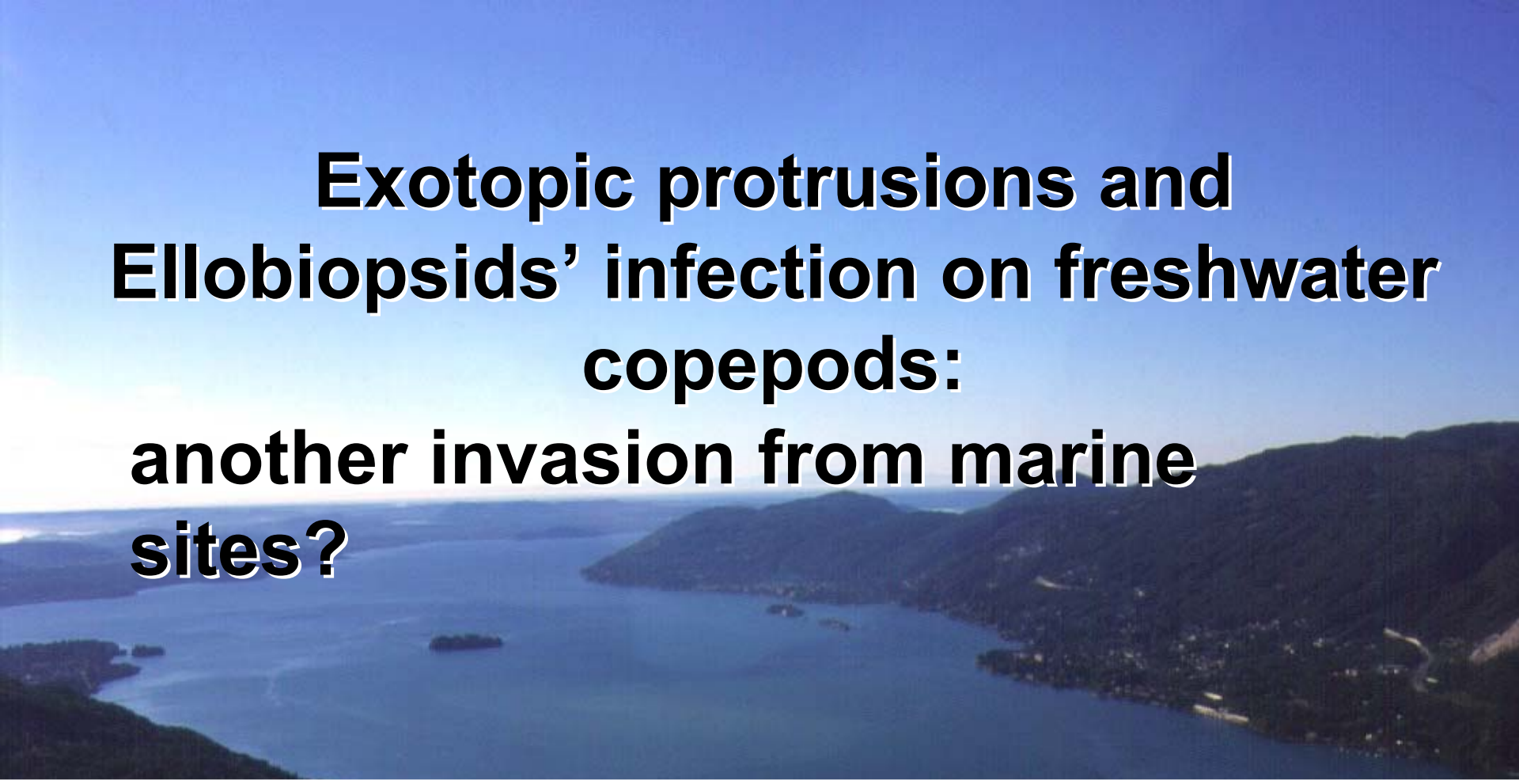
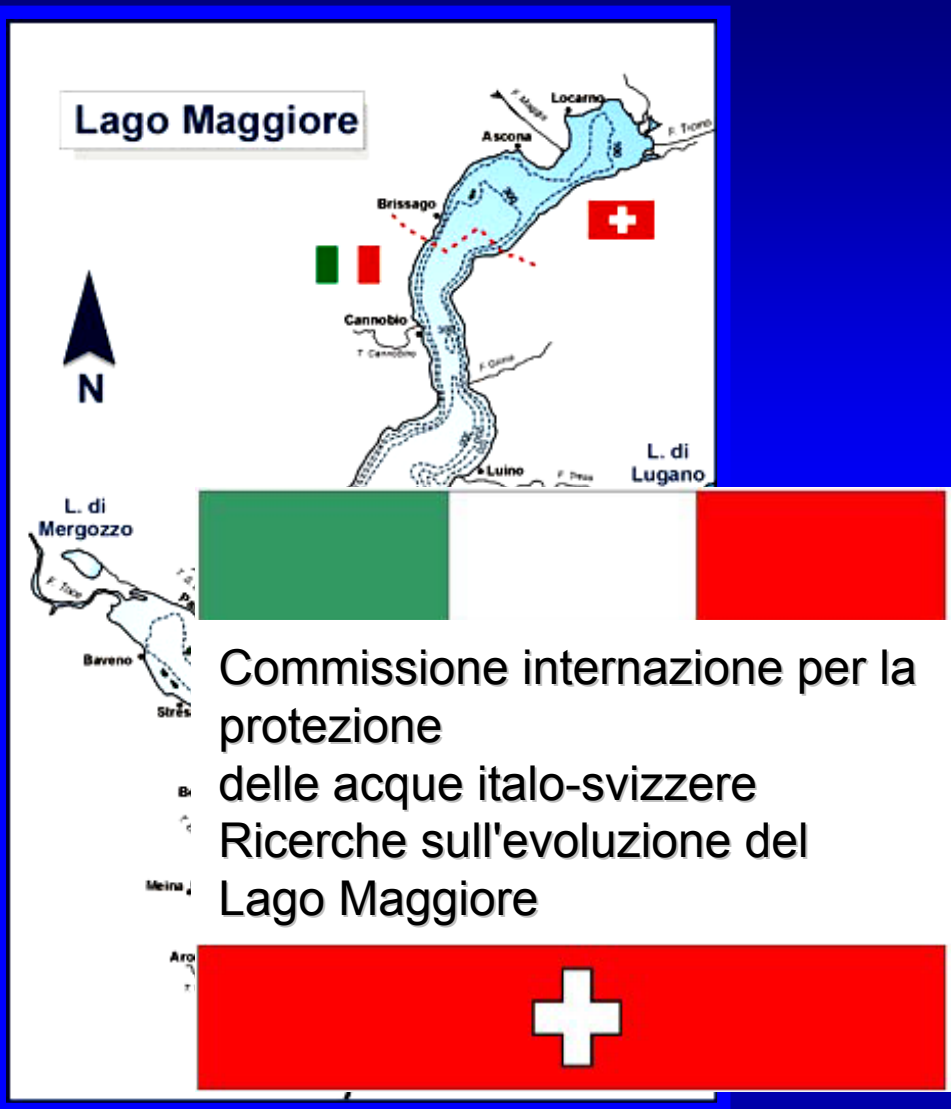


