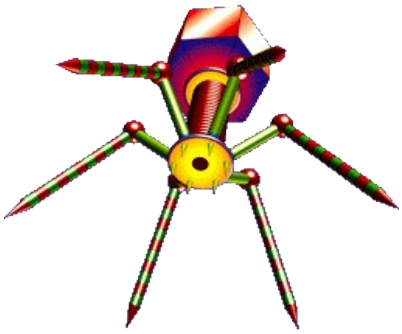

Bacteriophage Ecology Group (BEG) News

Dedicated to the ecology and evolutionary biology of the parasites of unicellular organisms (UOPs)

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April 1, 2000 issue (volume 4)

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Editorial

Editorials should be written on subjects relevant to The Bacteriophage Ecology Group as an organization, to *BEG News* (either the concept or a given issue of *BEG News*), or the science of Bacteriophage Ecology. While my assumption is that I will be writing the bulk of these editorials, I wish to encourage as many people as possible to seek to relieve me of this duty, as often as possible. Additionally, I welcome suggestions of topics that may be addressed. Please address all correspondence to abedon.1@osu.edu or to "Editorials," *Bacteriophage Ecology Group News*, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906. Please send all submissions as Microsoft Word documents, if possible (I'll let you know if I have trouble converting any other document formats), and in English.

2000 and Sun: A Phage Odyssey

The Dawn of Phage. To the straining brass and drums of Richard Straus (press here for a wave or midi rendition) a black monolith rises at dawn above the plains of Tbilisi in the guise of a *New York Times Magazine* article: A Stalinist Antibiotic Alternative (L. Osborne, Sunday, February 6, 2000.). Though a few of you have thrown metaphorical bones at this article, there is no denying that it has brought new-found popularity to phage therapy. A small band of phage ecologists using their bacteriophage club against infectious disease.

Phage Station One. Switch to that other Straus, Johann (press here). A second black monolith, in the guise of an e-mail, arrives from Nina Chanishvili,

slowly gliding into the only partially completed, centrifugal mess that is my office. This e-mail carries a secret. ("Just a moment...")

Journey to the Bacteria and the Bank Account. The secret, TMA-1 (Transmitted Magnetic Anomaly, version 1.0), now stored on my hard drive, gives explicit directions on how to donate money to the Eliava-D'Herelle International Association to help support the Eliava Institute of Bacteriophage, Microbiology and Virology, Tbilisi, Georgia (see also the Tbilisi Institute for Bacteriophage Therapy). The information, though no doubt complete, is about as intelligible to this ignorant American as an alien radio message beamed to Jupiter and beyond.("It's puzzling...")

Man and the Bank of America Machine. If anybody could tell me how to send money, it should be the recipient bank. Armed with knowledge that the Bank of American was the Institute's corresponding bank, I fired off an e-mail requesting, again, explicit directions on how to send money. ("I'm sorry Dave...")

The Bikelessness of Mansfield, Ohio. Figuring that my bank would at least know how to send money, that became my next destination. Spring break and global warming conspired to allow me to ride my bike (about 10 miles each way) to my bank on a sunny, 70°F (21°C) day in late March. Yes, based on people's reactions, in the semi-rural Midwest a bicycle is an unusual site. Meanwhile, at my bank, I asked the crucial question: "What information would I need to wire money to the Georgians" and, perhaps of greater relevance, did I have all of the information that I needed? It turned out, of course, that I did not (routing number???). Furthermore, I found out that it would cost me $18 per transaction to wire this money. Meanwhile my Windows 98 (2^{nd} Edition)-based computer once again began acting up, so I disconnected its higher brain functions. ("My mind is going...")

Beyond the Internet. Realizing that ever-higher technology was not going to be the answer, I re-boarded my two-wheeled pod (failing to close the pod door because it doesn't have a pod door) and entered into a psychedelic trip of Kubrickian proportion (or were those just cars blowing past me at 60 miles per hour?). I then faced an older though now perhaps wiser self. Gathering the last of my strength, and though as hard as it might be to imagine, this being nearly 2001 and all, I put pen to paper, writing a check and I then sent that check through the U.S. mail. ("I feel much better now...")

Closing Credits. To help support research into the use of bacteriophages as anti-infectious-disease antibacterials (phage therapy), as performed at the Eliava Institute, this is what you need to do: ("Sorry about this...")

1. E-mail Nina for account numbers and bank addresses (I hesitate to supply this information on the web)
2. Place in a cover letter the above information making sure that you include in that cover letter an indication that this will be a donation (i.e., place the word "DONATION" somewhere in the letter)
3. Also in this cover letter you should request a receipt
4. Make sure that you fill out the check paid to the order of "Eliava-D'Herelle International Society (Dr. Nina Chanishvili)"
5. Mail the letter to: Bank by Mail, P.O. Box 198465, Atlanta, GA 30384-8465

May the Force be with you...

MicroDude, a.k.a., **Stephen T. Abedon**

Developer and Editor
The Bacteriophage Ecology Group
Dedicated to the ecology and evolutionary biology of the parasites of unicellular organisms (UOPs)

(sound effects are brought to you by 2001: a space odyssey Internet Resource Archive)

Editorial Archive

- BEG: What we are, Where we are, Where we're going
- When Grown *In Vitro*, do Parasites of Multicellular Organisms (MOPs) become Unicellular Organism Parasites (UOPs)?
- Bacteriophages as Model Systems
- 2000 and Sun: A Phage Odyssey

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New BEG Members

The BEG members list can be found at beg_members.htm as well as on the BEG home page. As we add new members, these individuals will be introduced in this section. Note that, in fact, there are two ways of "joining" BEG. One, the traditional way, is to have your name listed on the web page and on the list server. The second, the non-traditional way, is to have your name only listed on the list server. The latter I refer to as "non-members" on that list. Members, e.g., individuals listed on the BEG home page, should be limited to individuals who are actively involved in science and who can serve as a phage ecology resource to interested individuals. If you have an interest in phage ecology but no real expertise in the area, then you should join as a non-member. To join as a member, please contact BEG using the following link: abedon.1@osu.edu. Include:

- your name
- your e-mail address
- your snail-mail address
- the URL of your home page (if you have one)
- a statement of whether or not you are the principal investigator
- a statement of your research interests (or phage ecology interests)
- a list of your phage ecology references, if any

Note that it is preferable that you include the full reference, including the abstract, if the reference is not already present in the BEG bibliography. Responsibility of members includes keeping the information listed on the BEG members list up to date including supplying on a reasonably timely basis the full references of your new phage ecology publications. Reprints can also be sent to *The Bacteriophage Ecology*

Group, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906. To join BEG as a non-member, please contact BEG using the following link: abedon.1@osu.edu and minimally include your name and e-mail address.

Please welcome our newest members

Cameron Haase-Pettingell	---	chaase @MIT.EDU	MIT, 68-330 77 Mass Ave., Cambridge, MA 02139
	interests:	Phage of cyanobacteria and their relationships in the open ocean.	
Jonathan King	PI	jaking @mit.edu	MIT, 68-330 77 Mass Ave., Cambridge, MA 02139
	interests:	Phage of cyanobacteria and their relationships in the open ocean.	
Peter Peduzzi	PI	peter.peduzzi@ univie.ac.at	Microbial Ecology Group, Department of Limnology, Institute of Ecology and Conservation Biology, University of Vienna, A-1090 Vienna, Austria
	interests:	Role of aquatic viruses in microbial and microbially mediated processes, material and energy fluxes in aquatic systems, microbial diversity; currently running program on the significance of particulate matter for virus and bacterial ecology in lake and river floodplain-systems.	
Mario Ramirez	---	ramirez @pen.gulbenkian.pt	ITQB, Apartado 127, R. da Qta. Grande 2780-901, Oeiras PORTUGAL
	interests:	Ecological role of phage in natural microbial communities, coevolution of phage and bacteria, phage and bacterial genome dynamics, phage therapy.	
Matthew B. Sullivan	---	mbsulli @mit.edu	77 Massachusetts Avenue, 48-208, Massachusetts Institute of Technology, Cambridge, MA 02139
	interests:	Interactions of bacteriophage on the oceanic primary producers, *Prochlorococcus* and *Synechococcus*.	

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New Links

Links relevant to The Bacteriophage Ecology Group fall into a number of categories (e.g., see Bacteriophage Ecology Links at beg_links.htm). Listed below are those links that overtly deal with phage ecology issues. With each issue of *BEG News* this list will be included, *in toto*, but updated with new links and with no-longer-working links both clearly indicated. If you know of a link that should be included on this page, or the whereabouts of a now-dead link, please let me know.

Bacteriophage Ecology Links

- **The Bacteriophage Ecology Group Members**
- Abundance and variety of bacteriophages
- Algal Virus Workshop (abstracts from June 14-18, 1998 meeting)
- Assessment of MS2 Bacteriophage Adsorption to Koch Membrane
- Bacteriophage Ecology Bibliography
- Bacteriophages (an overview) [site not up: 3/35/2000]
- Bdellovibrio
- BioVir Laboratories (an environmental testing laboratory)
- Characterization of Marine Viruses
- Coliphage Field Kit: Technical Final Report (lots of technical info on using coliphages as indicators of fecal contamination)
- Computer Experiments in Population Ecology (XGROW) Self-Study Exercises NEW
- The Curious Microbe: *Bdellovibrio*
- The Ecology of Computer Viruses
- Effects of Stress on Bacteriophage Replication NEW
- Evergreen International Phage Meeting (registration for 2000 meeting) NEW
- How the cholera bacterium got its virulence
- The Isolation of T-Even Phages
- The Microbe Zoo | Dirtland | House of Horrors [featuring the strangler fungus, *Vampirococcus* and *Bdellovibrio*]
- Molecular Bacterial Ecology Group
- Molecular ecology and evolution of *Streptococcus thermophilus* bacteriophages in industrial milk fermentations
- Particulate Biological Tracers (you will have to scroll down a ways to find this)
- PhageBiotics Foundation
- Phenotypic conversions as a result of pseudolysogeny
- Revenge of the Bug Zappers
- A Review of the ASCRC Starter Strategy
- Survival, Persistence, Transfer - An Update on Current Knowledge on GMOs and the Fate of their Recombinant DNA NEW
- Toward a Theory of Molecular Computing (includes Lambda-Phage Choice Between Lysis and Lysogeny Model)
- Transgenic Transgression of Species Integrity and Species Boundaries (a review)

Links to Phage-Ecology Abstracts

- **The Bacteriophage Ecology Group Bibliography**
- Aspects of the Ecological Role of Bacteriophages NEW
- Breakdown and Microbial Uptake of Marine Viruses and other lysis products
- Determination of Optimal Conditions for Bacteriophage Lysis of *Janthinobacterium lividum* Broth Cultures
- Distribution of cyanophages and total viruses along Georgia coatal [sic] rivers NEW
- Dynamic Interactions of Pseudomonas aeruginosa and Bacteriophages in Lake Water NEW
- The Effect of Microgravity on Inactivation of MS2 Bacteriophage by Chlorine
- The effect of phosphate status on virus populations during a mesocosm study
- Formation of submicron colloidal particles from marine bacteria by viral infection
- Genetic Diversity of Related Vibriophages Isolated from Marine Environments around Florida and Hawaii, USA
- Host Interactions and Growth Strategy of Aquatic Bacteriophages
- Investigations of the marine lysogenic bacterium H24. I. General description of the phage-host system NEW
- *Lactococcus garvieae* Phage
- Marine Bacteriophage Reproduction under Nutrient-Limited Growth of Host Bacteria. I. Investigations with Six Phage-Host Systems
- Marine Bacteriophage Reproduction under Nutrient-Limited Growth of Host Bacteria. II. Investigations with Phage-Host System [H3:H3/1] NEW
- Occurrence of Lysogenic Bacteria in Marine Microbial Communities as Determined by Prophage Induction NEW
- Prophage Induction of Indigenous Marine Lysogenic Bacteria by Environmental Pollutants NEW
- Reconsidering the Relationship Between Virally Induced Bacterial Mortality and Frequency of Infected Cells
- Significance of Lysogeny in the Marine Environment: Studies with Isolates and a Model of Lysogenic Phage Production NEW
- Sunlight-Induced DNA Damage and Resistance in Natural Viral Communities NEW
- Susceptibility of Bacteria in Estuarine Environments to Autochthonous Bdellovibrios NEW

