UNIVERSITY OF Southampton

Group Design Project

A Brazilian Adventure

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21^{st} January 2016

OURO BRANCO
Minas Gerais


FORTLEV

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Investigating the impacts of rapid decompression on the physiology of fishes

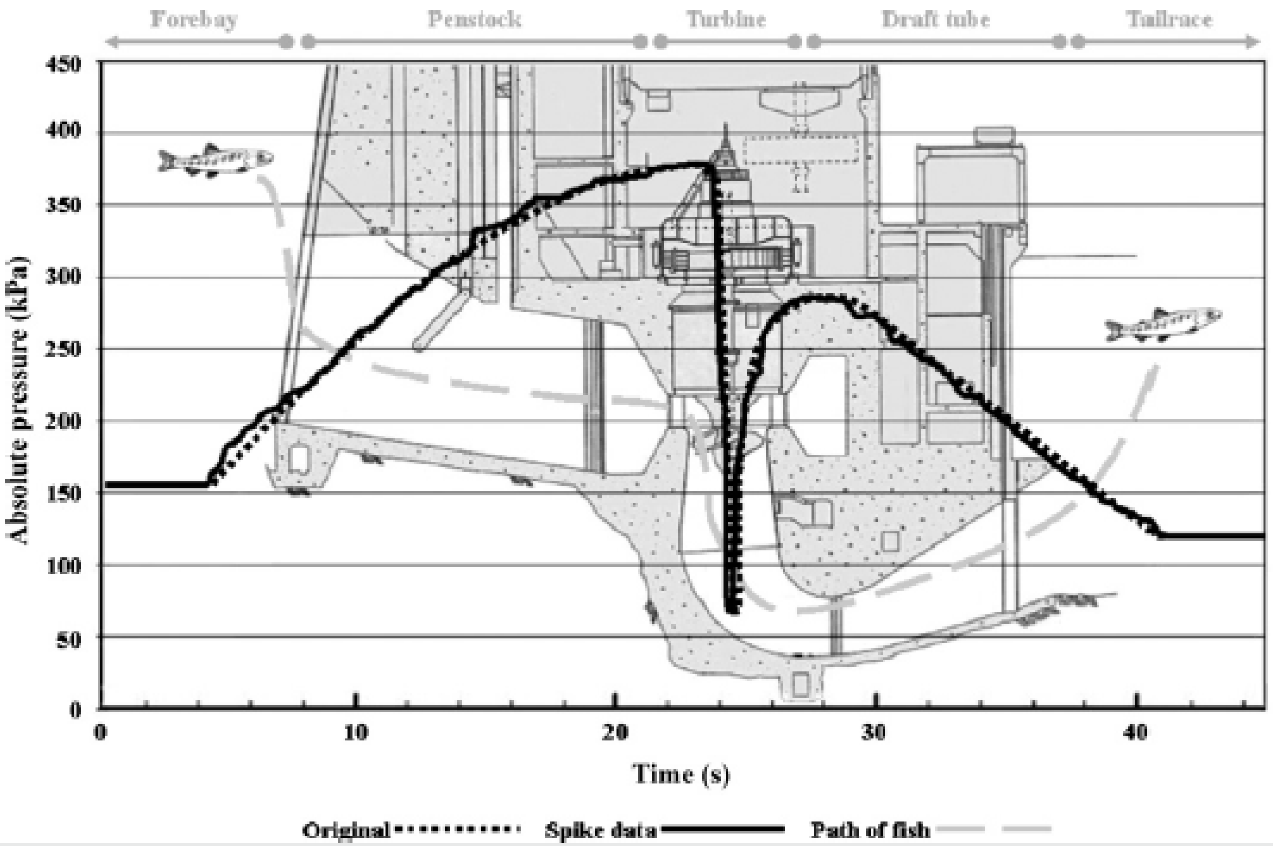
University of Southampton

Background

- Human development of hydropower is a major threat to freshwater ecosystems, causing:
  - Habitat destruction;
  - Pollution ;
  - Flow modification;
  - Fish injury/ death;
  - Barriers to migration

Figure 1: Itaipu Hydropower Dam, Brazil. Source: https://journals.worldnomads.com/

(a)



(b)

Figure 2: **(a)** Simulated turbine passage. Source: Seaburg *et al.* (2010);

