On the progress of understanding algal viruses

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The Pioneers

“Lytic agents” in algal cultures has been known since the early 60’s but the first observations of viral like particles (VLPs) in algal cells were made in the early 70’s. Systematic research in the field was initiated a decade later when two of the pioneers, James L. Van Etten and Russel H. Meints, in a fluke managed to isolate and culture viruses infecting Chlorella-like green algae. The Chlorella cells they used as host were zoochlorella endosymbionts isolated from the hydrozoa Hydra viridis and the ciliate Paramecium bursaria. These cells can be grown to high concentration in liquid cultures as well as on agar plates and the viruses they isolated could hence be grown to high titer, assayed by plaque formation and studied by standard bacteriophage technology. Another important early branch of algal virus research was fronted by Dieter G. Müller who in the 90’s isolated and characterized several viruses infecting brown macroalgae such as Ectocarpus and Feldmannia.

The modern era of aquatic viral ecology had its debut in the early 90’s when it was found that the abundance of viruses in marine ecosystems was high, that the fraction of virus infected bacteria in the ocean was significant and that virus infecting phytoplankton could be a major factor regulating primary production. Recognizing the importance of these findings several laboratories put a lot of efforts into isolating new and unknown algal viruses. Within a decade or so viruses infecting microalgae like Micromonas, Heterosigma, Chrysochromulina, Phaeocystis and Emiliania were isolated and characterized. The most conspicuous character of many of these algal viruses was perhaps that they were large both in particle and in genome size. Today these “large” viruses almost seem small when compared to the viruses that infect amoebae and have genome sizes over 1000 kb, e.g. the Pandoravirus, Megavirus, Mamavirus and Mimivirus. The large amount and type of genetic information encoded by all of these viruses has raised many evolutionary and ecological questions and it has spurred the debate on the origin of viruses and if viruses are alive or not.

While research on algal viruses still had a rather limited audience in the 90’s, viral ecology was met by more interest and attention. In an attempt to congregate the research community interested in algal viruses we organized the first Algal Virus Workshop in Bergen in 1998. As a forum for presenting recent results, exchanging ideas, discussing new methods, meeting old friends and making new, this small and focused workshop series has become a success and we can now look back on seven meetings held in Norway, Ireland, Japan, The Netherlands, Canada and USA. In 2008, the scope of the workshop expanded from Algal Viruses to Aquatic Viruses to include a wider range of research. In brief, these workshops have enhanced collaboration between different groups, promoted many individual careers and contributed in the developmental of this scientific field as a whole.

The Chlorella viruses

The large DNA algal viruses appear to be monophyletic and they are assigned to the newly created Phycodnaviridae family within the nucleocytoplasmic large DNA virus (NCLDV) group. Many of them are studied quite thoroughly and sequenced, but the algal virus we by far know the most about is the Chlorella virus Paramecium bursaria Chlorella Virus (PBCV). PBCV and related Chlorella viruses can only be propagated in exsymbiotic zoochlorella host strains and not in any naturally free living Chlorella strains. The zoochlorellas are protected against infection when inside Paramecium or Hydra and they are not found free-living in natural waters. Different Chlorella viruses are however found worldwide in aquatic habitats, so they appear to have a natural host that is different from symbiotic zoochlorella and free-living Chlorella cells. It is indeed a paradox that the algal type virus we know best has an unknown natural host. This host must be ubiquitous or the virus must be able to propagate in different hosts. The fact that some Chlorella viruses encode for hyaluronan, a glycosaminoglycan found in vertebrates, and the resent staggering discovery that algal virus genes are present in humans brains and may affect human cognitive functioning add to the mystery. Thus the true nature and ecology of the Chlorella viruses is still obscure and their natural hosts may even not be algae.