Populations of heterotrophic dinoflagellate *Noctiluca scintillans* in the Black Sea and the northern Adriatic Sea

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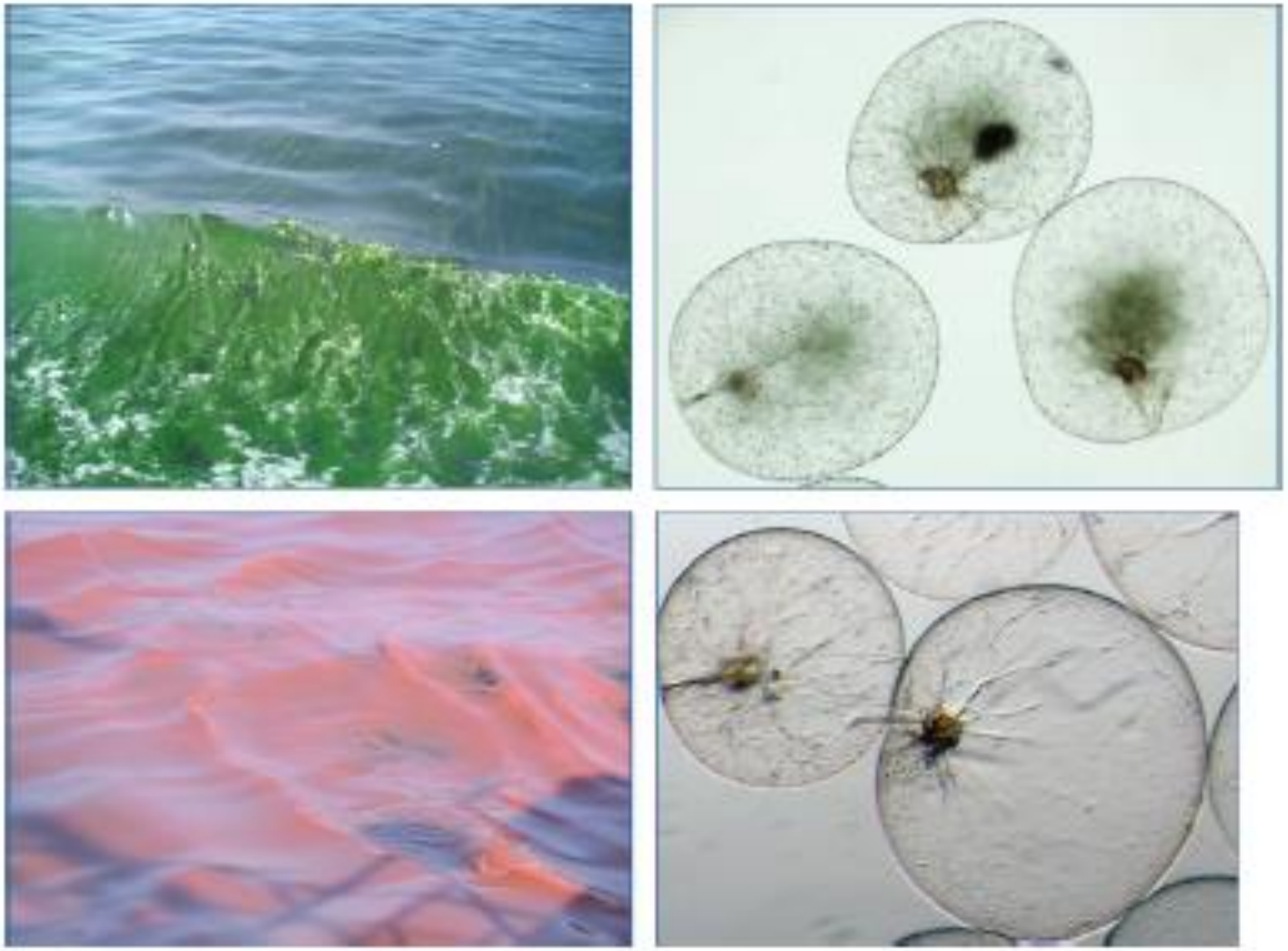
MARES2020, Varna, 2013



Two forms of *Noctiluca scintillans*: the green form (upper) with the endosymbiont *Pedinomonas noctilucae* and the heterotrophic red form (lower)

Harrison et al., 2011

Relationship between dynamics of population of *N. scintillans* and various factors