Fish Physiology

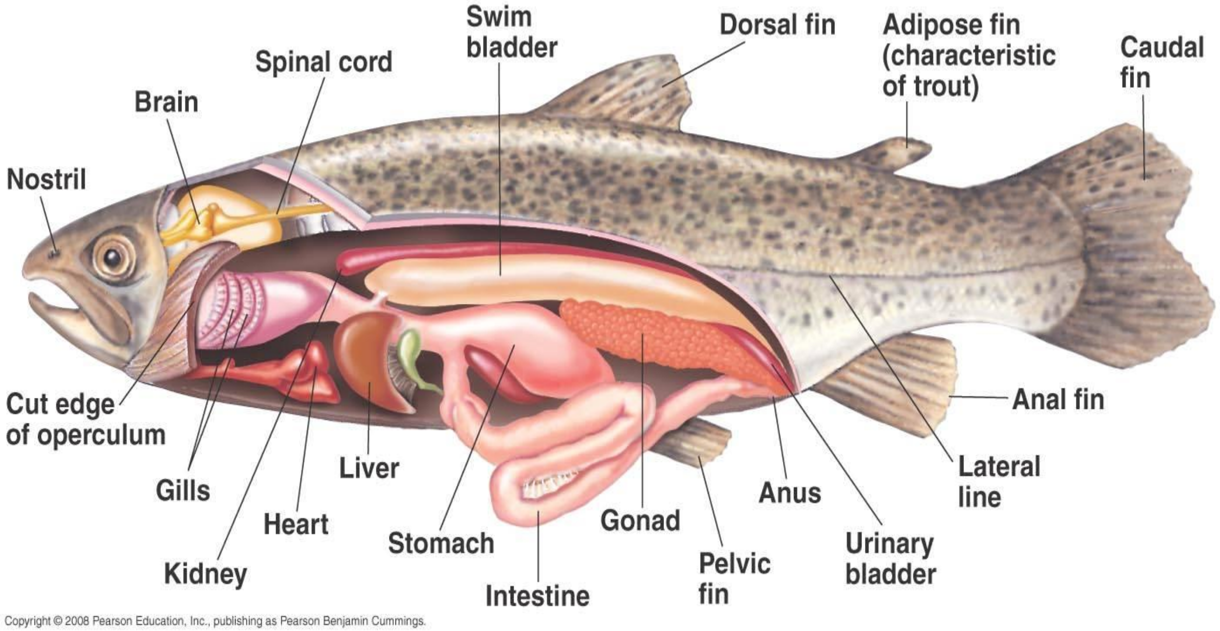


Figure 3(a): Internal morphology of a physostome fish species.
Source: https://classconnection.s3.amazonaws.com/902/flashcards/919902/jpg/34_16troutanatomy_l1342506900229.jpg

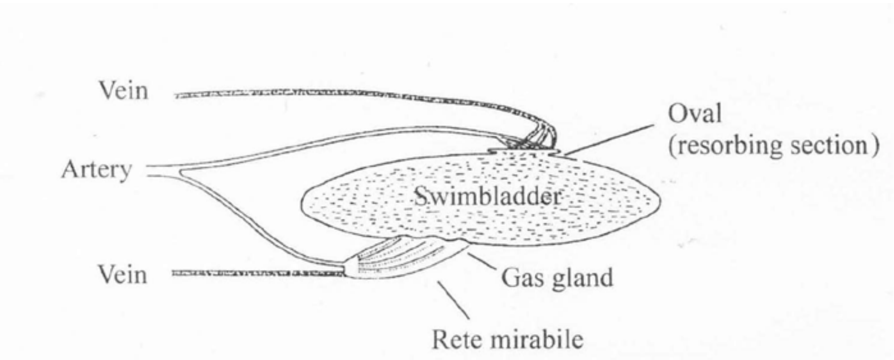
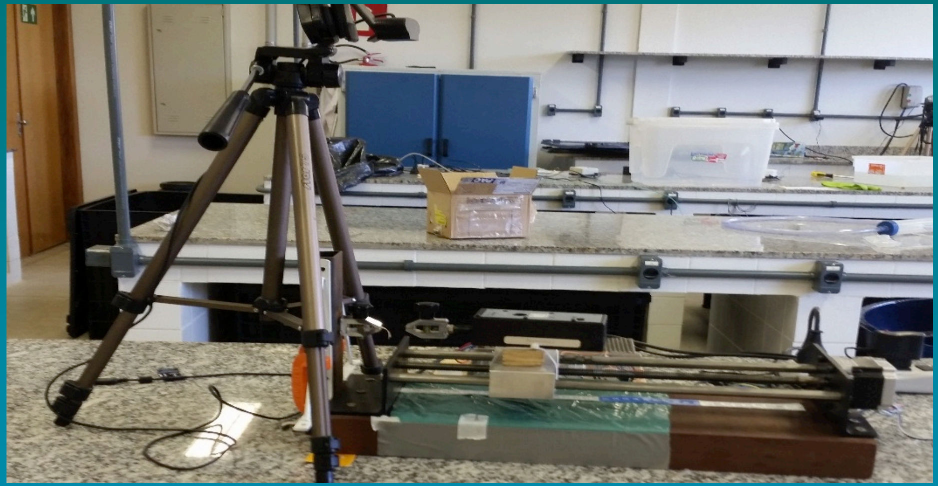


Figure 3(b): Swimbladder structure of a physoclist fish species (e.g. perch, *Perca fluviatilis*)
Source: Evans (1997)

Research In Brazil

Tensile Strength of Fish Swimbladders



Tensile Strength Trial Experiments

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- Initial experiments testing balloons:
  - Range of shapes and L:W ratios
  - Hand cut samples
  - 15mm/min extension rate

