

**Serveur Académique Lausannois SERVAL [serval.unil.ch](http://serval.unil.ch)**

## **Author Manuscript**

**Faculty of Biology and Medicine Publication**

**This paper has been peer-reviewed but does not include the final publisher proof-corrections or journal pagination.**

Published in final edited form as:

**Title:** In Chlamydia veritas.

**Authors:** Bavoil P, Kaltenboeck B, Greub G

**Journal:** Pathogens and disease

**Year:** 2013 Mar

**Volume:** 67

**Issue:** 2

**Pages:** 89-90

**DOI:** 10.1111/2049-632X.12026

In the absence of a copyright statement, users should assume that standard copyright protection applies, unless the article contains an explicit statement to the contrary. In case of doubt, contact the journal publisher to verify the copyright status of an article.

## In *Chlamydia* veritas

Patrik Bavoil<sup>1</sup>, Bernard Kaltenboeck<sup>2</sup>, Gilbert Greub\*<sup>3</sup>

<sup>1</sup>Department of Microbial Pathogenesis, University of Maryland, Baltimore, MD, USA; <sup>2</sup>

Department of Pathobiology, Auburn University, Auburn, AL, USA; <sup>3</sup>Institute of  
Microbiology, Centre Hospitalier Universitaire Vaudois and University of Lausanne,

Lausanne, Switzerland

\*Corresponding author:

Gilbert Greub, MD PhD

Center for Research on Intracellular Bacteria (CRIB),

Institute of Microbiology,

University of Lausanne

Lausanne, Switzerland

Phone: (00) 41 21 314 49 79

Fax: (00) 41 21 314 40 60

e-mail: [gilbert.greub@chuv.ch](mailto:gilbert.greub@chuv.ch)

**Word count:** 874

**Keywords:** *Chlamydia*, taxonomy, genus, species

To the Editor:

Microbial taxonomy is an essential tool used to classify strains into different clades, i.e. taxonomic units. While such a classification system is essential for both researchers and clinicians, it is often dismissed, or worse mutilated beyond recognition by the very people who should value it most. Indeed, despite the obvious importance of taxonomy, it is often considered by clinical and basic researchers as a useless arbitrary tool without much scientific basis, and to some it is just a painful reminder of years fruitlessly spent learning Latin in high school. Taxonomy is a necessary evil to all who ever use it, but many scientists simply botch it out of pure laziness. Yet the science we do is only as good as the words we use to report it, and at the very core of the myriad of scientific words microbiologists use lay taxonomic denomination and its derivatives.

Take *Chlamydia* as an example!

*Chlamydia*, known as a sexually transmitted pathogen by some and as an ocular pathogen by others, is actually a pathogen, first described in antiquity (1), that causes widespread infections in humans and animals. *Chlamydia* provides a rich taxonomic history since its first scientific description in 1945 when it was then known as *Miyagawanella* (2). Fast forward to 1957, and the taxonomic powers of the time decided on one family, the *Chlamydiaceae*, including two species, *Chlamydia psittaci* encompassing all veterinary chlamydial infections, and *Chlamydia trachomatis* encompassing ocular and genital infections of humans (3). This would not last as new molecular typing methods started to reveal the diversity of the *Chlamydiaceae*, and in 1999 Everett *et al* proposed a new chlamydial taxonomy based on two genera, *Chlamydia* and *Chlamydophila*, and nine species (4). What followed is best described as the era of the “Taxon Wars” (refer to [chlamydiae.com](http://chlamydiae.com)) where fleets of Chlamydia-philos and Chlamydophiles took over the *Chlamydia* universe. The former group however vastly exceeded the latter and the recommended use of *Chlamydophila* was poorly adhered to. At the root of the taxonomic dysfunction was a relatively minor distortion of the taxonomic rules set out in the Everett *et al* paper that were not applied to the letter in the proposed classification (5). Others felt that as a tool, taxonomy should be practical to its users (7) and that a new genus was simply unnecessary. More significantly however, the Everett *et al* paper sparked a healthy scientific discussion among Chlamydia-philos and Chlamydophiles alike about the unique evolutionary path of *Chlamydia* (and *Chlamydophila*). Indeed, as described

by Stephens *et al*, these obligate intracellular pathogens have evolved on a slow time scale relative to their free-living cousins owing to the sequestration and evolutionary constancy of their own environment, the cytosolic vacuole better known as the chlamydial inclusion (6). The Everett classification however provided a very needed practical classification at the species level that is now well respected across all *Chlamydia* research disciplines. We refer the reader to the latest rendition of Bergeys' manual (8), the taxonomic 'bible' for a detailed description of the current taxonomy of *Chlamydia* and *Chlamydia*-like organisms, whereby a single genus, *Chlamydia*, is now used, as well as nine species (*trachomatis*, *muridarum*, *suis*, *pneumoniae*, *pecorum*, *abortus*, *felis* and *caviae*), as originally proposed by Everett et al.

We conclude this letter by providing a lexicon of commonly used *Chlamydia* terms.

'*Chlamydia*' (italics, always cap C) is the genus (*Chlamydomphila* requiescat in pace), and is most appropriate when referring to *Chlamydia* in general terms.