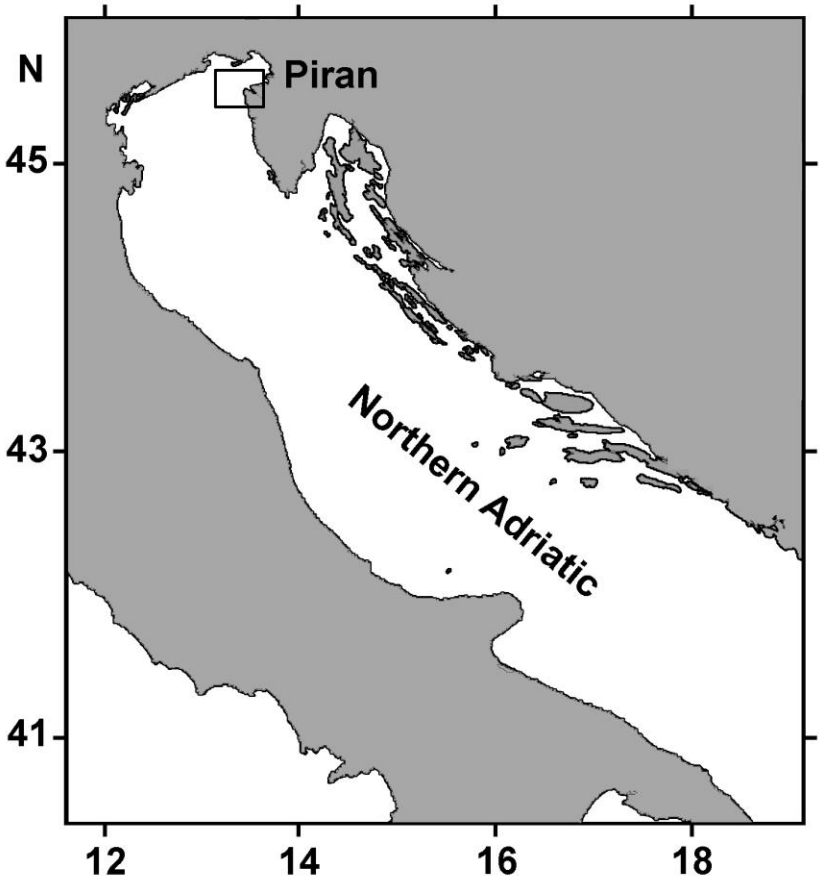
Parameter	Region	Description	Relationship	Reference
Phytoplankton	Japan Sea	Diatoms and chlorophyll a	**Positive**	Nakamura, 1998
	Southern Benguela	Total biomass	**Positive**	Painting et. al, 1993
	Red Sea	Diatoms and dinoflagellates species	**Negative**	Mohamed et. al, 2007
	Northern Adriatic Sea	Total biomass	No	Umani et. al, 2004
	Southern-eastern Australian coast	Diatoms	**Positive**	Dela-Cruz et. al, 2002
	Gulf of Oman	Chlorophyll a	No	Al-Azri et al., 2007
	South China Sea	Chlorophyll a	**Negative**	Huang and Y. Qi, 1997
Zooplankton	Northeast Atlantic	Mesozoplankton species	No	Hinder et al., 2012
	Northern Adriatic Sea	Net biomass	**Negative**	Umani et. al, 2004
	Sagami Bay, Japan	Biomass	No	Miyaguchi et. al, 2006
Temperature	North Sea	Winter SST	**Positive**	Heyen et al., 1998
	Red Sea	Sea surface	No	Mohamed et. al, 2007
	Black Sea, NWS	Winter SST	**Negative**	Oguz and Velikova, 2010
	Black Sea	Spring SST	**Negative**	Shiganova 2009

Relationship between dynamics of population of *N. scintillans* and various factors

Parameter	Region	Description	Relationship	Reference
Meteo-	Sagami Bay, Japan	Wind direction and rainfall	**Positive**	Miyaguchi et. al, 2006
	Gulf of Oman	Wind intensity and direction	**Positive**	Al-Azri et al., 2007
River discharge	Port Blair Bay Indian Ocean	Terrigenous and allochthonous inputs	**Positive**	Dharani et. al, 2004
Nutrients	Red Sea	Ammonia	**Positive**	Mohamed et. al, 2007
		Phosphates, Nitrates, Silicates	**Negative**	
	Port Hacking near Sydney	Ammonia in surface layer	**Positive**	Dela-Cruz et. al, 2002
		Nitrate concentration in surface layer	**Negative**	

The idea of the current research is to apply a comparative analysis of *Noctiluca* populations in two quite similar environments and to reveal the common factors driving the populations in both regions

