

# Effect of sex ratio on growth and survival in *Octopus vulgaris* (Cuvier, 1797) reared in floating cages.

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## INTRODUCTION

*Octopus vulgaris* is a potential candidate to diversify European aquaculture for its rapid growth and high market prices (Vaz Pires et al. 2004). One factor affecting industrial development of octopus culture is sexual maturation under rearing conditions. Octopus females can lose up to 30-60% of their initial body weight during egg-laying (Iglesias et al., 2000) and die after the paralarvae hatch (Guerra,

1992), while a correlation between males death and spermatocyst depletion has been recently reported by Estefanell et al. (2010b). The present experiment discusses the effect of three different sex ratios on growth, sexual maturation and survival in *O. vulgaris*.

## MATERIAL AND METHODS

- Floating cages: 2.6 m<sup>3</sup>, 42 shelters (Fig. 1, Fig. 2)
- Male:female sex ratios: 1:1, 1:0 and 4:1
- PIT tagging (Estefanell et al., 2010a)
- Rearing time: 60 days; Initial density: 10 kg/m<sup>3</sup>
- Diet: "discarded" bogue *Boops boops* from fish farms, *ad libitum* (Fig. 3)
- 20.2±0.4°C and 6.2±0.4 ppm
- Biological parameters: Absolute Growth Rate (AGR), Feed Conversion Rate (FCR) and Biomass Increment (BI)

- Macroscopic sexual maturity stages: Immature, Maturing, Mature and Post-reproductive (Dia and Goutschine, 1990)
- Macronutrient composition (AOAC, 1997), fatty acids (Christie, 1982; Izquierdo et al., 1990): diet, muscle-digestive gland from wild and reared octopuses
- Statistical analysis: General lineal model
  - Biological parameters (fixed factors: sex ratio, sex; covariable: initial weight)
  - Macronutrient composition (fixed factor: treatment)



**Fig. 1:** Floating cages (0.7 x 1.4 x 2.7 m, 2.6 m<sup>3</sup>) provided with 42 "T" shaped PVC tubes as shelters



**Fig. 2:** *O. vulgaris* inside a shelter in floating cages



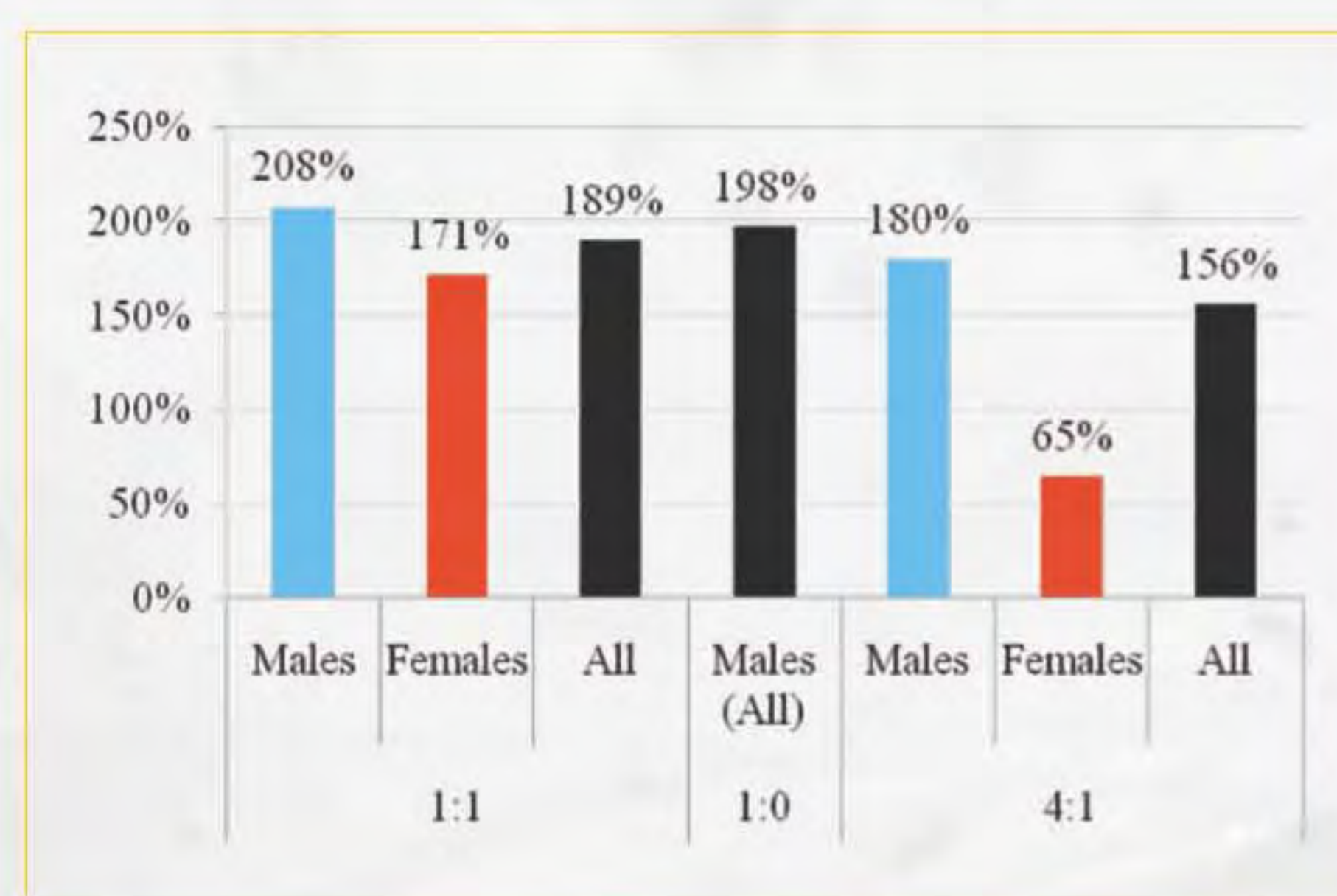
**Fig. 3:** "Discarded" bogue *Boops boops* from fish farms