- Swim bladders – ‘feasible’ shape refinement
  - ASTM D638 Standards ratio
  - Use of fresh and preserved tissue samples

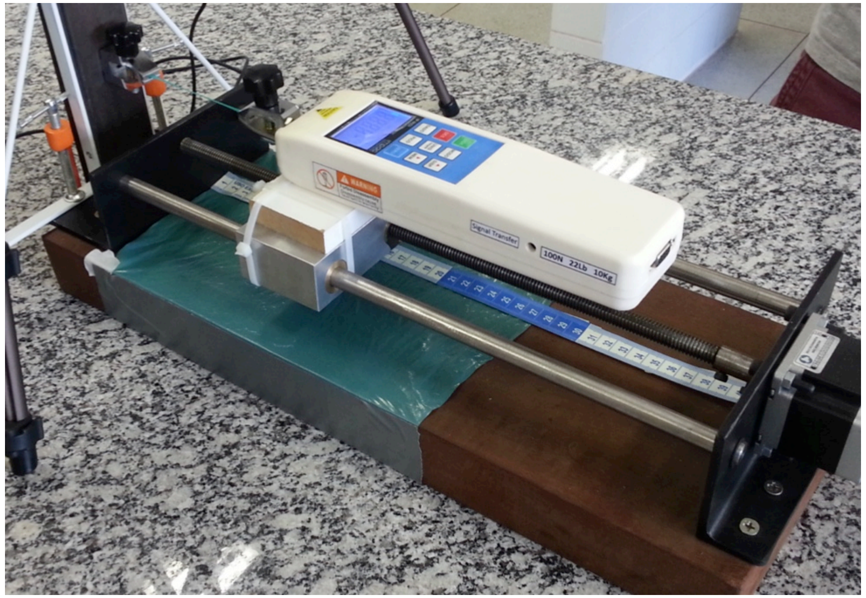
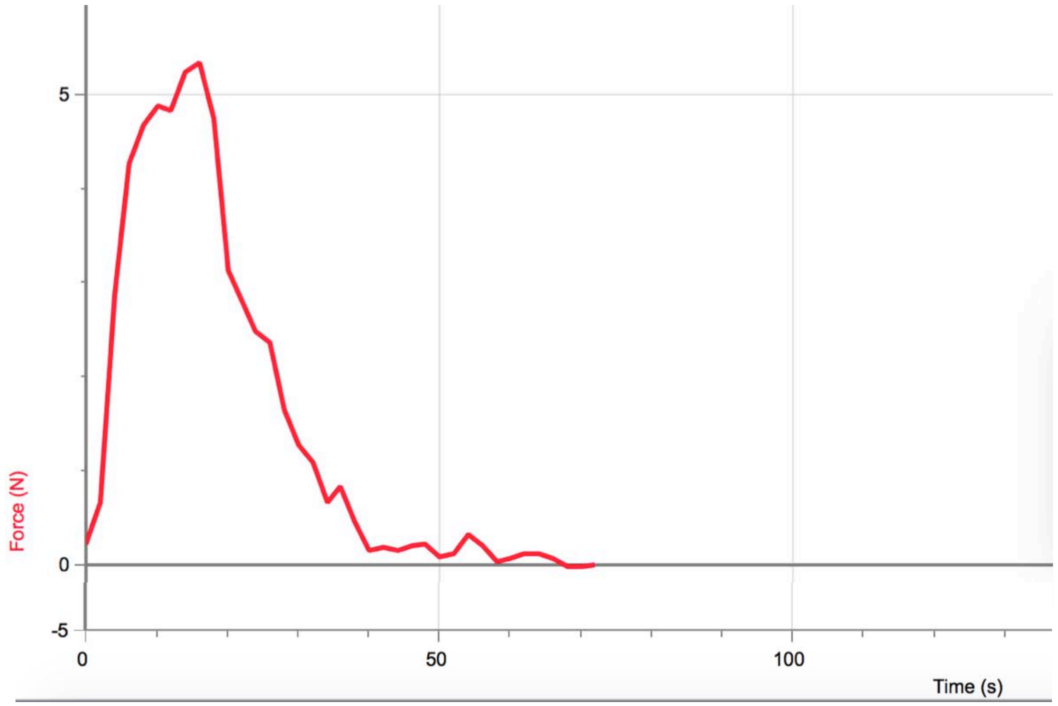


Figure 4(a): Tensile experiment run with ‘dog-bone’ balloon sample

Figure 4(b): Preparation and dimensional determination for samples

Tensile Experimentation

- Multiple sample conditions at 5mm/min extension rate
- 11mm work area for all samples [at start]
- Recording of initial tear location and length from starting point
- LoggerPro software used for recording Force (N) vs. Time