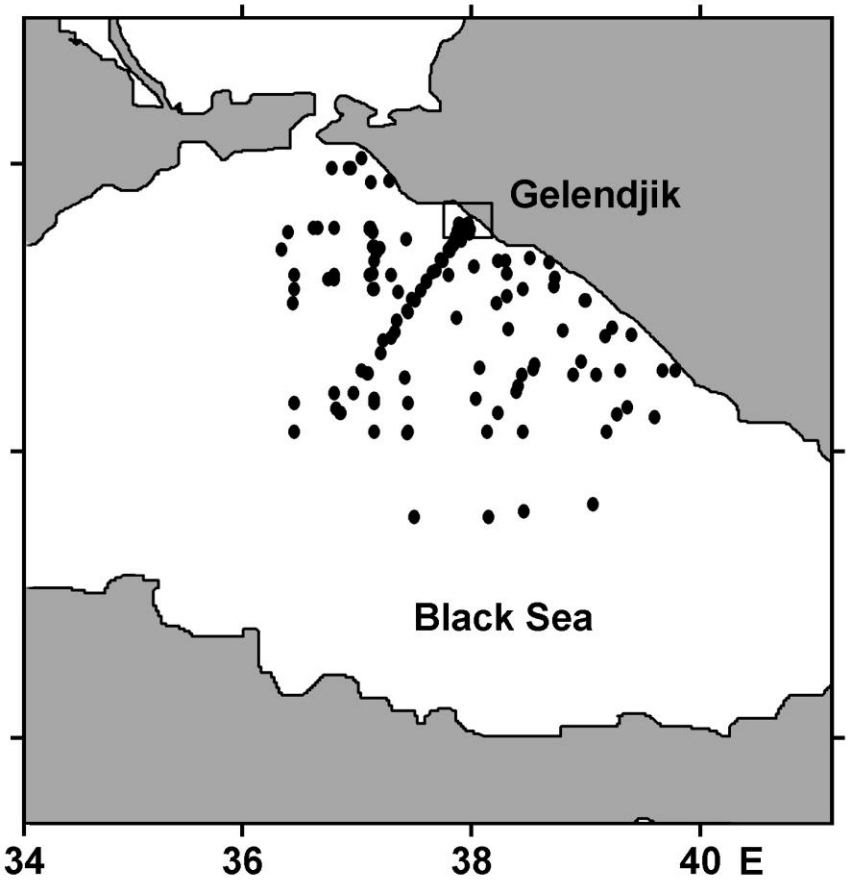
Sampling



Monitored site in the Northern Adriatic

sea bottom 20 м

bimonthly From 2004 to 2012



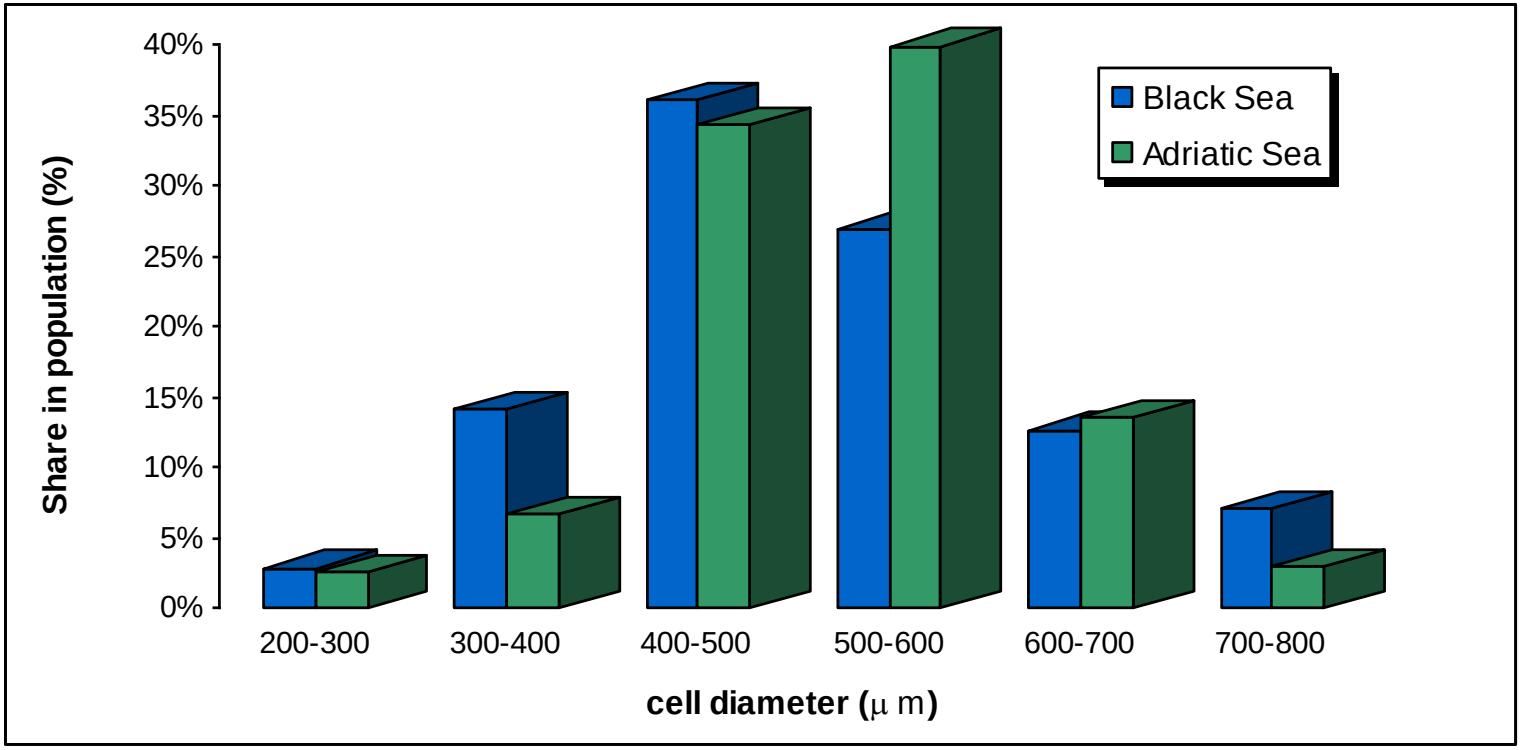
Monitored site in the Black Sea

sea bottom 7 м (Pier)

2-3 times per month from 2002 to 2012

Open waters (>50m) from 1997 to 2012 (447 stations)