Phage-Therapy Links

- **The Bacteriophage Ecology Group Phage Therapy References**
- An Alternative to Antibiotics?
- Bacteriophages: An alternative to antibiotics? NEW
- Challenge Grants: Joint Ventures in Biomedicine and Biotechnology (including phage therapy: "This challenge grants program seeks to support clinical research and trials to determine whether bacteriophage therapy is both efficacious and safe and whether development of resistance to the phage is a significant deterrent to its widespread adoption in hospital settings.")
- G. Eliava Institute of Bacteriophage (Tbilisi)
- Institute of Immunology and Experimental Therapy, Polish Academy of Sciences (Therapeutic Uses of Bacteriophages)
- Nature of Things - The Virus that Cures [10/29/98 CBC TV broadcast]
- Phage Companies
- Phage Therapy
- Phage Therapy
- Phages: Bacteria-Killing Viruses May Fight For Humankind Again
- Phage-Tech Interest Group
- Return of a Killer [11/2/98 *U.S. News and World Report* article on phage therapy]
- A Stalinist Antibiotic Alternative (New York Times Magazine article) (this article is now available only to New York Times subscribers) NEW
- Tbilisi Institute for Bacteriophage therapy
- Use of Phages in Treating Respiratory Illness

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New Features

In this section I will highlight new or updated features of the BEG site. If you have any ideas of how either the BEG site or *BEG News* might be improved, please let me know.

Links to Phage-Ecology Abstracts:

If you find a phage-ecology abstract out on the web, send it to me (well, its URL) and I'll pop it into this new section. Of course, all of these abstracts are already on line in the phage-ecology bibliography. Perhaps I have too much time on my hands?

Phage-Ecology Meta-Tag Links:

The Bacteriophage Ecology Group splash page (www.phage.org) possesses a number of meta tags/names that are employed by search engines to help classify the site. These words are listed below and each is now linked to Google.com as a defined search. If you can think of additional tags/terms/names/keywords that may be included in this list, please e-mail me with your suggestion(s).

acellular (acellular and phage), actinophage, actinophages, bacteria sex, bacterial sex, bacteriophage, bacteriophage ecology, bacteriophage evolution, bacteriophage immunity, bacteriophage resistance, bacteriophage therapy, bacteriophage typing, bacteriophages, bacteriophagology, bdellovibrio, *Bdellovibrio* ecology (*Bdellovibrio* and ecology), carrier state ("carrier state" and phage), conjugation (bacteria and conjugation), cryptic phage, cryptic prophage, cyanophage, cyanophages, ecology, environmental biology, environmental microbiology, evolution, evolutionary biology, fecal pollution, indicator (fecal and indicator and phage), generalized transduction, generalized transducing phages (generalized transducing phage), halophage, halovirus, heteroimmune phages, homoimmune phages, horizontal transfer, legionella, lysis (lysis and phage), lysogen, lysogenic, lysogeny, lysis (lysis and phage), marine viruses, microbial population biology, microbiology, mycovirus, mycoviruses, parasitism (parasitism and phage), phage, phage ecology, phage evolution, phage genetics, phage immunity, phage therapy, phage typing, phages, phagology, phycovirus, phycoviruses, population biology ("population biology" and phage), predation (predation and phage), predator (predator and phage), prey (prey and phage), prophage, prophage derepression, prophage induction, phage as transposons, pseudolysogeny, recombination (recombination and phage), specialized transducing phages,

symbiosis (symbiosis and phage), transduction ("transduction in the wild"), vampirococcus, virioplankton, viral disinfection, virology, virus, virus ecology, virus evolution, viruses.

Phage Books:

Hans Ackermann has been helping me compile a list of books that have bacteriophages as an important theme. Below is the list as it current stands. If you know of any others, please e-mail me with their titles, etc.

1. *The Bacteriophage: Its Role in Immunity* (English translation, 1922)
2. *Bacteriophage Phenomena* (1923)
3. *Arrowsmith* (1926)
4. *The Bacteriophage and its Behavior* (English translation, 1926)
5. *The Bacteriophage and its Clinical Application* (English translation, 1930)
6. *Bacteriophage in the Treatment and Prevention of Cholera* (1932)
7. *The Bacteriophage: A Historical and Critical Survey of 25 Years Research* (1946)
8. *Le Bacteriophage: Sa Nature et son Emploi Thérapeutique* (1946)
9. *Phage-Typing of Shigella sonnei* (1946)
10. *Le Bactériophage: Premier Colloque International* (1953)
11. *Les bactéries lysogènes et la notion de provirus* (1954)
12. *Bakteriophagie, 1917 bis 1956 (a bacteriophage bibliography)* (1957)
13. *Biophysik der Bakteriophagen* (1959)
14. *Bacteriophages* (1959)
15. *Papers on Bacterial Viruses* (1960)
16. *Bakteriophagen, Objekte der Modernen Genetik* (1962)
17. *Molecular Biology of Bacterial Viruses* (1963)
18. *Stochastic Models For Bacteriophage* (1965)
19. *Bacteriophages* (1966)
20. *Phage and the Origins of Molecular Biology*, Expanded Edition (first edition, 1966; expanded second edition, 1992)
21. *Bakteriophagie 1957-1965 (Bacteriophagy 1957-1965)* (1967)
22. *The Genetics of Bacteria and their Viruses: Studies in Basic Genetics and Molecular Biology* (1964, 1968, 1970)
23. *Ultrastruction of Bacterial Viruses* (1970)
24. *Bacteriophage Biochemistry* (1971)
25. *Bacterial Genetics and Temperate Phage* (1971)
26. *The Bacteriophage Lambda* (1971)
27. *Genetics Experiments with Bacterial Viruses* (1971)
28. *Virulent Phage* (1971)
29. *Morphogenesis of T-Even Bacteriophages* (1973)
30. *Ultrastructure of Animal Viruses and Bacteriophages. An Atlas.* (1973)
31. *Morphology and Ultrastructure of Shigella and Klebsiella bacteriophages* (1974)
32. *Phage* (1974)
33. *Bacteriophages* (1975)
34. *RNA Phages* (1975)
35. *Bacterial, Phage and Molecular Genetics. An Experimental Course* (1976)
36. *Regulation and Genetics: Bacterial DNA Viruses* (1976)
37. *Reproduction: Bacterial DNA Viruses* (1976)
38. *The Single-Stranded DNA Phages* (1978)
39. *Phage-Typing of Coagulase-Negative Staphylococci* (1979)
40. *Bacteriophage Assembly* (1980)
41. *Transfektsiia Nukleinovymi Kislotami Bakteriofagov* (1980)
42. *Bacteriophages as Indicators of Human Enteric Viruses in Activated Sludge Waterwater Treatment* (1983)
43. *Bacteriophage T4* (1983)
44. *Lambda II* (1983)
45. *A Slot Machine, a Broken Test Tube : An Autobiography* (1984)
46. *Viral Control of Nuisance Cyanobacteria (Blue-Green Algae). II. Cyanophage Strains, Stability on Phages and Hosts, and Effects of Environmental Factors on Phage-Host Interactions* (1985)
47. *Viruses of Prokaryotes* (volumes I & 2, 1987)
48. *Phage Ecology* (1987)
49. *Phage Mu* (1987)
50. *The Bacteriophages* (volumes I & 2, 1988)
51. *The Molecular Biology of Bacterial Virus Systems* (1988)
52. *Thinking About Science: Max Delbrück and the Origins of Molecular Biology* (1988)
53. *Bacteriophages from China. An Electron Microscopical Atlas* (1991)
54. *Practical Phage Control* (1991)
55. *Bakterienviren* (1992)
56. *A Genetic Switch : Phage and Higher Organisms* (second edition, 1992)
57. *Bacterial and Bacteriophage Genetics* (1994)
58. *Molecular Biology of Bacteriophage T4* (1994)
59. *Darwin's Radio* (1999)
60. *Felix D'Herelle and the Origins of Molecular Biology* (1999)

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Upcoming Meetings

The BEG Meetings link will continue, but reminders about upcoming meetings will be placed in this section of *BEG News*. If you know of any meetings that might be of interest to BEG members, please send this information for posting to abedon.1@osu.edu or to "BEG Meetings," *Bacteriophage Ecology Group News*, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906.

Evergreen International Phage Meeting:

This year's meeting runs from June 7 to June 11 on the campus of McGill University (Montreal, Quebec, Canada). The meeting will cover all aspects of phage biology, from basic mechanisms and molecular biology to phage ecology and phage therapy. This is our default general phage ecology meeting. Be there or be square!

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Jobs

The BEG Employment / Job Listings page will no longer be maintained. Instead, any job listings will be found in this section of *BEG News*. If you are looking to*fill* a bacteriophage-ecology related position or are in *search of* a bacteriophage-ecology related position, please feel free to advertise as s uch here (there will be no charge, of course). Legitimate information only, please, and *BEG News* cannot be held responsible for any incorrect information supplied by posters. Send any information for posting to abedon.1@osu.edu or to "BEG Jobs," *Bacteriophage Ecology Group News*, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906.

POSITION ANNOUNCEMENT: POSTING DATE: 1-31-2000; AVAILABILITY: IMMEDIATE Post-doctoral position in *Salmonella* and enterohemorragic *E.coli* (EHEC) phage ecology and phage therapy: Position available to investigate the natural history, field ecology and diagnostic and/or therapeutic potential of bacteriophages specific for *Salmonella typhimurium* and EHEC O157, O111, and O26 in the livestock production environment. Will involve both lab and field based research. Ideal candidate will be a PhD microbiologist with experience in isolating and characterizing bacteriophages from the field. Previous work experience with Salmonella and EHEC is not necessary. Two year position with annual extensions possible. Annual salary of approx. $38,000 + benefits. Starting date: negotiable, but prefer between prior to Sept 2000. Interested candidates should contact Jim Keen, Animal Health Research Unit, USMARC, Clay Center, NE 68933; Ph: 402-762-4343 Email: keen@email.marc.usda.gov for additional information

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Submissions

Submissions are non-editorial items describing or highlighting some aspect of bacteriophage ecology including news pieces, historical pieces, reviews, and write- ups of research. Peer review of submissions is possible and a desire for peer review should be indicated. Send all submissions to abedon.1@osu.edu or to "Submissions", Bacteriophage Ecology Group News, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906. Please send all submissions as Microsoft Word documents, if possible (I'll let you know if I have trouble converting any other doc ument formats), and in English.

Some Quotations

"The phage group wasn't much of a group. I mean, it was a group only in the sense that we all communicated with each other. And that the spirit was- open. This was copied straight from Copenhagen, and the circle around Bohr, so far as I was concerned. In fact, the first principle had to be openness. That you tell each other what you are doing and thinking. And that you don't care who has the priority." -Max Delbrück, quoted on p. 42 of Horace Freeland Judson's *The Eight Day of Creation*, Cold Spring Harbor Laboratory Press (1996)

"We are not primarily interested in the destruction of the *bacteria*, intent on applying what we find to the therapy of infectious diseases caused by *bacteria*. Nor are we interested, primarily, in devising means to frustrate the growth of the *viruses*, intent on applying such knowledge ot the therapy of infectious diseases in plants, animals and men caused by *viruses*. Such motives, noble though they are, are ulterior to our cause." -Max Delbrück, 1946, The Harvey Lectures, p. 163.