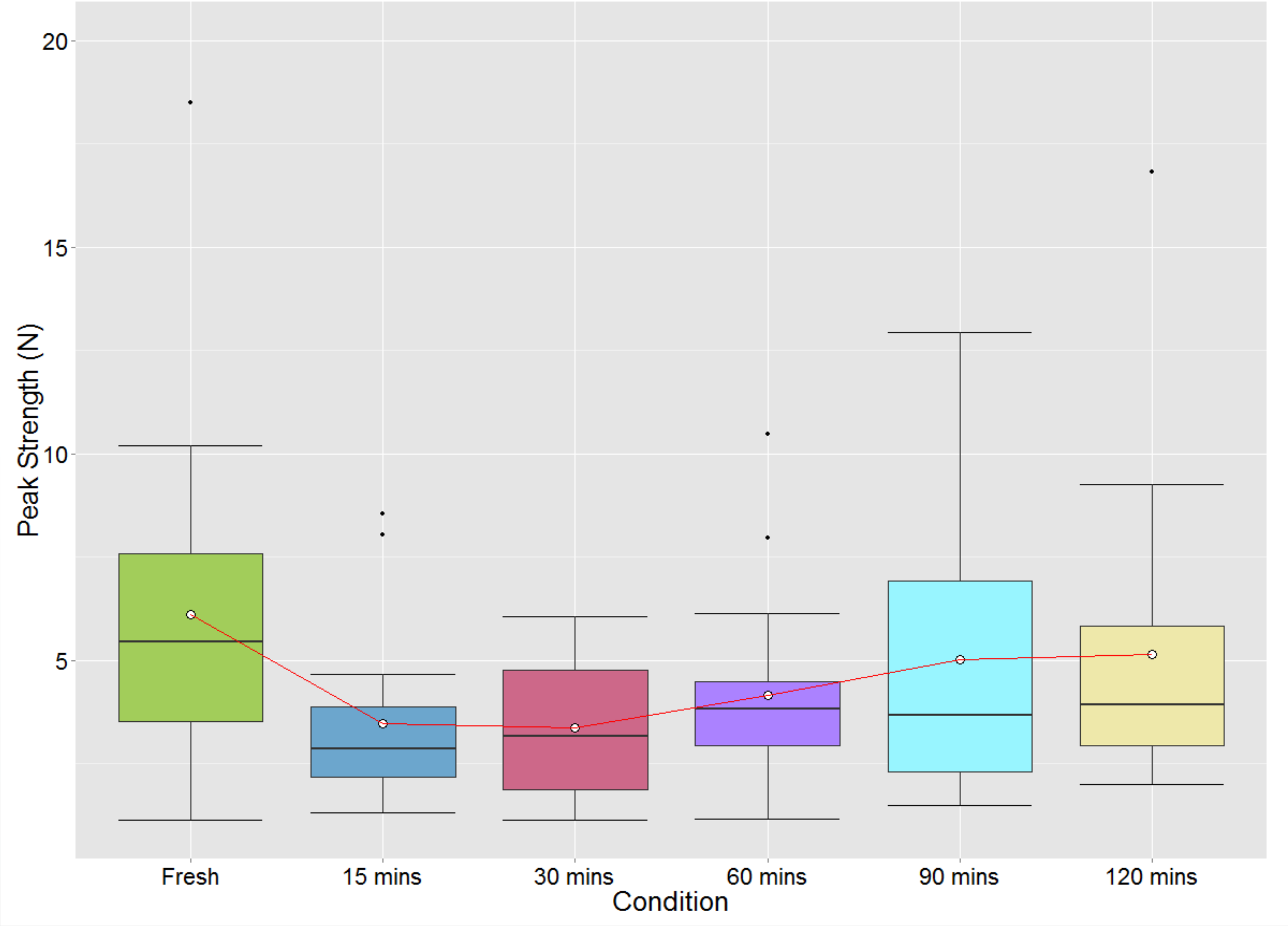


Results

Figure 5: Box plot showing the peak strength (N) required to cause structural failure in a 5 x 25 mm sample of curimba (*Prochilodus lineatus*) swimbladder.

Plot shows the variation among samples tested while fresh, or after being allowed to dry for 15, 30, 60, 90, or 120 minutes.

Kruskal-Wallis rank sum test:
$p = 0.06$.



