Physiological and enzymatic respiration in *Aurelia aurita* and *Pelagia noctiluca*

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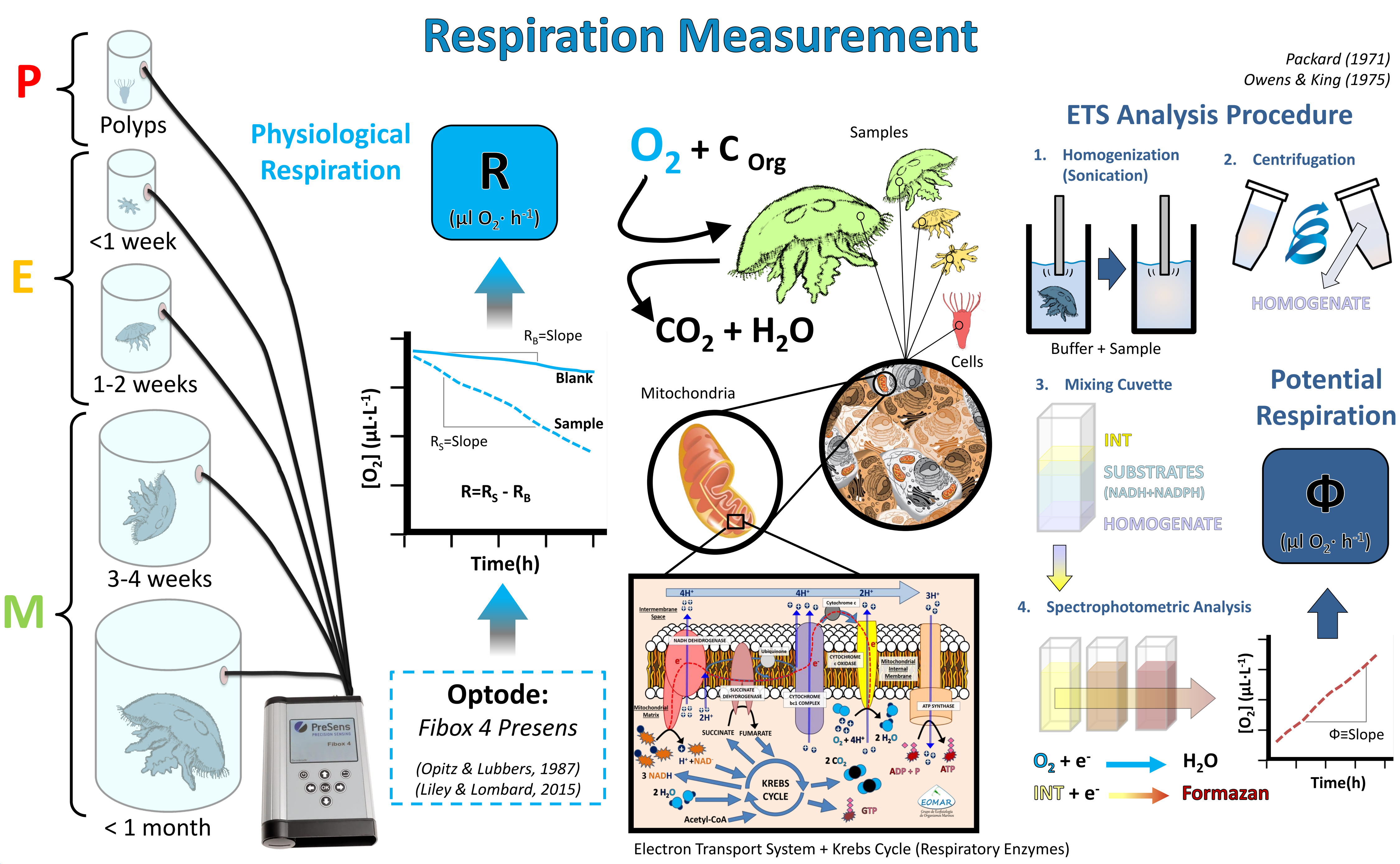
6TH INTERNATIONAL JELLYFISH BLOOMS SYMPOSIUM