Exotopic protrusions and Ellobiopsids' infection on freshwater copepods: another invasion from marine sites?

Università degli Studi di Firenze

Biological Invasions in Inland Waters

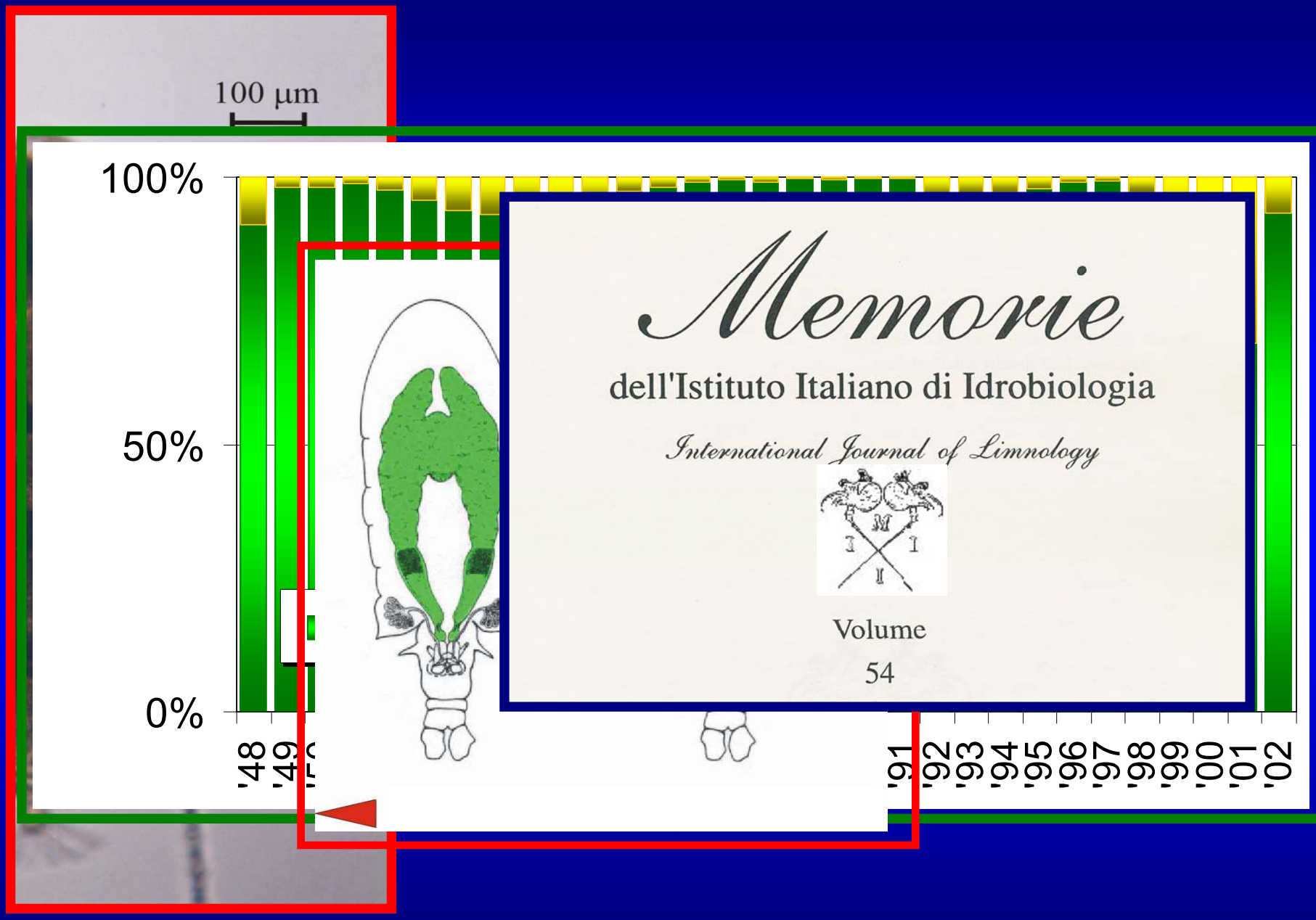
International Workshop - Florence, May 5-7, 2005



Commissione internazione per la protezione
delle acque italo-svizzere
Ricerche sull'evoluzione del Lago Maggiore