Results Cont'd

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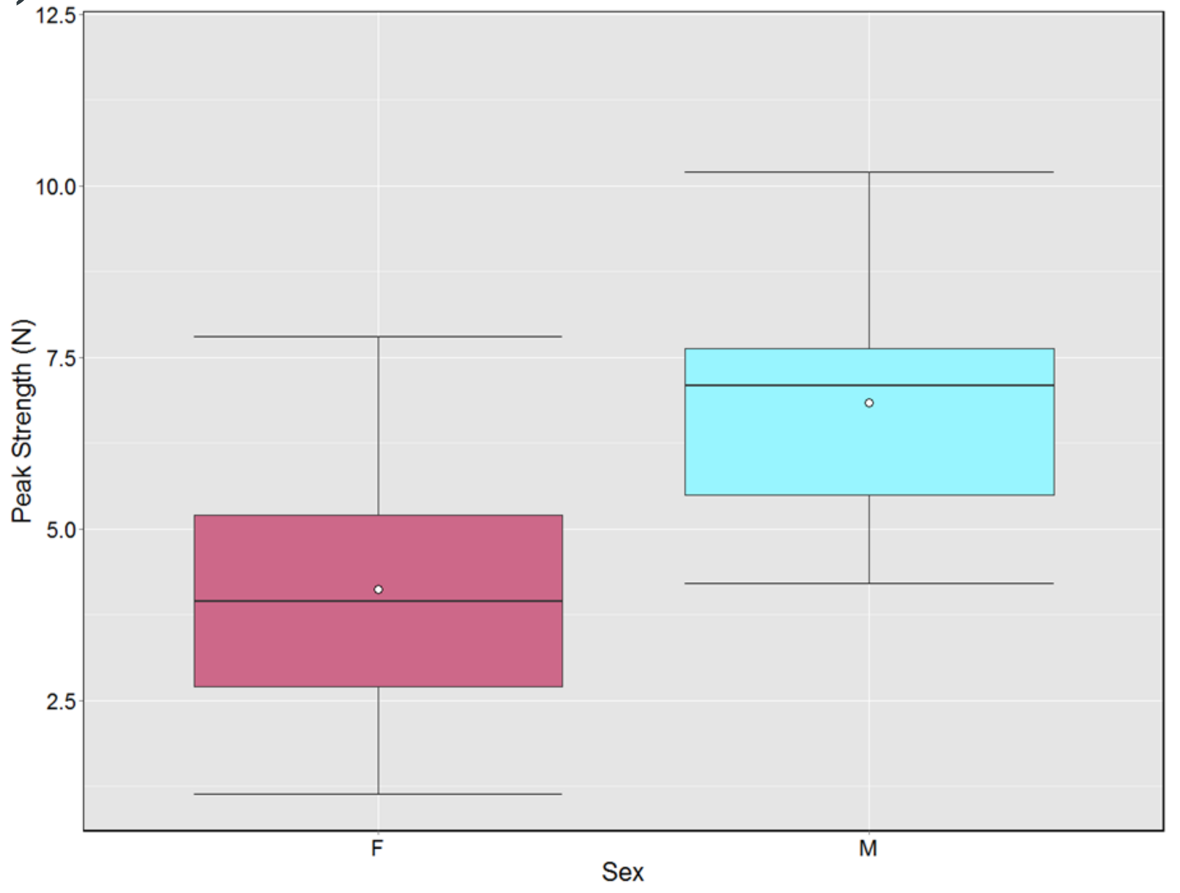
(a)



(b)