INTRODUCTION

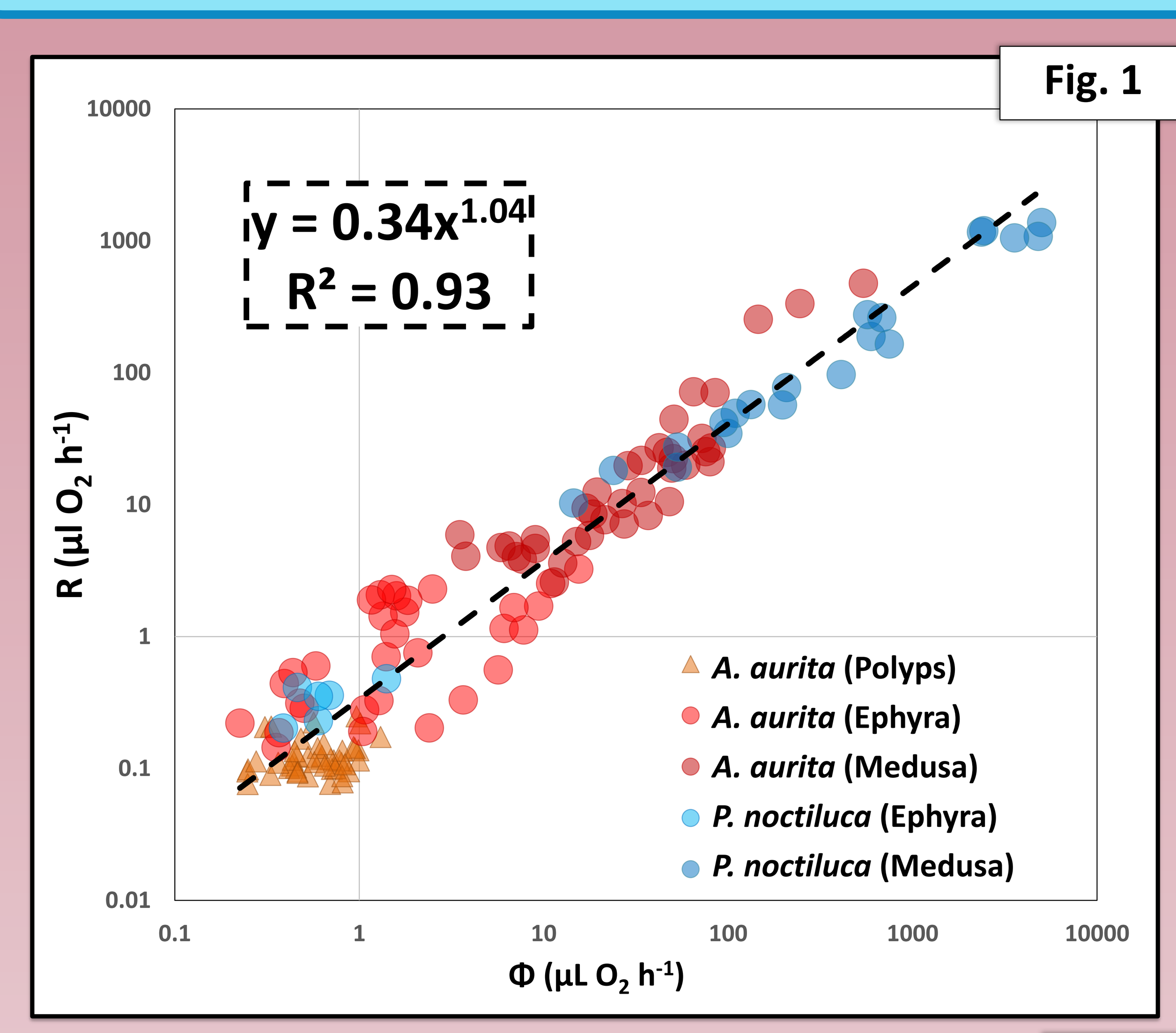
Respiration rate is traditionally determined using incubations while monitoring oxygen consumption (R). However, jellyfish may be the hardest members of zooplankton to study using incubations due to their fragility and their sizes. Here we test the use of an alternative, enzyme analysis of the electron transport system; which ultimately controls oxygen reduction at a cellular level during respiration.