Long-term zooplankton records: 1978-

data from 1909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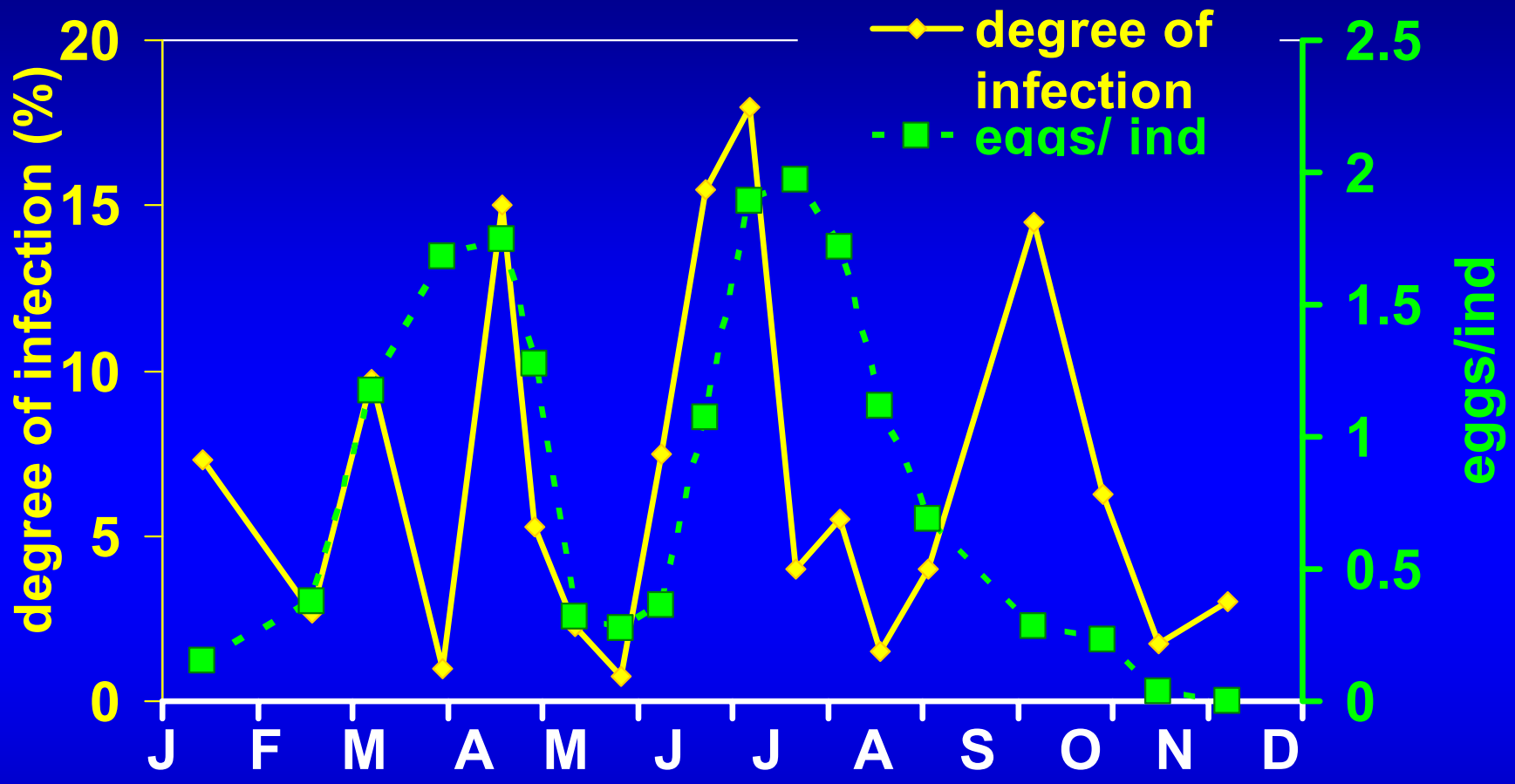
Memorie
dell'Istituto Italiano di Idrobiologia
International Journal of Limnology
Volume
54

- level of infection of the population, i.e. the percentage of infected/total number of animals

- prevalence, i.e. the proportion of infections on different species and/or developmental stages

Specificity of the host: adults or pre-adults of *Eudiaptomus padanus*



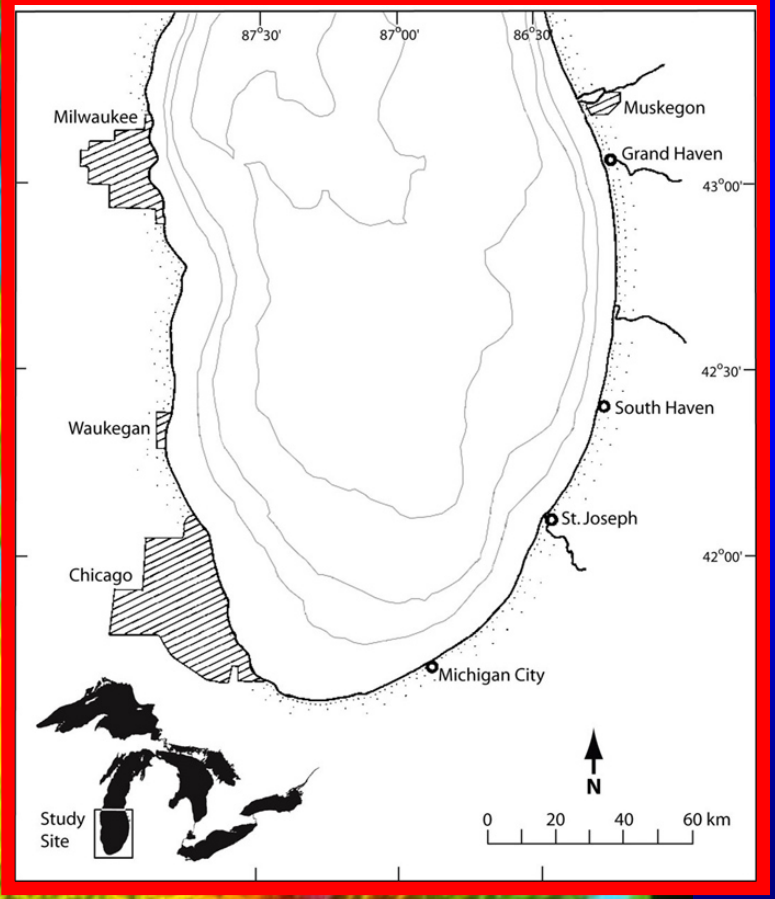
Infection dynamics related to egg production and adults' share

source to the north and west of the scene.