Cell size spectrum of *Noctiluca* in the Black and northern Adriatic Seas

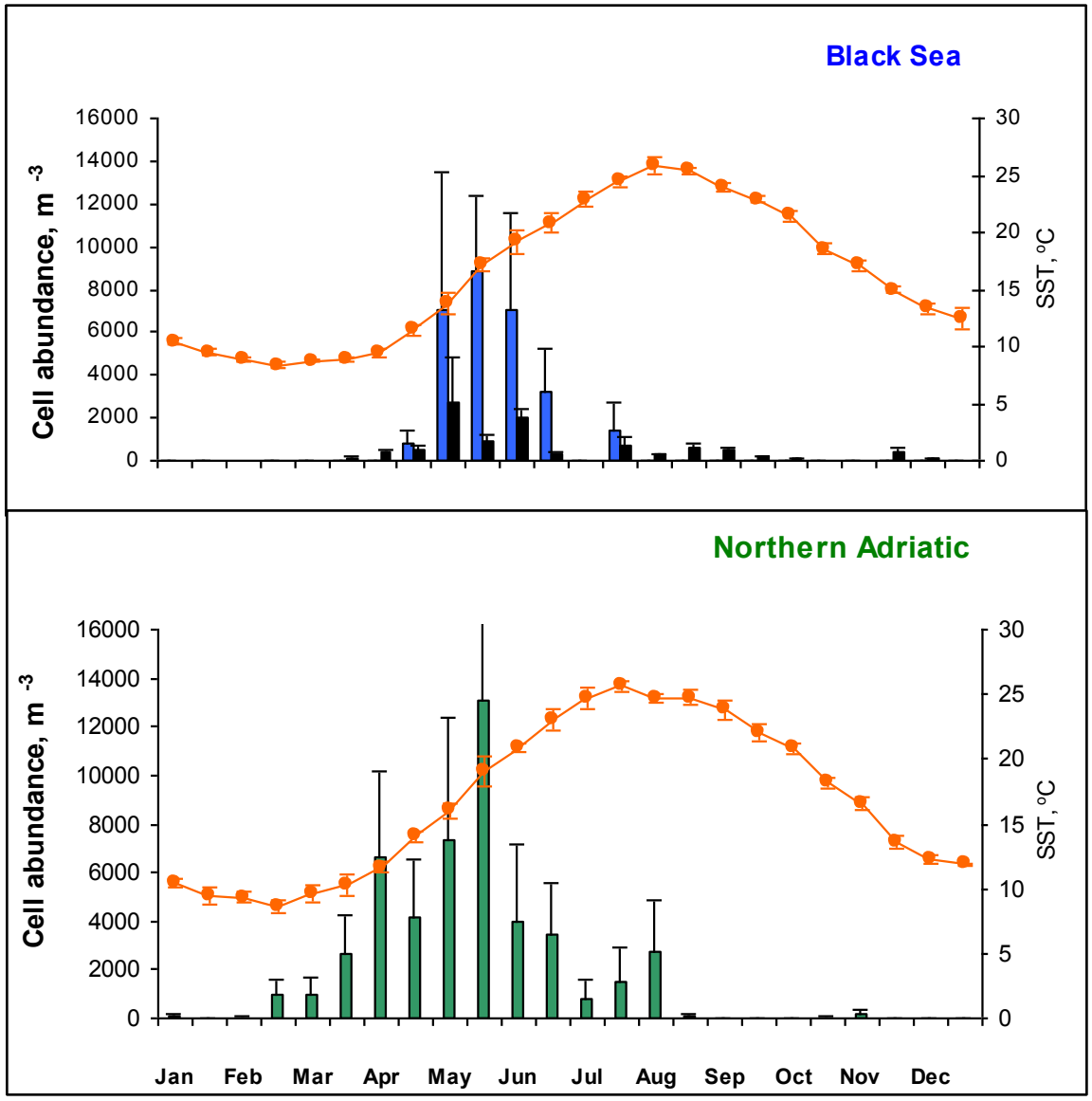


Характеристики популяций Noctiluca в Адриатическом и Черном морях в период массового развития (май-июнь) и осенью (сентябрь-октябрь)

Period	Cells	Food vacuoles		Feeding cells
	Diameter (μm)	Number per cell	Diameter (μm)	% in samples
Adriatic Sea				
May	507±7.0 (280)	1.78±0.14 (192)	79±2.0 (341)	79±6.0 (19)
September-October	468±9.1 (106)	0.69±0.09 (106)	94±4.4 (73)	49±7.0 (11)
p	***0.003***	***0.003***	***0.01***	***0.03***
Black Sea				
1 May – 15 June	536±5.7 (280)	1.58±0.09 (280)	95±2.8 (426)	76±3.2 (28)
September-October	514±2.5 (2152)	1.46±0.06 (1150)	86±1.1 (1701)	65±2.0 (115)
p	***0.002***	*0.26*	***0.000***	***0.008***

