
 - Endocrinology
 - Secondary (external) sexual characteristics
 - Behaviour
- Females retain juvenile characteristics whereas males appear to mature



Production of Triploids



Production of Triploids



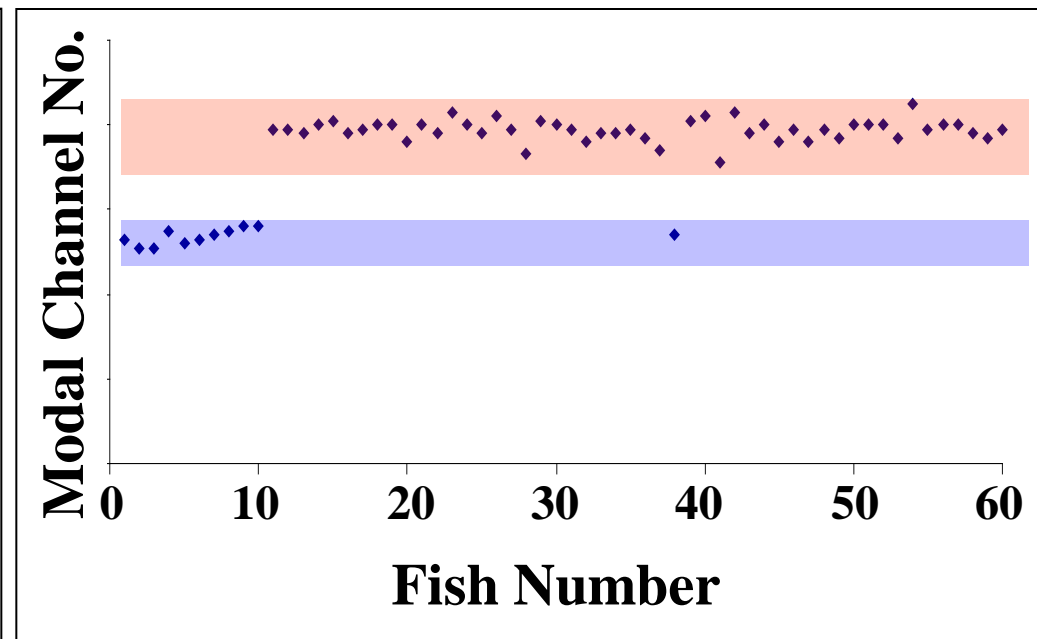
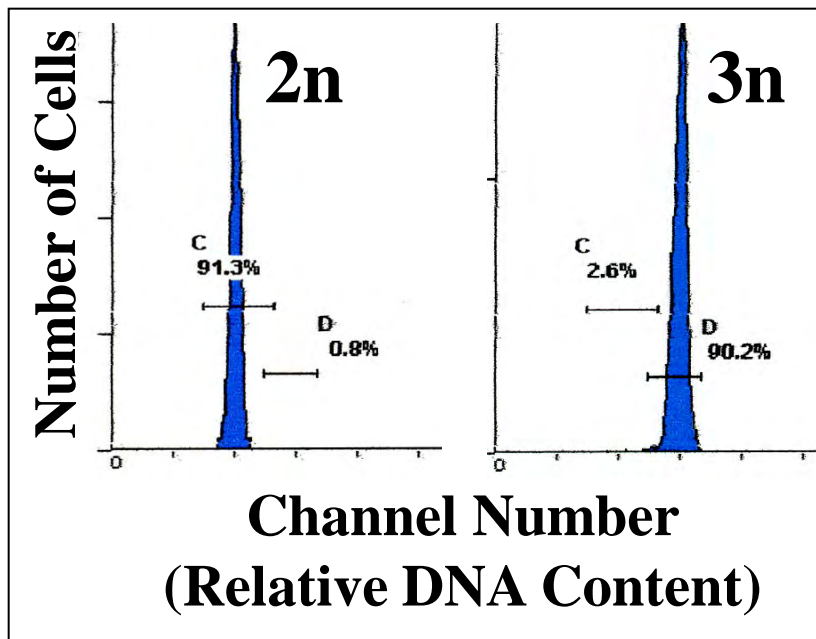
Production of Triploids