"Today, a bacterial virus is a parasitic microbe in ecology, a bacterial organelle during its existence as prophage, a marker on the bacterial chromosome in breeding experiments with lysogenic bacteria, a subgamete for which names are lacking when it transmits lysogeny, a vector of unrelated bacterial organelles, including other prophages, in transduction experiments, and the inciter of an explosive disease of nucleic acid metabolism when it mimics T2. Bacteriophages are all these things, and probably more to be discovered. To ask which is the correct view is to ask what is the proper function of a window: to admit light, to let in air, to keep out wind, to exclude rain, to frame a pleasing landscape, or to pique the peeping Tom." -Alfred Day Hershey, 1957, Bacteriophage T2: parasite or organelle?, *The Harvey Lecture, Series LI*, 1955-1956, Academic Press, pp. 229-239 (quote is on page 238).

"Our inability to find phenotypes for so many mutants (of the newly completed *Caenorhabditis elegans* sequence) only reflects our ignorance of life. The advocates of 'modern' molecular biology, many of whom are trained in the art of cloning genes, will need to go back to their friends and colleagues versed in physiology, neurobiology, ecology and population biology; these disciplines will be critical in teasing apart the function of all of those genes. 'Functional genomics' is synonymous with 'biology'-biology against rich tableaux of sequence information. Who does not remember the seminars in which the speaker professed an interest in some biological phenomenon, and then nose-dived into a 40-minute description of gene mapping, cloning and sequencing? With the completion of the genome projects, one senses that these days will soon be over: back to biology." -Ronald H. A. Plasterk, 1999, Hershey heaven and *Caenorhabditis elegans*, *Nature Genetics* 21:63-64 (quote is the last paragraph of the article).

Submission Archive

- On an Invisible Microbe Antagonistic to the Dysentery Bacillus by Felix d'Herelle

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Letters

Letters should consist of comments, short statements, or personal editorials. Send all letters to abedon.1@osu.edu or to "Letters", Bacteriophage Ecology Group News, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansf ield, Ohio 44906. Please send all letters in English and all mailed or attached letters as Microsoft Word documents, if possible (I'll let you know if I have trouble converting any other document formats). In addition, to standard letters, BEG receives questions on a regular basis that may be addressed by BEG members. These qu estions are listed below. Anybody interested in answering these questions through *BEG News*, e-mail me at the following address: abedon.1@osu.edu. Alternatively, answer through the prompt following each question. Please note that these questions have n ot been edited for grammar, spelling, or clarity.

D'Herelle was not a Stalinist

To the editor of the *New York Times Magazine*,

I am a virologist specializing in bacteriophage taxonomy and electron microscopy and I have founded the "Felix d'Herelle Reference Center for Bacterial Viruses". I attended a bacteriophage meeting in Tbilisi in 1998 and visited the Eliava Institute. I am also an advisor of the Eliava Foundation and I know several of the people mentioned in your article.

First, I enjoyed very much Mr. Osborne's paper. His description of the dire conditions in the Eliava Institute is only too accurate.

What I do not agree with, is d'Herelle's description as an admirer of Stalin. D'Herelle went to Russia in 1933 when this country was actively importing foreign scientists and know-how, on invitation of G. Eliava, his coworker and friend from his time at the Pasteur Institute in Paris. Eliava had founded a bacteriophage institute in Tbilisi. One of d'Herelle's books, "Bacteriophage in the Phenomenon of Recovery", was translated into Russian (Tbilisi, 1935). The introduction, which I have read myself, contains nothing more that the mandatory praise of "socialism". I have seen much worse. The book was dedicated to Stalin, but this appears, in the words of d'Herelle's biographer, as a precondition to publication.

There is an excellent and recent biography of d'Herelle (William C. Summers, "Felix d'Herelle and th Origins of Molecular Biology", Yale University Press, 1999). D'Herelle comes across as extraordinarily neutral and without strongly held views. At most one can say that he was a left-leaning liberal and a materialist. This is a far cry from the ardent Stalinist in your article.

Hans-W. Ackermann, MD, Professor
Department of Medical Biology
Faculty of Medicine
Laval University
Quebec, P.Q., Canada G1K 7P4

Questions

No entry.

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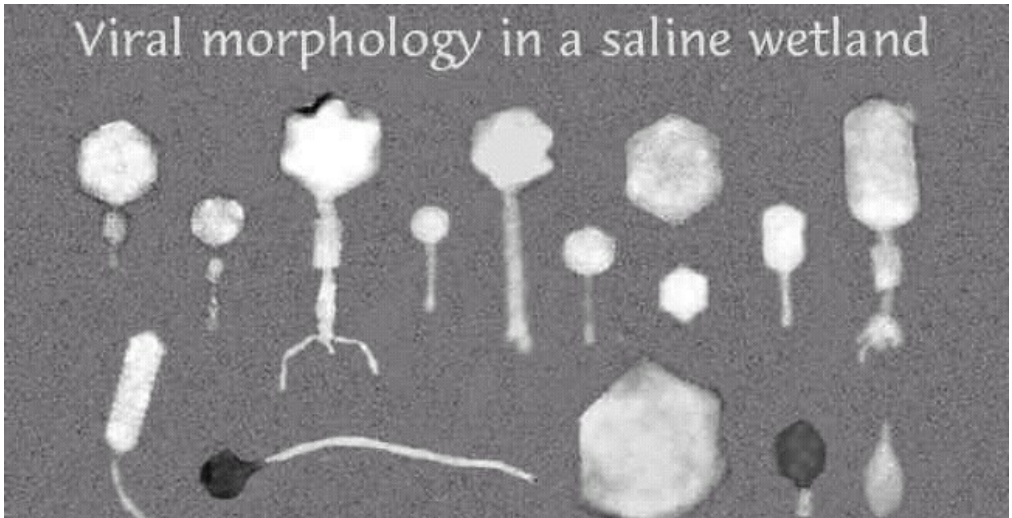
Phage Images

Please send any phage images that you would like to present in this section to "Phage Images," *The Bacteriophage Ecology Group*, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906. Alternatively, you may scan the images yourself and send them as an attachment to abedon.1@osu.edu. Please save all scans in gif or jpg formats and preferably with an image size (in terms of width, height, and kbytes) that will readily fit on a standard web page.



Phage Image Archive

- The Face of the Phage
- Bacteriophage T2 by H.-W. Ackermann
- SSV1-Type Phage
- Saline Lake Bacteriophage - David Bird

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New Publications

New bacteriophage publications are listed below. Each quarter not-yet-listed publications from the previous two years will be presented along with their abstracts. The indicator "???" denotes, of course, that specific information is not yet in the BEG Bibliography. Please help in the compilation of the BEG Bibliography by supplying any updated information, correcting any mistakes, and, of course, sending the references to your bacteriophage ecology publications, as well as the references to any bacteriophage ecology publications that you know of but which are not yet in the bibliography (send to abedon.1@osu.edu or to "BEG Bibliography," *Bacteriophage Ecology Group News*, care of Stephen T. Abedon, Department of Microbiology, The Ohio State University, 1680 University Dr., Mansfield, Ohio 44906). Also, be sure to indicate any listed publications that you feel should not be presented in the BEG Bibliography. This list is also present with available abstracts at the end of *BEG News*.

1. Longitudinal study on the susceptibility to bacteriophages of *Staphylococcus aureus* strains isolated from dairy farms in Trinidad. Adesiyun, A. A., Romain, H. T. (1999). *Zentralblatt Fur Veterinarmedizin - Reihe B* 46:567-581. [PRESS FOR ABSTRACT]

2. *In situ* population dynamics of bacterial viruses in a terrestrial environment. Ashelford, K. E., Day, M. J., Bailey, M. J., Lilley, A. K., Fry, J. C. (1999). *Applied and Environmental Microbiology* 65:169-174. [PRESS FOR ABSTRACT]

3. Characterization of six bacteriophages of *Serratia liquefaciens* CP6 isolated from the sugar beet phytosphere. Ashelford, K. E., Fry, J. C., Bailey, M. J., Jeffries, A. R., Day, M. J. (1999). *Applied and Environmental Microbiology* 65:1959-1965. [PRESS FOR ABSTRACT]

4. Reconsidering the relationship between virally induced bacterial mortality and frequency of infected cells. Binder, B. (1999). *Aquatic Microbial Ecology* 18:207-215. [PRESS FOR ABSTRACT]

5. Rezervoary, interakcie a stabilita genov rezistencie na antibiotika. Syndrom "easy to get--hard to lose". [Reservoirs, interactions and stability of genetic resistance to antibiotics. The "easy to get--hard to lose" syndrome]. Blahova, J., Kralikova, K., Krcmery, V. (1999). *CASOPIS LEKARU CESKYCH* 138:424-428. [PRESS FOR ABSTRACT]

6. Phage therapy: past history and future prospects. Carlton, R. M. (1999). *Archivum Immunologiae et Therapiae Experimentalis* 47:267-274. [PRESS FOR ABSTRACT]

7. Evolutionary Reversals During Viral Adaptation to Alternating Hosts. Crill, W. D., Wichman, H. A., Bull, J. J. (2000). *Genetics* 154:27-37. [PRESS FOR ABSTRACT]

8. Molecular evidence for a new bacteriophage of *Borrelia burgdorferi*. Eggers, C. H., Samuels, D. S. (1999). *Journal of Bacteriology* 181:7308-7313. [PRESS FOR ABSTRACT]

9. Bacteriophage-like particles associated with the gene transfer agent of *Methanococcus voltae* PS. Eiserling, F., Pushkin, A., Gingery, M., Bertani, G. (1999). *Journal of General Virology* 80:3305-3308. [PRESS FOR ABSTRACT]

10. Characterization of a lytic virus infectious to the bloom-forming microalga *Aureococcus anophagefferens* (Pelagophyceae). Garry, R. T., Hearing, P., Cosper, E. M. (1998). *Journal of Phycology* 34:616-621. [PRESS FOR ABSTRACT]

11. Bacteriophages of dairy propionibacteria. Gautier, M., Rouault, A., Herve, C., Sommer, P., eret, V., Jan, G., Fraslin, J. M., Prevot, F., Coste, A. (1999). *Lait*-79:93-104. [PRESS FOR ABSTRACT]

12. Viral lysis and bacterivory during a phytoplankton bloom in a coastal water microcosm. Guixa-Boixareu, N., Lysnes, K., Pedros-Alio, C. (1999). *Applied and Environmental Microbiology* 65:1949-1958. [PRESS FOR ABSTRACT]

13. Preparation of phage-insensitive strains of *Tetragenococcus halophila* and its application for soy sauce fermentation. Higuchi, T., Uchida, K., Abe, K. (1999). *Bioscience, Biotechnology, and Biochemistry* 63:415-417. [PRESS FOR ABSTRACT]

14. Bacterial and viral abundances in hydrothermal event plumes over northern Gorda Ridge. Juniper, S. K., Bird, D. F., Summit, M., Pong Vong, M., Baker, E. T (1998). *Deep-Sea Research* 45:2739-2749. [PRESS FOR ABSTRACT]