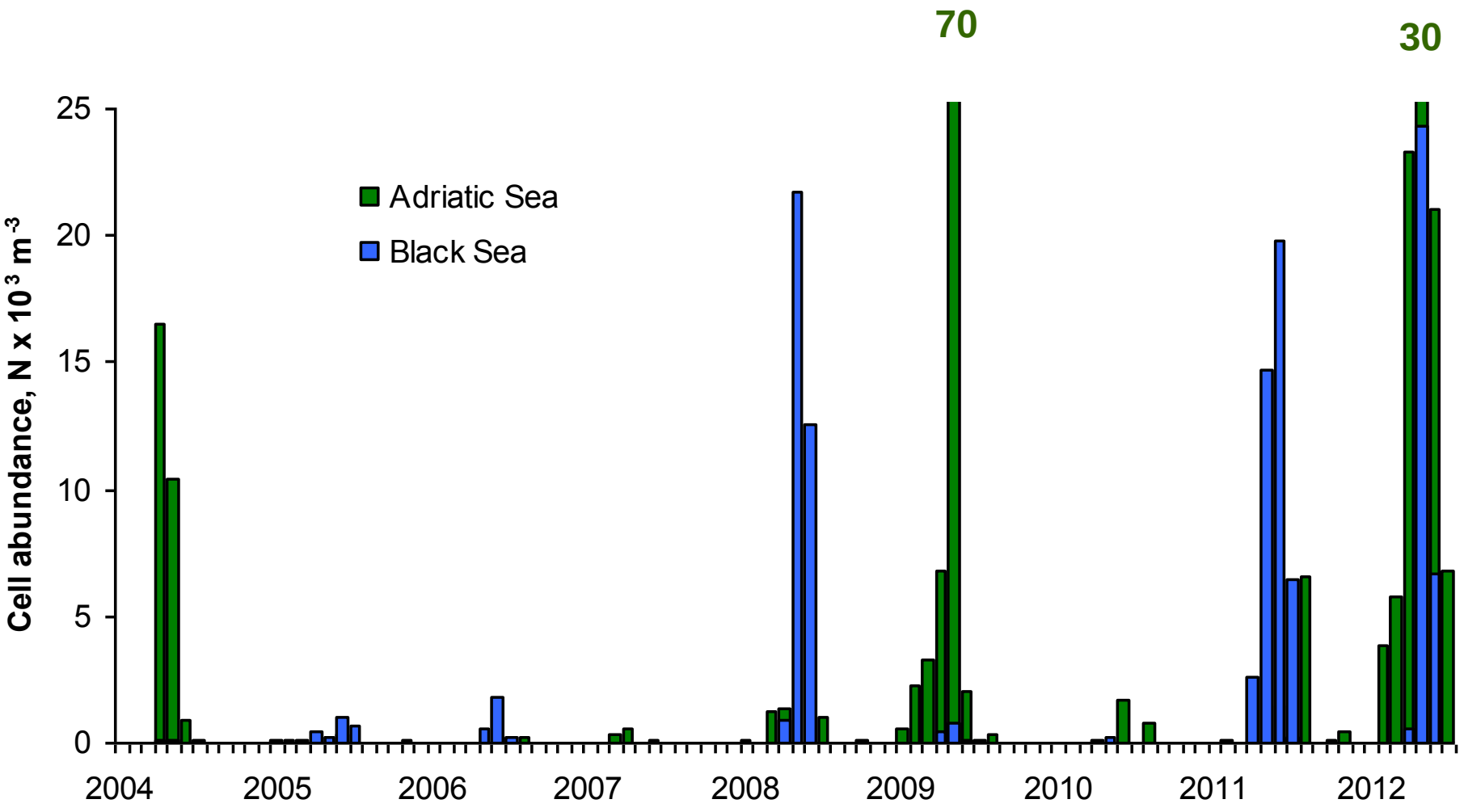
Mean ± SE. Number of measurements is given in brackets. p - probability of Null hyphothesis for two averages given above, the bold marks significant diffrence of means for 95% probability level.

Seasonal dynamics of Noctiluca in the Black and northern Adriatic Seas



- Pier
- Open waters
- SST, temperature on the surface

Long-term changes of *Noctiluca* populations



Correlation coefficients (r) between *Noctiluca* abundance (m^{-3}) and abiotic/biotic parameters

Parameter Mean for peak period	**Black Sea**		**Northern Adriatic**
	Monitored site	Open waters	Monitored site
Sea surface temperature, ^{o}C	0.09 *p=0.72, n=11*	0.52 *p=0.18, n=9*	0.27 *p=0.51, n=8*
Phytoplankton biomass (mean for the upper 15 m layer), $\mu g\ l^{-1}$	-0.18 *p=0.62, n=8*	-0.57 *p=0.89, n=9*	nd
Chlorophyll, $\mu g\ l^{-1}$	0.45 *p=0.22, n=9*	-0.18 *p=0.96, n=8*	0.63 *p=0.065, n=9*

Peak periods: Black Sea, 1 May – 15 June

Adriatic, 1 May – 1 June

n – number of observations (years)

nd – no data

np – no parameter

Correlation coefficients (r) between *Noctiluca* abundance (m^{-3}) and zooplankton

Parameter Mean for peak period	**Black Sea**		**Northern Adriatic**
	Monitored site	Open waters	Monitored site
Eggs of *Calanus euxinus*, m^{-3}	np	**0.76** *p=0.006, n=11*	np
Calanus euxinus , m^{-3}	np	0.01 *p=0.99, n=11*	np