- **Preferred method is pressure shock**
 - **Same treatment works for diversity of species:**
 - 5 min at 8,500 – 9,500 psi**
(58.6 – 65.5 x 10³ kPa)
 - **Only variable is time after fertilization**



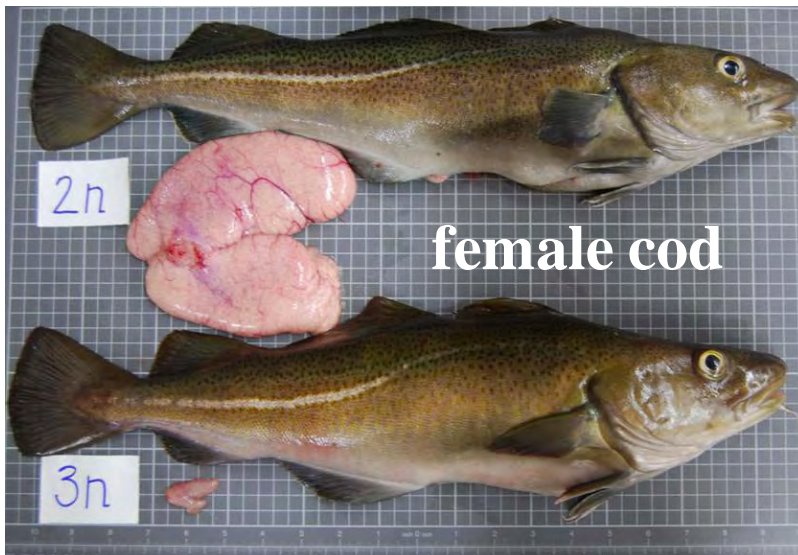
Identification of Triploids

- Preferred method is flow cytometry
 - Measure erythrocyte DNA content ($3n = 1.5 \times 2n$)
 - Easy, fast and accurate



Female Triploids

- The typical scenario
- Works *a priori*
- Requires all-female populations



Female Triploids

Standard procedure in trout aquaculture:

Mixed-sex (XX/XY) population + androgen



**100% phenotypically male population
(still 50% XX, 50% XY)**

F₁: XX♂ x XX♀ ➡ 100% XX♀
+ hydrostatic pressure ➡ 100% XXX♀

Female Triploids

- **Easy, accepted technology**
 - **E.g., rainbow trout (Troutlodge)**
- **Option for control of new introductions**
 - **Does not avoid ecological impacts but these will be limited to lifetime of the individuals**
- **Of no use for control of established invasive species**