15. Characterization of wild lambdoid bacteriophages: detection of a wide distribution of phage immunity groups and identification of a nus-dependent, nonlambdoid phage group. Kameyama, L., Fernandez, L., Calderon, J., Ortiz-Rojas, A., Patterson, T. A. (1999). *Virology* 263:100-111. [PRESS FOR ABSTRACT]

16. Genetic selection of phage engineered for receptor-mediated gene transfer to mammalian cells. Kassner, P. D., Burg, M. A., Baird, A., Larocca, D. (1999). *Biochemical & Biophysical Research Communications* 264:921-928. [PRESS FOR ABSTRACT]

17. Viruses in Antarctic lakes. Kepner, R. L., Wharton, R. A. Jr., Suttle, C. A. (1998). *Limnology and Oceanography* 43:1754-1761. [PRESS FOR ABSTRACT]

18. Bacteriophages: An altertnative to antibiotics? Lorch, A. (1999). *Biotechnology and Development Monitor* 39:14-17. [PRESS FOR ABSTRACT]

19. Establishment of bacteriophages in an immobilized cells system used for continuous inoculation of lactococci. Macedo, M. G., Champagne, C. P., Vuillemard, J. C., Lacroix, C. (1999). *International Dairy Journal* 9:437-445. [PRESS FOR ABSTRACT]

20. Applications of phage resistance in lactic acid bacteria. Moineau, S. (1999). *Antonie van Leeuwenhoek* 76:377-382. [no abstract]

21. Comparative survival of free shiga toxin 2-encoding phages and Escherichia coli strains outside the gut. Muniesa, M., Lucena, F., Jofre, J. (1999). *Applied and Environmental Microbiology* 65:5615-5618. [PRESS FOR ABSTRACT]

22. A whole-glove method for the evaluation of surgical gloves as barriers to viruses. Nelson, J. R., Roming, T. A., Bennet, J. K. (1999). *American Journal of Contact Dermatitis* 10:183-189. [PRESS FOR ABSTRACT]

23. Genetic variation of chlorella viruses: Variable regions localized on the CVK2 genomic DNA. Nishida, K., Kimura, Y., Kawasaki, T., Fujie, M., Yamada, T. (1999). *Virology* 255:376-384. [no abstract]

24. Breakdown and microbial uptake of marine viruses and other lysis products. Noble, R. T., Fuhrman, J. A. (1999). *Aquatic Microbial Ecology* 20:1-11. [PRESS FOR ABSTRACT]

25. A Stalinist Antibiotic Alternative. Osborne, L. (2000). *New York Times Magazine* ???-??? [PRESS FOR ABSTRACT]

26. Effect of biocides commonly used in the hospital environment on the transfer of antibiotic-resistance genes in *Staphylococcus aureus*. Pearce, H., Messager, S., Maillard, J. Y. (1999). *Journal of Hospital Infection* 43:101-107. [PRESS FOR ABSTRACT]

27. Performance of *Lactobacillus helveticus* spontaneous phage-resistant mutants in hard cheese production. Quiberoni, A., Reinheimer, J., Suarez, J. E. (1998). *International Dairy Journal* 8:941-949. [PRESS FOR ABSTRACT]

28. Bacterial lysis by phage--a theoretical model. Rabinovitch, A., Zaritsky, A., Fishov, I., Einav, M., Hadas, H. (1999). *Journal of Theorectical Biology* 201:209-213. [PRESS FOR ABSTRACT]

29. Coliphages and indicator bacteria in Boston Harbor, Massachusetts. Ricca, D. M., Cooney, J. J. (1999). *Environmental Toxicology* 14:404-408. [PRESS FOR ABSTRACT]

30. Development of phage resistant starter strains. Ross, R. P. (1999).5. [PRESS FOR ABSTRACT]

31. Transduction of enteric *Escherichia coli* isolates with a derivative of Shiga toxin 2-encoding bacteriophage _3538 isolated from *Escherichia coli* O157:H7. Schmidt, H., Bielaszewska, M., Karch, H. (1999). *Applied and Environmental Microbiology* 65:3855-3861. [PRESS FOR ABSTRACT]

32. Transduction of multiple drug resistance of *Salmonella enterica* serovar typhimurium DT104. Schmieger, H., Schicklmaier, P. (1999). *FEMS Microbiology Ecology* 170:251-256. [PRESS FOR ABSTRACT]

33. Isolation of phages and phage typing of *Bacillus cereus*. Smimizu, M., Inoue, M., Miyazawa, W., Itoh, T. (1998). *Japanese Journal of Food Microbiology* 15:147-152. [PRESS FOR ABSTRACT]

34. Skuteczne zastosowanie bakteriofagoterapii w ropnym zapaleniu opon mozgowo-rdzeniowych u noworodka. [Successful treatment with bacteriophage in purulent cerebrospinal meningitis in a newborn]. Stroj, L., Weber-Dabrowska, B., Partyka, K., Mulczyk, M., Wojcik, M. (1999). *Neurologia I Neuochirurgia Polska* 33:693-698. [PRESS FOR ABSTRACT]

35. Giant viruses infecting algae. Van Etten, J, Meints, R. H. (1999). *Annual Review of Microbiology* 53:447-494. [PRESS FOR ABSTRACT]

36. Algal viruses (*Phycodnaviridae*). Van Etten, J (1999). pp. 44-50 in Webster, R. G., Granoff, A. (eds.) *Encyclopedia of Virology*. Academic Press, London. [no abstract]

37. Phycodnaviridae. Van Etten, J. L. (1999). pp. 183-193 *Virus Taxonomy - Seventh Report*. [no abstract]

38. Surface layer variations affecting phage adsorption on seven *Lactobacillus helveticus* strains. Ventura, M., Callegari, M. L., Morelli, L. (1999). *Annali di Microbiologia ed Enzimologia* 49:45-53. [PRESS FOR ABSTRACT]

39. DNA virus contribution to host evolution. Villarreal, L. P. (1999). pp. 391-420 *Origin and Evolution of Viruses*. Academic Press, London. [no abstract]

40. Isogenic lysogens of diverse shiga toxin 2-encoding bacteriophages produce markedly different amounts of shiga toxin. Wagner, P. L., Acheson, D. W., Waldor, M. K. (1999). *Infection and Immunity* 67:6710-6714. [PRESS FOR ABSTRACT]

41. Size-specific mortality of lake bacterioplankton by natural virus communities. Weinbauer, M. G., Hoefle, M. G. (1998). *Aquatic Microbial Ecology* 15:103-113. [PRESS FOR ABSTRACT]

42. Lysogeny and prophage induction in coastal and offshore bacterial communities. Weinbauer, M. G., Suttle, C. A. (1999). *Aquatic Microbial Ecology* 18:217-225. [PRESS FOR ABSTRACT]

43. Sunlight-induced DNA damage and resistance in natural viral communities. Weinbauer, M. G., Wilhelm, S. W., Suttle, C. A., Pledger, R. J., Mitchell, D. L. (1999). *Aquatic Microbial Ecology* 17:111-120. [PRESS FOR ABSTRACT]

44. The panda and the phage: compensatory mutations and the persistence of small populations. Whitlock, M., Otto, S. P. (1999). *Trends in Ecology and*

Evolution 14:293-294. [no abstract]

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New Publications with Abstracts

For your convenience, a list of new publications without associated abstracts (but with links to abstracts) is found above. The list presented below is identical to the above list except that abstracts are included.

1. **Longitudinal study on the susceptibility to bacteriophages of *Staphylococcus aureus* strains isolated from dairy farms in Trinidad. Adesiyun, A. A., Romain, H. T. (1999). *Zentralblatt Fur Veterinarmedizin - Reihe B* 46:567-581.** A 6-month longitudinal study was conducted on 30 dairy cows in early lactation and their human handlers on six farms across Trinidad. Weekly samples of bulk milk, composite milk and anterior nares and hand swabs from human handlers were collected and cultured for Staphylococcus aureus on Baird-Parker agar (BPA). The susceptibility of *S. aureus* strains to bacteriophages and the relatedness of strains isolated over the study period were determined. Sixty-three (51.2%) of 123 strains of *S. aureus* from bulk milk were typable compared with 111 (57.3%) of 194 and 82 (61.7%) of 133 strains isolated from composite milk and human handlers, respectively. The differences were not statistically significant (P > 0.05; chi 2). Bovine phage 42D lysed 3.3% (4 of 123), 16.5% (32 of 194) and 12.0% (16 of 133) of S. aureus strains isolated from bulk milk, composite milk and human handlers, respectively. The differences were statistically significant (P < 0.001; chi 2). Amongst bulk milk isolates of S. aureus, 35 (31.8%) of 110 exhibited relatedness in 11 groups based on their phage patterns and groups. The mean maximum interval between the first and last detection of related *S. aureus* strains in a group was 11.5 +/- 7.3 weeks. Amongst composite milk strains of *S. aureus*, 23 (46.0%) of 50, 25 (62.5%) of 40 and 22 (53.7%) of 41 exhibited relatedness on farms IB 2, IB 27 and IC 23, respectively, but the differences were not statistically significant (P > 0.05; chi 2). On farm IB 2, five groups of related strains of *S. aureus* were detected with a mean maximum interval of detection of 18.2 +/- 8.5 weeks compared to farm IB 27 where five groups of related strains were also observed but with an interval of 13.8 +/- 8.2 weeks. On farm IC 23, a total of seven groups of related S. aureus strains were detected with a mean interval of 8.0 +/- 5.5 weeks. For human strains of *S. aureus* from farm IB 2, nine (56.3%) of 16 strains isolated from anterior nares exhibited relatedness in three groups with a mean maximum interval of 13.3 +/- 4.7 weeks compared to four (25.0%) of 16 hand swab isolates which exhibited relatedness in two groups with mean interval of detection of 11.0 +/- 1.4 weeks. The differences were not statistically significant (P > 0.05; chi 2). On farm IB 27, for anterior nares isolates, eight (72.7%) of 11 exhibited relatedness in two groups with a mean maximum interval of detection of 20.5 +/- 2.1 weeks compared to hand swab isolates, with six (50.0%) of 12 showing relatedness in two groups and a mean interval of 10.5 +/- 2.1 weeks. It was concluded that dairy cows and their human handlers carried particular strains of *S. aureus* at various sites for extended periods, which served as continuous sources of contamination of milk and may play a significant role in the occurrence of subclinical mastitis, with an obvious economic impact.

2. ***In situ* population dynamics of bacterial viruses in a terrestrial environment. Ashelford, K. E., Day, M. J., Bailey, M. J., Lilley, A. K., Fry, J. C. (1999). *Applied and Environmental Microbiology* 65:169-174.** Predation by bacteriophages is thought to control bacterial numbers and facilitate gene transfer among bacteria in the biosphere. A thorough understanding of phage population dynamics is therefore necessary if their significance in natural environments is to be fully appreciated. Here we describe the in situ population dynamics of three separate phage populations predating on separate bacterial species, living on the surface of field-grown sugar beet (Beta vulgaris var. Amethyst), as recorded over a 9-month period. The distributions of the three phage populations were different and fluctuated temporally in 1996 (peak density, approximately 10(3) PFU g-1). One of these populations, predating on the indigenous phytosphere bacterium *Serratia liquefaciens* CP6, consisted of six genetically distinct DNA phages that varied in relative abundance to the extent that an apparent temporal succession was observed between the two most abundant phages, phi CP6-1 and phi CP6-4.