Peak periods: Black Sea, 1 May – 15 June

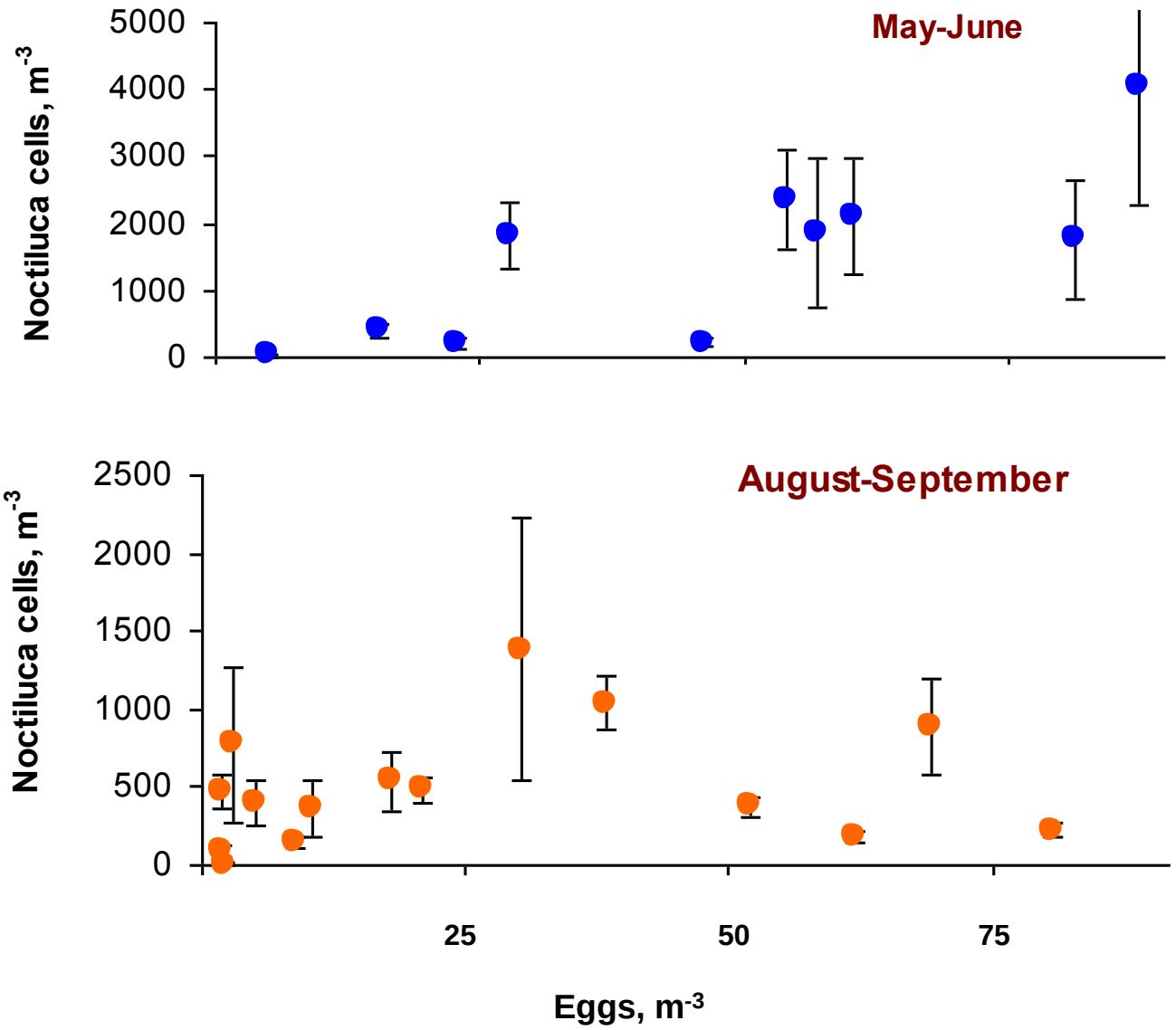
Adriatic, 1 May – 1 June

n – number of observations (years)