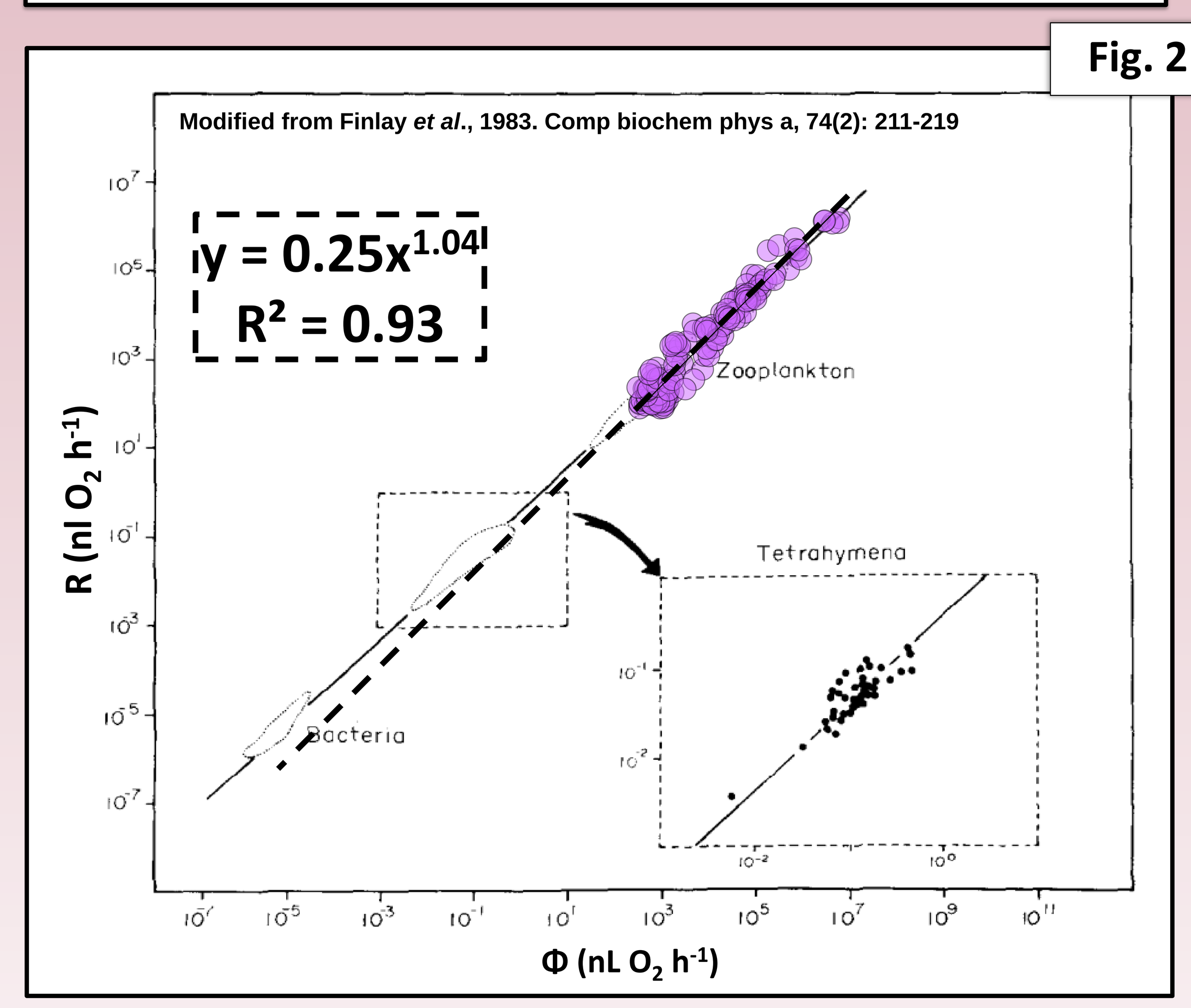
This enzyme analysis provides a measurement of the maximum respiratory capacity of the organism (Φ). This enzyme technique may help avoid logistical issues of incubating jellyfish, they could even be applied to dead or damage organisms during sampling or fragments unfit for incubation. We tested the application of these techniques on life stages of *Aurelia aurita* and *Pelagia noctiluca* from the Loro Parque Foundation's aquariums.