3. **Characterization of six bacteriophages of *Serratia liquefaciens* CP6 isolated from the sugar beet phytosphere. Ashelford, K. E., Fry, J. C., Bailey, M. J., Jeffries, A. R., Day, M. J. (1999). *Applied and Environmental Microbiology* 65:1959-1965.** Six phages (Phi CP6-1 to (Phi CP6-6) that are commonly found in the phytosphere of sugar beet (Beta vulgaris var. Amethyst) were investigated, and their relative impacts on their host (*Serratia liquefaciens* CP6) were compared. There were fundamental differences between the two most abundant predators of CP6 Phi CP6-1 and Phi CP6-4), Like Phi CP6-2 and Phi CP6-5, Phi CP6-1 belonged to the family Siphoviridae, while Phi CP6-4 exhibited the morphology of the family Podoviridae, The other phages were members of the family Myoviridae, DNA-DNA crosshybridization revealed that Phi CP6-1 and Phi CP6-4 had little common DNA, although all of the other phages exhibited some genetic similarity. Like Phi CP6-2, Phi CP6-3, and Phi CP6-5, Phi CP6-1 was capable of forming a lysogenic association with its host, while Phi CP6-4 and Phi CP6-6 appeared to be entirely virulent. Single-step growth curve experiments revealed that Phi CP6-4 had a much shorter latent period and a smaller burst size than Phi CPC-1. Also, Phi CP6-1 could transduce a number of host chromosomal markers with transfer frequencies of 2.9 x 10 (-9) to 3.9 x 10(-7), whereas Phi CP6-4 could not transduce *S. liquefaciens* CP6 genes. When viewed in the context of the strikingly different temporal niches of these phages, our data provide an insight into how bacteriophage interactions with their hosts might reflect the natural ecology of bacteriophages, Our data also illustrate how the potential for gene transfer changes over time in an environment that supports several different phages.

4. **Reconsidering the relationship between virally induced bacterial mortality and frequency of infected cells. Binder, B. (1999). *Aquatic Microbial Ecology* 18:207-215.** The relative contribution of viral lysis to overall mortality in aquatic bacterial populations is often estimated as twice the frequency of infected cells (FIC). The `factor-of-two rule' upon which this estimate is based assumes (1) steady-state conditions, (2) that latent period is equivalent to generation time, and (3) that infected cells are not grazed. FIC values for this calculation are themselves derived from measurements of the frequency of visibly infected cells (FVIC) by the use of a simple conversion factor. A steady-state model was developed to more rigorously define the relationships between FIC, FVIC, and the fraction of mortality from viral lysis (FMVL). This model shows that even under the restrictive assumptions listed above, the factor-of-two rule systematically overestimates FMVL for typically reported values of FVIC. The model also shows that although grazing on infected cells further reduces FMVL for a given estimate of FIC, at the same time such grazing increases FIC for a given measurement of FVIC. In combination, these 2 effects minimize the influence of grazing on the calculation of FMVL from FVIC. Overall, the relationship between FMVL and FVIC is well approximated as follows: FMVL epsilon FVIC/ [gamma ln(2) (1 - epsilon - FVIC)], where gamma = the ratio between the latent period and generation time, and \g?\ = the fraction of the latent period during which viral particles are not yet visible. Using typically observed values of FVIC, and assuming that gamma = 1 (per assumption 2, above) and \g?\ = 0.186 (per literature estimates), the model suggests that, on average, viral lysis accounts for approximately 22% (range: 4.5 to 45%) of total bacterial mortality in a range of aquatic environments, corresponding to a mean overestimate of 24% (range: 4 to 44%) by the factor-of-two rule. Perhaps most importantly, the model shows that calculations of FMVL from FIC or FVIC are very sensitive to changes in the relative length of the latent period (gamma) and in the assumed proportion of the latent period during which viral particles are not recognizable (epsilon). Constraining these 2 factors would greatly improve the reliability of FMVL calculations.

5. **Rezervoary, interakcie a stabilita genov rezistencie na antibiotika. Syndrom "easy to get--hard to lose". [Reservoirs, interactions and stability of genetic resistance to antibiotics. The "easy to get--hard to lose" syndrome]. Blahova, J., Kralikova, K., Krcmery, V. (1999). *CASOPIS LEKARU CESKYCH* 138:424-428.** Enthusiasm after discovery of antibiotics and their use in clinical practice led to presumption that problems of bacterial infections will be soon resolved and forgotten and attention will be turned to other serious problems, such as viral infections or neoplastic diseases. However, instead of disappearance of bacterial infections, bacterial pathogens become more resistant to many antibiotics. The ability of bacterial strains to acquire resistance genes

from other bacteria, even of different species, causes increasing stability of resistance of bacteria. Transferable elements--resistance genes--often interact and create changed structures; this enables to preserve, stabilize, or under special conditions, transfer resistance genes. Transferable elements include plasmids, transposons, integrins and gene cassettes. Conjugation of bacteria, transduction by bacteriophages and transformation are the mechanisms by which these elements are transferred. A very significant property of transferable, mobilizable and transposable genetic systems of resistance is their stability and ability to adapt to new hosts. They do not lose it in the absence of antibiotics. The generally pessimistic view on future antibacterial chemotherapy should be a challenge to prevent the existence and spread of resistant strains of bacteria. It is much simpler and more convenient than "quench the fire" later. Best scheme is to stop resistance before it starts.

6. **Phage therapy: past history and future prospects. Carlton, R. M. (1999). *Archivum Immunologiae et Therapiae Experimentalis* 47:267-274.** Bacterial viruses (bacteriophages, also called "phages") can be robust antibacterial agents in vitro. However, their use as therapeutic agents, during a number of trials from the 1920s to the 1950s, was greatly handicapped by a number of factors. In part, there were certain limitations inherent in phage physiology (e. g. narrow host range, and rapid clearance from the body); in part there were technological limitations in the era (e.g. lysogeny not yet discovered); but the greatest limitation was the highly inadequate scientific methodologies used by practitioners at the time (e.g., their failure to conduct placebo-controlled studies, to remove endotoxins from the preparations, and to re-confirm phage viability after adding sterilizing agents to the preparations). In recent years, well-controlled animal models have demonstrated that phages can rescue animals from a variety of fatal infections, while non-controlled clinical reports published in Eastern Europe have shown that phages can be effective in treating drug-resistant infections in humans. This encouraging data, combined with the fact that drug-resistant bacteria have become a global crisis, have created a window of opportunity for phage therapy to be tested anew, this time using modem technologies and placebo-controlled designs. If successful, it can be used as a stand-alone therapy when bacteria are fully resistant to antibiotics, and as a valuable adjunct to antibiotics when the bacteria are still susceptible.

7. **Evolutionary Reversals During Viral Adaptation to Alternating Hosts. Crill, W. D., Wichman, H. A., Bull, J. J. (2000). *Genetics* 154:27-37.** Experimental adaptation of the bacteriophage fX174 to a *Salmonella* host depressed its ability to grow on the traditional *Escherichia* host, whereas adaptation to *Escherichia* did not appreciably affect growth on *Salmonella*. Continued host switching consistently exhibited this pattern. Growth inhibition on *Escherichia* resulted from two to three substitutions in the major capsid gene. When these phages were forced to grow again on *Escherichia*, fitness recovery occurred predominantly by reversions at these same sites, rather than by second-site compensatory changes, the more frequently observed mechanism in most microbial systems. The affected residues lie on the virion surface and they alter attachment efficiency, yet they occur in a region distinct from a putative binding region previously identified from X-ray crystallography. These residues not only experienced high rates of evolution in our experiments, but also exhibited high levels of radical amino acid variation among X174 and its known relatives, consistent with a history of adaptation involving these sites.

8. **Molecular evidence for a new bacteriophage of *Borrelia burgdorferi*. Eggers, C. H., Samuels, D. S. (1999). *Journal of Bacteriology* 181:7308-7313.** We have recovered a DNase-protected, chloroform-resistant molecule of DNA from the cell-free supernatant of a *Borrelia burgdorferi* culture. The DNA is a 32-kb double-stranded linear molecule that is derived from the 32-kb circular plasmids (cp32s) of the *B. burgdorferi* genome. Electron microscopy of samples from which the 32-kb DNA molecule was purified revealed bacteriophage particles. The bacteriophage has a polyhedral head with a diameter of 55 nm and appears to have a simple 100-nm-long tail. The phage is produced constitutively at low levels from growing cultures of some *B. burgdorferi* strains and is inducible to higher levels with 10 microg of 1-methyl-3-nitroso-nitroguanidine (MNNG) ml(-1). In addition, the prophage can be induced with MNNG from some Borrelia isolates that do not naturally produce phage. We have isolated and partially characterized the phage associated with *B. burgdorferi* CA-11.2A. To our knowledge, this is the first molecular characterization of a bacteriophage of *B. burgdorferi*.

9. **Bacteriophage-like particles associated with the gene transfer agent of *Methanococcus voltae* PS. Eiserling, F., Pushkin, A., Gingery, M., Bertani, G. (1999). *Journal of General Virology* 80:3305-3308.** The methanogenic archaeobacterium *Methanococcus voltae* (strain PS) is known to produce a filterable, DNase-resistant agent (called VTA, for voltae transfer agent), which carries very small fragments (4400 bp) of bacterial DNA and is able to transduce bacterial genes between derivatives of the strain. Examination by electron microscopy of two preparations of VTA that were concentrated and partially purified by different methods showed virus-like particles with isometric heads, about 40 nm in diameter, and with 61 nm long tails. These particles co-sedimented with the minute bacteriophage fX174 in a sucrose density gradient.

10. **Characterization of a lytic virus infectious to the bloom-forming microalga *Aureococcus anophagefferens* (Pelagophyceae). Garry, R. T., Hearing, P., Cosper, E. M. (1998). *Journal of Phycology* 34:616-621.** *Aureococcus anophagefferens* Hargraves and Sieburth has caused recurring monospecific blooms in Long Island embayments since it was first described in 1985. It was termed the "brown tide," due to the resulting water color, and has had a devastating effect on Long Island's (New York) marine ecosystem. In 1992, a virus that was capable of causing lysis of A. anophagefferens was isolated and maintained in culture. We report on the further characterization of this virus, *Aureococcus anophagefferens* virus-1 (AaV-1), indicated by a buoyant density of 1.2776 g times mL super(-1) in a CsCl equilibrium gradient. Electron microscopy revealed a phage with a hexagonal head and tail similar to previously described phages. By using adenovirus for calibration, the virus was found to have a head 50-55 nm wide and a tail 70-75 nm long. The viral band was infectious to *A. anophagefferens* after dialysis. The virus was composed of at least 16 distinct polypeptides ranging in molecular weight from 20 to 230 kDa. The adsorption coefficient for the virus was 7.2 x 10 super(-9) mL times min super(-1), and the burst size was calculated to be 9.4 viruses per A. anophagefferens cell at 20 degree C. Complete lysis of *A. anophagefferens* occurred with a titer as low as 893 viruses times mL super(-1), and the lower limit of infectivity was 93 viruses times mL super(-1). The virus lost its infectivity between 30 degree and 40 degree C. These results suggest that AaV-1 is highly infectious and that the role of the virus in preventing or ending A. anophagefferens blooms needs further investigation.

11. **Bacteriophages of dairy propionibacteria. Gautier, M., Rouault, A., Herve, C., Sommer, P., eret, V., Jan, G., Fraslin, J. M., Prevot, F., Coste, A. (1999). *Lait*- 79:93-104.** Characteristics of 2 types of phages infecting propionic acid bacteria that were isolated from Swiss-type cheeses were examined. One type belonged to group B1 of Bradley's classification and the other was a filamentous phage, the 1st of its type identified in Gram positive bacteria. Diversity, host spectrum and origin of the phages were studied. The phages were detected in raw milk and cheeses, but not in curd or cooked curd. Group 1 phages showed high homology and were probably derived from a common ancestor. All phages showed a very narrow host spectrum. Information on phages infecting *Propionibacterium freudenreichii* was used in the development of a cloning system for this bacterium. [This paper was presented at the 2nd Symposium on Propionibacteria, which was held in Cork, Republic of Ireland on 25-27 June 1998.]