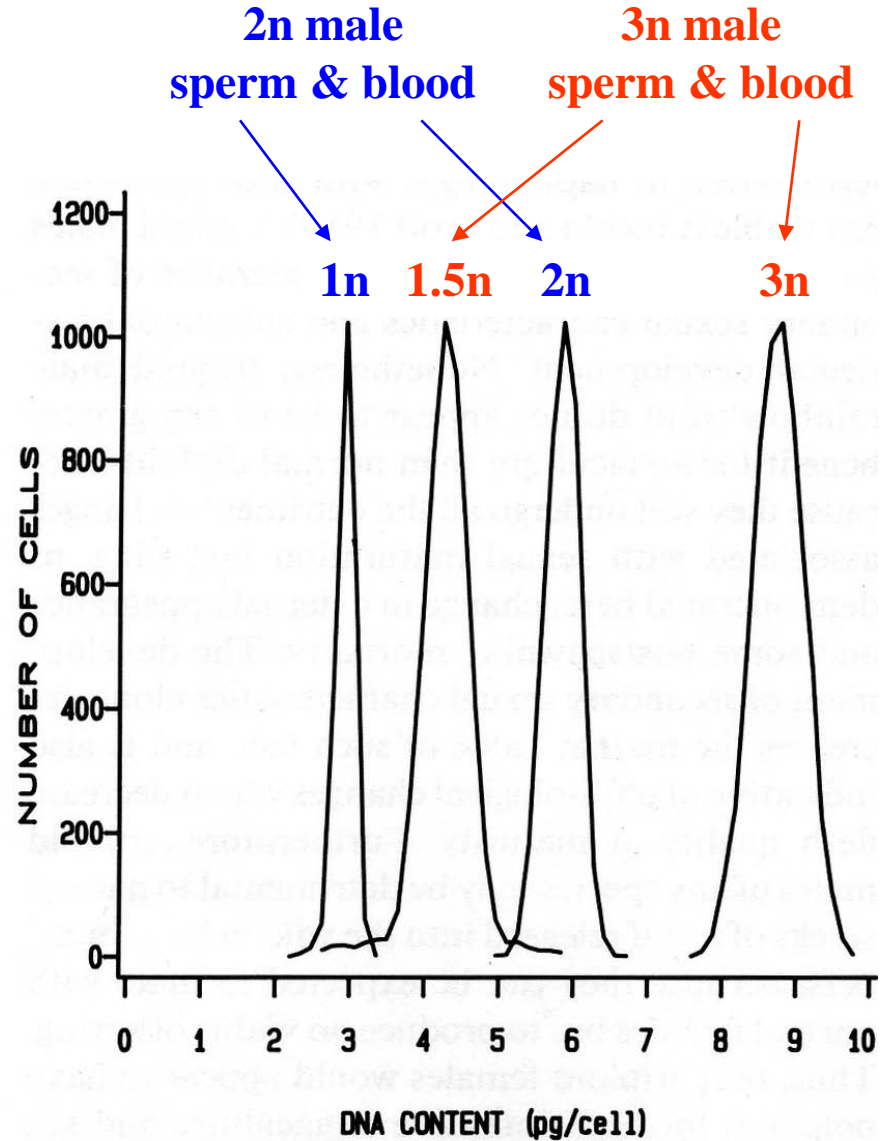
Male Triploids

- **Typically avoided in commercial aquaculture**
 - Normal reproductive physiology
 - Normal spawning behaviour
 - Produce functional sperm
 - Offspring are not viable
- **Candidate for “sterile male” approach to biocontrol**