## RESULTS AND DISCUSSION

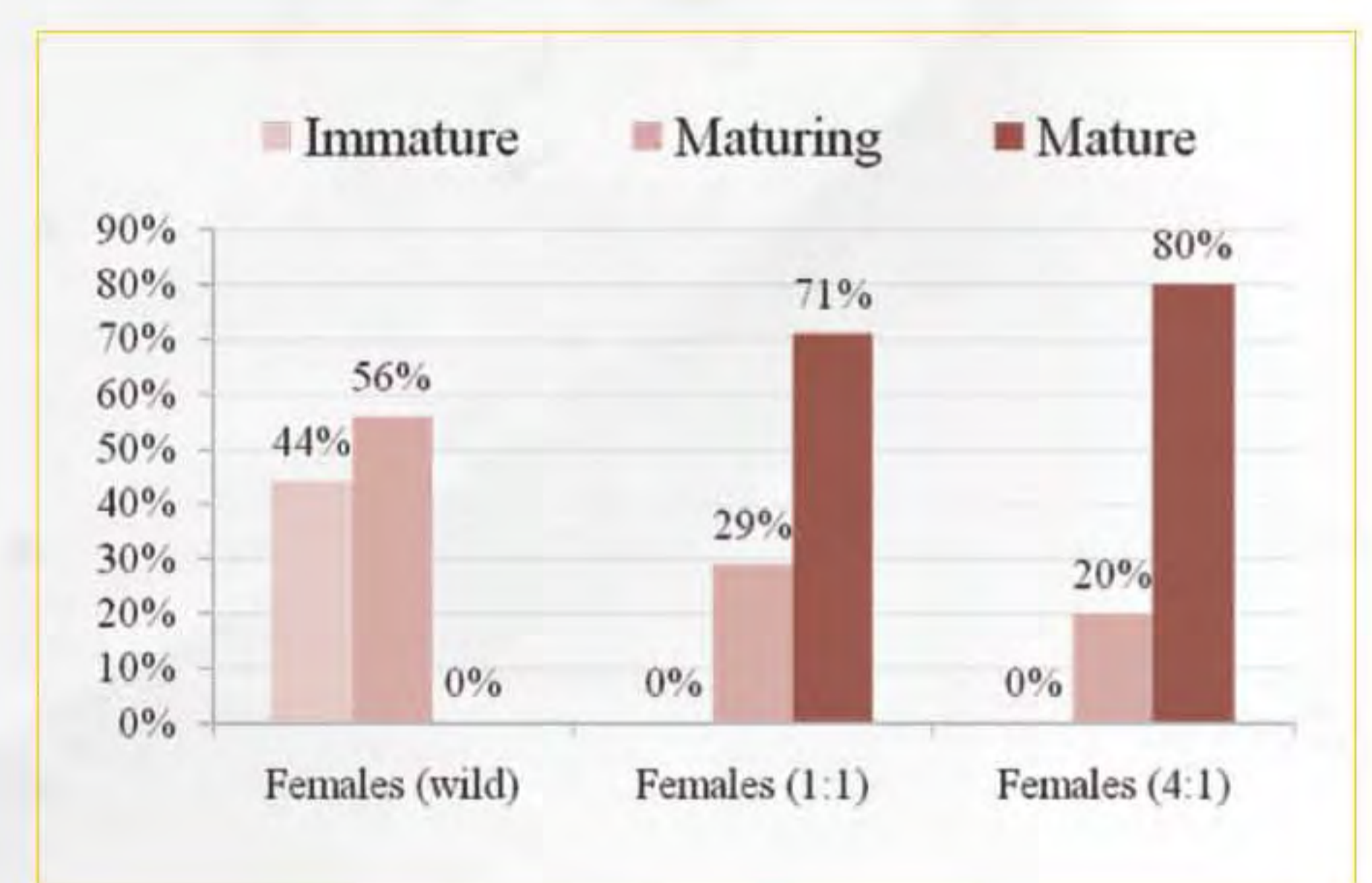
Growth rates observed in the present experiment were similar to those reported by mixed diets containing crustaceans, which underlines the potential of discarded bogue as a monodiet for *O. vulgaris* (Socorro et al., 2005; Rodríguez et al., 2006; García García et al., 2009). Males and sex ratios 1:1 and 1:0 showed higher growth rate, final weight and biomass increment than females and sex ratio 4:1 respectively (Table I, Fig. 4). Increasing competition among males to mate with the scarce females in sex ratio 4:1 also produced higher mortality and food conversion rate than in 1:1 and 1:0 treatments (Table I).