12. **Viral lysis and bacterivory during a phytoplankton bloom in a coastal water microcosm. Guixa-Boixareu, N., Lysnes, K., Pedros-Alio, C. (1999). *Applied and Environmental Microbiology* 65:1949-1958.** The relative importance of viral lysis and bacterivory as causes of bacterial mortality were estimated. A laboratory experiment was carried out to check the kind of control that viruses could exert over the bacterial assemblage in a non-steady-state situation. Virus-like particles (VLP) were determined by using three methods of counting (DAPI [4',6-diamidino-2-phenylindole] staining, YOPRO staining, and transmission electron microscopy). Virus counts increased from the beginning until the end of the experiment. However, different methods produced significantly different results. DAPI-stained VLP yielded the lowest numbers, while YOPRO-stained VLP yielded the highest numbers. Bacteria reached the maximal abundance at 122 h (3 x 10 super(7) bacteria ml super(-1)), after the peak of chlorophyll a (80 mu g liter super(-1)). Phototrophic nanoflagellates followed the same pattern as for chlorophyll a. Heterotrophic nanoflagellates showed oscillations in abundance throughout the experiment. The specific bacterial growth rate increased until 168 h (2.6 day super(-1)). The bacterivory rate reached the maximal value at 96 hours (0.9 day super(-1)). Bacterial mortality due to viral

infection was measured by using two approaches: measuring the percentage of visibly infected bacteria (%VIB) and measuring the viral decay rates (VDR), which were estimated with cyanide. The %VIB was always lower than 1% during the experiment. VDR were used to estimate viral production. Viral production increased 1 order of magnitude during the experiment (from 10 super(6) to 10 super(7) VLP ml super(-1) h super(-1)). The percentage of heterotrophic bacterial production consumed by bacterivores was higher than 60% during the first 4 days of the experiment; afterwards, this percentage was lower than 10%. The percentage of heterotrophic bacterial production lysed by viruses as assessed by the VDR reached the highest values at the beginning (100%) and at the end (50%) of the experiment. Comparing both sources of mortality at each stage of the bloom, bacterivory was found to be higher than viral lysis at days 2 and 4, and viral lysis was higher than bacterivory at days 7 and 9. A balance between bacterial losses and bacterial production was calculated for each sampling interval. At intervals of 0 to 2 and 2 to 4 days, viral lysis and bacterivory accounted for all the bacterial losses. At intervals of 4 to 7 and 7 to 9 days, bacterial losses were not balanced by the sources of mortality measured. At these time points, bacterial abundance was about 20 times higher than the expected value if viral lysis and bacterivory had been the only factors causing bacterial mortality. In conclusion, mortality caused by viruses can be more important than bacterivory under non-steady-state conditions.

13. **Preparation of phage-insensitive strains of *Tetragenococcus halophila* and its application for soy sauce fermentation. Higuchi, T., Uchida, K., Abe, K. (1999). *Bioscience, Biotechnology, and Biochemistry* 63:415-417.** Production of _D-10 phage-insensitive mutants of *Tetragenococcus halophila* D-10, used in industrial fermentation of soy sauce, is reported. Phage contact during selection initially resulted in lysogeny. Subsequently, phage-insensitive mutants were screened by replica plating so that mutant cells did not touch the phage during selection. 2 strains were selected from approx. 150 000. They grew normally in soy sauce mash (moromi) in the presence of phage _D-10, although had a similar extent of adsorption of _D-10, as did the parent strain. Industrial application of these strains in moromi fermentation is discussed.

14. **Bacterial and viral abundances in hydrothermal event plumes over northern Gorda Ridge. Juniper, S. K., Bird, D. F., Summit, M., Pong Vong, M., Baker, E. T (1998). *Deep-Sea Research* 45:2739-2749.** This study presents first-time observations of bacterial and viral abundances in hydrothermal event plumes. Two water-column event plumes were formed in conjunction with seismic events and seafloor volcanic eruptions on the northern Gorda Ridge in February--March 1996. Epifluorescence counts of bacteria and viruses were performed on water samples from 3 successive cruises staged in the 10--90 days that followed the onset of seismicity. Relative to background seawater at these 1800--3200 m depths, bacterial abundance was enhanced by 2-3 fold within both event plumes. In contrast, viral numbers were below background seawater values in the younger and more intense of the two event plumes (EP96A), and enhanced in the other (EP96B). Changes in viral abundance may be a secondary response to that of plume bacteria as well as being influenced by particle formation and precipitation within the plumes. Lower bacteria/heat, virus/heat and virus/bacteria ratios in EP96A versus EP96B confirm distinct differences in the microbial response to event plume formation, possibly related to observed differences in plume chemistry.

15. **Characterization of wild lambdoid bacteriophages: detection of a wide distribution of phage immunity groups and identification of a nus-dependent, nonlambdoid phage group. Kameyama, L., Fernandez, L., Calderon, J., Ortiz-Rojas, A., Patterson, T. A. (1999). *Virology* 263:100-111.** Temperate phages were isolated from fresh human fecal samples. Lambdoid phages were screened for growth on Nus+ but not Nus- bacteria. Approximately 100 independent lysogens of Nus-dependent phages were constructed and tested for immunity to superinfection by the same Nus-dependent phages. This identified 20 different phage immunity groups, 18 of which belonged to the lambdoid phage family. The DNA from the majority of these phages hybridized with a lambda DNA probe, and approximately 50% were recognized by anti-lambda antibodies. Furthermore most were inducible by UV light. Eleven phage recombinants with different immunity were obtained when a phage from each group was coinfected with lambda or its derivative lambdaBLK20. We also identified another immunity group with 48 members. None of these hybridized with either lambda or phi80 DNA probes nor were they recognized by anti-lambda serum. Most were not induced by UV light treatment, and no recombinants were obtained when crossed with either lambda or lambdaBLK20. Consequently, this group of Nus-dependent phages represent a new nonlambdoid phage family.

16. **Genetic selection of phage engineered for receptor-mediated gene transfer to mammalian cells. Kassner, P. D., Burg, M. A., Baird, A., Larocca, D. (1999). *Biochemical & Biophysical Research Communications* 264:921-928.** Although phage display is a powerful way of selecting ligands against purified target proteins, it is less effective for selecting functional ligands for complex targets like living cells. Accordingly, phage display has had limited utility in the development of targeting agents for gene therapy vectors. By adapting a filamentous bacteriophage for gene delivery to mammalian cells, however, we show here that it is possible to screen phage libraries for functional ligands capable of delivering DNA to cells. For example, when targeted with epidermal growth factor (EGF), M13 bacteriophage were capable of delivering a green fluorescent protein (GFP) gene to EGF receptor bearing cells in a ligand-, time-, and phage concentration-dependent manner. The EGF-targeted phage transduced COS-1 cells in a highly specific manner as demonstrated by competition with excess free EGF or alternatively with anti-EGF receptor antibodies. We further demonstrate that EGF-phage can be selected, by their ability to transduce EGF receptor bearing cells from libraries of peptide display phage. When phage were incubated with COS-1 cells, EGF ligand-encoding sequences were recovered by PCR from FACsorted, GFP-positive cells and the EGF-displaying phage were enriched 1 million-fold by four rounds of selection. These data suggest the feasibility of applying molecular evolution to phage gene delivery to select novel cell-specific DNA-targeting ligands. The same approach could be used to select genetically altered phage that are specifically designed and evolved as gene therapy vectors.

17. **Viruses in Antarctic lakes. Kepner, R. L., Wharton, R. A. Jr., Suttle, C. A. (1998). *Limnology and Oceanography* 43:1754-1761.** Water samples collected from four perennially ice-covered Antarctic lakes during the austral summer of 1996-1997 contained high densities of extracellular viruses. Many of these viruses were found to be morphologically similar to double-stranded DNA viruses that are known to infect algae and protozoa. These constitute the first observations of viruses in perennially ice-covered polar lakes. The abundance of planktonic viruses and data suggesting substantial production potential (relative to bacterial secondary and photosynthetic primary production) indicate that viral lysis may be a major factor in the regulation of microbial populations in these extreme environments. Furthermore, we suggest that Antarctic lakes may be a reservoir of previously undescribed viruses that possess novel biological and biochemical characteristics.

18. **Bacteriophages: An altertnative to antibiotics? Lorch, A. (1999). *Biotechnology and Development Monitor* 39:14-17.** Bacterial resistance to antibiotics has become a serious medical problem. Treatment with bacteriophages might pose an effective alternative that has long been known but has been ignored outside the former Soviet Union. The development of phage therapies exemplifies positive as well as negative implications for scientific development that is restricted in its access to the mainstream, English-language dominated scientific community.

19. **Establishment of bacteriophages in an immobilized cells system used for continuous inoculation of lactococci. Macedo, M. G., Champagne, C. P., Vuillemard, J. C., Lacroix, C. (1999). *International Dairy Journal* 9:437-445.** Effects of high dilution rates (10-30 h---1) on development of a low phage population inoculated in an immobilized cell technology continuous milk inoculation system were evaluated. Effects of medium on phage and bacterial kinetics of the bioreactor were also examined. Lactococcus lactis subsp. lactis CRA-1 and the appropriate bacteriophage _CRA-1 (homologue to L. lactis CRA-1) were used. Lactococci were immobilized in a 2-phase dispersion procedure, in 2.75% kappa-carrageenan/0/25% locust bean gum gel beads which were then used to continuously inoculate rehydrated low heat skim milk powder (9% solids); a synthetic medium (containing lactose, yeast extract, tryptone, MgSO4, KCl, CaCl2 and sodium citrate) was used for some fermentations at a dilution rate of 30 h---1. Acidifying activity tests were performed with fermented medium samples collected from the bioreactor. Even by reduction of phage contamination level from 10-5 to 10-2 pfu/ml and increasing dilution rate to 30 h---1, bacteriophages were not washed out and developed in the continuous immobilized bioreactor system with milk and synthetic media. High dilution rates effective against psychrotrophs and yeasts were not, therefore, effective against phages, so strategies are required to prevent problems associated with phage contamination. In

terms of use of immobilized cells for production of lactic starters, it may be that phage contamination could be controlled by use of phage-resistant media and/or conditions which prevent phage contamination. For continuous inoculation, it may be possible to immobilize phage-resistant or multiple phage-unrelated strains, to alleviate effects of contamination in pasteurized milk. Population dynamics of mixed cultures need to be examined.

20. **Applications of phage resistance in lactic acid bacteria. Moineau, S. (1999).** ***Antonie van Leeuwenhoek*** **76:377-382.**

21. **Comparative survival of free shiga toxin 2-encoding phages and Escherichia coli strains outside the gut. Muniesa, M., Lucena, F., Jofre, J. (1999).** ***Applied and Environmental Microbiology*** **65:5615-5618.** The behavior outside the gut of seeded Escherichia coli O157:H7, naturally occurring E. coli, somatic coliphages, bacteriophages infecting O157:H7, and Shiga toxin 2 (Stx2)-encoding bacteriophages was studied to determine whether the last persist in the environment more successfully than their host bacteria. The ratios between the numbers of E. coli and those of the different bacteriophages were clearly lower in river water than in sewage of the area, whereas the ratios between the numbers of the different phages were similar. In addition, the numbers of bacteria decreased between 2 and 3 log units in in situ survival experiments performed in river water, whereas the numbers of phages decreased between 1 and 2 log units. Chlorination and pasteurization treatments that reduced by approximately 4 log units the numbers of bacteria reduced by less than 1 log unit the numbers of bacteriophages. Thus, it can be concluded that Stx2-encoding phages persist longer than their host bacteria in the water environment and are more resistant than their host bacteria to chlorination and heat treatment.