MATERIALS & METHODS



RESULTS & DISCUSSION: R & Φ Analysis



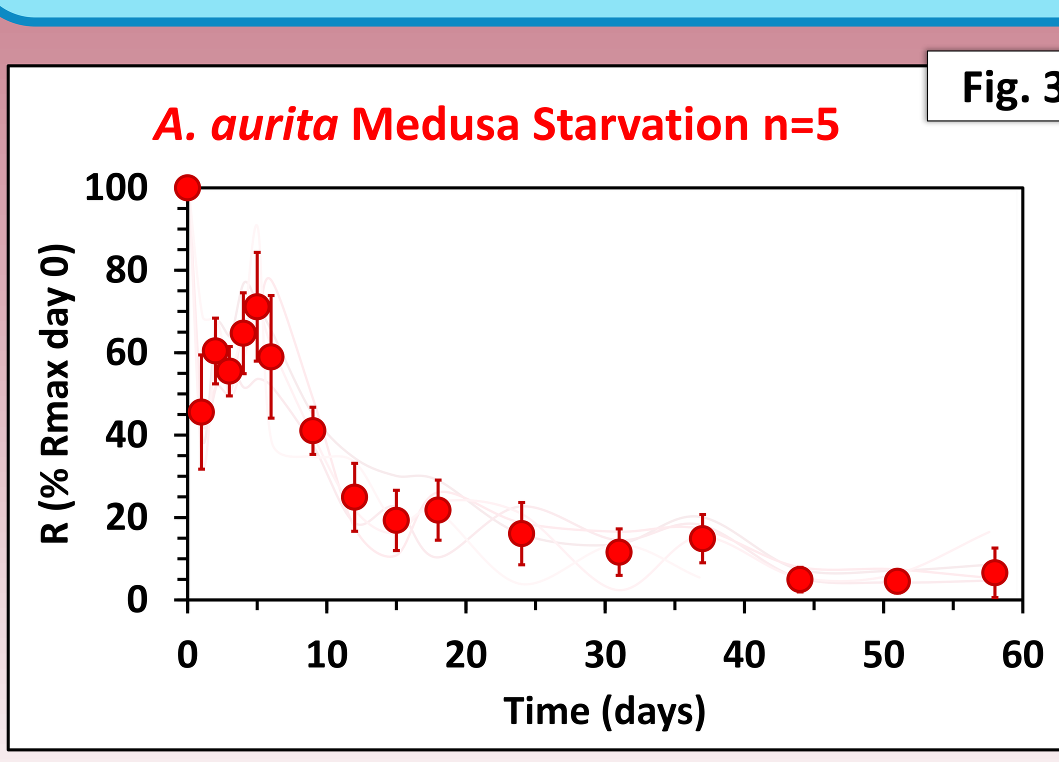


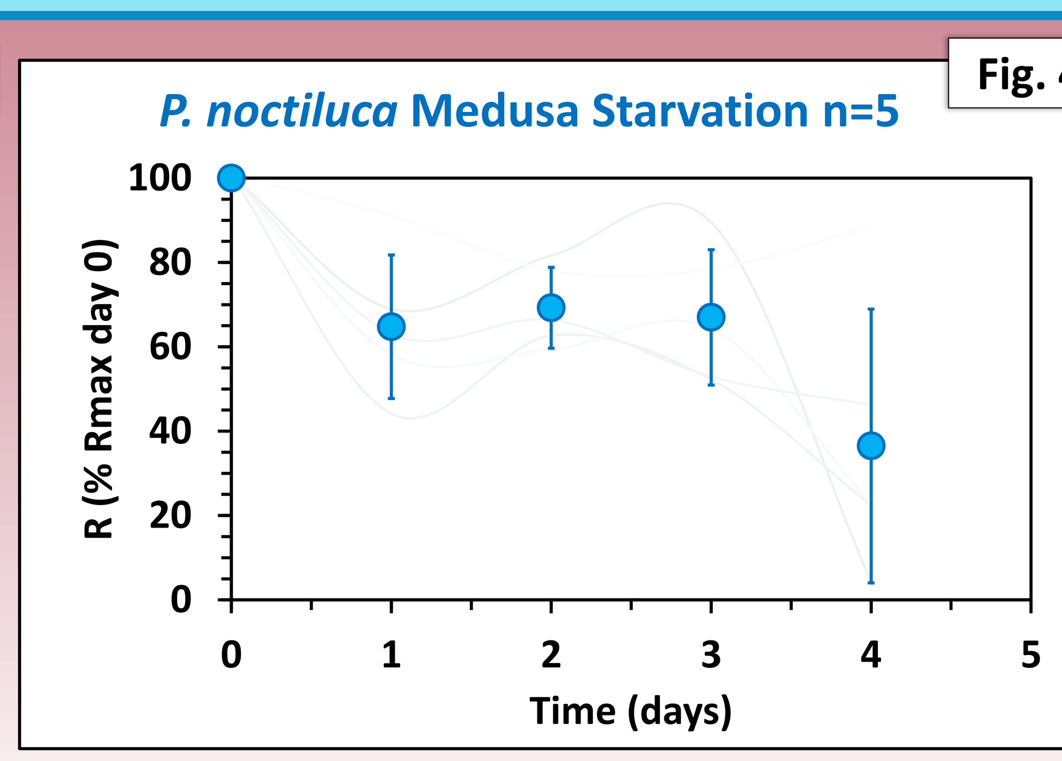
In Fig. 1 the resulting potential equation of R and Φ has a good coefficient of determination for the wide size range from polyp of a few milligrams to jellyfish sample of up to 70g of wet mass. In general Φ is greater than R which is expected since it is the biochemistry controlling the physiology. The resulting potential equation, which appears to work, for both species may be useful to estimate R from Φ results and; it can also be modelled using further chemical analysis of the enzymatic substrate concentration in the sample as shown in Osma et al. 2016.