-400 -200 0 200 400 600 800 1000 1300

Great Lakes Environmental Research Laboratory

Data sources:
- USGS 30 sec. topography from NOAA Geophysics of North America CD ROM.
- Lake bathymetric data from NOAA Data



Cooperative Oxford Laboratory

Gretchen Messick

ARCHIVES DE ZOOLOGIE EXPÉRIMENTALE ET
Tome 59, p. 1 à 475, pl. I à XVIII.
15 Mars 1920

LES

PÉRIDINIENS PARA

MORPHOLOGIE, REPRODUCT
ETHOLOGIE

PAR

ÉDOUARD CHATTON

Chef de laboratoire à l'Institut Pasteur, Paris.
Maître de Conférences à la Faculté des Sciences, Strasbourg

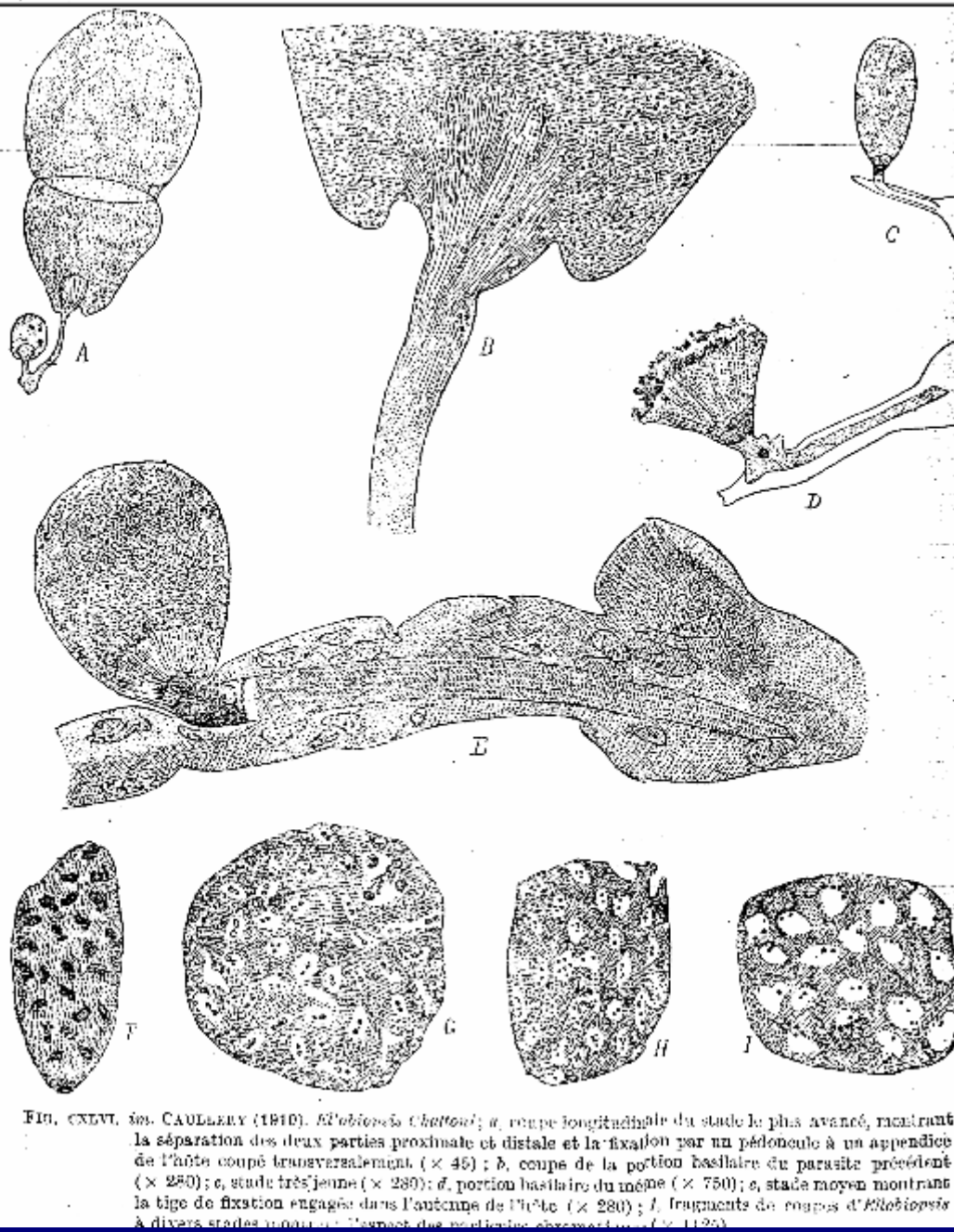


FIG. CXLVI, *bis*. CAULLERY (1910). *Hyalobrachola Chattoni*; *a*, coupe longitudinale du stade le plus avancé, montrant la séparation des deux parties proximale et distale et la fixation par un pédoncule à un appendice de l'hôte coupé transversalement (× 45) ; *b*, coupe de la portion basilaire du parasite précédent (× 280) ; *c*, stade très jeune (× 280) ; *d*, portion basilaire du même (× 750) ; *e*, stade moyen montrant la tige de fixation engagée dans l'antenne de l'hôte (× 280) ; *f*, fragments de coupes d'*Hyalobrachola* à divers stades pour montrer l'aspect des noyaux chromatiques (× 1125).

Arni Litt, Zoology Department, University of Seattle, Washington

«Coutiere (1911) a créé la famille des Ellobiopsidae por en ensemble de Protistes parasites des crustacés pelagique, dont le type est l' *Ellobiopsis chattoni* CAULLERY (1910)….»

E. chattoni, « Type de l'espéce parasite externe de *Calanus helgolandicus* à Banyuls-sur-Mer…. *Calanus helgolandicus* est un Copépode rare en Banyuls-sur-Mer »

« La Méditerranée ne semble pas être l'habitat de prédilection du *Calanus helgolandicus*, ni le milieu le plus propre à l'expansion de son parasite