22. **A whole-glove method for the evaluation of surgical gloves as barriers to viruses. Nelson, J. R., Roming, T. A., Bennet, J. K. (1999).** ***American Journal of Contact Dermatitis*** **10:183-189.** BACKGROUND: Today, because of the wide variety of infectious agents encountered in the health care environment, clinicians must be particularly concerned about the potential for small-sized virus penetration through glove defects. OBJECTIVE: To describe a method for testing gloves that evaluates the entire glove and allows for detection of low levels of virus penetration. Ten sets of 10 different gloves from 4 manufacturers were evaluated using this method. METHODS: Barrier properties were evaluated using the bacteriophage, phiX174. Gloves were filled with surfactant solution placed in flasks containing 10(6) viruses per mL. Flasks were agitated at 37 degrees C +/- 2 degrees C and assayed for 180 minutes. RESULTS: Virus penetration was detected in 8% of the 100 gloves tested using the quantitative assay. The qualitative assay determined that 14% of the gloves tested allowed penetration.

23. **Genetic variation of chlorella viruses: Variable regions localized on the CVK2 genomic DNA. Nishida, K., Kimura, Y., Kawasaki, T., Fujie, M., Yamada, T. (1999).** ***Virology*** **255:376-384.**

24. **Breakdown and microbial uptake of marine viruses and other lysis products. Noble, R. T., Fuhrman, J. A. (1999).** ***Aquatic Microbial Ecology*** **20:1-11.** To understand the roles of marine viruses in marine microbial food webs, it is important to determine rates and mechanisms of virus degradation and subsequent uptake of degraded virus material and other cell lysis products by heterotrophic marine bacteria. We radiolabeled and concentrated viruses and viral lysis products from either pure cultures (^{3}H) or natural communities (^{3}H and ^{33}P) and added them to seawater samples of differing trophic status from coastal (mesotrophic) and offshore (oligotrophic) California waters and French Mediterranean waters (oligotrophic). Rates of degradation were determined by the loss of high molecular weight radiolabel over time and the fate of the degraded material (microbial uptake or accumulation in low molecular weight pools) was followed by size fractionation and/or acid extraction. Preliminary experiments with ^{3}H-labeled, single-stranded RNA phage MS2 and marine phage H11/1 demonstrated that MS2 degraded significantly faster in coastal Santa Monica Bay seawater ($2.5 \pm 0.6\%\ h^{-1}$), than the marine phage, H11/1 ($0.99 \pm 0.1\%\ h^{-1}$). For labeled virus material from natural populations, rates of degradation were slower in oligotrophic waters (ranges from 1.0 to 3.3% h^{-1}) than in mesotrophic waters (ranges from 4.9 to 6.0% h^{-1}), corresponding to turnover rates of 1 to 4 d for this material. Degradation rates of labeled virus material are likely underestimates, because during preparation, degradation and uptake are continually occurring, resulting in accumulation of the less reactive products. The proportion of radiolabeled material taken up by microbes was greatest in oligotrophic waters, especially in the phosphate-limited Villefranche Bay, France, where most of the $^{33}PO_4$-labeled material was taken up in less than 7 h. In contrast, the majority of degraded ^{3}H-labeled material was not accumulated into biomass, and in 3 of 4 samples, accumulation was hardly detectable. The results suggest that viruses and lysis products are labile and turn over relatively rapidly, but often may not be efficiently incorporated into bacterial biomass.

25. **A Stalinist Antibiotic Alternative. Osborne, L. (2000).** ***New York Times Magazine*** **???-???** A hoary Soviet method for fighting infections may prove invaluable in an age of antibiotic resistance. Maybe that's why pharmaceutical companies are flocking to a remote laboratory in Tbilisi.

26. **Effect of biocides commonly used in the hospital environment on the transfer of antibiotic-resistance genes in** ***Staphylococcus aureus*****. Pearce, H., Messager, S., Maillard, J. Y. (1999).** ***Journal of Hospital Infection*** **43:101-107.** The effect of sub-minimal inhibitory concentrations of biocides, commonly used in the hospital environment, on the conjugation and transduction of plasmid pWG613 was investigated in three strains of *Staphylococcus aureus*. The highest transfer frequency was obtained in the conjugation experiments. A low concentration of povidone-iodine was found to significantly reduce transfer frequency by 10-fold in *S. aureus* SAU3/13136 mating, while other biocides had no effect at low concentrations. Cetrimide (0.0001%) was found to increase significantly transduction efficiency in S. aureus RF2 when the biocide was included in the recovery media. A low concentration of chlorhexidine or povidone-iodine reduced transduction efficiency in the same recipient. This study showed that reduction in transduction efficiency was caused by the direct effect of biocides on the recipient strains rather than on the phage 80 alpha particles.

27. **Performance of** ***Lactobacillus helveticus*** **spontaneous phage-resistant mutants in hard cheese production. Quiberoni, A., Reinheimer, J., Suarez, J. E. (1998).** ***International Dairy Journal*** **8:941-949.** From the strain *Lactobacillus helveticus* ATCC 15807, a total of 66 clones were isolated using the lytic phages hv and ATCC 15807-B1. Phenotypic parameters related to their phage resistance capacity (efficiency of plaquing, phage resistance stability, lysogeny and adsorption rates) were determined. The morphological, biochemical (sugar fermentation patterns) and technological (acidifying power, proteolytic activity and slime production) characteristics of the isolates were also studied. Phage resistance stability was a variable property among the isolates but a high level of resistance was exhibited as quantified by the efficiency of plaquing. Furthermore, a total absence of acquired lysogeny was demonstrated. The phage-resistant variants were completely or partially unable to bind phages and did not show differences with *Lb. helveticus* ATCC 15807 in their biochemical characteristics. However, the technological properties (acidifying powers and proteolytic activities) were heterogeneously distributed among the mutants. The variant RB1-28 (isolated under selective pressure of the phage ATCC 15807-B1) was evaluated for the technological performance in Sardo cheese production in comparison with Lb. helveticus ATCC 15807. There were no significant differences between the two types of cheeses, taking in consideration physicochemical parameters (proteolysis level, dry matter, total and soluble proteins, moisture), microbiological counts or sensory analysis. These phage-resistant variants could be employed in starter strain rotation programs for cheesemaking.

28. **Bacterial lysis by phage--a theoretical model. Rabinovitch, A., Zaritsky, A., Fishov, I., Einav, M., Hadas, H. (1999).** ***Journal of Theorectical Biology*** **201:209-213.** The similarity to materials corrosion is invoked to develop a model for phage-infected bacterial lysis based on the statistics of extremes. The importance of cell size, envelope thickness and lysozyme eclipse time on the final probability distribution of lysis is considered. Experiments are suggested to test the model.

29. **Coliphages and indicator bacteria in Boston Harbor, Massachusetts. Ricca, D. M., Cooney, J. J. (1999). *Environmental Toxicology* 14:404-408.** Surface water was tested for two bacterial and two coliphage indicators of fecal pollution at four sites in Boston Harbor, MA over 1 year. Of 108 samples tested, somatic coliphages, fecal coliforms, enterococci, and F-specific phages were present in 107, 105, 73, and 58 water samples, respectively. The means of all samples, per 100 mL, were 195.6 pfu (range: 0-1833) for somatic coliphages, 101.3 cfu (0-2670) for fecal coliforms, 20.0 pfu (0-261) for F-specific phages, and 3.1 cfu (0-32) for enterococci. Somatic coliphages and fecal coliforms were more prevalent indicators of fecal pollution than enterococci and F-specific phages. No indicator correlated well with any of the others. No statistically significant difference in phage numbers was found between samples taken in summer and winter. No correlation was found between salinity and any indicator. There was no increase in counts of any indicator due to localized input from two marinas.

30. **Development of phage resistant starter strains. Ross, R. P. (1999).5.** Bacteriophage infection of starter cultures causes significant losses in the manufacture of cheese and other fermented dairy products. In this study, a number of bacteriophage resistant strains were developed using molecular genetic techniques. 3 new natural plasmid (DNA)-associated bacteriophage resistance systems were identified. The detailed genetic make-up of the phage resistance plasmid (pMRC01) was elucidated. Bacteriophages currently evolving in the industrial cheesemaking environment were monitored to facilitate the choice of phage resistance systems for use in commercial starter cultures which can more effectively target the problematic phage types. 2 highly virulent phages targeting important cheese starters were identified in the industrial cheesemaking environment. A reliable food-grade method to facilitate transfer of phage resistance systems to cheesemaking starter strains was developed, based on bacteriocin immunity-linked phage resistance. Phage resistant cheese starter cultures were developed through natural selection and by molecular manipulation using phage genetic resistance plasmids. The phage resistance plasmid pMRC01 was introduced into 31 cheese starter strains. All phage resistant starter strains resulting from the strain improvement research were evaluated under stringent laboratory conditions. Selected strains were then evaluated in pilot-scale Cheddar cheese trials and were subsequently validated in commercial cheese plants.

31. **Transduction of enteric *Escherichia coli* isolates with a derivative of Shiga toxin 2-encoding bacteriophage _3538 isolated from *Escherichia coli* O157:H7. Schmidt, H., Bielaszewska, M., Karch, H. (1999). *Applied and Environmental Microbiology* 65:3855-3861.** [Shiga toxin (Stx)-producing *Escherichia coli* (STEC) strains have emerged as serious foodborne pathogens.] In this study, the ability of a detoxified derivative of a Stx2-encoding bacteriophage to infect and lysogenize enteric *E. coli* strains and to develop infectious progeny from these lysogenized strains was investigated. The stx2 gene of *E. coli* O157:H7 strain 3538/95 (a human isolate) was replaced by the chloramphenicol acetyltransferase (cat) gene from plasmid pACYC184. Phage _3538 (Deltastx2::cat) was isolated after induction of *E. coli* O157:H7 strain 3538/95 with mitomycin. A variety of strains of enteropathogenic *E. coli* (EPEC), enteroinvasive *E. coli* (EIEC), STEC, enterotoxigenic *E. coli* (ETEC), enteroaggregative *E. coli* (EAEC) and *E. coli* from stool microflora of healthy individuals were infected with _3538(Deltastx2::cat) and plaque formation and lysogenic conversion of wild-type *E. coli* strains were investigated. With the exception of 1 EIEC strain, none of the *E. coli* strains supported formation of plaques when used as indicators for _3538(Deltastx2::cat). However, 2 of 11 EPEC, 11 of 25 STEC, 2 of 7 EAEC, 1 of 3 EIEC and 1 of 6 *E. coli* isolates from stool microflora integrated phage [DNA] in their chromosomes and expressed resistance to chloramphenicol. Following induction with mitomycin, these lysogenic strains released infectious particles of _3538(Deltastx2::cat) that formed plaques on a lawn of *E. coli* laboratory strain C600. Results demonstrate that _3538(Deltastx2::cat) was able to infect and lysogenize particular enteric strains of pathogenic and nonpathogenic *E. coli* and that the lysogens produced infectious phage progeny. [It is concluded that] Stx-encoding bacteriophages are able to spread stx genes among enteric *E. coli* strains.