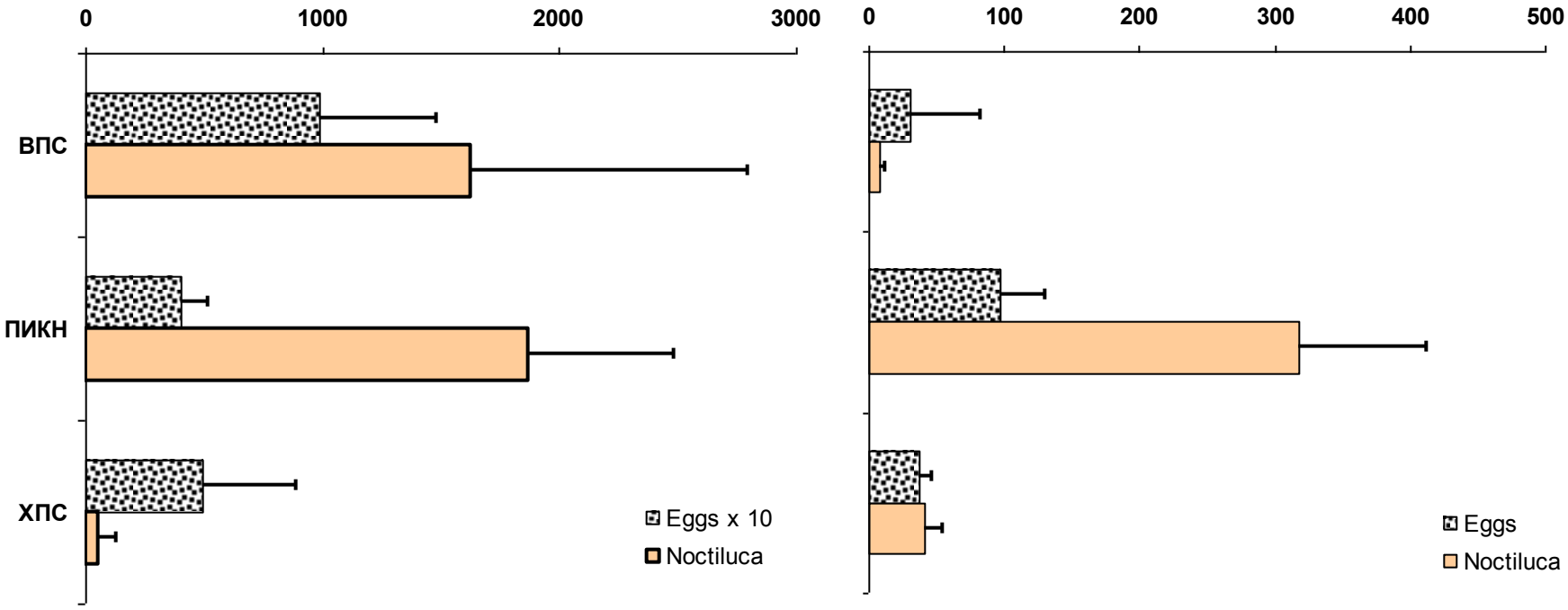
nd – no data

np – no parameter

Abundance of *Noctiluca* versus *Calanus euxinus* eggs in the open waters of the Black



Vertical distribution of cells (m^{-3}) of *Noctiluca* and eggs of *Calanus euxinus* in the Black Sea



May-June

6 profiles average

August-September

19 profiles average

Correlation coefficients (r) between *Noctiluca* abundance (m^{-3}) and wind intensity

Parameter Mean for peak period	**Black Sea**		**Northern Adriatic**
	Monitored site	Open waters	Monitored site
Wind velocity, $m\ s^{-1}$	-0.54 *p=0.09, n=11*	**-0.9** *p=0.001, n=11*	-0.57 *p=0.1, n=9*
Square wind velocity, $m^2\ s^{-2}$	**-0.72** *p=0.01, n=11*	**-0.94** *p=0.001, n=11*	-0.55 *p=0.1, n=9*
Windy hours, per month	**-0.63** *p=0.043, n=11*	**-0.92** *p=0.001, n=11*	**-0.67** *p=0.04, n=9*

