# JELLYFISH IN THE NORTHERN ADRIATIC: A 200 YEAR STORY

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## Abstract

A 200 year time series of scyphomedusae occurrence in the northern Adriatic was analysed using the wavelet technique to assess the major periodicities. The analysis of the historical time series revealed that four scyphomedusae, *A. aurita*, *C. hysoscella*, *C. tuberculata* and *R. pulmo*, have been present regularly in the northern Adriatic over the last 200 years, with two major periods of jellyfish proliferations. The first period in the years around 1910 was characterised by common significant periodicity of 8 to 12 years. In the second period, from the late 1970's onward, two common periodicities were revealed, those shorter than 8 years and a longer one of 20 - 30 years.

*Keywords: Adriatic Sea, Blooms, Cnidaria, Medusae, Time Series*

### Introduction

In recent years connections between jellyfish blooms and variations in climate have been emphasised ([1], [2]). Very few long-term time series of gelatinous plankton blooms exist due to fragility of these organisms and sampling difficulties. Although large scyphomedusae are generally more rigid than other gelatinous plankton, sampling using conventional oceanographic gears is complicated due to their size [3]. Therefore, most of the data on jellyfish populations are descriptive rather than quantitative, and the problem of choosing a suitable method often arises when analysing time series. Moreover, non-linear, aperiodic and non-stationary processes are very common in nature [4]. This constitutes a limitation when applying most of the analytical techniques for the time series analysis used for detecting periodicity. A powerful tool for analysing such data is wavelet transformation, a time scale and/or time frequency decomposition of the signal useful in analysing the non-stationary, aperiodic and noisy signals that are very often found in ecological time series [5].

### Materials and Methods

A data set of the presence/absence of scyphomedusae in the northern Adriatic during the last 200 years was constructed on the basis of 21 papers describing plankton in the northern Adriatic, published over the time span from 1875 till today, in addition to our own (MBS Piran) observations. The constructed time series has been analysed using continuous wavelet analysis [5].

### Results

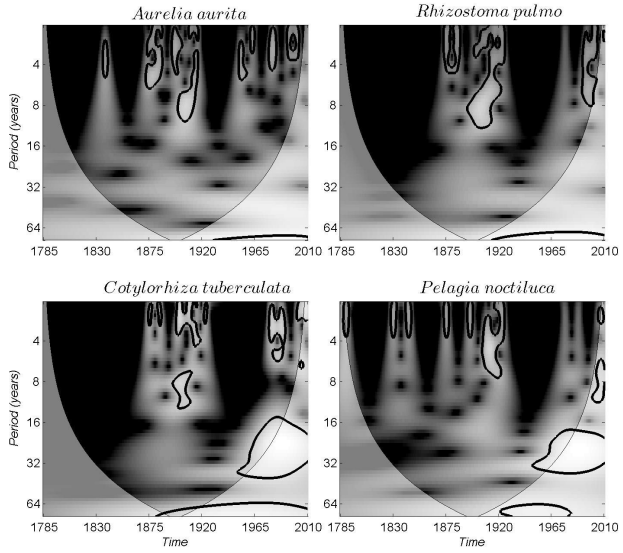


Fig. 1. Wavelet spectra of the four scyphomedusae time series in the northern Adriatic.

Analysis has shown that the five scyphomedusae (*Aurelia aurita* (Linnaeus, 1758), *Chrysaora hysoscella* (Linnaeus, 1766), *Cotylorhiza tuberculata* (Macri, 1778), *Pelagia noctiluca* (Forskål, 1775), and *Rhizostoma pulmo* (Macri, 1778)) have been present regularly in the northern Adriatic over the last 200 years. The most frequently reported scyphomedusae in the northern Adriatic over the whole period of study were *A. aurita* and *R. pulmo*. In the present decade, notably from 2004 onwards, *Aurelia* has been present every year in large numbers from the beginning of February to the end of June, while *Rhizostoma* was the most abundant during 2003 and 2006, after which its numbers decreased significantly. In contrast, *Chrysaora* and *Cotylorhiza* were observed regularly during the last decade but never in high numbers, as blooms were rarely noted. The presence of the latter was regularly reported from the northern Adriatic, mostly from August to September. The presence of holoplanktonic *P. noctiluca* in the northern Adriatic was first recorded in 1790. Between 1976 and 1986 *Pelagia* formed intensive blooms. The population collapsed after spring of 1986 and only appeared again at the beginning of 2004 after an 18 year absence. During the recent bloom, *Pelagia* was most abundant in 2006, more precisely from November 2005 to March 2007.

Although the life cycle, population dynamics and the ability to adapt to different environments differ between the species, the wavelet spectra showed a similar pattern for four meroplanktonic scyphomedusae (*A. aurita, C. hysoscella, C. tuberculata* and *R. pulmo)* with two major periods of jellyfish proliferation in the northern Adriatic during the 200 years. The first period began around 1875 and lasted until 1922, while the second has proceed from the late 1970's onward, following nearly 40 years of almost no jellyfish observations. During the first period of jellyfish proliferation the common periodicity of 8 to 12 years was detected. In contrast, the second period has been characterised by a shorter common periodicity of < 8 years and an additional longer term periodicity of 20-40 years. The latter is significant only in the case of *C. tuberculata* and *P. noctiluca* wavelet spectra. The first period of *Pelagia* proliferations is characterised by a significant periodicity of 8 years and the second period with a significant periodicity between 20 to 30 years.

### Conclusions

The analysis of the historical time series revealed that five scyphomedusae, *A. aurita*, *C. hysoscella*, *C. tuberculata*, *P. noctiluca* and *R. pulmo*, have been present regularly in the northern Adriatic over the last 200 years, with two major periods of jellyfish proliferations. The first period is characterised by common significant periodicity of 8 to 12 years and the second period with two common periodicities, one shorter than 8 years and a longer one between 20 and 30 years.

## References

1 - Lynam, C. P., S. J. Hay and A. S. Brierley., 2004. Interannual variability in abundances of North Sea jellyfish and links to the North Atlantic Oscillation. *Limnol. Oceanogr*., 49(3): 637-643.

2 - Molinero, J. C., M. Casini and E. Buecher., 2008. The influence of the Atlantic and regional climate variability on the long-term changes in gelatinous carnivore populations in the northwestern Mediterranean. *Limnol. Oceanogr*., 53(4): 1456-1467.

3 - CIESM., 2001. Gelatinous zooplankton outbreaks: theory and practice, *CIESM Workshop Series 14*, Monaco, 112 pp.

4 - Hsieh, C. H., S. M. Glaser, A. J. Lucas and G. Sugihara., 2005. Distinguishing random environmental fluctuations from ecological catastrophes for the North Pacific Ocean. *Nature* 435: 336-340.

5 - Torrence C. and G. P. Compo., 1998. A Practical Guide to Wavelet Analysis. B. *Am. Meteorol. Soc*., 79 (1): 61-78.