Even though they follow the potential equation, polyps showed a slight difference with respect to other life stages of similar mass. This could show changes in the metabolism as *A. aurita* transitions from sessile to planktonic. The polyps show a high control of their metabolism their sessile lifestyle may have a slightly different relation between R and Φ than the other pulsating life stages.

The results for jellyfish R and Φ are very similar to results for zooplankton studied by Finlay et al. 1983 (Fig. 2) and their distribution seem to agree with results that cover 10 orders of magnitude. This shows the strong relation between enzymes and physiology across multiple life forms and sizes.

RESULTS & DISCUSSION: Effect of Starvation & R/Φ





In general, respiratory metabolism behaved similarly the first days with a strong decrease with respect day 0, then stabilizing to finally drop again. However, *A. aurita* survived without food for 58d while *P. noctiluca* were in really bad shape after 4d. *A. aurita*'s slight shrinking could also explain the decrease in respiratory metabolism. Regardless, *A. aurita* shows an evolutionary advantage to survive low food conditions.

Species	Life stage	Conditions	n	R/Φ
A. aurita	Polyp	24h Unfed	45	0.23 ± 0.12
		33d Unfed	6	0.26 ± 0.17
	Ephyra	<2h Unfed	31	0.65 ± 0.48
	Medusa	<2h Unfed	38	0.61 ± 0.38
		58d Unfed	5	0.36 ± 0.25
P. noctiluca	Ephyra	24h Unfed	6	0.54 ± 0.20
	Medusa	24h Unfed	20	0.41 ± 0.15
		4d Unfed	5	0.36 ± 0.33

The R/Φ shows what fraction is being used of the respiratory maximum. R adapts to the environmental conditions. Φ is more constitutive and starts to change after prolonged effects. (Table) In average, the closer the respiratory measurement to the feeding moment the closer R is to Φ. Enzymatic analysis may allow to study of regulation of physiology knowing its potential and to observe if conditions cause alterations at the biochemical level.

There are few studies of polyp respiration. The polyps present an exceptionally low R/Φ compared to other life stages and is fairly constant from 24h to 33d. Similarly Shick 1975 and Ikeda et al. 2017 described the respiration of recently fed polyps as 4 times as high as starved ones and reached basal rates after 2 days. Polyps have probably a high control over their metabolism which allows there survival low food conditions.

CONCLUSIONS

- Enzyme analysis of the ETS may provide a useful option to study respiration especially for the fragile cumbersome jellyfish. It appears to hold a relation with R over 10 orders of magnitude.
- R/Φ improves our understanding of the impact of the environment on respiratory metabolism.
- *A. aurita* survives starvation longer than *P. noctiluca*. R/Φ shows that it may be due to changes in size and respiratory biochemistry.
- The relationship between R and Φ and R/Φ in polyp's is different from the other life stages showing inkling of the respiratory control that may allow polyps to survive hostile conditions.

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REFERENCES:

Finlay et al., 1983. Comp biochem phys a, 74(2): 211-219
Ikeda et al. 2017. MAR ECOL PROG SER. 568:87-100.
Liley & Lombard (2015). J EXP MAR BIOL ECOL. 471: 226-231.
Opitz & Lubbers (1987). U.S. Patent Nº 4,643,877.
Osma et al. (2016). MAR BIOL 163(7): 146
Owens & King (1975). MAR BIOL. 30:27-36.
Packard (1971). J MAR RES. 29(3): 234-244.
Shick (1975). MAR BIOL LAB. 148: 117-140.