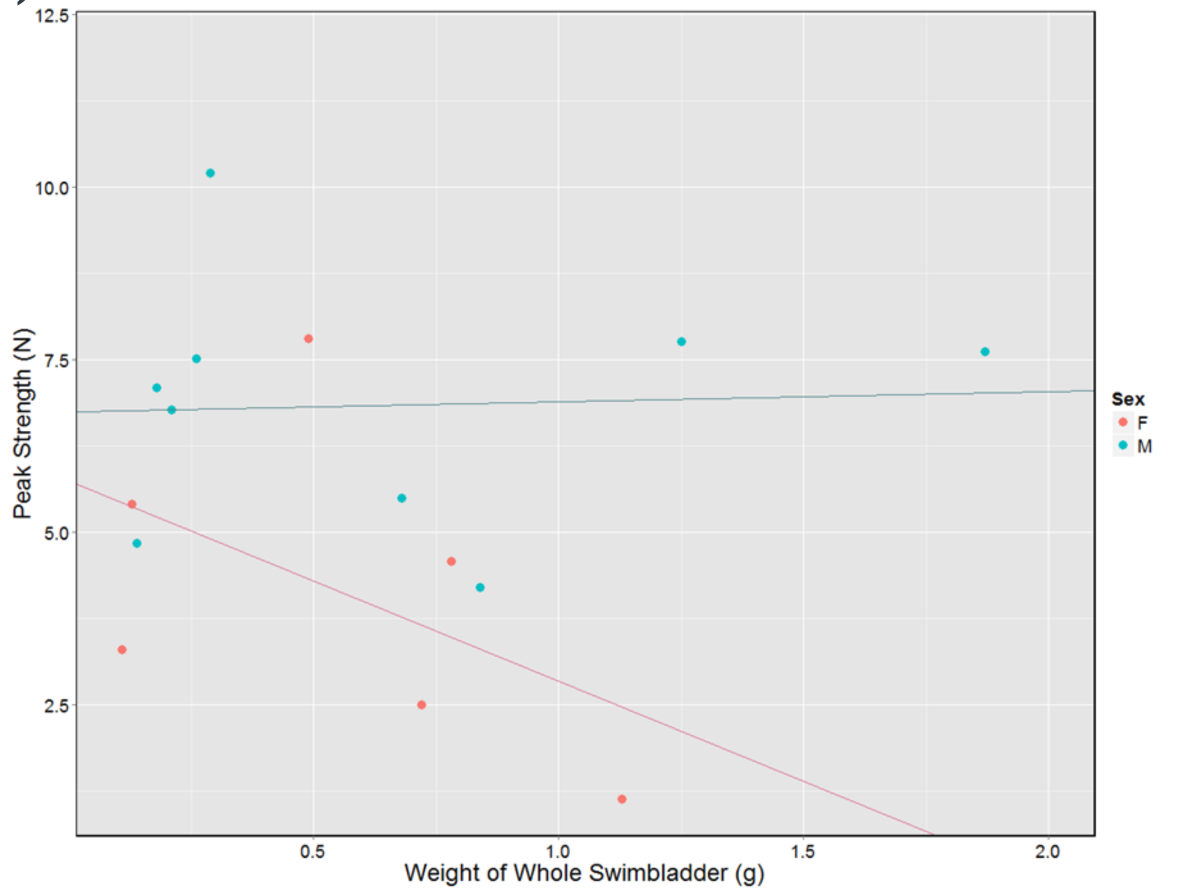


Figure 6: (a) Box blot (log-transformed one-way ANOVA ***p***-value < 0.05) and **(b)** scatter plot with trend-line (log-transformed two-way ANOVA ***p***-value < 0.05), comparing sex-based differences in peak strength required to cause structural failure in a 5 x 25 mm sample of curimba swimbladder.

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Research In Brazil

Barotrauma: Effects of rapid decompression on fish physiology

Barotrauma Methodology

- Physostomous species (curimba, *P. lineatus)*
- 10-15 fish per trial (N=50 per treatment)
- Four treatments:
  - Control (no decompression)
  - 0.5 bar
  - 1.0 bar
  - 1.5 bar (qualitative analysis)
- 4-6 hour acclimation
- Ran pressure profile

(increase->rapid decrease->return to acclimation pressure)

- Weighed (g), measured (standard & total length, mm)
- Mortality assessment and necropsy

Figure 7: Curimba gulping air into their swimbladders at the beginning of the acclimatisation period.

Experimental Pressure Profiles

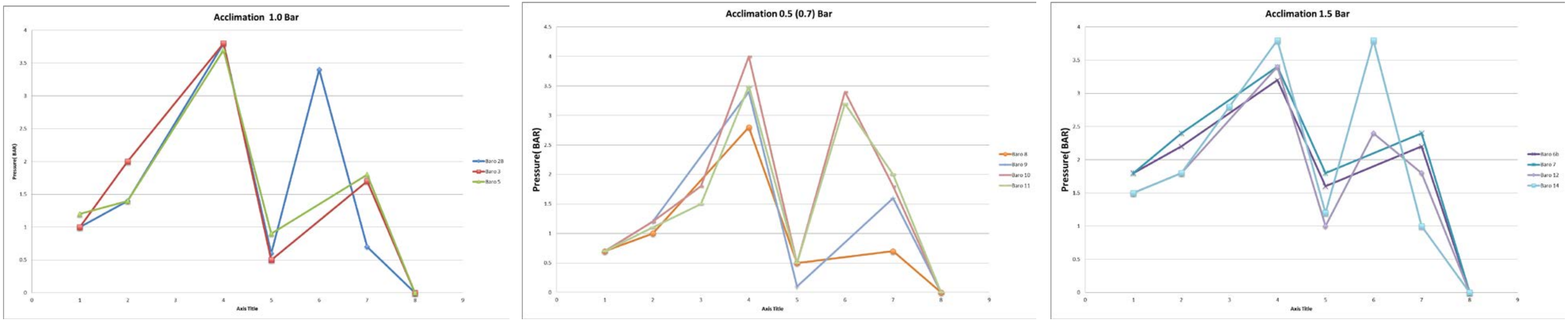


Figure 8: Profile pressure per treatment 1, 0.5 and 1.5 bar acclimation pressures from left to right

Factor Bar-atm 0.987	1 bar Acclimation			0.5 bar Acclimation				1.5 bar Acclimation			
	Baro 2B	Baro 3	Baro 5	Baro 8	Baro 9	Baro 10	Baro 11	Baro6b	Baro 7	Baro 12	Baro 14
Nadir pressure (atm)	0.6	0.5	0.9	0.5	0.1	0.5	0.5	1.6	1.8	1.0	1.2
Average Nadir Pressure (atm)	0.7			0.4				1.4			

Table 1: Nadir Pressures per Barotrauma experiment and average per treatment

Research Questions

1. Does the occurrence of each damage type differ significantly between each treatment?

2. Is there a significant difference in the total number of damage types exhibited by a single fish between treatments?

3. Do some damage types occur more frequently together than others?

4. Which independent variables (length, weight and nadir depth) produce the best fit model for each binary response variable (i.e. damage type)?