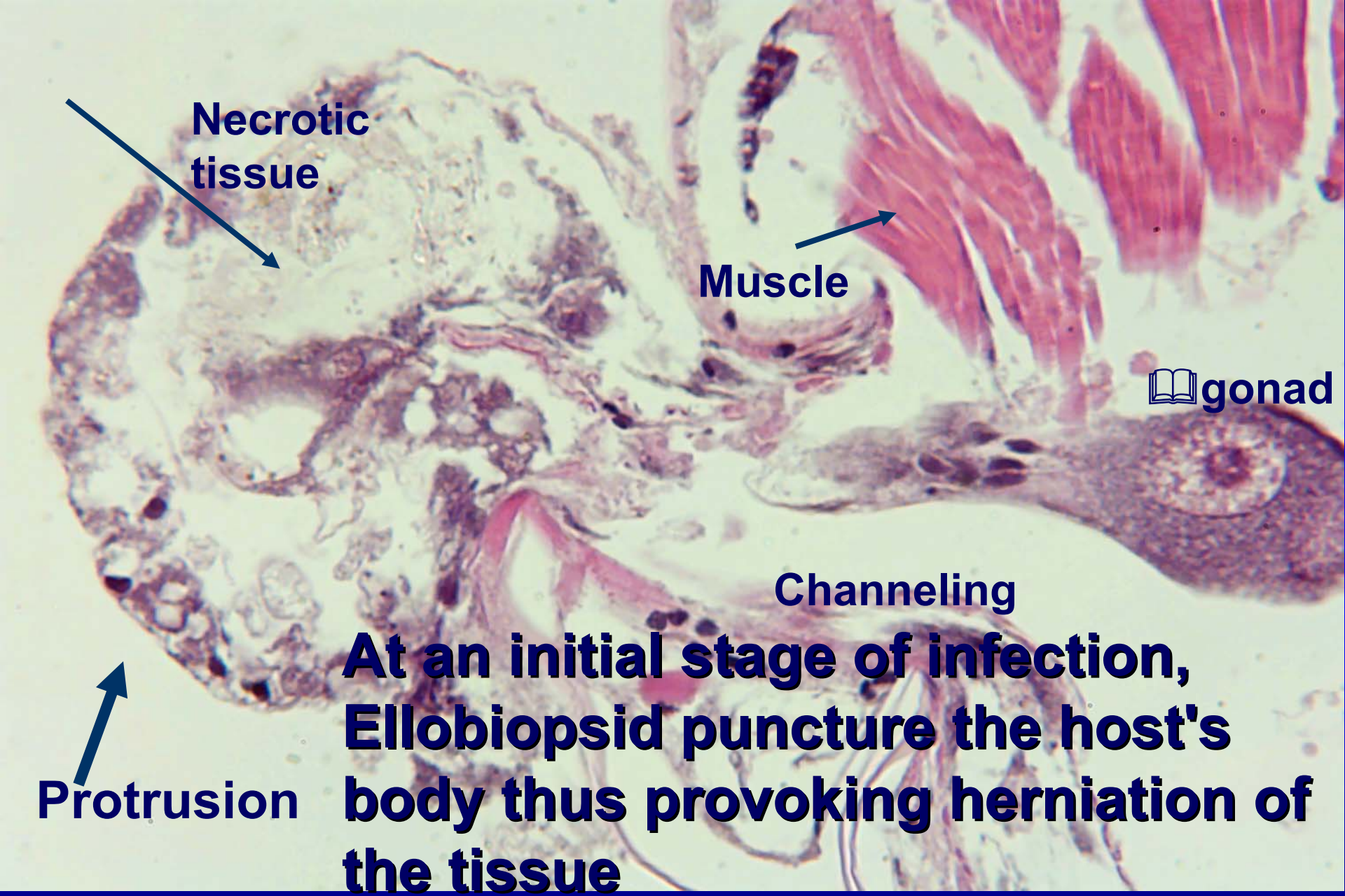
L'un et l'autre paraissent être surtout des formes septentrionales :

Loch Fyne, Scotland (Scott,1896)

North Sea and the Baltic on *Calanus finmarchicus*, *Pseudocalanus* (?), *Acartia clausi* (Apstein, 1911)

- They were well known from marine copepods
- No record from freshwater sites

Lake Maggiore



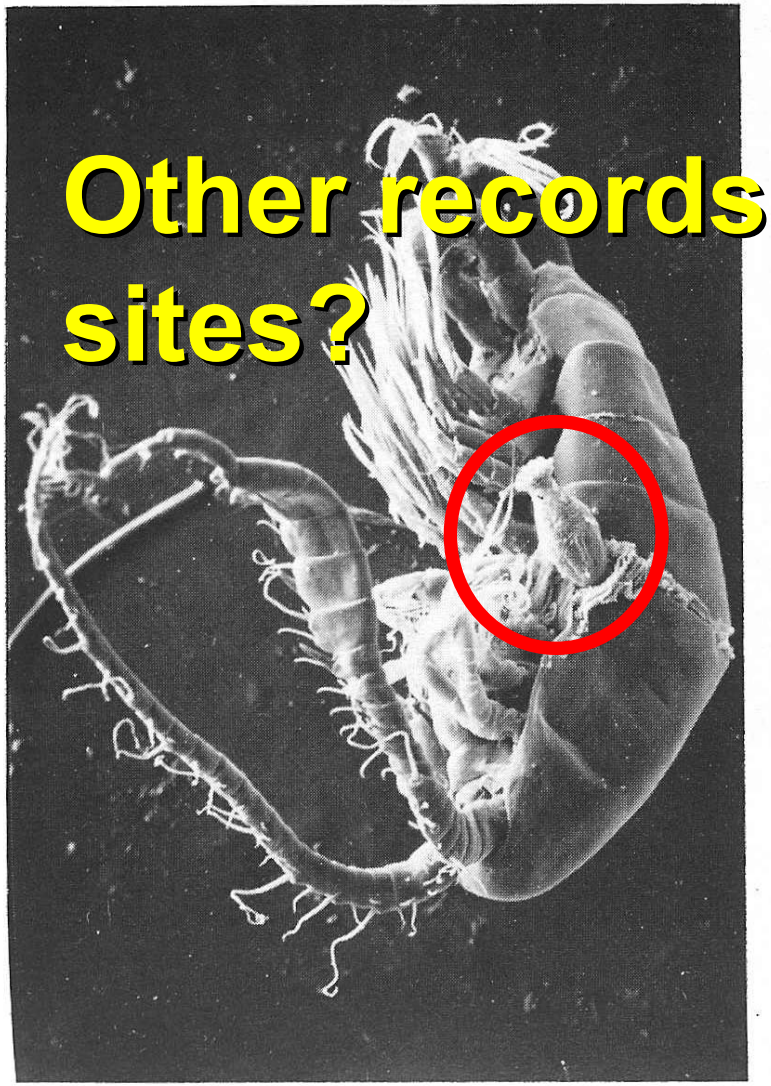
Channeling and necrotic tissue

Any records from marine sites in Italy?