Peak periods: Black Sea, 1 May – 15 June

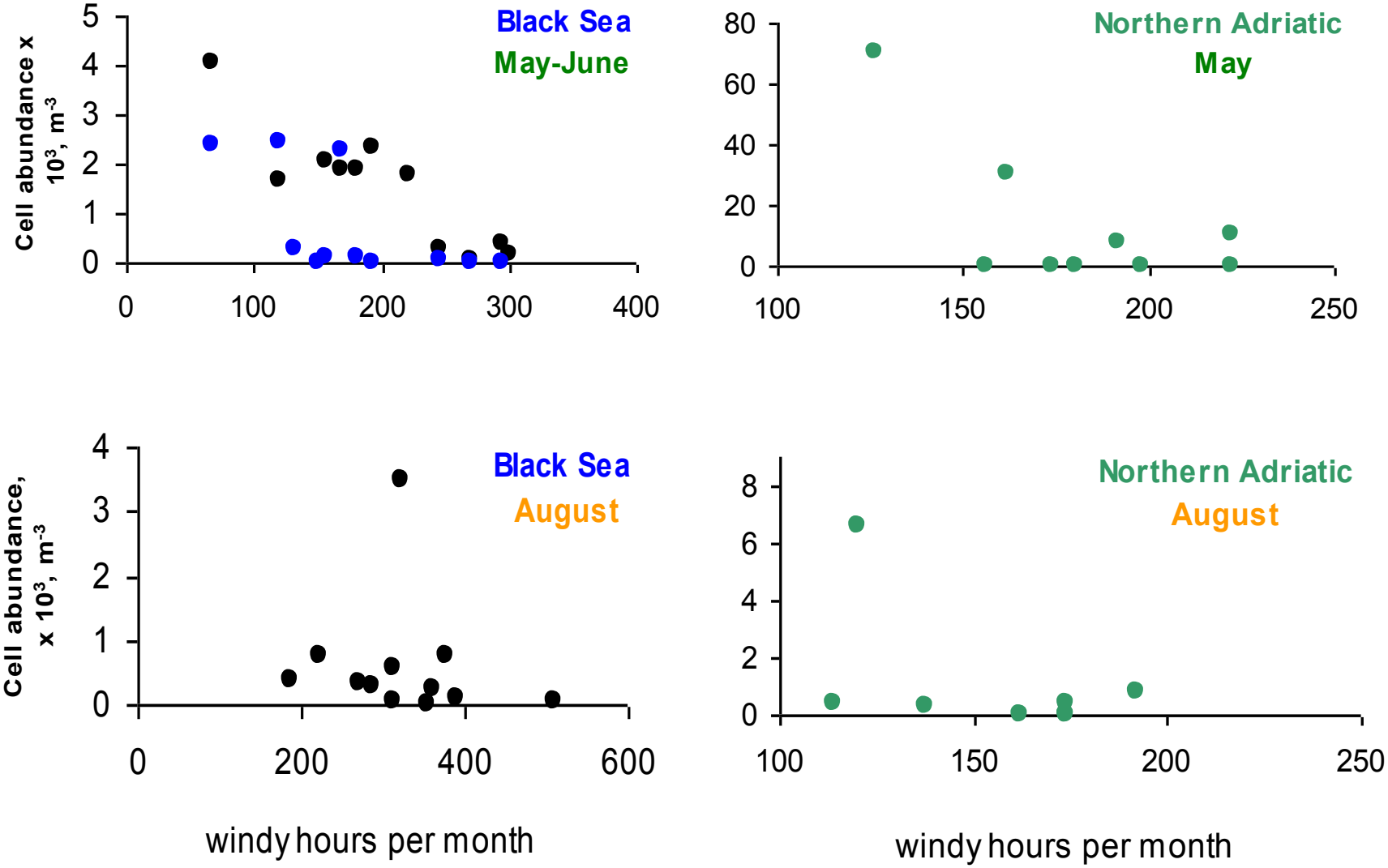
Adriatic, 1 May – 1 June

n – number of observations (years)

nd – no data

np – no parameter

Abundance (m^{-3}) of *Noctiluca* versus number of windy hours



Turbulence prevents:

- Attaching of food particles
- Creation of mucus threads
- Formation of the food roll
- Transportation of the food roll to the cytostome

Correlation coefficients (r) between *Noctiluca* abundance (m-3) and it abundance in previous months

Parameter Mean for peak period	**Black Sea**		**Northern Adriatic**
	Monitored site	Open waters	Monitored site
Noctiluca abundance in April, m^{-3}	**0.75** *p=0.02, n=10*	nd	0.45 *p=0.22, n=9*
Noctiluca abundance in March, m^{-3}	0.58 *p=0.1, n=10*	nd	**0.72** *p=0.03, n=9*

Peak periods: Black Sea, 1 May – 15 June

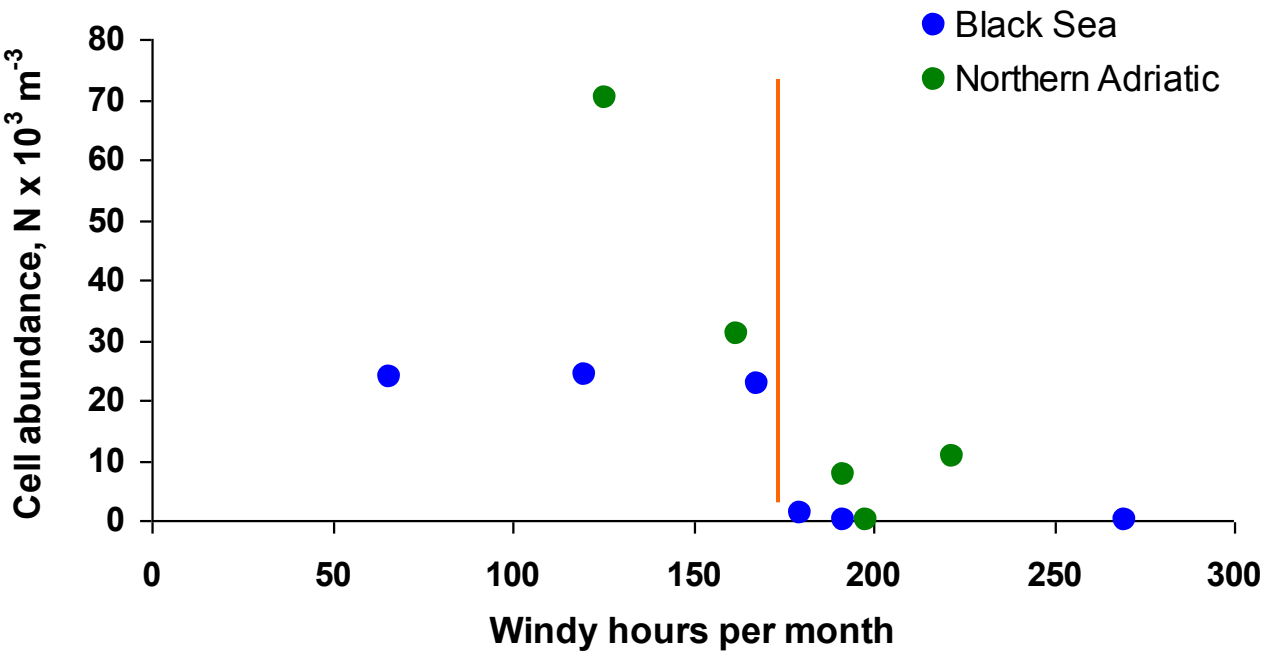
Adriatic, 1 May – 1 June

n – number of observations (years)

nd – no data

np – no parameter

Abundance (m^{-3}) of *Noctiluca* versus number of windy hours at the monitored sites in the Black Sea and in the northern Adriatic Sea



If the average cell numbers in April is a more than 100 cell m^{-3}

Thank you!

Thank for attention