Necropsis

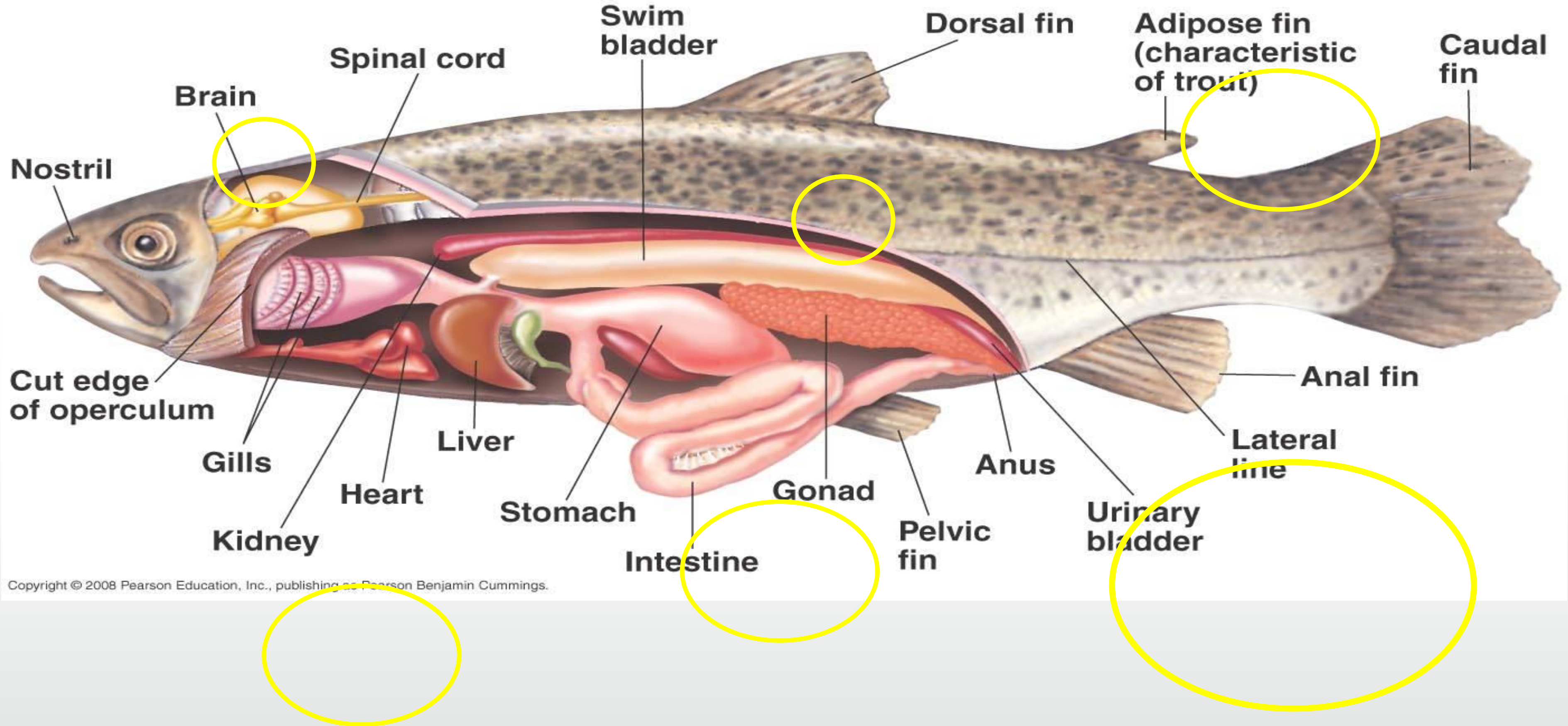
External

- Haemorrhaging
- Gill and fin emboli
- Exophthalmia
- Eversion (stomach or intestine)