Male Triploids

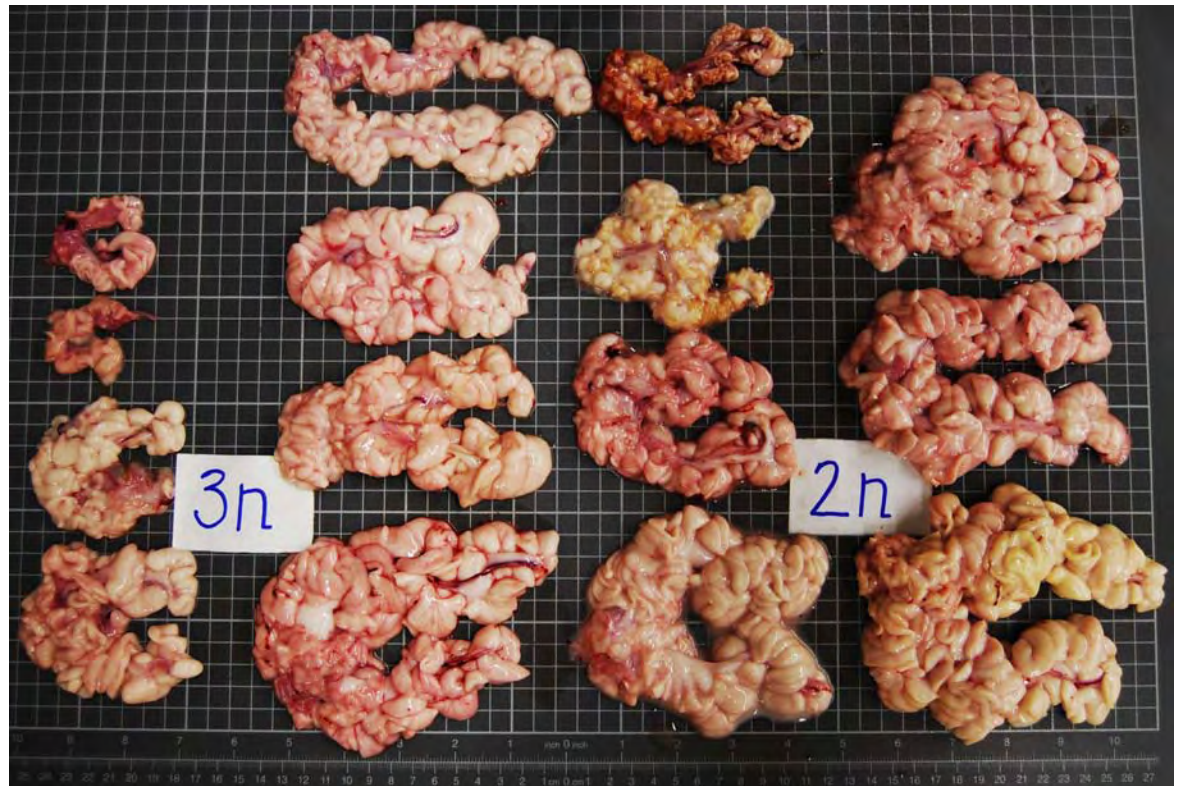


male brook charr



Male Triploids

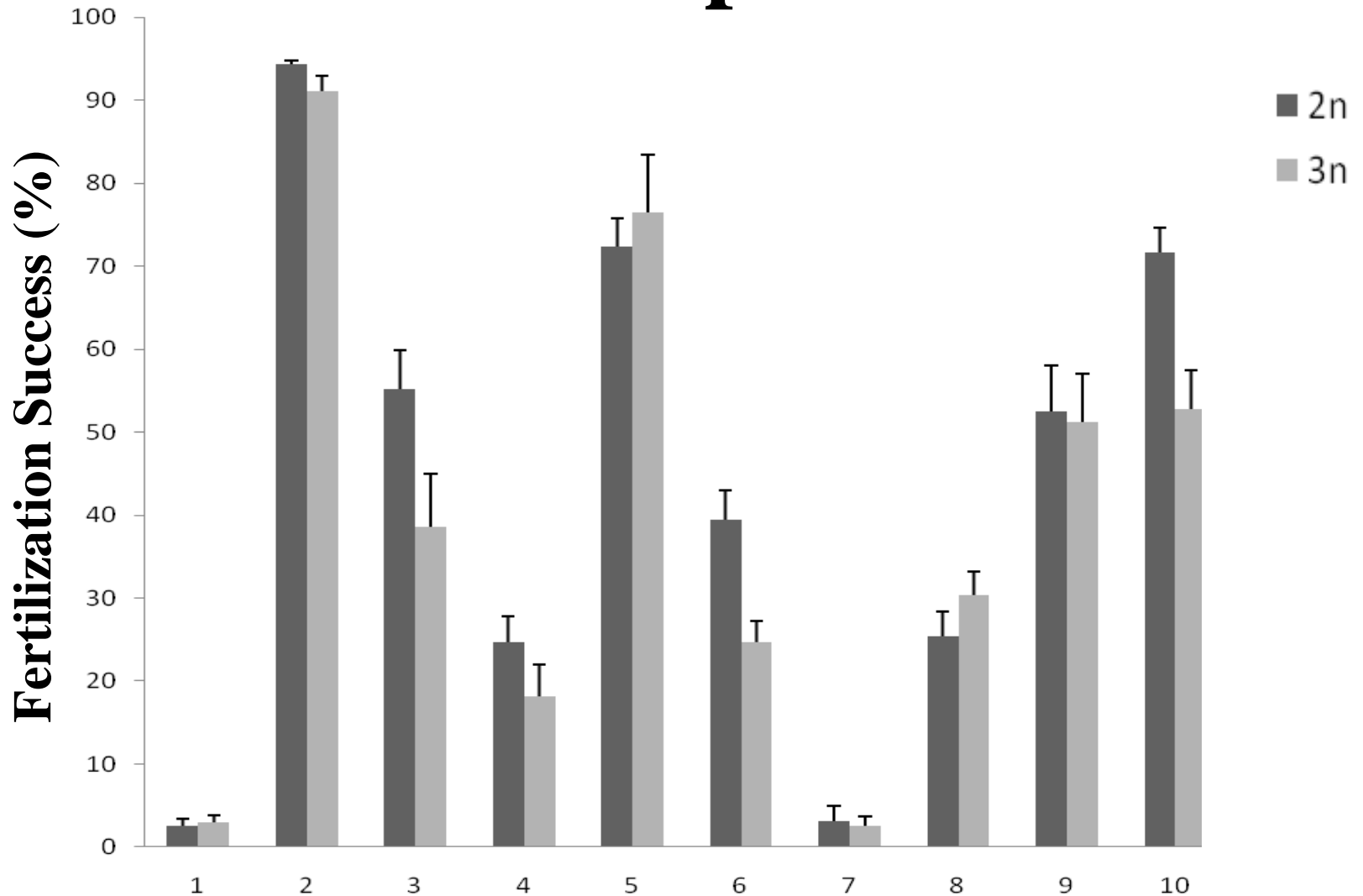
- Atlantic cod as example (Nat Feindel MSc)