'chlamydia' or 'chlamydiae' (plural) (no italics, lower case, cap C only at the start of a sentence) are the latinized common descriptors, and should be used equivalent to 'bacterium' or 'bacteria'. As a rule, if you can easily replace chlamydia/chlamydiae with bacterium/bacteria in a sentence, then that is the way it should be written.

'chlamydial' (no italics, lower case, cap C only at the start of a sentence) is the adjective, and should be used equivalent to 'bacterial'. If you can replace chlamydial with bacterial in a sentence, then you are good.

Then there are the taxonomic groups:

'*Chlamydiae*' (always cap C, italics) strictly speaking is the Phylum, hence should be used when referring globally to the *Chlamydiaceae*, *Parachlamydiaceae* and all other so-called *Chlamydia*-like organisms not cataloged or discovered yet.

Below the Phylum, there is the Class '*Chlamydiia*' (not a typo, 2 i's!!!) which no one ever uses because it only includes one Order, the *Chlamydiales*, so why bother!

Next, '*Chlamydiales*' is the Order and should be used when referring to more than one Family-level lineage, for instance the *Chlamydiaceae* and *Parachlamydiaceae*.

The Families are the '*Chlamydiaceae*', '*Parachlamydiaceae*', '*Waddliaceae*' and '*Simkaniaceae*'. All four families are primed for expansion at the species level for the *Chlamydiaceae*, and at the genus and species levels for the *Parachlamydiaceae*, *Waddliaceae* and *Simkaniaceae*, reflecting their greater diversity.

In all matters that matter, including taxonomy, there exists a grey area: Many will use *Chlamydiae* to refer to all taxonomic groups that are below the Phylum level and since there is currently only one Class, and one Order within the Class, the *Chlamydiales*, in essence *Chlamydiae* is synonymous to *Chlamydiales*. However, if you do not want to confuse readers in about 1 million years from now, when a new Class named *Chlamydiia* will surely have emerged, then you should use *Chlamydiales* when referring to the *Chlamydiaceae*, *Parachlamydiaceae*, *Waddliaceae* and *Simkaniaceae*.

### **Acknowledgments**

We thank Drs. Garry Myers, Gunna Christiansen, Roger Rank, Priscilla Wyrick, Ted Hackstadt, Peter Timms, Konrad Sachse, Gerry Byrne, Lee-Ann Campbell, Deborah Dean, Matthias Horn, Robert Brunham, Richard Stephens for their support and helpful comments.

## References

- (1) Trompoukis C, Kourkoutas D. Trachoma in the late greek antiquity and the eraly Byzantine periods. *Can J Ophtalm* 2007; **42** (6): 870-874.
- (2) Jones H., Rake G. and Stearns B. Studies on lymphogranuloma venereum. III. The action of the sulfonamides on the agent of lymphogranuloma venereum. *Journal of Infectious Diseases*, 1945, 76, 55-69.
- (3) Rake, G.W. "Family II. Chlamydiaceae Rake, Fam. Nov." In: R.S. Breed, E.G.D. Murray, and N.R. Smith (eds.), *Bergey's Manual of Determinative Bacteriology*, seventh edition, The Williams & Wilkins Co, Baltimore (1957). p. 957.
- (4) Everett K.D.E., Bush R.M. and Aandersen A.A. Emended description of the order *Chlamydiales*, proposal of *Parachlamydiaceae* fam. nov. and *Simkaniaceae* fam. nov., each containing one monotypic genus, revised taxonomy of the family *Chlamydiaceae*, including a new genus and five new species, and standards for the identification of organisms. *Int. J. Syst. Bacteriol.*, 1999, **49**, 415-440.
- (5) Schachter, J., Stephens, R.S., Timms, P., Kuo, C., Bavoil, P.M., Birkelund, S., Boman, J., Caldwell, H., Campbell, L.A., Chernesky, M., Christiansen, G., Clarke, I.N., Gaydos, C., Grayston, J.T., Hackstadt, T., Hsia, R., Kaltenboeck, B., Leinonnen, M., Ocjius, D., McClarty, G., Orfila, J., Peeling, R., Puolakkainen, M., Quinn, T.C., Rank, R.G., Raulston, J., Ridgeway, G.L., Saikku, P., Stamm, W.E., Taylor-Robinson, D., Wang, S.P., and Wyrick, P.B. "Radical changes to chlamydial taxonomy are not necessary just yet." *Int. J. Syst. Evol. Microbiol.* 2001, **51**:249
- (6) Stephens RS, Myers G, Eppinger M, Bavoil PM. Divergence without difference: phylogenetics and taxonomy of *Chlamydia* resolved. *FEMS Immunol Med Microbiol.* 2009; **55**(2):115-9.
- (7) Greub G. International Committee on Systematics of Prokaryotes. Subcommittee on the taxonomy of the Chlamydiae: minutes of the inaugural closed meeting, 21 March 2009, Little Rock, AR, USA. *Int J Syst Evol Microbiol.* 2010; **60**:2691-3.
- (8) Kuo C.C., Stephens R. "Family I. Chlamydiaceae" In: Krieg NR, Staley JT, Brown D.R, Hedlund B.P., Paster B.J., Ward, N.L., Ludwig W., Whitman W.B. (eds.), *Bergey's Manual of Systematic Bacteriology*, second edition, Springer, New York (2011). p. 845.