Internal

- Rupture or expansion of swimbladder
- Haemorrhaging
- Emboli

Presence/absence only



Preliminary Results

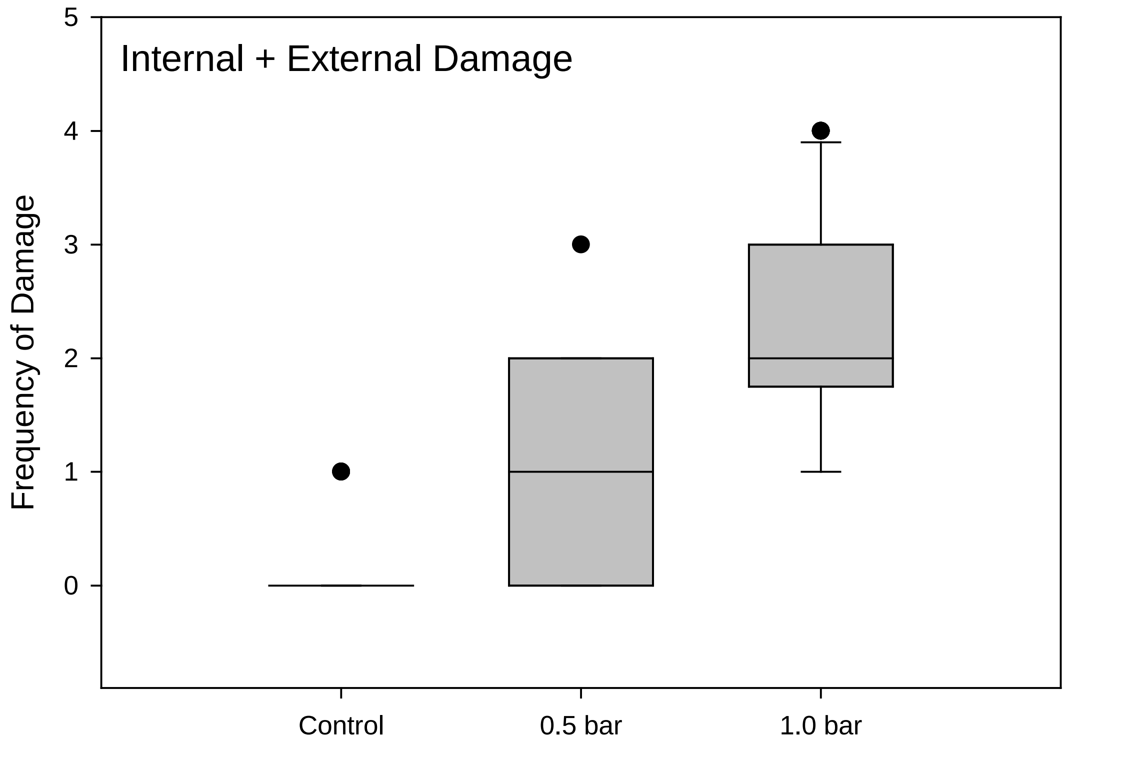


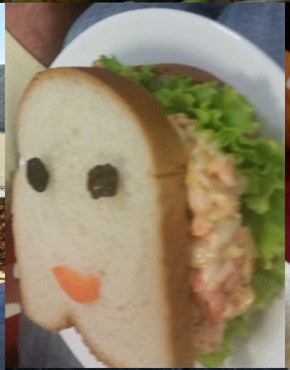
Figure 10: Box plot showing the frequency occurrence of internal and external damage for each of the three treatments.

Social Activities In Brazil


UNIDOS PELO GALO
CAM
VENDE
MRV
WATERGATE BAY


Cachaça
Ouro Preto - MG
670ml
Cachaças de Minas
CRUZEIRO
VASCO
BOTAFOGO


áustria
DUNKEL
Bäcker



International Collaboration: Back in the U.K.


Dinner at Pilgrim House Chinese Restaurant


Night out in Jesters


Cycle ride at the New Forest


Dinner at Hannah's House

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Research In the U.K.

The effect of parasite infections on the tensile strength of the European eel swimbladder

Upcoming Tensile Strength Research (U.K.)

Since the 1980’s, the disease anguillicolosis caused by the invasive nematode worm *Anguillicoloides crassus* has emerged as a new threat to the already critically endangered eel.

The worms parasitise the swimbladder and cause:

- inflammatory reactions;
- haemorrhages and fibrosis;
- blood loss, affecting the physiology and general metabolism of the eel;

References

- Brown, R.S., Colotelo, A.H., Pflugrath, B.D. Boys, C.A., Baumgartner, L.J., Deng, Z.D., Silver, L.G.M., Brauner, C.J., Mallen-Cooper, M., Phonekhampeng, O., Thorncraft, G. & Singhanouvong, D. **2014**. Understanding Barotrauma in Fish Passing Hydro Structures: A Global Strategy for Sustainable Development of Water Resources. *Fisheries*. **39 (3)**, 108-122.

- Evans, D. H. **1997**. *The physiology of fishes*, United States, CRC Press LLC.

- Lefebvre, F., Contournet, P., Crivelli, A.J. **2002.** The health state of the eel swimbladder as a measure of parasite pressure by *Anguillicola crassus*. *Parasitology*. **124 (4)**, 457-63.

- Lefebvre, F., Fazio, G., Palstra, A.P., Szkely, C., Crivelli, A.J., **2011**. An evaluation of indices of gross pathology associated with the nematode *Anguillicoloides crassus* in eels. *Journal of Fish Diseases*, **34**, 31–45.

- Palstra, A.P., Heppener, D.F.M., Van Ginneken, V.J.T., Szekely, C. & van den Thillart, G.E.E.J.M. **2007.** Swimming performance of silver eels is severely impaired by the swimbladder parasite *Aguillicola crassus*. *Journal of Experimental Marine Biology and Ecology*. **352**, 244–256.

- Stephenson, J.R., Gingerich, A.J., Brown, R.S., Pflugrath, B.D., Deng, Z., Carlson, T.J., Langeslay, M.J., Ahmann, M.L., Johnson, R.L. & Seaburg, A.G. **2010.** Assessing barotrauma in neutrally and negatively buoyant juvenile salmonids exposed to simulated hydro-turbine passage using a mobile aquatic barotrauma laboratory. *Fisheries Research*. **106**, 271-278.

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THANK YOU!