YES

Ellobiopsid on *Acartia latisetosa* from Mar Piccolo di Taranto; photo by Giovanni Fanelli, CNR ITT, now CNR ISMAR, Taranto

Lake Midmar, South Africa



Other records form freshwater sites?

Lake Maggiore, Italy

First record of a freshwater calanoid *Tropodiaptomus spectabilis* (Kiefer, 1929) (Crustacea, Copepoda) as host of an ellobiopsid parasite

Nancy A.Rayner and Eleanor M.King

Department of Zoology, University of Natal, Pietermaritzburg, 3200, Republic of South Africa

Abstract. Ellobiopsids have been recorded as parasites of marine pelagic Crustacea. An unidentified ellobiopsid has been discovered for the first time in freshwater, its host being a calanoid, *Tropodiaptomus spectabilis* (Kiefer), in South Africa.

basing their decision on the morphology of the zoospores of *Thalassomyces marshallii* Kane, which have the unique flagellation of the dinoflagellates. No records can be found in the literature of ellobiopsids having been found on freshwater Crustacea. Host species are usually euphausiids, mysids and amphipods (Vader, 1973). Jepps (1937) recorded *Ellobiopsis chattoni* Caullery as a parasite of *Calanus finmarchicus* Gunnerus, a marine calanoid of the Clyde Sea area, and noted that it was first recorded by Scott in the Firth of Clyde in 1896.

An ellobiopsid parasite has been found to parasitise *Tropodiaptomus spectabilis*, the dominant calanoid (Rayner, 1981) in Lake Midmar (29°30′S; 30°12′E), a warm-temperate oligotrophic impoundment situated at an altitude of 1044 m in the Natal midlands, Republic of South Africa. At full supply the surface area of the lake is 15.59 km² and the mean depth 11.4 m (Breen, 1983).

Ellobiopsis chattoni Caullery as a parasite of *Calanus finmarchicus* Gunnerus, a marine

Pergamon

Annual Review of Fish Diseases, Vol. 4, pp. 241–271, 1994

0959-8030/94 $24.00

0959-8030(94)E0001-G

THE PARASITIC DINOFLAGELLATES OF MARINE CRUSTACEANS

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Chesapeake Bay National Estuarine Research Reserves in Virginia,
Virginia Institute of Marine Science, The College of William and Mary,
Gloucester Point, VA, 23062, USA

Abstract. Parasitic dinoflagellates have recently emerged as significant disease agents of commercially important crustaceans. For example, epizootics of *Hematodinium* have seriously affected certain crab and lobster fisheries. The parasitic dinoflagellates of crustaceans are, however, relatively unknown. Marine crustaceans are parasitized by two orders of dinoflagellates: the Blastodinida and the Syndinida. Crustaceans are also parasitized by the Paradinida and the Ellobiopsidae, taxa that have close historical ties and possible taxonomic affinities with the dinoflagellates. The taxonomy and life history patterns of the different parasitic species are largely dictated by their host–parasite relationships. For example, sporulation in the blastodinids occurs internally but is completed externally with the expulsion of spores via the anus of the host. The egg-parasitic chytriodinids sporulate externally after destroying their host egg. The tissue-dwelling syndinids have plasmodia that sporulate internally and generally kill their hosts upon the expulsion of the dinospores. Unfortunately, complete life cycles have not been elucidated for any of the parasitic forms, hence characteristics of the life cycles must be applied cautiously to the systematics of the taxa. For example, gamogony and the presence of resting cysts are only known from a few species; they probably occur in most species. Further work on the life cycles of the parasitic dinoflagellates of crustaceans should concentrate on establishing the life cycles of representative species from each order or family. Parasitic dinoflagellates infect copepods, amphipods, mysids, euphausiids, and decapods. Their pathogenicity varies with their invasiveness in the host. The gut-dwelling blastodinids are relatively benign, while the chytriodinids kill their host egg. Members of the pervasive Syndinida and Paradinida are overtly pathogenic and insidiously ramify throughout the hemal sinuses and organs of their hosts. Members of the Ellobiopsidae vary from the commensal *Ellobiocystis* to the overtly parasitic *Thalassomyces*. Host castration and feminization are common pathologic results of infection by these parasites. The severity of the castration is dependent upon the invasiveness of the parasitic species and the duration of the infection, while the degree of feminization is related to the stage at which the host acquires the infection. Most of the parasitic dinoflagellates occur in epizootics in their host populations. Recent epizootics of *Hematodinium* spp. have had severe effects on crustacean fisheries in Alaska, Virginia, and Scotland, and may potentially result in changes to the benthic communities of the hosts. The epizootics are often associated with host–parasite systems that occur in regions with unique hydrological features, such as fjords or poorly draining estuaries with shallow sills. These regions are ideal for the application of a "landscape" ecology approach that could lead to a better understanding of the epizootiology of parasitic dinoflagellates and other marine pathogens.

Keywords. Epizootiology, Life cycle, Taxonomy, Pathology, *Actinodinium*, *Atelodinium*, *Blastodinium*, *Chytriodinium*, *Dissodinium*, *Ellobiocystis*, *Ellobiopsis*, *Hematodinium*, *Paradinium*, *Parallobiopsis*, *Rhizellobiopsis*, *Schizochytriodinium*, *Syltodinium*, *Syndinium*, *Thalassomyces*, *Trypanodinium*

literature on marine environments and or that dealing with fish diseases

"included in the review are two protistan taxa of unknown affinities, the Paradina and the Ellobiopsidae. Their inclusion is warranted for comparative purposes and to illustrate the unresolved questions on their affinities to the dinoflagellates".