Male Triploids

Trio	Batch	n	% sired		Trio	Batch	n	% sired	
			2n	3n				2n	3n
1	01.02.08	24	100	0	5	27.02.08	14	0	100
	11.02.08	19	100	0		06.03.08	11	0	100
2	19.02.08	25	96	4	10.03.08	35	14	86	
	02.03.08	13	15	85	18.03.08	11	0	100	
3	06.03.08	21	0	100	24.03.08	11	0	100	
	12.03.08	6	0	100	30.03.08	15	0	100	
	18.03.08	32	72	28	09.03.08	31	29	71	
4	21.02.08	14	0	100	12.03.08	14	0	100	

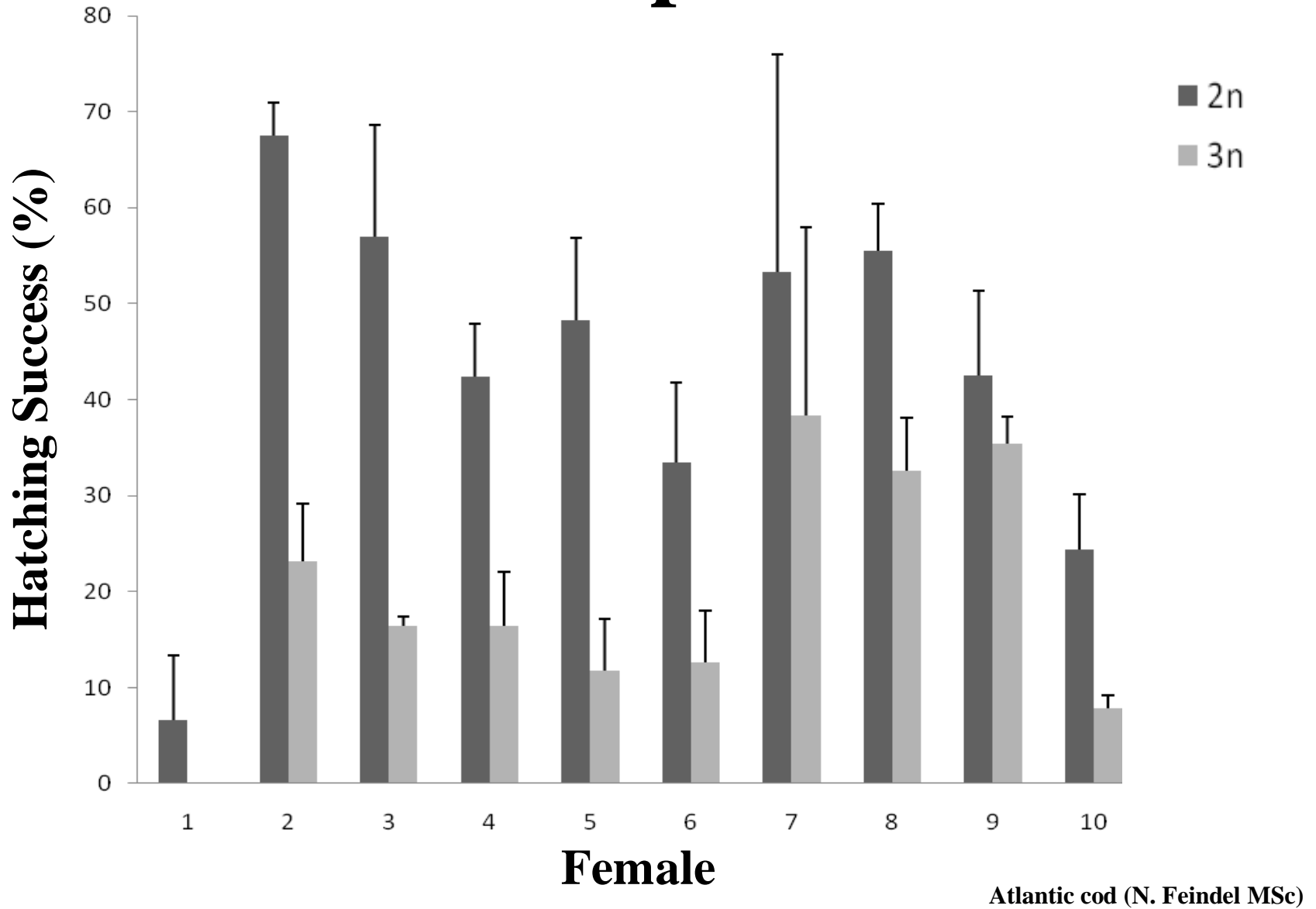
Male Triploids