High lipid discarded bogue (44% dry weight) reflected in digestive gland in reared octopuses, while macronutrient composition in muscle was similar to wild specimens.

Regarding sexual maturity, males were constantly mature regardless of treatment. On the contrary, females showed a different pattern (Fig. 5), with increasing number of maturing-mature in reared specimens. No octopus in post-reproductive stage was found, which could explain high survival observed in the present experiment (Estefanell et al., 2010b).



**Fig. 4:** Biomass increment according to "sex" and "sex ratio" along the experimental period



**Fig. 5:** Macroscopic sexual maturity stages in females under different conditions of sex ratio

**Table 1:** Initial rearing conditions and biological parameters.

Sex ratio	1:1			1:0	4:1			p<0.05
	Male	Female	All	Male (All)	Male	Female	All	
Ni	15	15	30	30	24	6	30	
Wi (g.)	872±97	875±101	873±96	862±115	844±92	880±95	854±91	-
Wf (g.)	2681±562	2543±487	2615±506	2652±599	2576±517	1742±647	2482±551	SR*-S
AGR (g./day)	29.6±9.2	27.7±7.5	29.3±8.2	30.0±9.2	26.6±9.2	16.8±8.4	25.8±8.3	SR*-S
Survival (%)	100	93.3	96.7	96.7	91.7	83.3	90.0	
FCR	-	-	2.6	2.5	-	-	3.3	

\*SR" and "S" indicate significant difference according to Sex Ratio and Sex respectively (p<0.05)  
\* Final weight and AGR in sex ratio 1:1 and 1:0 are higher than in 4:1.

**Table 2:** Proximal composition in muscle and digestive gland from wild and reared octopuses (% dry substance ± S. D.) (p<0.05).

Treatment	Wild (initial)	1:1	1:0	4:1
Lipids (%)	21.5±4.8a	53.2±3.6b	51.1±4.1b	47.6±2.5b
Proteins (%)	67.6±7.2b	39.1±2.3a	39.6±4.8a	42.7±2.7a
Moisture (%)	70.7±4.7b	55.9±2.8a	54.1±2.1a	60.9±0.7a
Ash (%)	1.8±0.1b	1.3±0.1a	1.2±0.1a	1.3±0.0a
Lipids (%)	5.6±0.2	5.4±0.6	5.6±0.1	5.0±0.3
Proteins (%)	78.7±3.7	83.8±2.0	82.9±1.8	81.4±1.1
Moisture (%)	82.5±0.5c	80.0±0.4a	81.6±0.2bc	81.3±0.3b
Ash (%)	1.8±0.1b	1.8±0.1b	1.5±0.0a	1.7±0.1b

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## CONCLUSION

- Discarded bogue from fish farms could be used as alternative diet for the final stage of *O. vulgaris* on-growing.
- Male segregation would maximize biomass increment.
- Under the conditions described, sex ratios close to 1:1 produced higher biomass increment than 4:1