Differences among the genera are based on the structure of attachment (invasive or non-invasive, and single or multiple) as well as the number of trophomeres as well as gonomeres, and the way they sporulate

- *Ellobiocystis*……a single trophomere attached to the host via a noninvasive mucoid stalk, and 1-2 gonomeres arising form the trophomere

- *Ellobiopsis* …….possessing a trophomere with a single, invasive peduncle for host attachment ; multiple gonomeres arising from the trophomere

- *Parallobiopsis coutieri* …. A trophomere with a sucker-like holdfast and a simple, invasive peduncle; a single gonomere developing from the trophomere

"the genus *Ellobiocystis* does not penetrate into the body of its host, and the location around the buccal appendages suggest a commensal relation with their hosts"…

Little is known on the pathology of *E. chattoni* infections. The penetration of the invasive stalk into the …. host causes localized damage to the surrounding musculature

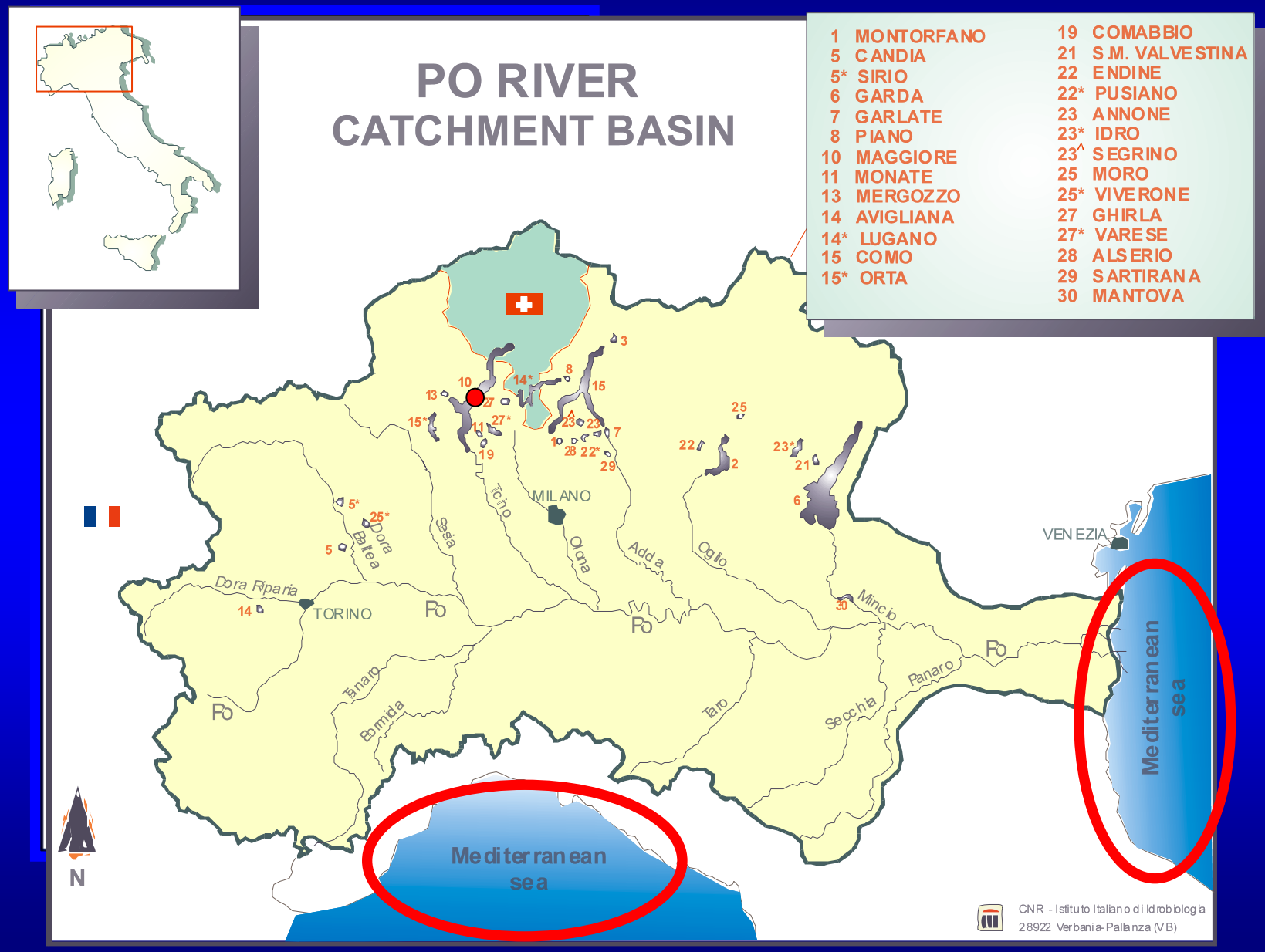
- **The life cycle is also briefly outlined**

"A flagellated spore presumably settles close to…the host, developing into a trophomere, which in *Ellobiopsis* penetrates through the host cuticle, apparently functioning in absorption"…in *E. fagei*, sporulation starts as the gonomere becomes tightly constricted from the trophomere" and the spore are released, whose phate is unknown"

While being known since a very long time for marine copepods, it seems to be relatively new for freshwater copepods

possible explanations for this:

- a general lack of interest on structures by fw zooplanktologists
- a basic ignorance of the marine literature by the fw zooplanktologists
- while being an old phenomenon for marine specimens, is it a relatively new one for freshwater copepods?