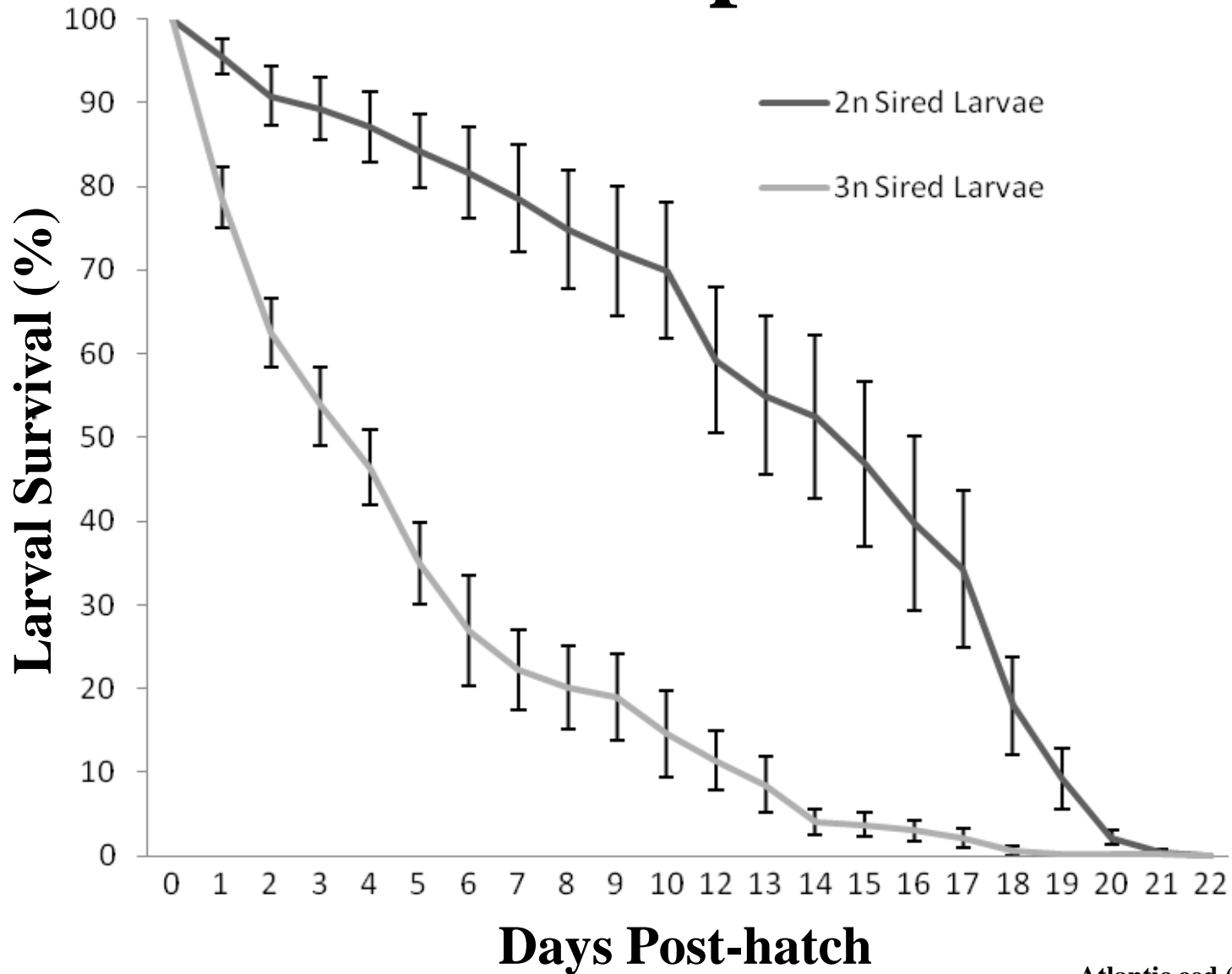
Female

Atlantic cod (N. Feindel MSc)

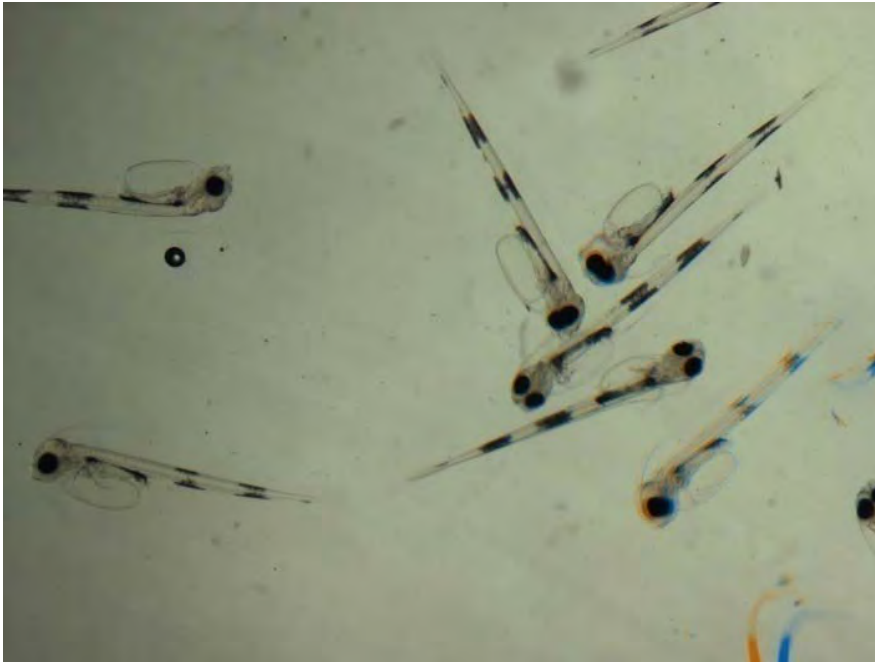
Male Triploids



Male Triploids



Male Triploids



2n-sired larvae



3n-sired larvae

Male Triploids

- **Suitability for “sterile male” approach to biocontrol will depend on ...**
 - **Effectiveness of large-scale triploidy induction**
 - **Does it have to be 100% successful?**
 - **Production of all-male populations**
 - **Techniques only developed for a handful of species**
 - **Confirmation of competitive spawning ability**
 - **Ecological effects of mass release of $3n$ males**

Thanks!

Some New Brunswick Exotics

Muskellunge



<http://pond.dnr.cornell.edu/nyfish/Esocidae/muskellunge.jpg>
http://pond.dnr.cornell.edu/nyfish/Centrarchidae/smallmouth_bass.jpg
http://chazylakekings.files.wordpress.com/2008/02/rainbow_trout.jpg

Smallmouth bass



Rainbow trout