32. **Transduction of multiple drug resistance of *Salmonella enterica* serovar typhimurium DT104. Schmieger, H., Schicklmaier, P. (1999). *FEMS Microbiology Ecology* 170:251-256.** *Salmonella enterica* serovar typhimurium, definite type (DT)104, has emerged as a new epidemic strain since 1990 and is characterized by multiple drug resistance of various combinations. In order to understand how resistance genes have spread, the possibility of transferring the resistance genes of DT104 strains to various recipients was examined. Transduction occured with the generalized transducing phage ES18 and with phage PDT104 (this phage resides as a prophage in all of the DT104 strains analysed so far). This implies that all DT104 strains carry in their genome a potent vehicle for horizontal transfer and spread of resistance genes. Resistance genes were found to be tightly clustered in the DT104 chromosome.

33. **Isolation of phages and phage typing of *Bacillus cereus*. Smimizu, M., Inoue, M., Miyazawa, W., Itoh, T. (1998). *Japanese Journal of Food Microbiology* 15:147-152.** A set of phages for typing *Bacillus cereus* was developed. 96 phages were isolated from 85 soil samples using *B. cereus* (of 36 H-serovars) as indicator strains. 11 phages were selected based on their stability and host range, and could be classified into 5 groups. 5 phages (_a, _b, _c, _d and _e) were used as a typing phage set. At routine test dilution (RTD) and 100 x RTD, 36 B. cereus strains were typed into 17 phage patterns (83.3% typeable) and 11 phage patterns (100% typeable), 25 isolates from powdered fish meal samples were typed into 9 phage patterns (48% typeable) and 9 phage patterns (100% typeable), and 100 isolates from soil samples were typed into 24 phage patterns (79% typeable) and 14 phage patterns (100% typeable), respectively. [From En summ.]

34. **Skuteczne zastosowanie bakteriofagoterapii w ropnym zapaleniu opon mozgowo-rdzeniowych u noworodka. [Successful treatment with bacteriophage in purulent cerebrospinal meningitis in a newborn]. Stroj, L., Weber-Dabrowska, B., Partyka, K., Mulczyk, M., Wojcik, M. (1999). *Neurologia I Neuochirurgia Polska* 33:693-698.** The subject of this report is the case of purulent meningitis in new-born caused by *Klebsiella pneumoniae* . As the intensive antibiotic therapy turned out to be ineffective phage therapy was applied. Oral administration of specific phage preparate for the period of 5 weeks resulted in complete sterilization of cerebrospinal fluid and unquestionable improvement of child's health. However, after several ventriculopunctures some complications appeared (haemorrhage into central nervous system, extra infection). They were treated in standard way. Because of increasing internal hydrocephalus and necessity of operation, the child was sent to suitable hospital for further treatment.

35. **Giant viruses infecting algae. Van Etten, J, Meints, R. H. (1999). *Annual Review of Microbiology* 53:447-494.** *Paramecium bursaria* chlorella virus (PBCV-1) is the prototype of a family of large, icosohedral, plaque-forming, double-stranded-DNA-containing viruses that replicate in certain unicellular, eukaryotic chlorella-like green algae. DNA sequence analysis of its 330,742-bp genome leads to the predicition that this phycodnavirus has 376 protein encoding genes and 10 transfer RNA genes. The predicited gene products of ~40% of these genes resemble proteins of known function. the chlorella viruses have other features that distinguish them from most viruses, in addition to thier large genome size. These feature include: *(a)* The viruses encode multiple DNAmethyltransferases and DNA site-specific endonucleases; *(b)* PBCV-1 encodes at least part, if not the entire machinery to glycosylate its proteins; *(c)* PBCV-1 has a tleast two types of introns-a self-splicing intron in a transcription factor-like gene and a splicesomal processed type of intron in its DNA polymerase gene. Unlike the chlorella viruses, large double-stranded-DNA-containing viruses that infect marine, filamentous brown algae have a circular genome and a lysogenic phase in their life cycle.

36. **Algal viruses (*Phycodnaviridae*). Van Etten, J (1999). pp. 44-50 in Webster, R. G., Granoff, A. (eds.) *Encyclopedia of Virology*. Academic Press, London.**

37. **Phycodnaviridae. Van Etten, J. L. (1999). pp. 183-193 *Virus Taxonomy - Seventh Report.***

38. **Surface layer variations affecting phage adsorption on seven *Lactobacillus helveticus* strains. Ventura, M., Callegari, M. L., Morelli, L. (1999). *Annali di Microbiologia ed Enzimologia* 49:45-53.** Previous studies have demonstrated that *Lactobacillus helveticus* CNRZ 892 is covered by a protein of the S-layer type. The gene coding for this protein was isolated and sequenced. The central region of S-layer protein of this strain was shown to play a role of

receptor for the virulent phage CNRZ 832-B1. Data are presented on S-layer encoding genes isolated from 7 *L. helveticus* strains showing differing sensitivity to the CNRZ 832-B1 phage. Sequence analysis of genes isolated from the phage sensitive strains ATCC 12046, ATCC 15009 and CNRZ 303 showed, in the central part, an identical nucleotide sequence with that obtained from CNRZ 892. In S-layer gene sequences of phage resistant strains, unable to adsorb the phage CNRZ 832-B1 (CNRZ 35, I160, HLMI and M696), point mutations were localized in the same region as the CNRZ 892 isogenic mutants. Data suggest that a change in _1 amino acid in this area seems to affect phage adsorption. [From En summ.]
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39. **DNA virus contribution to host evolution. Villarreal, L. P. (1999). pp. 391-420 *Origin and Evolution of Viruses*. Academic Press, London.**

40. **Isogenic lysogens of diverse shiga toxin 2-encoding bacteriophages produce markedly different amounts of shiga toxin. Wagner, P. L., Acheson, D. W., Waldor, M. K. (1999). *Infection and Immunity* 67:6710-6714.** We produced isogenic *Escherichia coli* K-12 lysogens of seven different Shiga toxin 2 (Stx2)-encoding bacteriophages derived from clinical Shiga toxin-producing E. coli (STEC) isolates of serotypes O157:H7, O145, O111, and O83 to assess the variability among these phages and determine if there were phage-related differences in toxin production. Phage genomic restriction fragment length polymorphisms (RFLP) and superinfection resistance studies revealed significant differences among these phages and allowed the seven phages to be placed into five distinct groups. Experiments revealed striking differences in spontaneous phage and toxin production that were correlated with the groupings derived from the RFLP and resistance studies. These results suggest that the genotype of the Stx2 prophage can influence the level of phage release and toxin expression by host strains and thus may be relevant to STEC pathogenesis

41. **Size-specific mortality of lake bacterioplankton by natural virus communities. Weinbauer, M. G., Hoefle, M. G. (1998). *Aquatic Microbial Ecology* 15:103-113.** The potential effect that viral lysis has on the cell size distribution of bacterioplankton was investigated during late summer stratification in Lake Plusssee, Germany. Size-specific bacterial mortality due to viral lysis was estimated from in situ samples by a transmission electron microscopy based examination of visibly infected cells (VIC) and in an experiment with varying concentrations of the natural virus community. In all depth layers the highest percentage of cells was found in a cell length class that was smaller for the entire bacterial community (0.3-0.6 mu m) than for VIC (0.6-0.9 mu m). For cells <2.4 mu m the highest frequency of VIC (FVIC) was detected in the size classes 0.6-0.9 and 0.9-1.2 mu m, and the FVIC was high in the size classes 1.2-1.5 (all depth layers) and 1.5-1.8 mu m (meta- and hypolimnion). The estimated mortality due to viral lysis in these size classes was significant with maxima of 29 to 55% in the epilimnion, 30 to 59% in the metalimnion and 56 to 107% in the hypolimnion. In all depth layers the FVIC of bacteria <0.3 mu m in length was ca 30% of that averaged for the entire bacterial community, and in the experiment the percentage of cells <0.3 mu m was highest in enclosures with high viral activity.

42. **Lysogeny and prophage induction in coastal and offshore bacterial communities. Weinbauer, M. G., Suttle, C. A. (1999). *Aquatic Microbial Ecology* 18:217-225.** The influence of solar radiation and hydrogen peroxide on induction of lysogens, and the resulting effect on bacteriophage production and bacterial mortality was investigated for coastal and oceanic marine bacterial communities at 6 stations in the western Gulf of Mexico. The percentage of lysogenic cells induced by mitomycin C was also determined. Solar radiation and hydrogen peroxide were not as effective as mitomycin C at inducing phage production. The burst size of cells induced by mitomycin C was estimated by transmission electron microscopy, assuming that cells completely filled with viral particles were on the verge of bursting. The smallest estimates of burst size were associated with oligotrophic oceanic stations and ranged from 15 to 28 viruses produced per lytic event, while in more productive coastal waters the estimated burst sizes ranged from 33 to 64. The mitomycin C-induced phage production and burst size were used to estimate the number of lysogenic bacterial cells. On average, the percentage of inducible lysogens was higher at offshore (1.5 to 11.4%) than at coastal (0.8 to 2.2%) stations. However, with the exception of 1 station, less than 5% of the bacteria could be induced to produce phage, suggesting that lysogens only occasionally comprised a significant component of these bacterial communities. The proportion of lysogens that could be induced by sunlight, relative to those that could be induced by mitomycin C, was lower at oceanic than coastal stations. This implies that prophages in optically transparent offshore waters were more resistant to induction by solar radiation, or that most lysogens that could be triggered by sunlight were already induced. Based on a steady-state model, induction of lysogenic bacteria by solar radiation or hydrogen peroxide could result in between 0 and 3.5% or 0.9 and 3.4% of the total bacterial mortality, respectively. Our results imply that solar radiation and hydrogen peroxide induced lysogenic phage production were not an important source of phage production or bacterial mortality in offshore or coastal waters of the western Gulf of Mexico.

43. **Sunlight-induced DNA damage and resistance in natural viral communities. Weinbauer, M. G., Wilhelm, S. W., Suttle, C. A., Pledger, R. J., Mitchell, D. L. (1999). *Aquatic Microbial Ecology* 17:111-120.** Using a highly specific radioimmunoassay, the sunlight-induced formation of cyclobutane pyrimidine dimers (CPDs) and pyrimidine (6-4) pyrimidone photoproducts ([6-4] PPs) in viral DNA was investigated for natural virus communities in offshore and coastal waters of the western Gulf of Mexico as well as for clonal viral isolates. Concentrations of (6-4) PPs were consistently lower than CPD concentrations, and ranged from 1.5 to 17.0% of total measured photodamage. The accumulation of photoproducts varied among the natural viral community, the marine *Vibrio* phage PWH3a-P1 and the *Synechococcus* sp. DC2 (WH7803) cyanophage SYN-M3, which were deployed *in situ* from dawn until dark. Natural viral communities were more resistant to DNA damage than the cyanophage isolate SYN-M3, which was more resistant to damage than bacteriophage PWH3a-P1. Moreover, depth profiles revealed that photodamage in viral isolates deployed in the water column accumulated more rapidly at offshore stations than at coastal stations. In natural virus communities collected from offshore surface waters, photodamage accumulated during the solar day with maximum damage occurring between 15:00 and 18:00 h. Depth profiles obtained during calm seas showed that photodamage concentrations were high in surface waters at the offshore stations and at 1 coastal station. Results at other coastal stations undergoing significant mixing demonstrated no photoproduct accumulations. Results demonstrate that natural virus communities were more tolerant to DNA damaging radiation than the laboratory isolates used in this study. Consequently, laboratory isolates can be poor proxies for UV impacts on natural viral communities.

44. **The panda and the phage: compensatory mutations and the persistence of small populations. Whitlock, M., Otto, S. P. (1999). *Trends in Ecology and Evolution* 14:293-294.**

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Contact Steve Abedon (microdude+@osu.edu) with suggestions, criticisms, comments, or anything else that might help make this a better site.