PO RIVER
CATCHMENT BASIN
1 MONTORFANO
5 CANDIA
5* SIRIO
6 GARDA
7 GARLATE
8 PIANO
10 MAGGIORE
11 MONATE
13 MERGOZZO
14 AVIGLIANA
14* LUGANO
15 COMO
15* ORTA
19 COMABBIO
21 S.M. VALVESTINA
22 ENDINE
22* PUSIANO
23 ANNONE
23* IDRO
23^ SEGRINO
25 MORO
25* VIVERONE
27 GHIRLA
27* VARESE
28 ALSERIO
29 SARTIRANA
30 MANTOVA
MILANO
TORINO
VENEZIA
Dora Riparia
Dora Baltea
Sesia
Ticino
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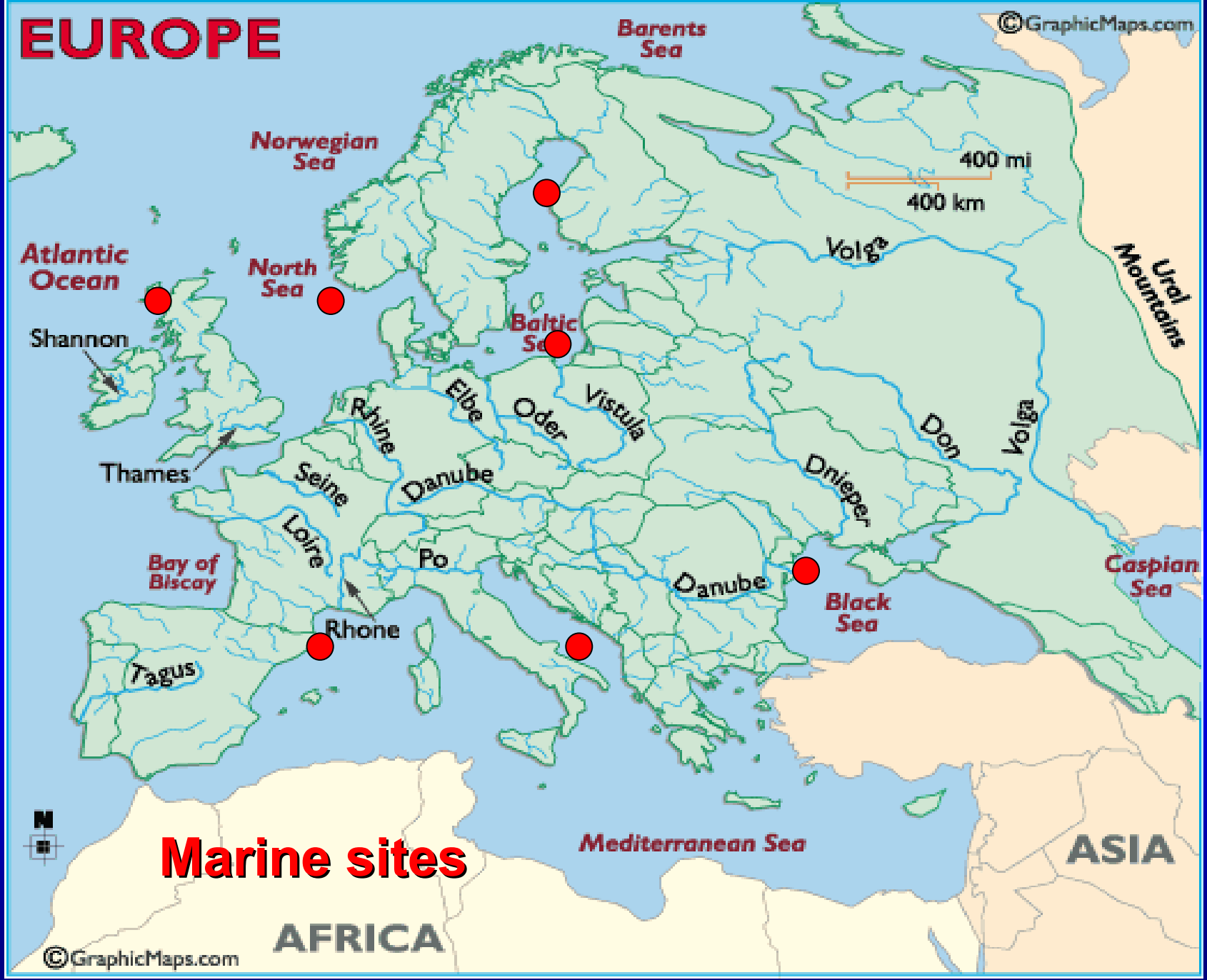
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Marine sites

Ellobiopsidae				
Ellobiocystis caridarum	*P. pacifica*	<10–84.0	Auke Bay, Alaska	54
Ellobiopsis chattoni	*Calanus finmarchius*	0.3	Loch Striven, Scotland	45
	Metridia longa	5.0–22.4	Kachemak Bay, Alaska	57
	Undinula vulgaris	8.3	Bay of Bengal, India	50
	U. vulgaris	26.0	Zanzibar Channel off Africa	90

Freshwater sites

Lake Midmar, South Africa
Lake Maggiore, Italy
Lake Michigan
Small inland lakes in Michigan

Invasive animals established in the **Great Lakes** drainage since the mid-**1980s** originate mainly from the Ponto-Caspian area

Common name	Year of Discovery	Endemic region	Mode of transfer	Probable donor region
Ruffe	1986	Ponto-Caspian	Ballast water	Danube River
Zebra mussel	1988	Ponto-Caspian	Ballast water	Baltic Sea
Quagga mussel	1989	Ponto-Caspian	Ballast water	Black Sea
Rudd	1989	Eurasia	Bait release	--
Round goby	1990	Ponto-Caspian	Ballast water	Black Sea
Tubenose goby	1990	Ponto-Caspian	Ballast water	Black Sea
New Zealand mudsnail	1991	New Zealand	Ballast water	Baltic Sea
Blueback herring	1995	Atlantic, N.A.	Canal	Atlantic N.A.
Echinogammarus amphipod	1994	Ponto-Caspian	Ballast water	Baltic Sea
Acineta noticrae ciliate	1997	Eurasia	Ballast water	Black Sea
Cercopagis waterflea	1998	Ponto-Caspian	Ballast water	Baltic Sea
Daphnia lumholtzi	1999	Africa, Asia, Aust.	Fish ?	Ohio Reservoirs
Schizopera borutzkyi	1999	Ponto-Caspian	Ballast water	Danube River
Heteropsyllus nr. nunni	1996	Atlantic N.A.	?	Atlantic N.A.
Sphaeromyxa sevastopoli **protist**	1994	Black Sea	Ballast water	Black Sea
Scolex pleuronectis cestode	1994	Black Sea	Ballast water	Black Sea
Ichthyocotylurus pileatus trematode	1994	Black Sea	Ballast water	Black Sea
Nitocra incerta copepod	1999	Ponto-Caspian	Ballast water	Black Sea
3 testate rhizopod spp.	2003	Ponto-Caspian	Ballast water	Eurasia

is it possible that the more recent records from freshwater sites are the result of an invasion from the marine sites? Like reported for other invasions?

Further investigations on a broader scale are needed, to verify this hypothesis

Mechanisms of international transport for these parasites:

- Infected copepods moving in ballast water?
- Spores carried on air currents?
- Other dispersal mechanisms?

Florence, Italy

Thank you for your attention